OPD EXP SYSTEM

EN

# MINIOPD EXP - OPD EXP
# USER'S MANUAL - ASYNCHRONOUS



TDE MACNO

Tecnologie Digitali Elettroniche S.p.A.

Excellence in the Control

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# 1 INTRODUCTION

To help the customer during the configuration of the drive, the manual is organized to follow faithfully the structure of the configurator (OPDExplorer) that allows, according to a logical sequence, to set all the sizes needed for the proper functioning of the drive.

In particular, each chapter refers to a specific folder of OPDExplorer which includes all the relative parameters.

Also, at the beginning of each chapter of the manual, is showed the location of the folder in the OPDExplorer tree, which the chapter refer, and the complete table of sizes of the folder in question. The control values are divided as follows:

- Parameters
- Connections
- Input logic functions
- Internal values
- Output logic functions

In the tables of the control value, the last column on the right "Scale" 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 and represent the factor which to divide the value stored to obtain the real value set, as following indicated:

$$\text{Value} = \frac{\text{Internal representation}}{\text{Scale}}$$

Examples:
MAIN_SUPPLY → P87 – Main supply voltage
Value = 400
Scale = 10
Int. rep. = 4000

## 1.1 PARAMETERS (P)

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** (<u>black text</u> in OPDExplorer): may be changed without having to open any key, even when running;

**Reserved parameters** (<u>blu text</u> in OPDExplorer): 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** (<u>violet text</u> in OPDExplorer): 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.

Take careful note of the reference values for each parameter so that they are set correctly.

## 1.2 CONNECTIONS (C)

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

## 1.3 INPUT LOGIC FUNCTIONS (I)

The input logic functions are 32 commands that come from configured terminal board logic inputs, from the serial line, and from the fieldbus. The meaning of this logical functions depend on the application, so please refer to specific documentation.

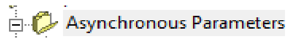
## 1.4 INTERNAL VALUES (D)

Internal values are 128 variables within the drive that can be shown on the display or via serial on the supervisor. They are also available from the fieldbus.
The first 64 values are referred to motor control part and are always present. The second 64 values are application specific.
Pay close attention to the internal representation base of these values as it is important if readings are made via serial line or fieldbus.

## 1.5 OUTPUT LOGIC FUNCTIONS (O)

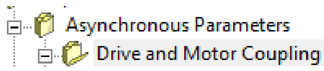
The logic functions are 64, the first 32 display drive status and second 32 are application specific.
All output functions can be assigned to one of the 4 logic outputs.

# 2 ASYNCHRONOUS PARAMETERS



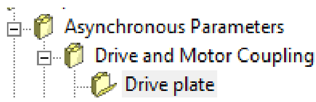

The “Asyncrhonous Parameters” are used to control the current or speed of a feedback vector induction motor. The speed and current reference values are generated by the application. See the application parameters for further information. As an absolute position value is not required for the sensors (managed 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.
The “Asyncrhonous Parameters” 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.

## 2.1 DRIVE AND MOTOR COUPLING




This section is usefull during motor start-up to obtain the best coupling between drive and motor. It’s very important to follow the correct sequence explained in the next paragraphs

### 2.1.1 DRIVE PLATE




| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| MAIN_SUPPLY | P87 - Main Supply voltage | 180.0 | 780.0 | 400 | V rms | 10 |
| DRV_I_NOM | P53 - Rated drive current | 0.0 | 3000.0 | 0 | A | 10 |
| DRV_I_PEAK | P113 - Maximum drive current | 0.0 | 3000.0 | 0 | A | 10 |
| I_OVR_LOAD_SEL | C56 - Current overload | 0 | 3 | 3 | | 1 |
| PRC_DRV_I_MAX | P103 - Drive limit current | 0.0 | 800.0 | 200 | % DRV_I_NOM | 40.96 |
| DRV_F_PWM | P101 - PWM frequency | 1000 | 16000 | 5000 | Hz | 1 |
| DRV_F_PWM_CARATT | P156 - PWM frequency for drive definition | 1000 | 16000 | 5000 | Hz | 1 |
| DRV_E_CARATT | P167 - Characterization voltage | 200.0 | 690.0 | 400 | V rms | 10 |
| DEAD_TIME | P157 - Dead time duration | 0.0 | 20.0 | 4 | µs | 10 |
| T_RAD | P104 - Radiator time constant | 10.0 | 360.0 | 80 | s | 10 |
| T_JUNC | P116 - Junction time constant | 0.1 | 10.0 | 3.5 | s | 10 |
| OVR_LOAD_T_ENV | P155 - Ambient temperature reference value during overload | 0.0 | 150.0 | 40 | °C | 10 |

This parameters are related to the drive characteristic. The user has to set only the main supply voltage and select the current overload.

### 2.1.1.1 DRIVE CURRENT OVERLOAD SELECTION

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).

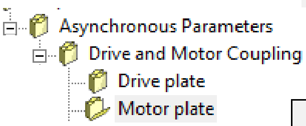
Now the drive will only overload if the temperature drops below the rated value, which will only occur after a period of operation at currents below the rated current.

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<br>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

## 2.1.2 MOTOR PLATE




| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| PRC_MOT_I_NOM | P61 - Rated motor current ( I NOM MOT) | 10.0 | 100.0 | 100 | % DRV_I_NOM | 327.67 |
| MOT_V_NOM | P62 - Rated motor voltage | 100.0 | 1000.0 | 380 | Volt | 10 |
| MOT_F_NOM | P63 - Rated motor frequency | 10.0 | 800.0 | 50.0 | Hz | 10 |
| PRC_MOT_V_MAX | P64 - Max. operating voltage | 1.0 | 200.0 | 100 | % MOT_V_NOM | 40.96 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| MOT_SPD_MAX | P65 - Max. operating speed (n MAX) | 50 | 60000 | 2000 | RPM | 1 |
| MOT_COS_PHI | P66 - Nominal power factor | 0.500 | 1.000 | 0.894 | | 1000 |
| MOT_POLE_NUM | P67 - Number of motor poles | 1 | 12 | 4 | | 1 |
| PRC_MOT_I_THERM | P70 - Motor thermal current | 10.0 | 110.0 | 100 | % PRC_MOT_I_NOM | 10 |
| MOT_TF_THERM | P71 - Motor thermal time constant | 30 | 2400 | 180 | s | 1 |

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

| Name | Description |
|---|---|
| PRC_MOT_I_NOM | P61 - Rated motor current ( I NOM MOT) |
| MOT_V_NOM | P62 - Rated motor voltage |
| MOT_F_NOM | P63 - Rated motor frequency |
| MOT_POLE_NUM | 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 = (Inom_motor *100.0))/(Inom_drive)**

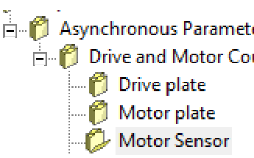
Example: Drive: OPEN 22
Inom_drive = 22A overload 200%
Motor: MEC series, Vn = 380V, f = 50Hz, Inom_motore = 20A,
P61 = (20*100)/22 = 90.9%
P62 = 380.0
P63 = 50.0

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

| Name | Description |
|---|---|
| PRC_MOT_V_MAX | P64 - Max. operating voltage |
| MOT_SPD_MAX | P65 - Max. operating speed (n MAX) |
| PRC_MOT_I_THERM | P70 - Motor thermal current |
| MOT_TF_THERM | P71 - Motor thermal time constant |

These important parameters must be specified alongside the exact characteristics of the feedback sensor used. 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.

## 2.1.3 MOTOR SENSOR



| Name | Description | Min | Max | Default | UM | Scal e |
|---|---|---|---|---|---|---|
| SENSOR_SEL | C00 - Speed sensor | Range | | 1 | | 1 |
| | | 1 | Encoder | | | |
| | | 4 | Resolver | | | |
| | | 5 | Resolver RDC | | | |
| | | 8 | Sin/Cos incr | | | |
| RES_POLE | P68 - Number of absolute sensor poles | 1 | 12 | 2 | | 1 |
| ENC_PPR | P69 - Number of encoder pulses/revolution | 0 | 60000 | 1024 | pulses/rev | 1 |
| EN_TIME_DEC_ENC | C74 - Enable incremental encoder time decode | 0 | 1 | 0 | | 1 |
| RES_TRACK_LOOP_BW | P89 - Tracking loop bandwidth direct decoding of resolver | 100 | 10000 | 1800 | rad/s | 1 |
| RES_TRACK_LOOP_DAMP | P90 - D Traking loop bandwidth | 0.00 | 5.00 | 0.71 | | 100 |
| RES_CARR_FRQ_RATIO | C67 - Resolver carrier frequency | Range | | 0 | | 1 |
| | | -3 | f PWM ÷ 8 | | | |
| | | -2 | f PWM ÷ 4 | | | |
| | | -1 | f PWM ÷ 2 | | | |
| | | 0 | f PWM | | | |
| | | 1 | f PWM x 2 | | | |
| | | 2 | f PWM x 4 | | | |
| | | 3 | f PWM x 8 | | | |
| EN_SENSOR_TUNE | C68 - Enable sensor auto-tuning | 0 | 1 | 0 | | 1 |
| EN_INV_POS_DIR | C76 - Invert positive cyclic versus | 0 | 1 | 0 | | 1 |
| KP_SINCOS1_CHN | P164 - Resolver or Incremental Sin/Cos sine and cosine signal amplitude compensation | 0.0 | 200.0 | 100 | % | 163.8 4 |
| OFFSET_SIN1 | P165 - Resolver or Incremental Sin/Cos sine offset | -16383 | 16383 | 0 | | 1 |
| OFFSET_COS1 | P166 - Resolver or Incremental Sin/Cos cosine offset | -16383 | 16383 | 0 | | 1 |
| OFFSET_SINCOS_ENC | D38 - Compensation Sin/Cos analog/digital term | | | 0 | pulses | 1 |
| SENSOR_FRQ_IN | D39 - Input frequency | | | 0 | kHz | 16 |
| HW_SENSOR1 | D63 - Sensor1 presence | | | 0 | | 1 |
| SENS1_ZERO_TOP | D55 - Sensor1 Zero Top | | | 0 | pulses | 1 |
| EN_SINCOS_PREC_POS | C70 - Enable SinCos Analog-Digital compensation into position | 0 | 1 | 0 | | 1 |

For correct motor sensor setup is necessary to set the motor sensor present:

| Name | Description |
|---|---|
| SENSOR_SEL | C00 - Speed sensor |

and, for the specific sensor present, the following parameters.
For the TTL encoder and the incremental sin-cos encoder:

| Name | Description |
|---|---|
| ENC_PPR | P69 - Number of encoder pulses/revolution |

And for the resolver:

| Name | Description |
|---|---|
| RES_POLE | P68 - Number of absolute sensor poles |
| RES_CARR_FRQ_RATIO | C67 - Resolver carrier frequency |

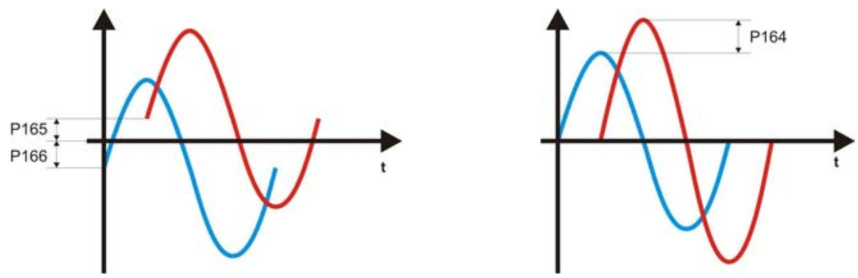
After that is necessary proceed with the auto tuning procedure.

## 2.1.3.1 FINE SETUP MOTOR SENSOR

For some kind of sensor, after the auto tuning procedure is possible set some sensor parameter to increase the performance.

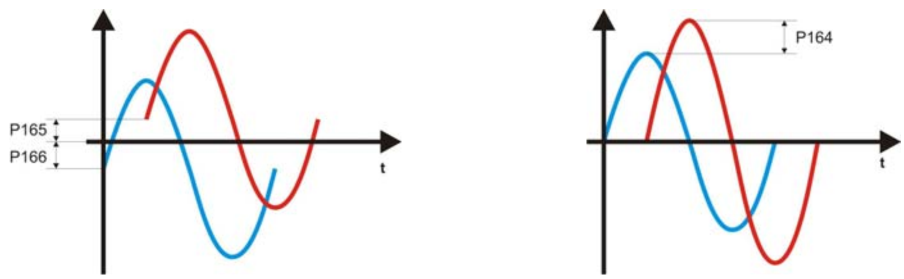
### 2.1.3.1.1 FINE SETUP FOR RESOLVER

The fine tuning resolver setup allows  to set, with a semiautomatic procedure, any offset and a multiplicative factor to adjust the signals acquired by the resolver channels in order to increase system performance.
The procedure begins by setting C68 = 1 and giving a reference speed that the motor can run at 150 rpm.
The motor  have to run for about 30 seconds after stop the test is completed.
Automatically updates the values of P165 and P166 (offset) and P164 (multiplication factor to adjust the amplitude)

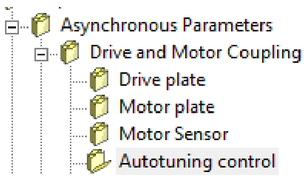



### 2.1.3.1.2 FINE SETUP FOR INCREMENTAL SIN/COS ENCODER

The fine tuning incremental sin/cos encoder setup allows  to set, with a semiautomatic procedure, any offset and a multiplicative factor to adjust the signals acquired by the incremental sin/cos encoder channels in order to increase system performance.
The procedure begins by setting C68 = 2 and giving a reference speed that the motor can do one o two turns .
After stop the test is completed.
Automatically updates the values of P165 and P166 (offset) and P164 (multiplication factor to adjust the amplitude)




## 2.1.4 AUTOTUNING CONTROL AND MOTOR MEASURED MODEL



| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| EN_TEST_CONN | C41 - Enable sensor and motor phase tests | 0 | 1 | 0 | | 1 |
| PRC_I_TEST_CONN | P114 - Current in connection tests for UVW, Poles and reading Rs | 0.0 | 100.0 | 100 | % DRV_I_NOM | 327.67 |
| EN_AUTOTUNING | C42 - Enable auto-tunings | Range<br>0 No<br>1 Test 1 and 2<br>2 Test 3 and 4<br>3 All | | 0 | | 1 |
| DIS_DEF_START_AUTO | C75 - Disable Autotuning starting from default values | 0 | 1 | 0 | | 1 |
| TEST3-4_ACC_TIME | P121 - Test 3 and 4 acceleration time | 0.01 | 199.99 | 6.8 | s | 100 |
| PRC_I_TEST_DELTA_VLS | P129 - Test current to establish VLS | 0.0 | 100.0 | 30.0 | % | 327.67 |
| TEST_CONN_FEEDBACK | P79 - Connection tests: Encoder: pulses counted, Resolver or Sin Cos Enc: time reading | -19999 | 19999 | 0 | | 0 |
| EN_TEST_SPD | C53 - Enable test of start-up time | Range<br>0 Not enabled<br>1 Start up<br>2 Step | | 0 | | 1 |
| TEST_SPD_T_MAX | P130 - Torque during start-up test | 0.0 | 100.0 | 100 | % MOT_T_NOM | 40.96 |
| TEST_SPD_MAX | P132 - Speed during start-up test | -100.00 | 100.00 | 100 | % MOT_SPD_MAX | 163.84 |
| TEST_SPD_SPACE_MAX | P134 - Maximum revolutions during start-up test | 0.00 | 3000.0 | 100 | revolutions | 10 |
| PRC_MOT_FRICTION | P136 - Friction torque | 0.0 | 100.0 | 0 | % MOT_T_MOM | 40.96 |
| START_TIME | P169 - Start up time | 0 | 19999 | 10 | ms | 1 |

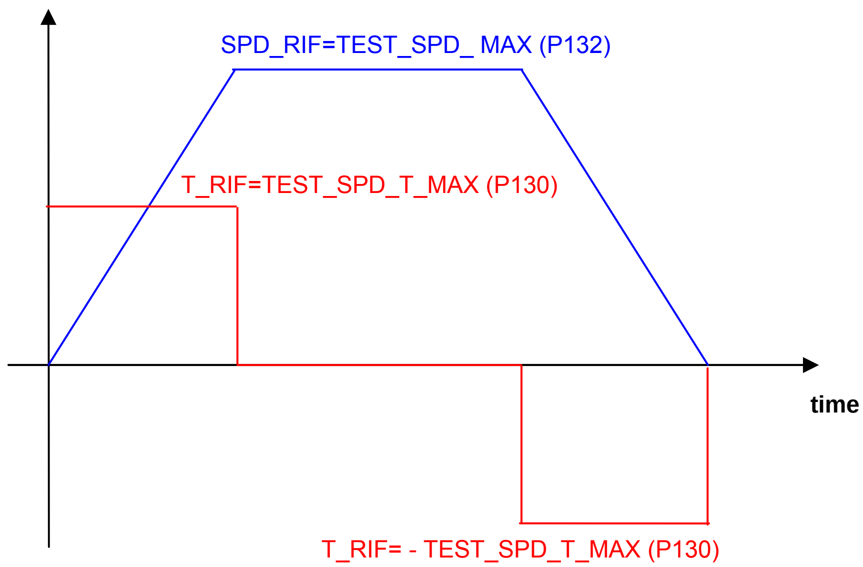
Speed test are useful for measure total system inertia and to set correctly speed regulator gains.
For safety reasons it’s possible to limit maximum speed test with parameter P130, maximum motor torque with parameter P132 and maximum space admitted for test with P134 revolutions.
The drive doesn’t go over these limits during test execution.

### 2.1.4.1 START-UP TIME

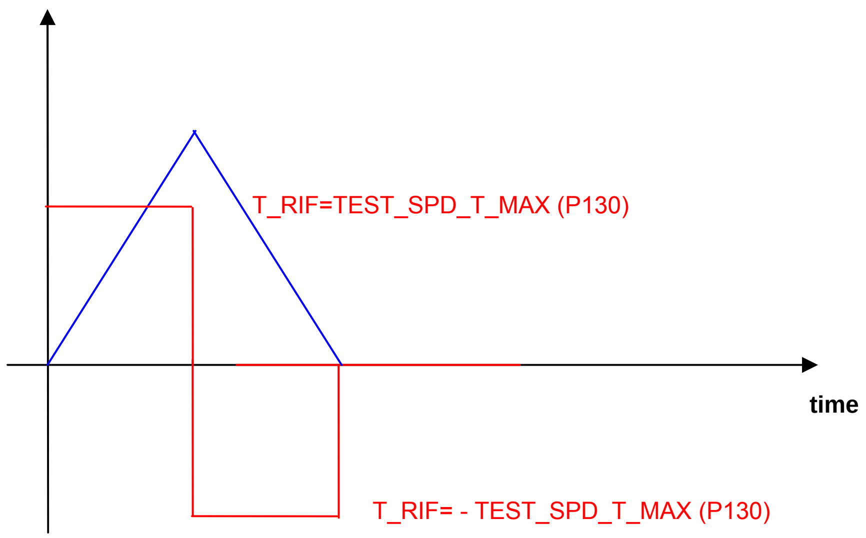
Start-up time is defined like the time needed to reach maximum speed (P65) with nominal motor torque.

This autotest is useful to measure total system inertia and frictions.
For enable this test set C53=1 (EN_TEST_SPD = 1 Start Up). In the display appears “Auto”.
Give the run command and automatically the motor starts to move and than return to zero speed.
At this point switch off the run command. Parameter P169 is set with the start-up time in milliseconds, parameter P136 is set with friction measured in percent of motor nominal torque.
Automatically C53 is cleared to 0 and the test is finished.

If the space admitted is enough the speed profile is trapezoidal:


SPD_RIF=TEST_SPD_ MAX (P132)
T_RIF=TEST_SPD_T_MAX (P130)
time
T_RIF= - TEST_SPD_T_MAX (P130)

Otherwise:


T_RIF=TEST_SPD_T_MAX (P130)
time
T_RIF= - TEST_SPD_T_MAX (P130)

## 2.1.4.2 STEP RESPONSE

Step response is a common mode to test speed loop stability and dynamic performance.
For enable this test set C53=2 (EN_TEST_SPD = 2 Step). In the display appears “Auto”.
At this point all speed reference are ignored, instead a fixed speed reference is calculated equals to maximum test torque (P130) divided by speed regulator proportional gain. In this way giving this step speed reference, the torque requested doesn’t go over maximum torque admitted.
Linear ramps are automatically disabled. Giving the run command, motor starts and try to follow the reference with its dynamic performance.
Evaluating the speed response it’s possible to understand the system stability and speed loop bandwidth.
With Real Time Graph is possible to see the motor speed response. Set:

Post Trigger Points = 90%
Trigger level = 1%
Sample Time = 1

Trigger Type = standard +03 Speed Reference
Trigger slope = ascending

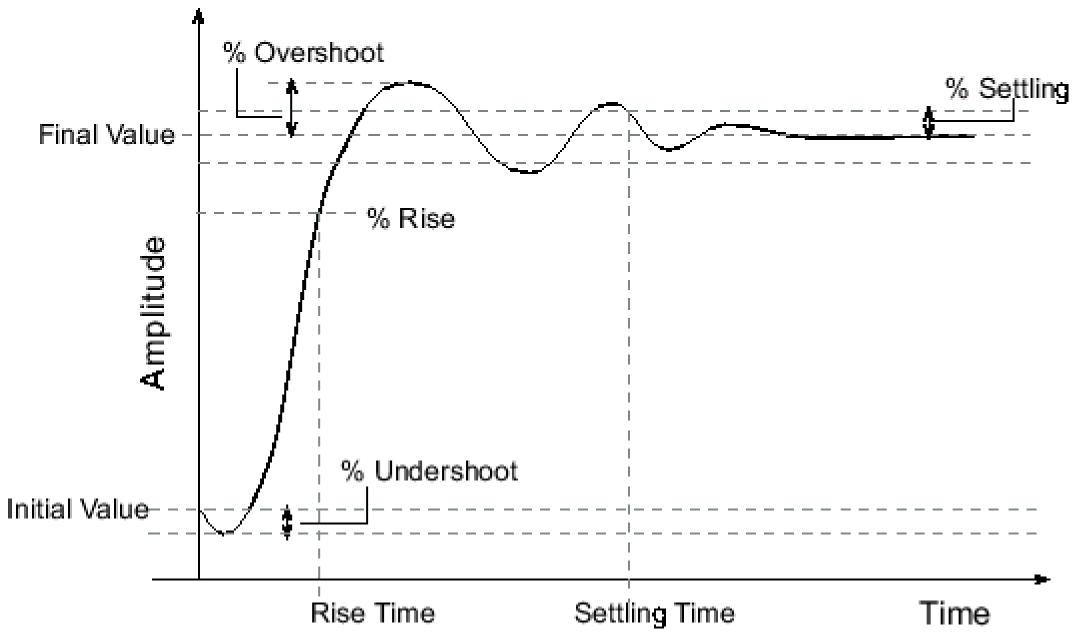
Channels = 2

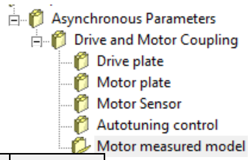
Channel A = Standard - o03 Reference speed value after ramps
Channel B = Standard - o49 Rotation speed not filtered

Set speed regulator gain and look the step response. Try and repeat until the speed response has good stability and bandwidth.
Motor runs at constant speed until the run command is on.
Switch off the run command to stop the motor and start a new test.
Step response test is finished only when C53 is manually clear to 0.

## 2.1.4.2.1 SPEED REGULATOR GAIN SETTING SUGGESTIONS

1. First of all disable integral part setting lead time constant P32 with a big value (> 500ms).
2. Try to find the best proportional gain P31 and filter time constant P33 to obtain a step response with max overshoot of 20%. It’s important to evaluate also the acoustic and electrical motor noise.
3. Reduce lead time constant P32 up to minimum value without increase the overshoot






| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| PRC_MOT_T_MAX | P41 - Maximum torque at full load | 0.0 | 400.0 | 400.0 | % MOT_T_NOM | 40.96 |
| MOT_COS_PHI | P66 - Nominal power factor | 0.500 | 1.000 | 0.894 | | 1000 |
| PRC_MOT_I_T_NOM | P72 - Nominal torque current | 5.0 | 100.0 | 95.2 | % PRC_MOT_I_NOM | 327.67 |
| PRC_MOT_I_FLX_NOM | P73 - Nominal flux current | 5.0 | 100.0 | 30.2 | % PRC_MOT_I_NOM | 327.67 |
| T_ROTOR | P74 - Rotor time constant Tr | 10 | 10000 | 182 | ms | 1 |
| T_STATOR | P75 - Stator time constant Ts | 0.0 | 50.0 | 8.5 | ms | 10 |
| PRC_DELTA_VRS | P76 - Voltage drop due to stator resistor | 1.0 | 25.0 | 2.0 | % MOT_V_NOM | 327.67 |
| PRC_DELTA_VLS | P77 - Voltage drop due to leakage inductance | 5.0 | 100.0 | 20.0 | % MOT_V_NOM | 327.67 |
| MOT_T_NOM | P78 - Nominal motor torque | 0.5 | 3000.0 | 0.0 | Nm | 10 |
| PRC_DEAD_TIME_CMP | P102 - Dead time compensation | 0.0 | 100.0 | 22.0 | ‰ PRC_MOT_V_MAX | 32.76 |
| MOT_V0 | P128 - Voltage motor at nominal speed with no load | 0.0 | 100.0 | 100.0 | % MOT_V_NOM | 327.67 |
| K_FLX45 | P131 - Magnetic characteristic point 1 | 0.0 | 120.0 | 90.2 | % | 40.96 |
| K_FLX55 | P133 - Magnetic characteristic point 2 | 0.0 | 120.0 | 90.5 | % | 40.96 |
| K_FLX65 | P135 - Magnetic characteristic point 3 | 0.0 | 120.0 | 91.1 | % | 40.96 |
| K_FLX75 | P137 - Magnetic characteristic point 4 | 0.0 | 120.0 | 91.8 | % | 40.96 |
| K_FLX82 | P139 - Magnetic characteristic point 5 | 0.0 | 120.0 | 92.7 | % | 40.96 |
| K_FLX88 | P141 - Magnetic characteristic point 6 | 0.0 | 120.0 | 94.2 | % | 40.96 |
| K_FLX93 | P143 - Magnetic characteristic point 7 | 0.0 | 120.0 | 95.8 | % | 40.96 |
| K_FLX97 | P145 - Magnetic characteristic point 8 | 0.0 | 120.0 | 98.1 | % | 40.96 |
| K_FLX100 | P147 - Magnetic characteristic point 9 | 0.0 | 120.0 | 100.0 | % | 40.96 |
| K_FLX102 | P149 - Magnetic characteristic point 10 | 0.0 | 120.0 | 102.0 | % | 40.96 |
| PRC_DEAD_TIME_CMP_XB | P151 - Xb = cubic coupling zone amplitude | 0.0 | 50.0 | 0.0 | % DRV_I_NOM | 163.84 |
| PRC_DEAD_TIME_CMP_YC | P152 - Yc = compensation at rated drive current | 50.0 | 100.0 | 100 | % DEAD_TIME_COMP | 327.67 |
| PRC_DEAD_TIME_CMP_X0 | P153 - Xoo = dead zone amplitude | 0.0 | 50.0 | 0 | % DRV_I_NOM | 163.84 |

The first step for the auto-tuning procedure is the sensor test.
After to set the correct parameters in the Motor sensor section is necessary to complete the auto-tuning procedure for the sensor present and selected.

## 2.1.4.3 TTL ENCODER

### 2.1.4.3.1 SENSOR PARAMETERS

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

### 2.1.4.3.2 SPEED SENSOR TEST

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 code 0 is triggered
- **P79<0** : meaning that Encoder channels are exchanged, therefore A14 code 0 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 3 is triggered. In the first check if it is correct the Encoder number of pulses per revolution and the number of motor poles.
- **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.

## 2.1.4.4 RESOLVER

### 2.1.4.4.1 SENSOR PARAMETERS

It’s necessary have to set correctly the parameter **P68**
**Note: resolve poles number cannot be grater than motor poles number (P67),** otherwise it is triggered the alarm A15 with code 0.

### 2.1.4.4.2 SPEED SENSOR TEST

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

**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 code 0 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:

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

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 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.

## 2.1.4.5 INCREMENTAL SIN COS ENCODER

### 2.1.4.5.1 SENSOR PARAMETERS

It's necessary to have set correctly the parameter P69

### 2.1.4.5.2 SPEED SENSOR TEST

. 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.
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 code 0 is triggered
- **P79<0** : meaning that Encoder channels are exchanged, therefore A14 code 0 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 3 is triggered. In the first check if it is correct the Encoder number of pulses per revolution and the number of motor poles.
- **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. The subsequent tests can now be carried out

## 2.1.4.6 AUTO-TUNING PROCEDURES

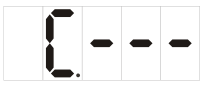
### 2.1.4.6.1 SENSOR TESTS

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

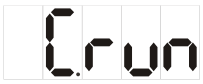
- Check that the direction of rotation of the motor phases and the sensor correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the speed sensor used is set correctly.

**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:




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 on the display:




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.

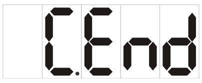
**During the test, the motor will make a complete revolution at low speed.**
**Do not worry if this revolution is a little noisy.**

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 code=1** is enabled, the test current is too low, check if the motor phases are correctly connected to the drive

- If **A14 code=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 code=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 on the display:




and the drive does not trigger an alarm.
Now disable RUN by setting its digital input to 0 or clearing C21.
The subsequent tests can now be carried out.

### 2.1.4.6.2 FINE SENSOR SETUP

After the first part of the autotunning, in some case, is possible to set some parametes regarding the sensor to obtain a better system performance.
Dopo la prima parte dell'autotaratura, in alcuni casi, si possono settare alcuni parametri relativi al sensore in modo da migliorare le prestazione del sistema:

### 2.1.4.6.3 ENCODER 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

## 2.1.5 IDENTIFYING MODELS OF INDUCTION MOTOR

### 2.1.5.1 MOTOR AUTO-TUNING PARAMETERS

| Name | Description |
|---|---|
| PRC_MOT_T_MAX | P41 - Maximum torque at full load |
| MOT_COS_PHI | P66 - Nominal power factor |
| PRC_MOT_I_T_NOM | P72 - Nominal torque current |
| PRC_MOT_I_FLX_NOM | P73 - Nominal flux current |
| T_ROTOR | P74 - Rotor time constant Tr |
| T_STATOR | P75 - Stator time constant Ts |
| PRC_DELTA_VRS | P76 - Voltage drop due to stator resistor |
| PRC_DELTA_VLS | P77 - Voltage drop due to leakage inductance |
| MOT_T_NOM | P78 - Nominal motor torque |

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 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 = $I_0$ / Inom 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:

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

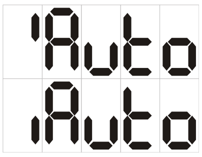
These other parameters are not as important and the default values may be left if more reliable data are unavailable.
This test reads the basic electrical parameters that characterise the induction motor being used so that it can be modelled according to the rotor magnetic flux. After these values have 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. |

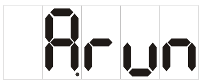
The display will show the following setting according to which tests are enabled:



Test 1 and 2 enabled

Test 3 and 4 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 the following indicaton 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.

#### 2.1.5.1.1 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:

| Name | Description |
|---|---|
| PRC_DELTA_VRS | P76 - Voltage drop due to stator resistor |
| PRC_DEAD_TIME_CMP | P102 - Dead time compensation |

#### 2.1.5.1.2 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 $\Delta V_{LS}$.
This test modifies the following parameters:

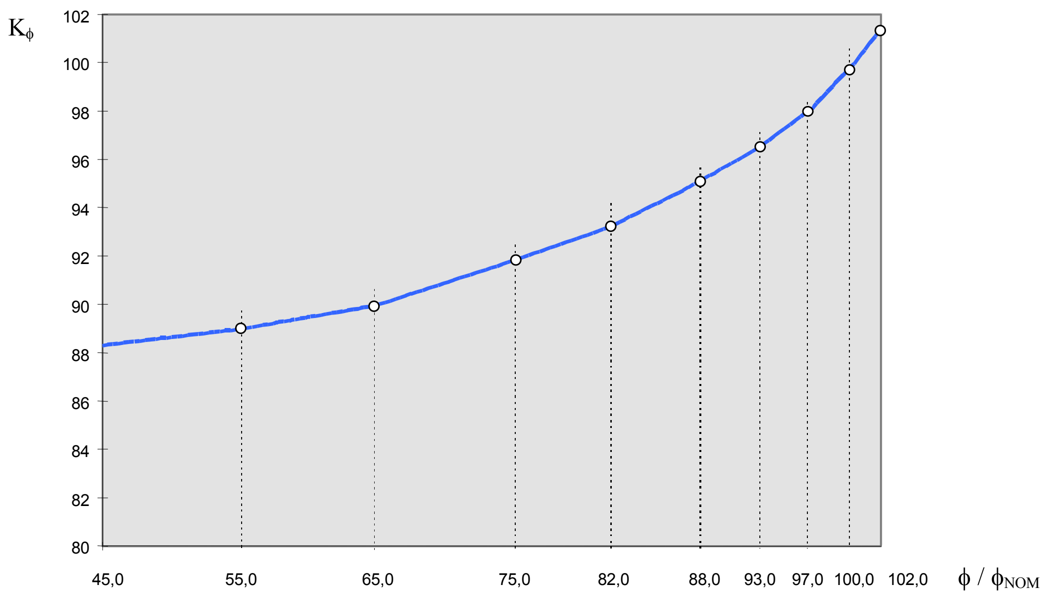
| Name | Description |
|---|---|
| PRC_DELTA_VLS | P77 - Voltage drop due to leakage inductance |
| I_REG_KP | P83 - Kpc current regulator proportional gain |

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

#### 2.1.5.1.3 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 Kϕ is equal to:

$$\frac{Id/I\phi}{\Phi/\Phi_{NOM}}$$

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/ ϕNOM | 45.0% | 55.0% | 65.0% | 75.0% | 82.0% | 88.0% | 93.0% | 97.0% | 100.0% | 102.0% |
| | P131 | P133 | P135 | P137 | P139 | P141 | P143 | P145 | P147 | P149 |
| Kϕ | ..... | ...... | ...... | ...... | ...... | ....... | ....... | ....... | ...... | ...... |

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

| Name | Description |
|---|---|
| PRC_MOT_I_FLX_NOM | P73 - Nominal flux current |

## 2.1.5.1.4 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.**

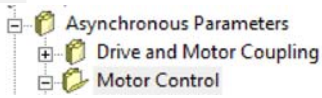
The following parameters are modified at the end of the test:

| Name | Description |
|---|---|
| PRC_MOT_T_MAX | P41 - Maximum torque at full load |
| T_ROTOR | P74 - Rotor time constant Tr |
| T_STATOR | P75 - Stator time constant Ts |
| MOT_T_NOM | P78 - Nominal motor torque |
| V_REG_KP | P80 - Kpi voltage regulator proportional gain |
| V_REG_TF | P82 - Tfi voltage regulator (filter) time constant |
| I_REG_TI | P84 - Tic current regulator lead time constant |
| I_REG_TF | P85 - Tfc current regulator (filter) time constant |

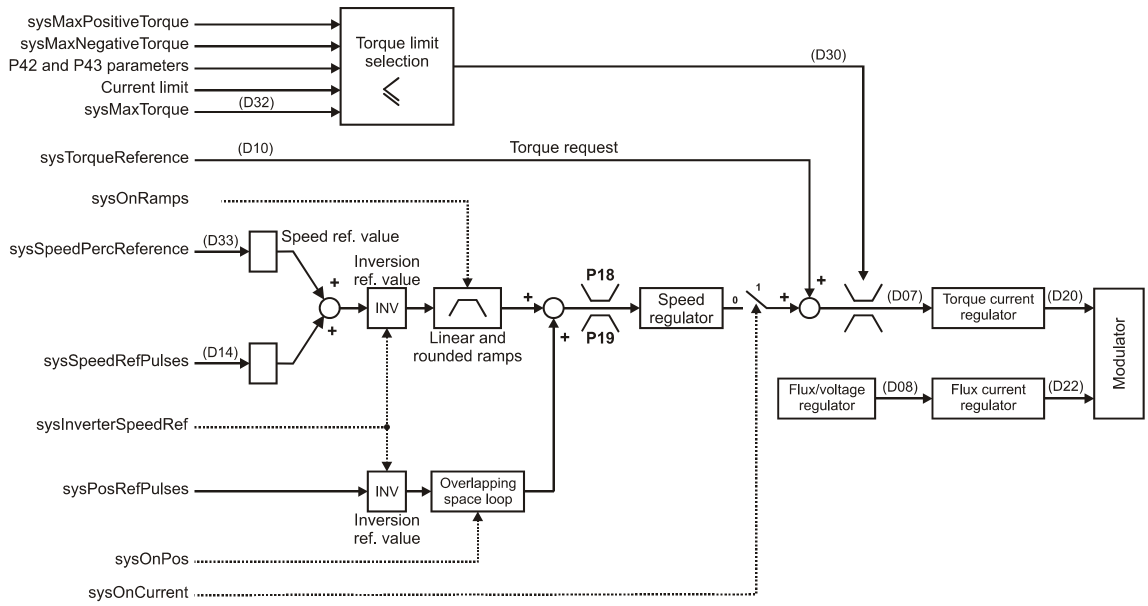
By the end of this test, the current and flow regulators will have been completely self-set and made compatible with the motor connected to the drive.
These readings also help estimate the Maximum motor torque (**P41**) which is important if the motor flux has to be considerably weakened.
The speed regulator 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.

| Name | Description |
|---|---|
| END_SPD_REG_KP | P31 - KpV final speed regulator proportional gain |
| END_SPD_REG_TI | P32 - TiV final speed regulator lead time constant |
| END_SPD_REG_TF | P33 - TfV final speed regulator (filter) time constant |

## 2.2 MOTOR CONTROL




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.




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). 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.

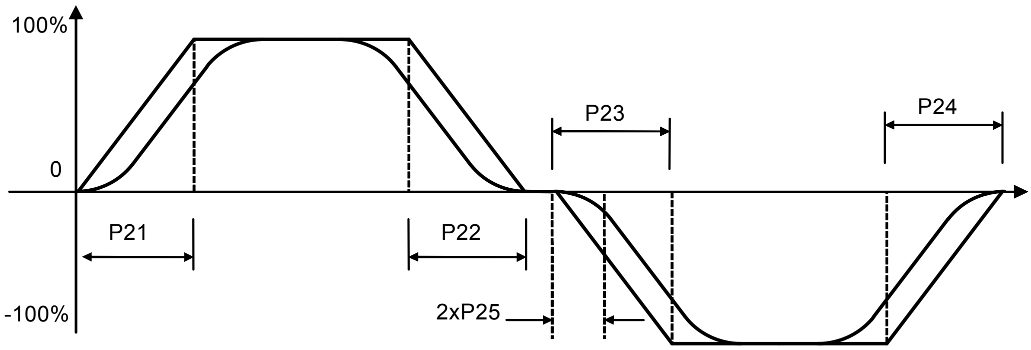
## 2.2.1 ACCELERATIO RAMPS AND SPEED LIMIT

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| PRC_CW_SPD_REF_ MAX | P18 - Max. CW speed reference value limit | -105.0 | 105.0 | 105.02 | % MOT_SPD_MAX | 163.84 |
| PRC_CCW_SPD_REF _MAX | P19 - Max. CCW speed reference value limit | -105.0 | 105.0 | 105.02 | % MOT_SPD_MAX | 163.84 |
| CW_ACC_TIME | P21 - CW acceleration time | 0.01 | 199.99 | 10 | s | 100 |
| CW_DEC_TIME | P22 - CW deceleration time | 0.01 | 199.99 | 10 | s | 100 |
| CCW_ACC_TIME | P23 - CCW acceleration time | 0.01 | 199.99 | 10 | s | 100 |
| CCW_DEC_TIME | P24 - CCW deceleration time | 0.01 | 199.99 | 10 | s | 100 |
| TF_RND_RAMP | P25 - Rounded filter time constant | 0.1 | 20.0 | 5 | s | 10 |
| DEC_TIME_EMCY | P30 - Emergency brake deceleration time | 0.01 | 199.99 | 10 | s | 100 |
| EN_LIN_RAMP | P236 - Enable linear ramp | 0 | 1 | 0 | | 1 |
| EN_RND_RAMP | C27 - Rounded ramp | 0 | 1 | 0 | | 1 |
| EN_INV_SPD_REF | P237 - Invert reference signal software | 0 | 1 | 0 | | 1 |
| EN_DB | C81 - Enable dead zones | Range<br>0 Not enable<br>1 Zone 1<br>2 Zone 2 | | 0 | | 1 |
| DB1_START | P179 - Dead zone 1 initial speed | 0 | 30000 | 0 | rpm | 1 |
| DB1_END | P180 - Dead zone 1 final speed | 0 | 30000 | 0 | rpm | 1 |
| DB2_START | P181 - Dead zone 2 initial speed | 0 | 30000 | 0 | rpm | 1 |
| DB2_START | P182 - Dead zone 2 final speed | 0 | 30000 | 0 | rpm | 1 |
| PRC_TOT_APP_SPD_ REF | D02 - Speed reference value before ramp | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_END_SPD_REF | D03 - Speed reference value after ramp | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |

In the standard application, by default (**P236=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% |

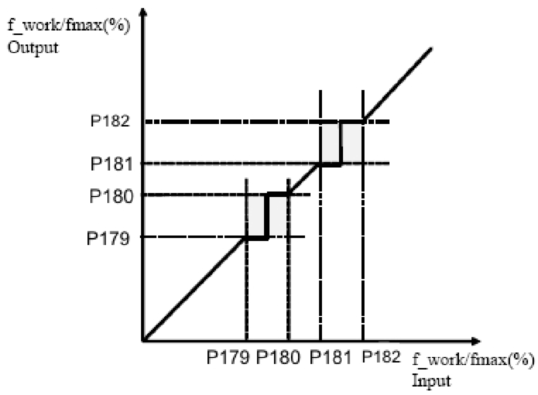
Setting sensitivity is 10 msec and the time must be between 0.01 and 199.99 seconds.
The default values are the same for all the parameters and are equal to 10 sec.
In the standard application, ramps can be enabled via a configurable logic input (**I22**) which works parallel to connection P236: I22=H is the same as setting P236=1. This input ensures maximum flexibility in ramp use in that the ramps are enabled only when required.
In the other application please refer to the specific documentation in order to enable the ramps
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.

## 2.2.1.1 FREQUENCY JUMPS TO AVOID RESONANCES

Using the parameters **P179**, **P180**, **P181** and **P182** it is possible to exclude, as working frequencies, all those frequencies falling within the two bands defined between P179 - P77 and P78 – P182, where P179, P77, P78 and P182 are expressed as % of the maximum working frequency (see diagram)



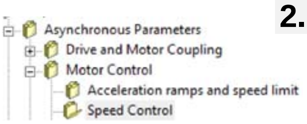

Wherever exclusion bands are pre-set the drive behaves in the following way:
If the set frequency reference falls within the exclusion band it is maintained at the lower value of the band, if the set value is less than the mid band value, while if the value is greater than the mid band value it assumes the upper value.

In a transitional phase however the system passes through all of the band's frequencies (ramp). The use or otherwise of the exclusion bands requires the setting of the corresponding connection **C38**:
Band 1 (P179-P180) **C81=0 (Default)** not excluded, **C81=1** excluded
Band 2 (P181-P182) **C81<2** not excluded, **C81=2** excluded
For example if the working fmax = 50Hz and the plant presents two resonance frequencies which are quite clear at 45Hz and 35Hz the frequencies between 43 - 47 Hz and 33 - 37 Hz could be excluded setting

P179 = (33/50)* 100.0 = 66.0%
P180 = (37/50)* 100.0 = 74.0% — First band

P181 = (43/50)* 100.0 = 86.0%
P182 = (47/50)* 100.0 = 94.0% — Second band

C81=2 Enables both exclusion bands




## 2.2.2 SPEED CONTROL

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| END_SPD_REG_KP | P31 - KpV final speed regulator proportional gain | 0.1 | 400.0 | 4 | | 10 |
| END_SPD_REG_TI | P32 - TiV final speed regulator lead time constant | 0.1 | 3000.0 | 80 | ms | 10 |
| END_SPD_REG_TF | P33 - TfV final speed regulator (filter) time constant | 0.0 | 25.0 | 0.8 | ms | 10 |
| EN_TF2_SPD_REG | C69 - Enable 2nd order filter on speed regulator | 0 | 1 | 0 | | 1 |
| START_SPD_REG_TF | P34 - TfV initial speed regulator (filter) time constant | 0.0 | 25.0 | 0.8 | ms | 10 |
| PRC_SPD_THR_GAIN_CHG | P44 - End speed for speed PI gain change | 0.0 | 100.0 | 0 | % MOT_SPD_MAX | 163.84 |
| START_SPD_REG_KP | P45 - KpV initial speed PI proportional gain | 0.1 | 400.0 | 4 | | 10 |
| START_SPD_REG_TI | P46 - TiV initial speed PI lead time constant | 0.1 | 3000.0 | 80 | ms | 10 |
| EN_SPD_REG_MEM_CORR | C77 - Enable PI speed gains compenstation | 0 | 1 | 0 | | 1 |
| EN_SPD_REG_D | C72 - Enable feedforward | 0 | 1 | 0 | | 1 |
| SPD_REG_KD_TF2 | P168 - Second order feedforword filter | 0.0 | 1000.0 | 0.0 | ms | 10 |
| PRC_MOT_SPD_MAX | P51 - Maximum speed for alarm | 0.0 | 125.0 | 120.0 | % MOT_SPD_MAX | 163.84 |
| PRC_END_SPD_REF | D03 - Speed reference value after ramp | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_MOT_SPD | D04 - Speed reading | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_T_REF | D05 - Torque request | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| MOT_SPD | D21 - Motor rotation speed | | | 0 | rpm | 1 |

### 2.2.2.1 MANAGING SPEED REFERENCE VALUES

The application generates two speed reference values:

- One , sysSpeedReference, is a percentage of the maximum speed (set in parameter P65) displayed in internal value d33 and on monitor o41.
- The other, sysSpeedRefPulses is electrical pulses for a period of PWM. This particular reference is used so as not to be lose any pulses if the frequency input is used. Internal normalization is done with 65536 pulses per mechanical revolution.

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

### 2.2.2.2 INVERTING AND LIMITING SPEED REFERENCE VALUES

In the standard application, logic function **I12** "**Speed reference value inversion**", which is assigned to an input (the default is input 6), or connection **P237** are used to invert the reference value according to the following logic (OR-exclusive):

| | |
|---|---|
| I12 = 0 P237 = 0 | Reference value not inverted (default values) |
| I12 = 1 P237 = 0 | Reference value inverted |
| I12 = 0 P237 = 1 | Reference value inverted |
| I12 = 1 P237 = 1 | Reference value not inverted |

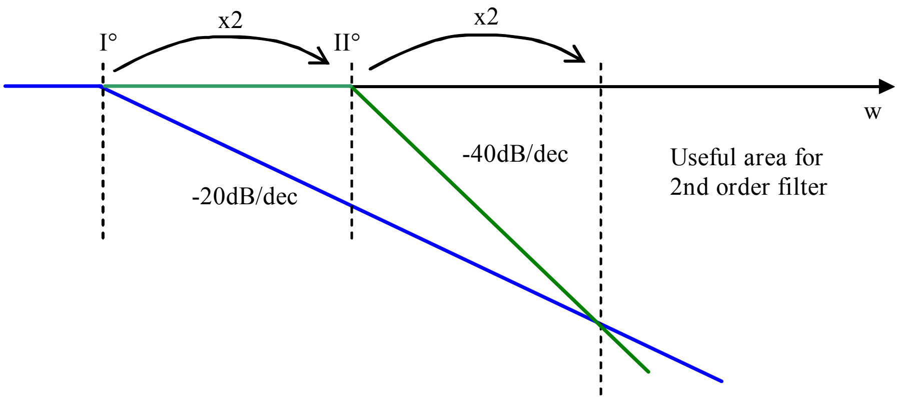
The reference value is inverted before the ramp thus, if the ramp is not disabled, the direction of rotation changes gradually (default C36=0 and I12=0).
There is another chance, to invert positive speed rotation setting C76=1.
Enabling this function, with the same speed reference and speed measured, 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 ±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% |

### 2.2.2.3 2ND ORDER SPEED REGULATOR FILTER

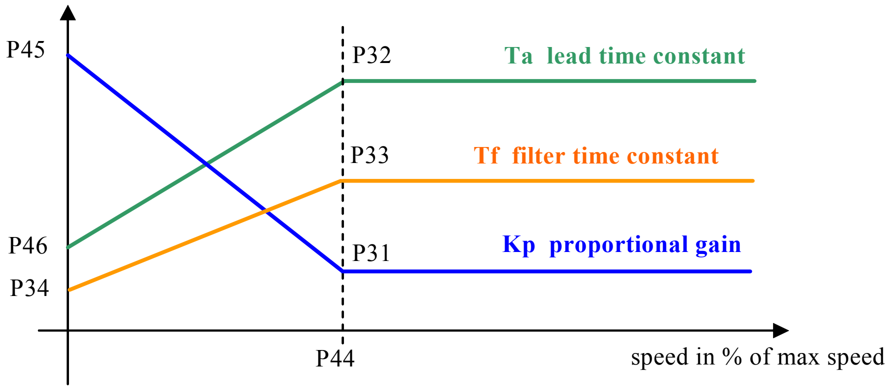
The speed regulator filter can be changed by using a 2nd order one.
To enable this function set **C69=1**. Parameter **P33** will always set the filter time constant in milliseconds, and thus its natural pulsation, given that internal damping is always set to 0.8 so that the filter is quick to respond 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.

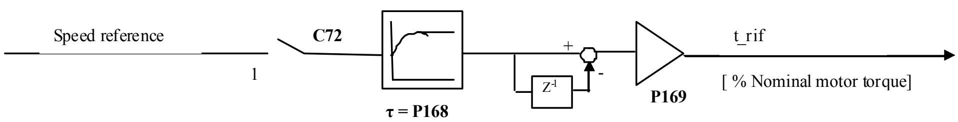
## 2.2.2.4 VARIABLE SPEED REGULATOR GAINS

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.



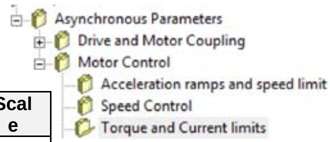

## 2.2.2.5 TORQUE FEED-FORWARD ON SPEED REFERENCE

It's possible to enable the Torque feed-forward on speed reference using **C72** connection:
It' 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 **P168** in ms) and taking account of total inertia (setting parameter P169 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 P169.
It's useful to set some milliseconds of filter (P168) on order to avoid too much noise on torque reference for the time derivative.
When it's enabled this function the torque reference produced is added to the speed regulator output.
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.
Note1: torque feed-forward isn't appropriate in load variable inertia applications.

## 2.2.3 TORQUE AND CURRENT LIMITS

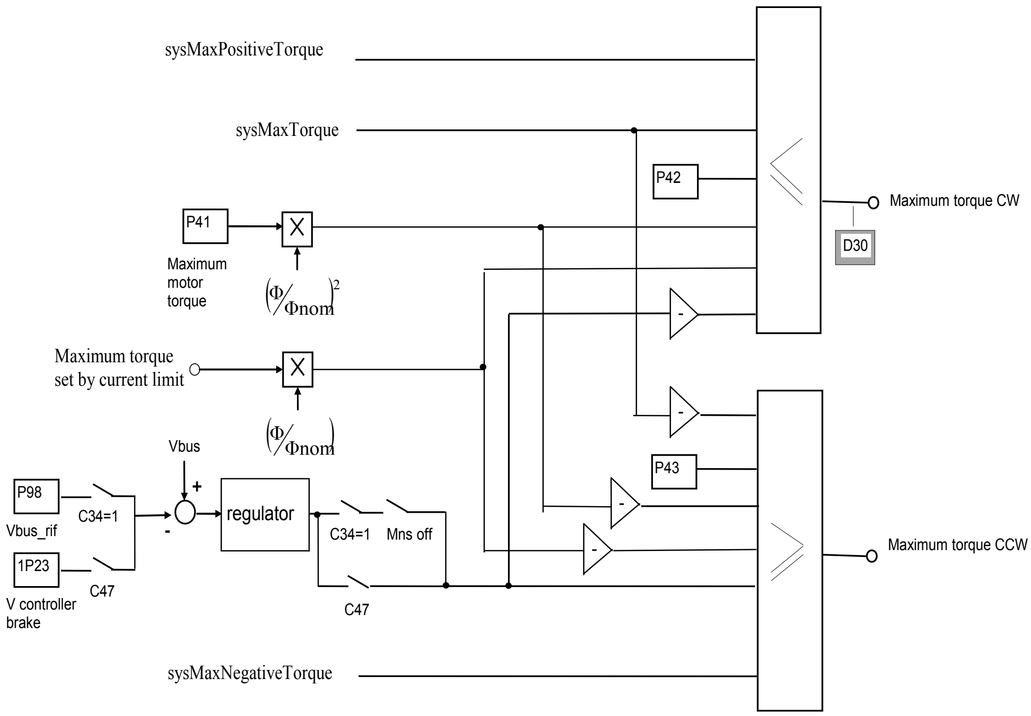



| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| PRC_DRV_I_PEAK | P40 - Current limit | 0.0 | 200.0 | 200 | % DRV_I_NOM | 40.96 |
| PRC_MOT_T_MAX | P41 - Maximum torque at full load | 0.0 | 400.0 | 400.0 | % MOT_T_NOM | 40.95 |
| PRC_DRV_CW_T_MAX | P42 - Maximum torque in the positive direction of rotation | 0.0 | 400.0 | 400.0 | % MON_T_NOM | 40.96 |
| PRC_DRV_CCW_T_MAX | P43 - Maximum torque in the negative direction of rotation | -400.0 | -0.0 | -400.0 | % MOM_T_NOM | 40.96 |
| PRC_DRV_T_MAX | D30 - Maximum torque | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_DRV_I_T_MAX | D31 - Maximum torque by current limit | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_DRV_I_MAX | D29 - Current limit | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |

### 2.2.3.1 CHOOSING THE ACTIVE TORQUE LIMIT

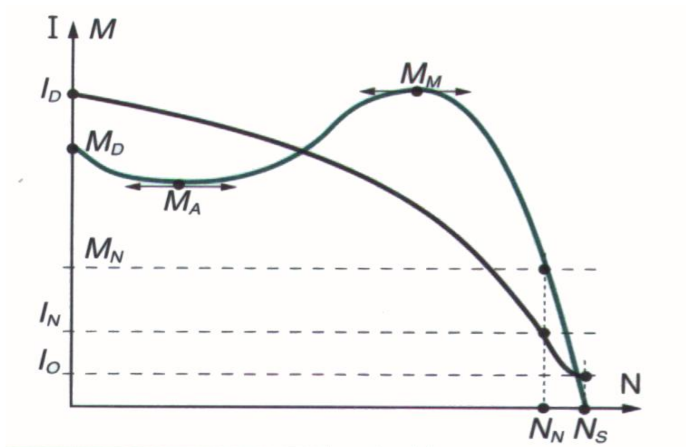
The positive and negative torque limits are chosen to restrict the following values:

- 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: sysMaxTorque (symmetrical), sysMaxPositiveTorque and sysMaxNegativeTorque (asymmetrical)
- Maximum torque limited by the regulator output in order to back up the bus voltage should the mains fail;
- 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**).




## 2.2.3.2 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 (Ns). 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 (Ns – N in the graph).




**Id** = starting current

**In** = rated current
**Io** = no-load current

**Md** = starting torque
**Ma** = acceleration torque
**Mm** = max. torque
**Mn** = rated torque

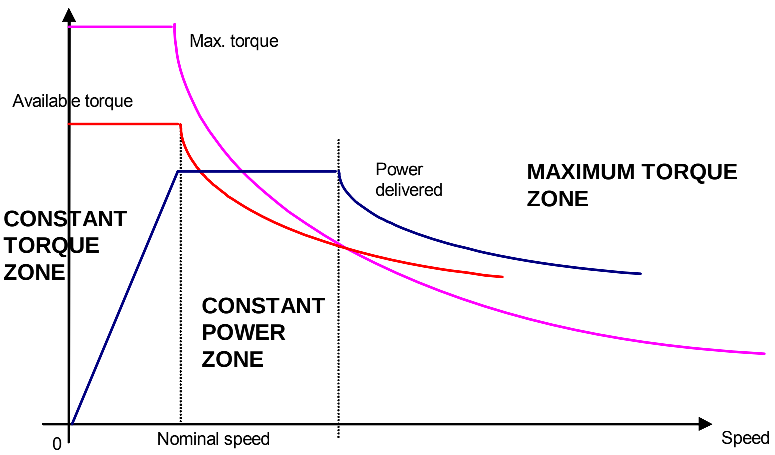
**Nn** = rated speed
**Ns** = synchronism speed

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

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/ϕnom ratio. Thus the motor has three working areas:

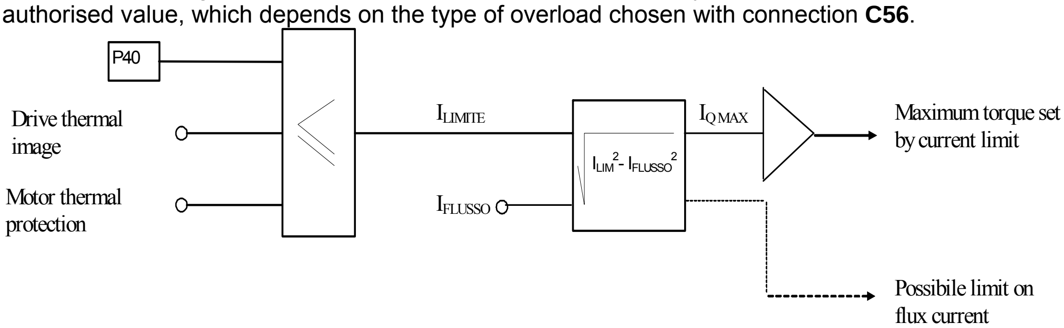
- **Constant torque**: the maximum torque is available up to the rated speed (as long as the current to deliver it is available);
- **Constant power**: over the rated speed, flux is reduced proportionally to speed, the available torque also drops in proportion to speed, the power delivered is constant;
- **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.



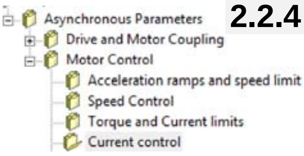

To ensure regulation stability, **P41** must be set with the Maximum torque divided by Rated motor torque. This limit will decrease during flux weakening with the square of the speed.

## 2.2.3.3 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




## 2.2.4 CURRENT CONTROL

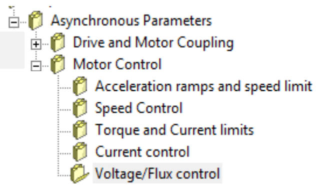
| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| I_REG_KP | P83 - Kpc current regulator proportional gain | 0.1 | 100.0 | 2.6 | | 10 |
| I_REG_TI | P84 - Tic current regulator lead time constant | 0.0 | 1000.0 | 8.5 | ms | 10 |
| I_REG_TF | P85 - Tfc current regulator (filter) time constant | 0.0 | 25.0 | 0 | ms | 10 |
| PRC_I_REG_KP_COEFF | P126 - KpI Corrective coeff. estimated Kp for current loops | 0.0 | 200.0 | 100 | % | 40.96 |
| PRC_I_DECOUP | P158 - Corrective coefficient for decoupling terms | 0.0 | 200.0 | 0 | % | 40.96 |
| DIS_I_DECOUP | C59 - Disable dynamic decoupling + feedfoward | 0 | 1 | 0 | | 1 |
| I_DELAY_COMP | P160 - PWM delay compensation on the currents | -800.0 | 800.0 | 40 | % TPWM | 40.96 |
| PRC_IQ_REF | D07 - Request torque current Iq rif | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| PRC_ID_REF | D08 - Request magnetizing current Id rif | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| PRC_IQ | D15 - Current torque component | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| PRC_ID | D16 - Current magnetizing component | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| PRC_VQ_REF | D20 - Vq rif | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| PRC_VD_REF | D22 - Vd rif | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| MOT_I | D11 - Current module | | | 0 | A rms | 16 |
| EL_FRQ | D13 - Rotor flux frequency | | | 0 | Hz | 16 |
| ACTV_POW | D01 - Active power delivered | | | 0 | kW | 16 |
| SLI_FREQ | D34 - Slip frequency | -20 | 20.0 | 0 | Hz | 40.96 |
| PRC_MOT_T | D35 - Actual torque produced | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |

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 Kp; **P84**, time in ms of the lead time constant Ta equal to the integral regulator time constant multiplied by the gain (Ta = Ti*Kp); and **P85**, filter constant in ms.

**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 Kp 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**.

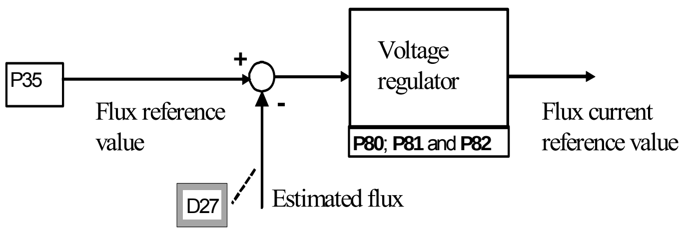
## 2.2.5 VOLTAGE/FLUX CONTROL




| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| PRC_FLX_REF | P35 - Flux Reference | 0.0 | 120.0 | 100 | % MOT_FLX_NOM | 40.96 |
| V_REF_COEFF | P36 - Kv Max operating voltage multiply factor | 0.0 | 100.0 | 100 | | 327.67 |
| PRC_FLX_MIN | P52 - Minimum Flux admitted | 0.0 | 100.0 | 2 | % MOT_FLX_NOM | 40.96 |
| V_REG_KP | P80 - Kpi voltage regulator proportional gain | 0.1 | 100.0 | 9.1 | | 10 |
| V_REG_TF | P82 - Tfi voltage regulator (filter) time constant | 0.0 | 1000.0 | 11 | ms | 10 |
| MOD_INDEX_MAX | P122 - Max. modulation index | 0.500 | 0.995 | 0.98 | | 1000 |
| PRC_V_REF_DCBUS | P125 - Voltage reference function of DC bus | 0.0 | 100.0 | 96.00 | % | 327.67 |
| PRC_V_REG_KP_COEFF | P127 - KpV Corrective coeff. estimated Kp for voltage loops | 0.0 | 200.0 | 100 | % | 40.96 |
| V_DELAY_COMP | P161 - PWM delay compensation on the voltages | -800.0 | 800.2 | 50.0 | % TPWM | 40.96 |
| V_REF | D09 - Voltage reference value at max. rev. | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| MOT_V | D17 - Stator voltage reference value module | | | 0 | V rms | 16 |
| PRC_MOT_V | D18 - Stator voltage reference value module | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| MOD_INDEX | D19 - Modulation index | -100 | 100 | 0 | | 40.96 |
| MOT_FLX | D27 - Motor Flux | | | 0 | % MOT_FLX_NOM | 40.96 |

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.**

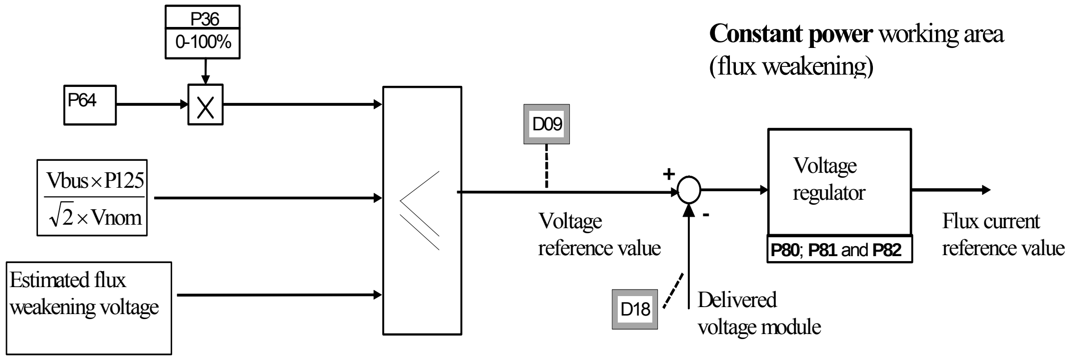
**Constant torque working area**




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**):

- o Parameter **P64** “Maximum operating voltage” multiplied by coefficient **P36;**
- o 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 √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 Kp; **P81**, time in ms of the lead time constant Ta equal to the integral regulator time constant multiplied by the gain (Ta = Ti*Kp); and **P82**, filter constant in ms.

**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 Kp and Ta flux loop"
The voltage/flux regulator limit is normally set at ± 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.

## 2.2.5.1 STARTUP WITH A MOTOR MAGNETIZED

**C38** provides 3 different ways for starting up the motor:

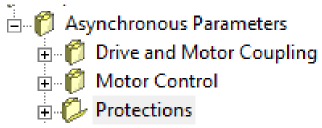
| | | |
|---|---|---|
| C38=0 | Standard operation | When RUN is enabled, the machine is magnetized with the maximum delivered torque at zero for a time equal to P29. The flux is then checked to see whether it exceeds the minimum (P52). If it does, the torque is "freed", if it does not the drive triggers 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.<br><br>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 ≠ 0 in that a voltage ≠ 0 may be created on terminals U,V,W without enabling the RUN command**

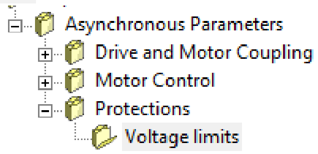
### 2.2.5.2 WAIT FOR MOTOR DEMAGNETIZING

When the drive is switched off it is dangerous to switch on immediately, due to the unknown magnetic flux position that could produce a motor over–current. The only chance it's to wait the time needed for the magnetic flux to reduce itself with its time constant that depend on the motor type and can vary from few milliseconds to hundreds of milliseconds.
For this reason has been introduced the parameter **P28** that set the wait time after power switch off after that, it's possible to switch on the power another time: also if the user gives the RUN command during this wait time, the drive waits to complete it before enabling another time the power.
Parameter P28 is defined in time units of 100us so the default value 10000 correspond to 1 second.

## 2.3 PROTECTION




### 2.3.1 VOLTAGE LIMITS




| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| MAIN_SUPPLY | P87 - Main Supply voltage | 180.0 | 780.0 | 400 | V rms | 10 |
| DCBUS_MIN_MAIN_LOST | P97 - Minimum voltage level for forced mains off | 100.0 | 1200.0 | 425 | V | 10 |
| DCBUS_REF_MAIN_LOST | P98 - Voltage reference value in Support 1 | 220.0 | 1200.0 | 600 | V | 10 |
| DCBUS_REG_KP | P86 - Kp3 Bus control proportional gain | 0.05 | 10.00 | 3.5 | | 100 |
| KP_DCBUS | P105 - Corrective factor for Bus voltage | 80.0 | 200.0 | 100 | % | 10 |
| DCBUS_MIN | P106 - Minimum voltage of DC Bus | 220.0 | 1200.0 | 400 | V | 10 |
| DCBUS_MAX | P107 - Maximum voltage of DC Bus | 350.0 | 1200.0 | 800 | V | 10 |
| DCBUS_BRAKE_ON | P108 - Bus voltage threshold for brake ON | 350.0 | 1200.0 | 770 | V | 10 |
| DCBUS_BRAKE_OFF | P109 - Bus voltage threshold for brake OFF | 350.0 | 1200.0 | 760 | V | 10 |
| DCBUS_REF | P123 - Smart brake voltage cut-in level | 300.0 | 1200.0 | 750 | V | 10 |
| RECT_BRIDGE_SEL | C45 - Rectification bridge 0 = diodes, 1 = semicontrolled | Range<br>0 Diods<br>1 Half controller bridge | | 0 | | 1 |
| PW_SOFT_START_TIME | P154 - Soft start enabling time | 150 | 19999 | 500 | ms | 1 |
| MAIN_LOST_SEL | C34 - Managing mains failure | Range<br>0 Trying to work<br>1 Recovery<br>2 Free<br>3 Emergency brake | | 0 | | 1 |
| ALL_RST_ON_MAIN | C35 - Automatic alarm reset when mains back on | 0 | 1 | 0 | | 1 |
| EN_DCBUS_MAX_CTRL | C47 - Enable smart brake | 0 | 1 | 0 | | 1 |
| EN_PW_SOFT_START | C37 - Enable soft start | 0 | 1 | 1 | | 1 |
| DC_BUS | D24 - Bus voltage | | | 0 | V | 16 |

## 2.3.1.1 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 connection 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

| C37 | A03 | Mains Presence | Soft start enable | oL10 |
|---|---|---|---|---|
| X | H | X | OFF | L |
| X | L | X | OFF | L |
| 0 | L | X | OFF | L |
| 1 | L | L | OFF | L |
| 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.**

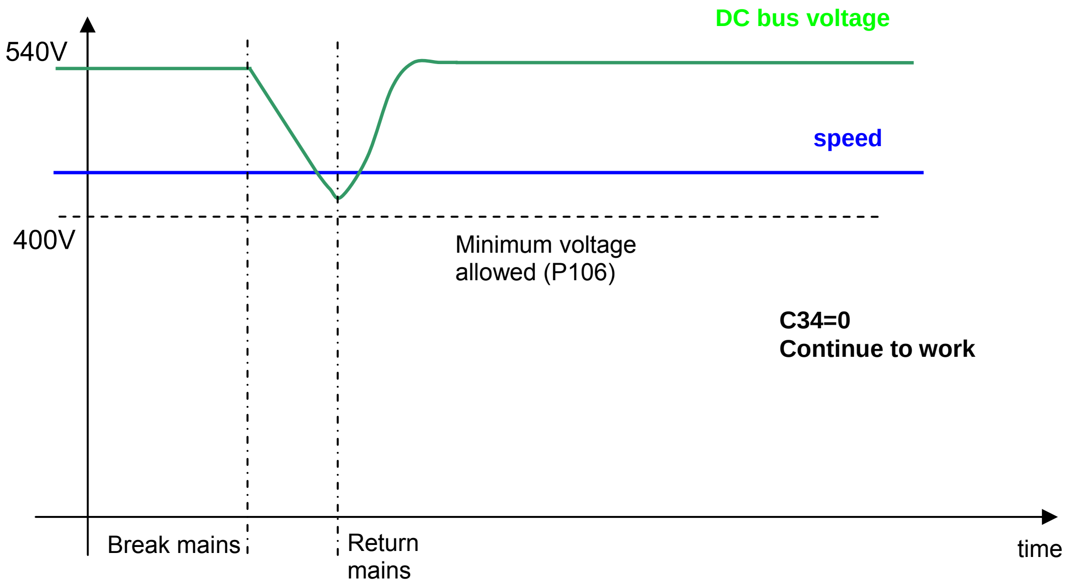
## 2.3.1.2 VOLTAGE BREAK CONTROL FOR MAINS FEEDING

The mains break control is configurable through the following connections:

| Name | Description |
|---|---|
| MAIN_LOST_SEL | C34 - Managing mains failure |
| ALL_RST_ON_MAIN | C35 - Automatic alarm reset when mains back on |

## 2.3.1.2.1 CONTINUING TO WORK (C34=0; DEFAULT)

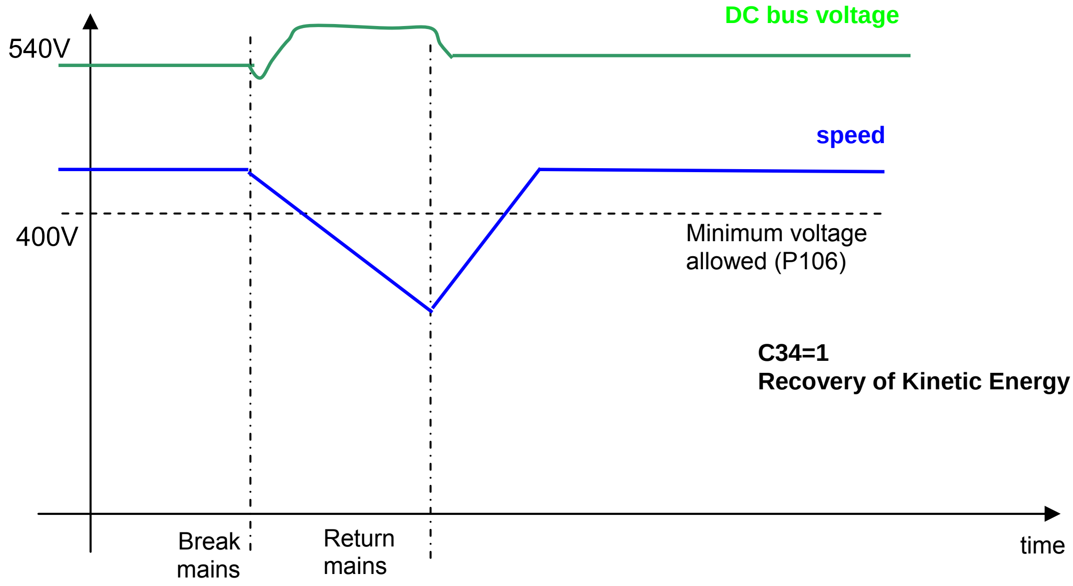
This operating procedure is adapted to those applications in which it is fundamental to have unchanged working conditions in each situation. Setting C34=0 the drive, even if the mains supply voltage is no longer available, continues to work as though nothing has been modified over the control, pulling 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.

## 2.3.1.2.2 RECOVERY OF KINETIC ENERGY (C34=1)

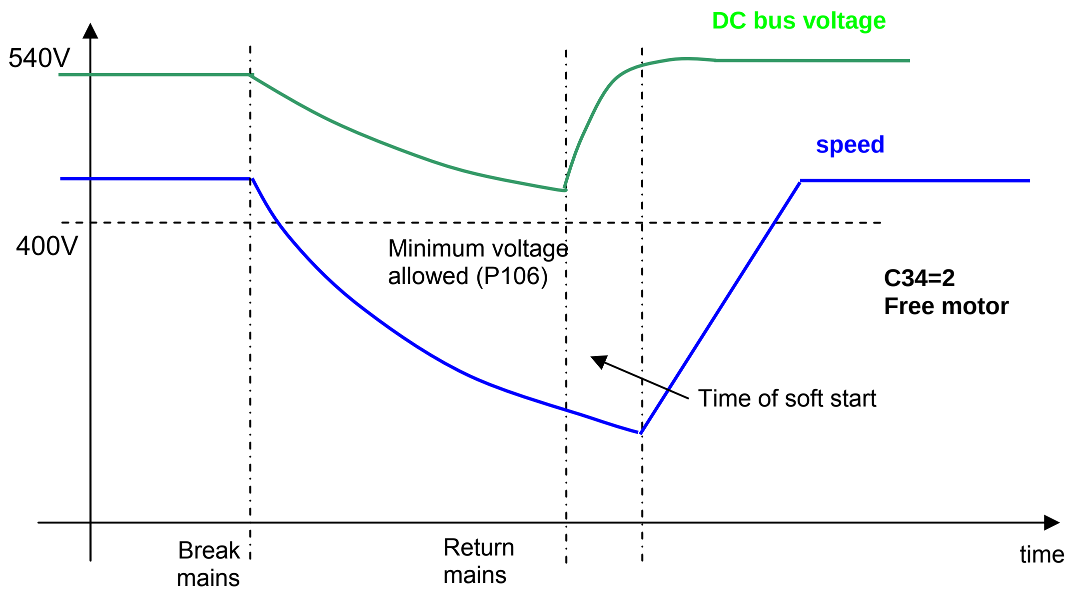
This operating procedure is adapted to those applications in which it is temporarily possible to reduce the speed of rotation to confront the mains break. This function particularly adapts in the case of fewer applied motors and with high energy.
The qualification of such a function is obtained setting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

### 2.3.1.2.3 OVERCOMING MAINS BREAKS OF A FEW SECONDS WITH FLYING RESTART (C34=2)

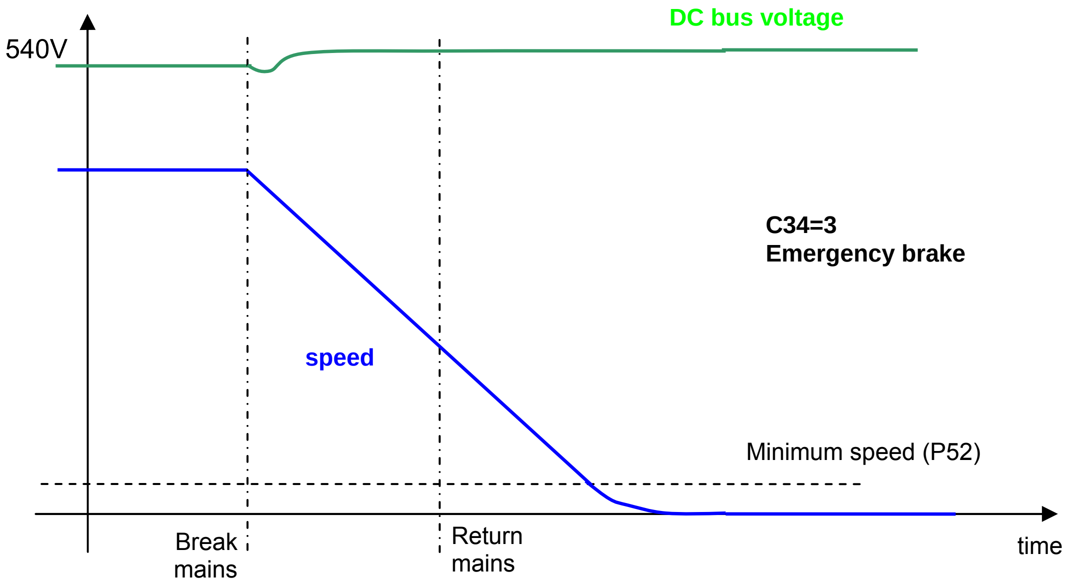
This operating procedure is adapted to those applications in which it is fundamental to not go into alarm in the case of mains break out and is temporarily prepared to disable the power in order for the motor to resume when the mains returns.
The qualification of such a function is obtained setting C34=2.
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.

## 2.3.1.2.4 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.

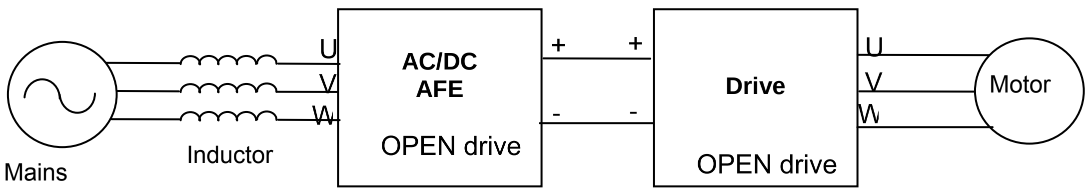



## 2.3.1.3 BRAKING MANAGEMENT

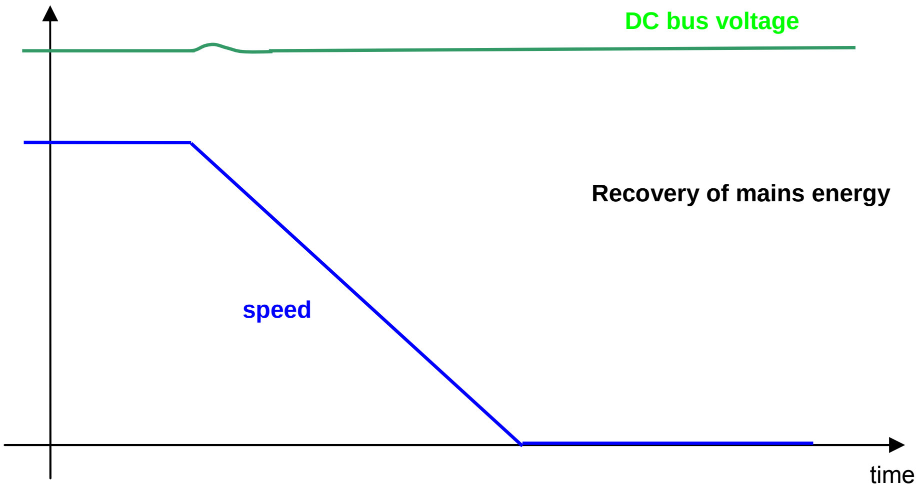
The drive is in a position to work on four quadrants, therefore is also in a position to manage the motor recovery Energy. There are three different, possible controls:

## 2.3.1.3.1 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.

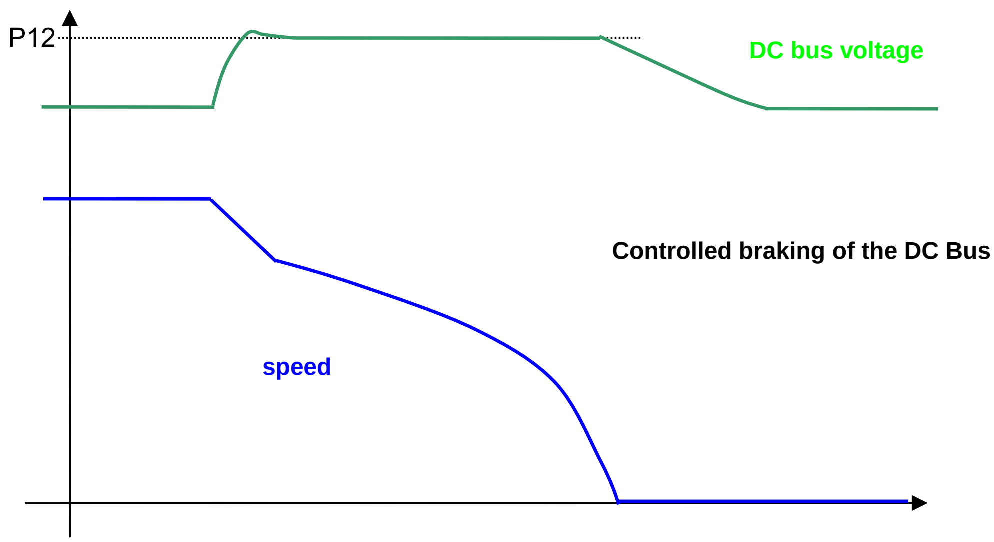


The use of an AC/DC AFE permits a controlled voltage level of the intermediate power (DC Bus) and raises to best control the motors winded to a voltage close to the line voltage. The drive's dynamic behavior results in a way that optimizes the work as motor or generator.
There is a possibility to connect 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.



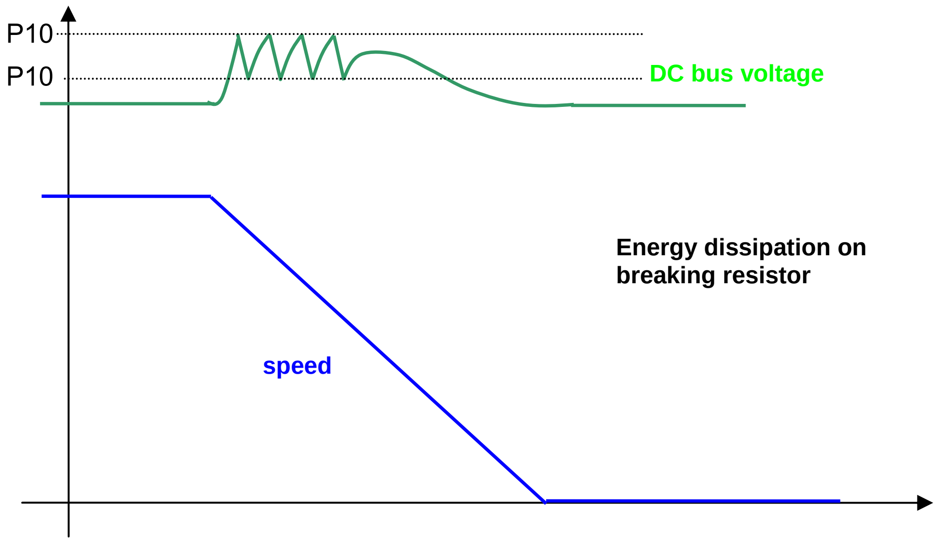

### 2.3.1.3.2 BRAKING WITH DC BUS CONTROL (C47=1)

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.



## 2.3.1.3.3 KINETIC ENERGY DISSIPATION ON BREAKING RESISTANCE

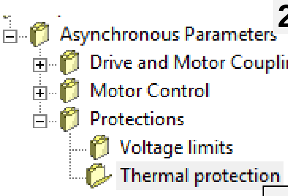
The standard solution for the OPEN drive is the dissipation of kinetic Energy on braking resistor. All the OPEN drives are equipped with an eternal braking circuit, while the braking resistor must be connected externally, with the appropriate precautions.
With this solution, the Bus' maximum level of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




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**.




## 2.3.2 THERMAL PROTECTION

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| MOT_THERM_PRB_SEL | C46 - Enable motor thermal probe management (PTC/NTC) | Range<br>0<br>1<br>2<br>3<br>4 | <br>No<br>PTC<br>NTC<br>I23<br>KTY84-130 | 1 | | 1 |
| MOT_TEMP_MAX | P91 - Maximum motor temperature (if read with PT100) | 0.0 | 150.0 | 130 | °C | 10 |
| DRV_THERM_PRB_SEL | C57 - Enable radiator heat probe management (PTC/NTC) | 0 | 1 | 1 | | 1 |
| MOT_PRB_RES_THR | P95 - Motor NTC or PTC resistance value for alarm | 0 | 19999 | 1500 | Ohm | 1 |
| PRC_MOT_DO_TEMP_THR | P96 - Motor thermal logic output 14 cut-in threshold | 0.0 | 200.0 | 100 | % PRC_MOT_I_THERM | 40.96 |
| KP_MOT_THERM_PRB | P115 - Multiplication factor for motor PTC/NTC/PT100 analog reference value | 0.00 | 200.00 | 100 | | 163.84 |
| KP_DRV_THERM_PRB | P117 - Multiplication factor for radiator PTC/NTC analog reference value | 0.00 | 200.00 | 100 | | 163.84 |
| DRV_TEMP_MAX | P118 - Max. temperature permitted by radiator PTC/NTC | 0.0 | 150.0 | 90 | °C | 10 |
| DRV_START_TEMP_MAX | P119 - Max. temperature permitted by radiator PTC/NTC for start-up | 0.0 | 150.0 | 75 | °C | 10 |
| DRV_DO_TEMP_THR | P120 - Radiator temperature threshold for logic output o.15 | 0.0 | 150.0 | 80 | °C | 10 |
| EN_MOT_THERMAL_ALL | C32 - Motor thermal switch ' Block drive ? | 0 | 1 | 1 | | 1 |
| MOT_THERM_CURV_SEL | C33 - Auto-ventilated thermal motors | Range<br>0<br>1<br>2<br>3 | | 0 | | 1 |
| DRV_TEMP | D25 - Radiator temperature reading | | | 0 | °C | 16 |
| MOT_TEMP | D26 - Motor temperature | | | 0 | °C | 16 |
| REG_CARD_TEMP | D40 - Regulation card temperature | | | 0 | °C | 16 |
| MOT_PRB_RES | D41 - Thermal probe resistance | | | 0 | Ohm | 1 |
| PRC_DRV_I_THERM | D28 - Motor thermal current | -100 | 100 | 0 | % soglia All | 40.96 |

### 2.3.2.1 MOTOR THERMAL PROTECTION

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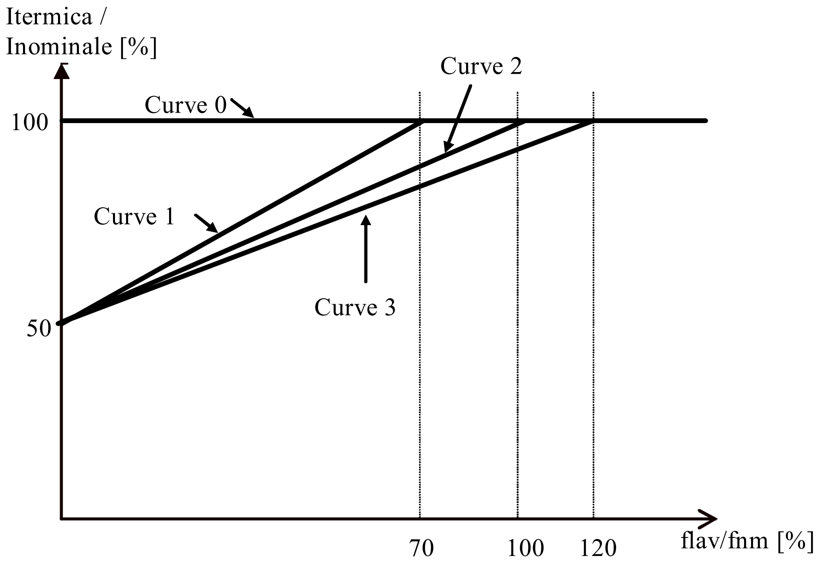
Parameters **P70** (thermal current as a % of the rated motor current), **P71** (motor thermal constant in seconds) and the current delivered by the drive are used to calculate the presumed operating temperature of the motor considering an ambient temperature equal to the permitted maximum; the losses 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.

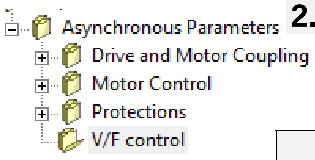
Internal value d28 and analog output 28 display a second-by-second reading of the motor thermal current as a percentage of the rated motor current. When 100% is reached, the motor thermal switch cuts in.
**P96** can be set with an alarm threshold which, when breached, commutes logic output **o.L.14** 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 |

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 | Visualizationin d26 |
|---|---|---|
| 0 | No motor thermal protection enabled | |
| 1 | **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 (D41) |
| 2 | **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 (D41) |
| 3 | **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** | ----- |
| 4 | KTY84 | Motor temperature (D26) |




## 2.4 V/F CONTROL

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| EN_VF_CNTL | C80 - Enable V/f control | 0 | 1 | 0 | | 1 |
| PRC_VF_SLIP_CMP | P170 - Slip motor compensation | 0.0 | 400.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| VF_TF_SLIP_CMP | P171 - Slip compensation factor filter | 0.0 | 150.0 | 35.0 | ms | 10 |
| PRC_VF_BOOST | P172 - Stator voltage drop compensation | 0.0 | 400.0 | 70.0 | % PRC_DELTA_VRS | 40.96 |
| VF_EN_DCJ | C83 - Enable dc brake | 0 | 1 | 0 | | 1 |
| PRC_VF_DCJ_I_MAX | P173 - Current limit during continuous braking | 0.0 | 100.0 | 100.0 | % DRV_I_NOM | 40.96 |
| PRC_VF_DCJ_F_MAX | P174 - Continuous breaking maximum frequency limit | 0.0 | 100.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| VF_EN_CHR_AUTOSET | C88 - Calculate V/f characteristic nominal knee | 0 | 1 | 0 | | 1 |
| PRC_VF_CHR_V1 | P175 - V/f characteristic point 1 voltage | 0.0 | 100.0 | 0.0 | % PRC_MOT_V_MAX | 40.96 |
| PRC_VF_CHR_F1 | P176 - V/f characteristic point 1 frequency | 0.0 | 100.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| PRC_VF_CHR_V2 | P177 - V/f characteristic point 2 voltage | 0.0 | 100.0 | 0.0 | % PRC_MOT_V_MAX | 40.96 |
| PRC_VF_CHR_F2 | P178 - V/f characteristic poitn 2 frequency | 0.0 | 100.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| PRC_VF_V_REG_D | P183 - Voltage regulator derivative coefficient multiplying term | 0.0 | 100.0 | 100.0 | % | 327.67 |
| VF_EN_SEARCH | C84 - Enable search during motor rotation | Range<br>0<br>1<br>2<br>3<br>4 | <br>No<br>Freq +<br>Freq -<br>Rif 0 +<br>Rif 0 - | 0 | | 1 |
| PRC_VF_FSTART_SEARCH | P184 - Initial search frequency with rotating motor | 0.0 | 100.0 | 100.0 | % PRC_MOT_F_MAX | 40.96 |
| PRC_VF_FMIN_SEARCH | P185 - Minimum search frequency with rotating motor | 0.0 | 100.0 | 2.9 | % PRC_MOT_F_MAX | 40.96 |
| PRC_VF_T_MAX_SEARCH | P191 - Torque limit during fly restart | 0.0 | 100.0 | 150.0 | % DRV_T_NOM | 40.96 |
| VF_EN_STALL_ALL | C82 - Enable stall alarm | 0 | 1 | 1 | | 1 |
| VF_STALL_TIME | P186 - Working time during limit | 1 | 100 | 30 | s | 40.96 |
| PRC_VF_V_MAX_STATIC | P187 - Vs amplitude maximum static value | 0.0 | 100.0 | 97.5 | % PRC_MOT_V_MAX | 327.67 |
| VF_EN_ENGY | C86 - Enable energy saving | 0 | 1 | 0 | | 1 |
| VF_TI_ENGY | P188 - Energy saving regulator filter time constant | 100 | 2000 | 400 | ms | 1 |
| PRC_VF_FLX_MIN_ENGY | P189 - Energy saving admissible minimum flux | 0.0 | 100.0 | 20.0 | % MOT_FLX_NOM | 40.96 |
| VF_TF_I_MAX_AL | P190 - Current alarm filter | 0.0 | 150.0 | 10.0 | ms | 10 |
| VF_EN_OPEN_LOOP | C85 - Enable open loop working state | Range<br>0<br>1<br>2 | <br>No<br>Imax in V/f<br>Imax in V | 0 | | 1 |
| VF_EN_BYPASS | C87 - Enable flux angle bypass - frequency input | 0 | 1 | 0 | | 1 |

### 2.4.1 AUTOMATIC SETTING OF WORKING VOLTAGE/FREQUENCY

"V/f control" manages the an asynchronous motor without feedback.
This type of control has a good dynamic performance also in flux weakening area (4-5 times base frequency) and it's able to start the motor also with high load (2 times the nominal motor torque), but

it's no useful in that application where it's necessary to produce torque in steady state at frequency below 1Hz (in this case we recommend to use a motor with feedback and a Vector control).

To enable the voltage-frequency control set C80=characteristic

The most easier way to set the voltage-frequency characteristic is to use the automatic procedure. First of all set the maximum motor voltage (P64) and the maximum working speed (P65) and then set C88=1 .

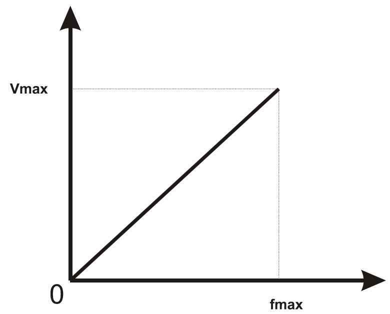
| Name | Description |
|---|---|
| PRC_MOT_V_MAX | P64 - Max. operating voltage |
| MOT_SPD_MAX | P65 - Max. operating speed (n MAX) |
| VF_EN_CHR_AUTOSET | C88 - Calculate V/f characteristic nominal knee |

Automatically the drive set the voltage-frequency characteristic in two possible way:

1. Linear way :

In this case, none characteristic points are set (P174-P175-P176-P177=0) and the maximum operating voltage P64 is set:

$$P64 = \frac{f_{max}}{f_{nom}}$$

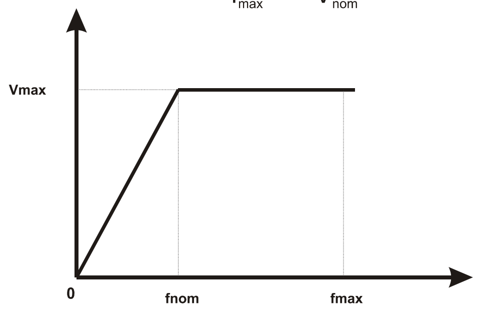



2. Characteristic FLUX WEAKENING AREA:
3.

When the maximum motor frequency is greater than nominal frequency automatically is set one characteristic point into nominal knee:

P175= 100%

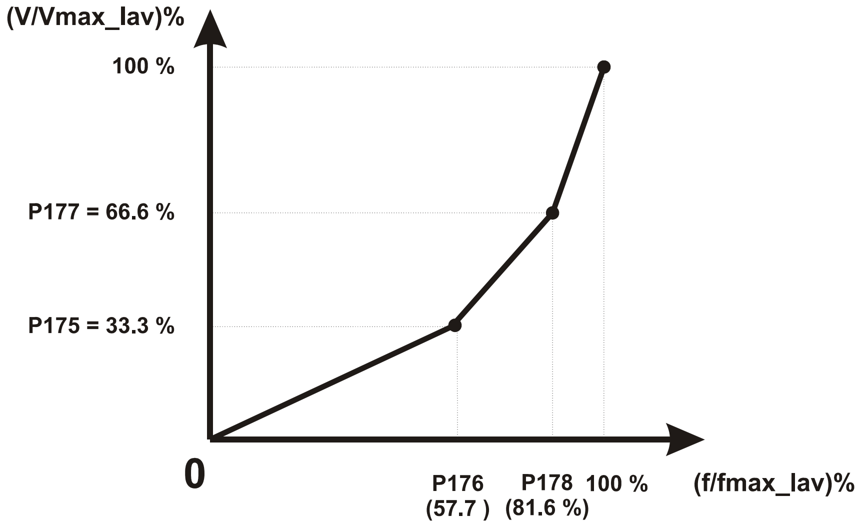
$$P176 = \frac{f_{nom}}{f_{max}} \times \frac{V_{max}}{V_{nom}}$$




## 2.4.2 MANUAL SETTING OF WORKING VOLTAGE/FREQUENCY CHARACTERISTIC

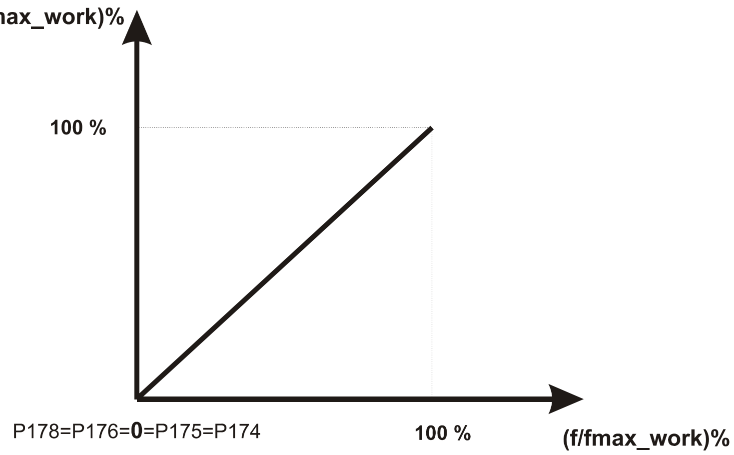
Using the parameters P175 , P176 , P177 and P178 it is possible to define a three-section working curve by points (so as to be better able to adjust to the desired characteristics).

Points P176 and P178 define the frequency percentage with reference to the maximum working frequency while points P175 and P177 define the percentage voltage with reference to the maximum working voltage (P64).
The following curve should clarify the explanation.



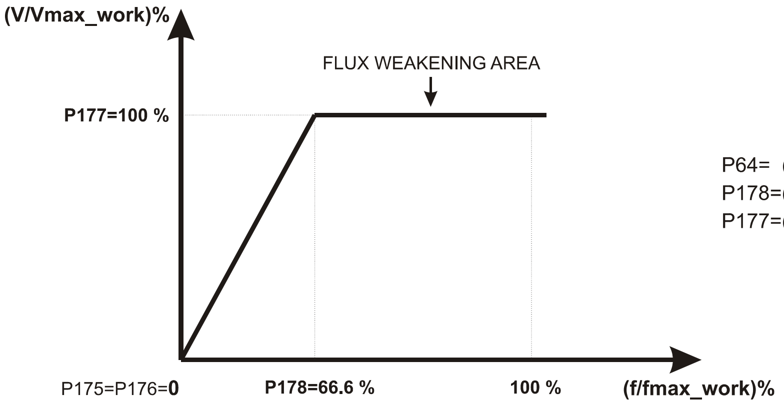

"TYPICAL CURVE WITH QUADRATIC TORQUE LOAD"

If a number of points which is less than two is sufficient to define the curve just program at 0 the frequencies of the points which are not used (P176 and/or P178), so that they will not be considered in the interpolation.
There are some limitations on setting the characteristic:
- Frequencies (P176 and P178) must be in rising order and the distance between two adjacent points must be greater than 5%
- Corresponding voltages (P175 and P177) must be in rising order.
If this limitations are not respected the system doesn't take in account the point whose component was set wrongly and it is cleared to 0. Every time one of this parameters (from P175 to P178) is changed, it is better to verify if the system has accepted the new value.
A linear type Voltage-Frequency characteristic is provided for the default for which P175=P176=P177=P178=0.




**STANDARD CURVE FOR A MOTOR WORKING IN CONSTANT TORQUE IN ALL ITS CHARACTERISTICS**

As an example we calculate the settings of the parameters in the case of a motor with a rated voltage of 380 Volts and a frequency of 50 Hz, which we want to work at full flux up to 50 Hz and a constant voltage from 50 Hz to 75 Hz.
Having traced the desired voltage-frequency we see that to program it is sufficient to use only one section point (see diagram).
From the maximum speed frequency desired (P65) and from the maximum working voltage (P64) we can calculate the P177 and P178 values with reference to the maximum values, while P175 and P176 will remain at 0.




P64= (380/380) * 100.0 = 100%
P178=(50/75) * 100.0 = 66.6%
P177=(380/380) * 100.0 = 100%

**CURVE FOR MOTOR WORKING ALSO IN FLUX WEAKENING AREA**

## 2.4.3 LOAD EFFECT COMPENSATION

### 2.4.3.1 VOLTAGE STATOR DROP COMPENSATION (START UP UNDER LOAD)

Using P36 parameter it is possible to increase the voltage value at low frequencies so as to compensate for the drop due to the stator resistance and so as to be able to have current and the refore torque even in the start up phase; this is necessary if the motors starts up under load. The value which can be set refers to the drop voltage on the Stator Resistor (P66) and can be adjusted from 0 up to a maximum of 400.0%. Particular care must be taken in setting the P172 value as it determines the current values fed at low speed: a value too low for P30 results in limiting the torque of the motor, while a value too high results in feeding high currents at low speed, whatever the load condition is.
In the start up under load it is useful to introduce a waiting time on the common ‘converter running so that the motor can magnetize itself, so that it has from the outset the torque expected available. The **P29** parameter makes it possible to quantify this wait time in milliseconds, in which the system is in an on-line state, but the frequency reference is forcibly held at 0. The most suitable value for P29 should be chosen according to the rating of the motor and the load conditions, but in any case should be from a minimum of 400ms for motors of 7.5 KW up to 1s for motors of 55KW.

### 2.4.3.2 SLIP COMPENSATION

By using parameter **P170** it is possible to partly compensate for the motor’s fall in speed when it takes up the load; the adjustment is in fact that regulation of motor controls stator frequency and does not control the real speed.
This compensation is obtained by increasing the motor’s working frequency by a quantity which is proportional to the percentage working torque multiplied by the percentage value set in P170 , in relation to the motor’s rated frequency.
The value to be set depends both on the motor’s rating and poles, in any case it can in general terms vary from 4% for a 7.5 KW motor to 1,8 - 2.0% for 45 KW motors. In default the compensation is excluded P170 = 0.

## 2.4.4 PARTICULAR CONTROL FUNCTIONS

### 2.4.4.1 MOTOR FLYING RESTART

Since the driver has a maximum current limit it can always be started running with no problems even if the motor is already moving, for example, by inertia or dragged by part of the load. In that event, on starting up, given that normally the frequency reference starts from values close to zero to gradually rise with the ramp times to the working value, the motor is first subjected to a sudden deceleration, within the limit, to then hook onto the reference and follow it with the ramp; this may be undesirable from a mechanical standpoint, and the process could also trigger the overvoltage alarm for converters which do not have a braking device. To avoid this it is possible to suitably program connection **C84** , “Enable motor flying restart“, which makes it possible to identify the speed of rotation of the motor, stressing it as little as possible, and to position the output reference from the ramp at a value corresponding to that rotation so as to start from that reference to then go on to working values. This motor search function is primarily in one direction and thus needs to know in advance the direction of rotation of the motor, positive frequency or negative frequency, which must be programmed in C84 ; if the selection is wrong the motor is first braked to about zero speed to then follow the reference to go to working speed (as if the search function had not been used). If there is a passive load and the inertia keeps the motor in rotation, it’s possible to select a search dependently upon the sign of enabled frequency reference (C84=3-4).
There are two different values for C84 to enable this kind of search, the only difference is for manage the case in which the frequency reference was zero: in this particular situation with C84=3 the system searches for positive frequency, while with C84=4 the search will be made for negative frequency.
The C50 connection has five programming values which are selected as indicated below :

- C84=0 flying restart doesn’t enabled
- C84=1 flying restart managed with positive frequency quadrant search
- C84=2 flying restart managed with negative frequency quadrant search
- C84=3 flying restart managed dependently upon the sign of enabled frequency reference (like C84=1 for 0)
- C84=4 flying restart managed dependently upon the sign of enabled frequency reference (like C84=2 for 0)

The start frequency in motor flying restart can be set in parameter **P184** (default 100%) in percentage of maximum frequency. This parameter can help the search algorithm limiting the range of frequency. With parameter **P185** it’s possible to set the minimum target frequency in order to inject an active current also if the motor is stopped.
If the maximum frequency is greater than 250% of nominal motor frequency could be some problems in the motor flying restart because it’s difficult to inject the active current with a slip so high. In that case the only possibility is to reduce the start search frequency (with P184) on condition that really the motor cannot run more quickly.

**If it’s enabled the motor flying restart, the power is switch-on with the motor standstill and there is low load, it’s possible to have a transient initial state in which the motor starts running in the searching sense.**

If the flying restart doesn’t work correctly it’s possible to increase the reserved parameter **P191** (default value 5%) for increase the admitted search window .
In default the flying restart isn’t managed ( C84=0 )

# 3 STANDARD APPLICATION

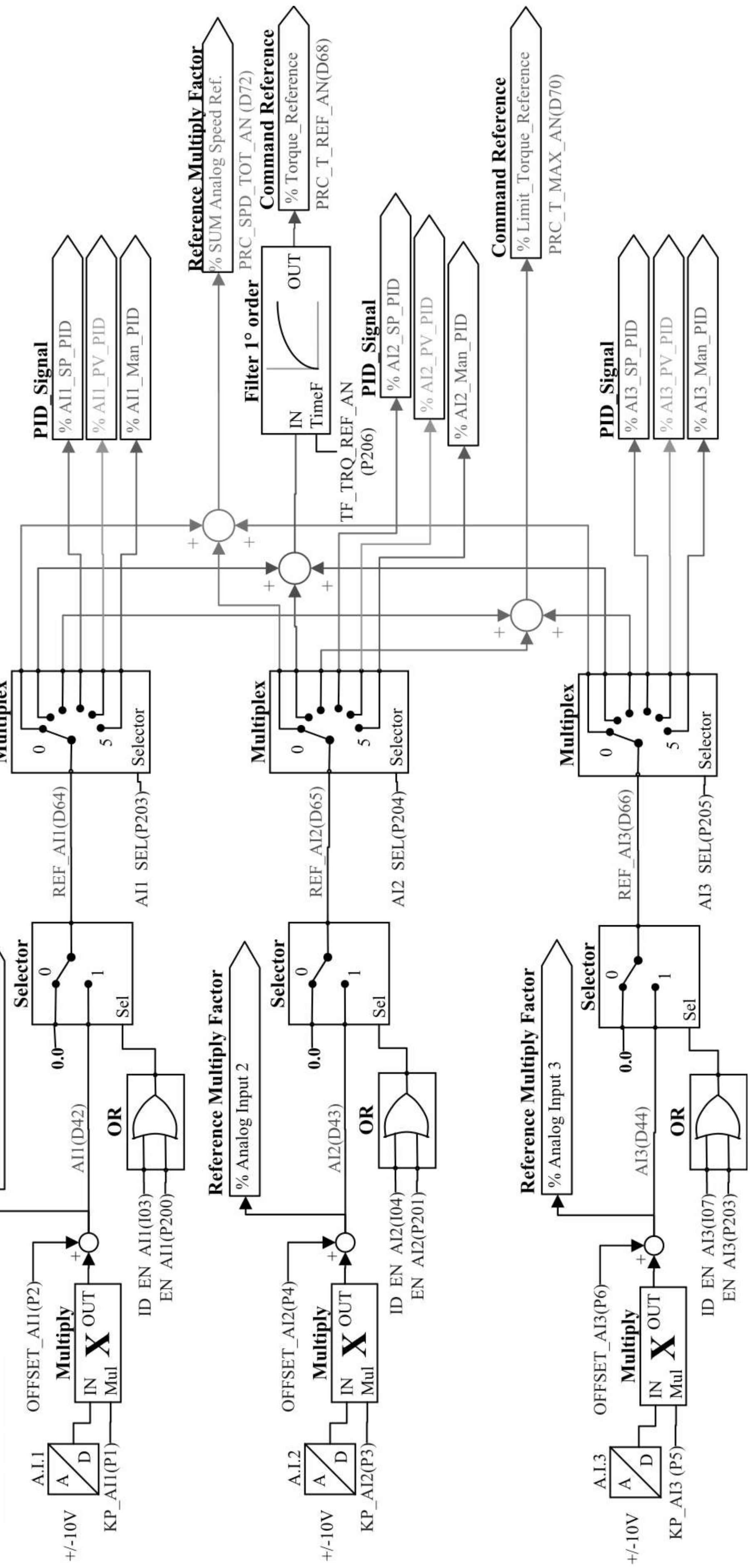
## 3.1 INPUT

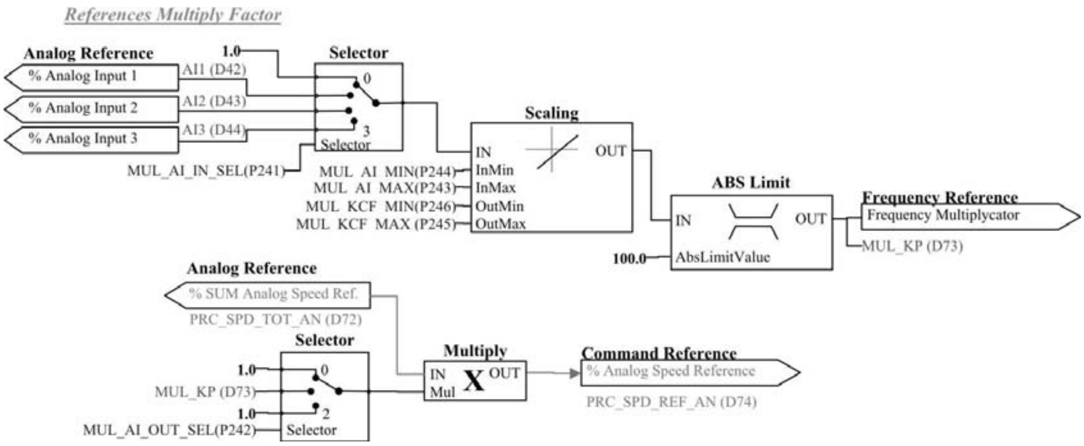
### 3.1.1 ANALOG REFERENCE

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| KP_AI1 | P01 - Corrective factor for analog reference 1 (AUX1) | -400.0 | 400.0 | 100 | % | 10 |
| OFFSET_AI1 | P02 - Corrective offset for analog reference 1 (AUX1) | -100.0 | 100.0 | 0 | % | 163.84 |
| AI1 | D42 - Analog Input AI1 | -100 | 100 | 0 | % | 163.84 |
| EN_AI1 | P200 - Enable analog reference value A.I.1 | 0 | 1 | 0 | | 1 |
| REF_AI1 | D64 - Reference from Analog Input AI1 | -100 | 100 | 0 | % | 163.84 |
| AI1_SEL | P203 - Meaning of analog input A.I.1 | Range<br>0 Speed ref.<br>1 Torque ref.<br>2 Torque limit ref.<br>3 Set point PID<br>4 Feedback PID<br>5 Manual set point PID | | 0 | | 1 |
| KP_AI2 | P03 - Corrective factor for analog reference 2 (AUX2) | -400.0 | 400.0 | 100 | % | 10 |
| OFFSET_AI2 | P04 - Corrective offset for analog reference 2 (AUX2) | -100.0 | 100.0 | 0 | % | 163.84 |
| AI2 | D43 - Analog Input AI2 | -100 | 100 | 0 | % | 163.84 |
| EN_AI2 | P201 - Enable analog reference value A.I.2 | 0 | 1 | 0 | | 1 |
| REF_AI2 | D65 - Reference from Analog Input AI2 | -100 | 100 | 0 | % | 163.84 |
| AI2_SEL | P204 - Meaning of analog input A.I.2 | Range<br>0 Speed ref.<br>1 Torque ref.<br>2 Torque limit ref.<br>3 Set point PID<br>4 Feedback PID<br>5 Manual set point PID | | 1 | | 1 |
| KP_AI3 | P05 - Corrective factor for analog reference 3 (AUX3) | -400.0 | 400.0 | 100 | % | 10 |
| OFFSET_AI3 | P06 - Corrective offset for analog reference 3 (AUX3) | -100.0 | 100.0 | 0 | % | 163.84 |
| AI3 | D44 - Analog Input AI3 | -100 | 100 | 0 | % | 163.84 |
| EN_AI3 | P202 - Enable analog reference value A.I.3 | 0 | 1 | 0 | | 1 |
| REF_AI3 | D66 - Reference from Analog Input AI3 | -100 | 100 | 0 | % | 163.84 |
| AI3_SEL | P205 - Meaning of analog input A.I.3 | Range<br>0 Speed ref.<br>1 Torque ref.<br>2 Torque limit ref.<br>3 Set point PID<br>4 Feedback PID<br>5 Manual set point PID | | 2 | | 1 |
| TF_TRQ_REF_AN | P206 - Filter time constant for analog torque reference value | 0.0 | 20.0 | 0 | ms | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PRC_T_REF_AN | D68 - Analog Torque reference from Application | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_APP_T_REF | D10 - Torque reference value (application generated) | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_T_MAX_AN_POS | D70 - Analog Torque Max from Application | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_APP_T_MAX | D32 - Maximum torque imposed (application generated) | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| MUL_AI_IN_SEL | P241 - Multiplication factor selection | 0 | 4 | 0 | | 1 |
| MUL_AI_OUT_SEL | P242 - Multiplication factor target | 0 | 2 | 0 | | 1 |
| MUL_AI_MAX | P243 - Max analog input value for multiplication factor | -180.00 | 180.00 | 100.0 | % A.I. | 163.84 |
| MUL_AI_MIN | P244 - Min analog input value for multiplication factor | -180.00 | 180.00 | 0.0 | % A.I. | 163.84 |
| MUL_KCF_MAX | P245 - Multiplication factor with max analog input (MUL_AI_MAX) | -100.0 | 100.0 | 1.0 | | 100 |
| MUL_KCF_MIN | P246 - Multiplication factor with min analog input (MUL_AI_MAX) | -100.0 | 100.0 | -1.0 | | 100 |
| STR_MUL_AI | P248 - Storing input multilpicative factor | 0 | 2 | 0 | | 1 |
| PRC_SPD_TOT_AN | D72 - Speed reference from AI1 + AI2 + AI3 | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| MUL_KP | D73 - Multiplication factor | -100.0 | 100.0 | 0 | % | 16 |
| PRC_SPD_REF_AN | D74 - Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_APP_SPD_REF | D33 - Speed reference (application generated) | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |

## *Analog References*






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

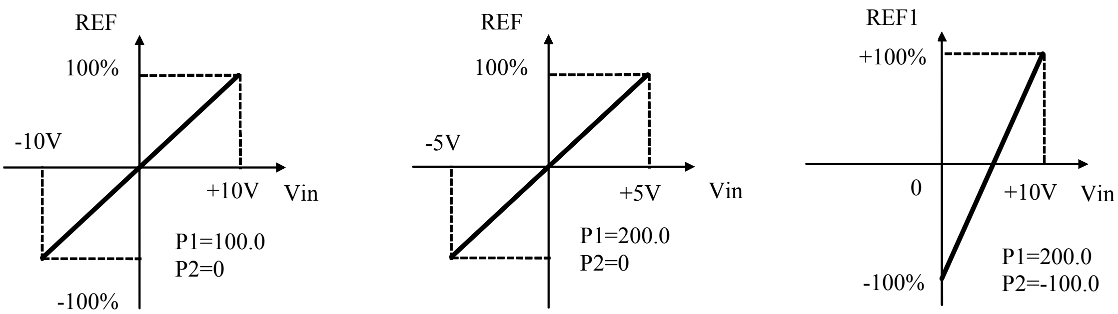
There can be up to 3 differential analog inputs (A.I.1 ÷ A.I.3) ± 10V which, after being digitally converted with a resolution of 14 bits, can be:

- conditioned by digital offset and a multiplicative coefficient
- enabled independently through configurable logic inputs or connections
- configured as meaning through the corresponding connection (**P203** ÷ **P205**)
- added together for the references with the same configuration

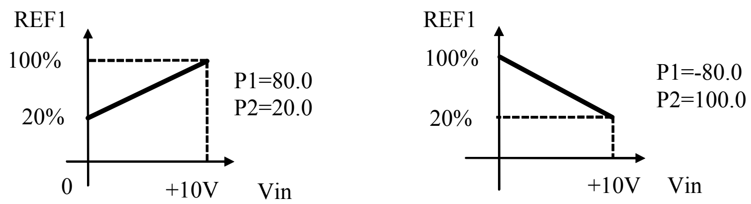
For example in the case of A.I.1, the result of the conditioning is given by the following equation:

**REF1= ((A.I.1/10)*P1) + 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.




**Default setting**




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 ⟹ 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 **P200** or the input logic function **I03** can be used, with the default allocated to logic input 3.
The connections P203 ÷and P205 are used to separately configure the three analog inputs available:

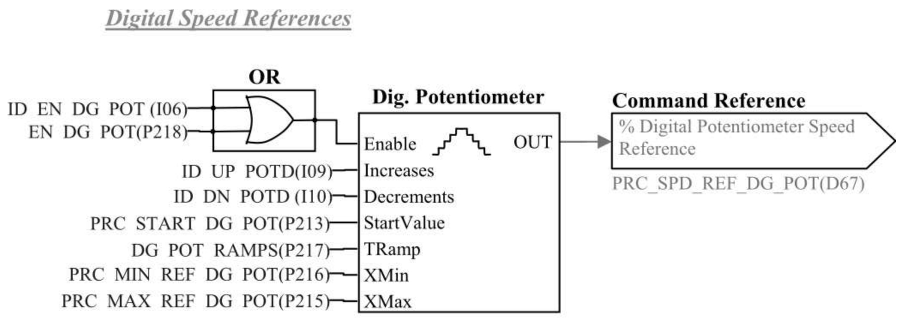
| C203 ÷ C205 | Description |
|---|---|
| 0 | Speed ref. |
| 1 | Torque ref. |
| 2 | Torque limit ref. |
| 3 | Set point PID |
| 4 | Feedback PID |
| 5 | Manual set point PID |

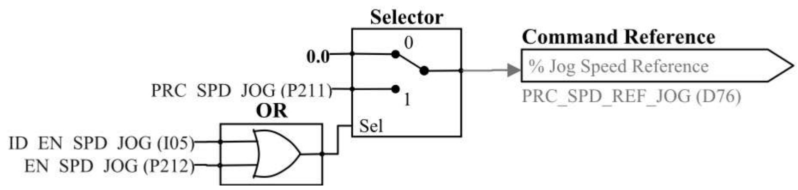
Several inputs can be configured to the same meaning so that the corresponding references, if enabled, will be added together.
Note: using the appropriate multiplicative coefficient for each reference it is therefore possible to execute the subtraction of two signals.
In the case of the torque limit, 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 P206. In the internal quantity d10 the torque reference can be viewed as set by the application

### 3.1.2 DIGITAL SPEED REFERENCE

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| PRC_SPD_JOG | P211 - Digital speed reference value (JOG1) | -100.00 | 100.00 | 0 | % MOT_SPD_MAX | 163.84 |
| EN_SPD_JOG | P212 - Enable jog speed reference | 0 | 1 | 0 | | 1 |
| PRC_SPD_REF_JOG | D76 - Jog Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_START_DG_POT | P213 - Motor potentiometer starting speed | -100.0 | 100.0 | 2.00 | % MOT_SPD_MAX | 163.84 |
| EN_MEM_DG_POT | P214 - Load final digital potentiometer reference value | 0 | 1 | 0 | | 1 |
| PRC_MAX_REF_DG_POT | P215 - CW motor potentiometer speed reference value | -105.0 | 105.0 | 105.02 | % MOT_SPD_MAX | 163.84 |
| PRC_MIN_REF_DG_POT | P216 - CCW motor potentiometer speed reference value | -105.0 | 105.0 | -105.02 | % MOT_SPD_MAX | 163.84 |
| DG_POT_RAMPS | P217 - Digital potentiometer acceleration time | 0.3 | 1999.9 | 50 | s | 10 |
| EN_DG_POT | P218 - Enable motor potentiometer reference value(A.I.4) | 0 | 1 | 0 | | 1 |
| PRC_SPD_REF_DG_POT | D67 - Digital Potentiometer Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_APP_SPD_REF | D33 - Speed reference (application generated) | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |




## 3.1.2.1 DIGITAL SPEED REFERENCE (JOG)

The value programmed in parameter **P211** 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 **P212=**1. The resolution is 1/10000 of the maximum working speed.

## 3.1.2.2 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**” (ID_UP_POTD) and “Digital potentiometer down **I10**” (ID_DN_POTD) .
The reference is obtained by increasing or decreasing an internal counter with the ID_UP_POTD and ID_DN_POTD functions respectively.
The speed of increase or decrease set by parameter **P217** (acceleration time of the digital potentiometer) which sets how many seconds the reference takes to go from 0 to 100%, keeping the ID_UP_POTD active (this times is the same as to go from 100.0% to 0.0% by holding ID_DN_POTD active). If ID_UP_POTD are ID_DN_POTD 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 functioning is summarised in the following table :

| Converter running on-line | ID_UP_POTD | ID_DN_POTD | 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. |

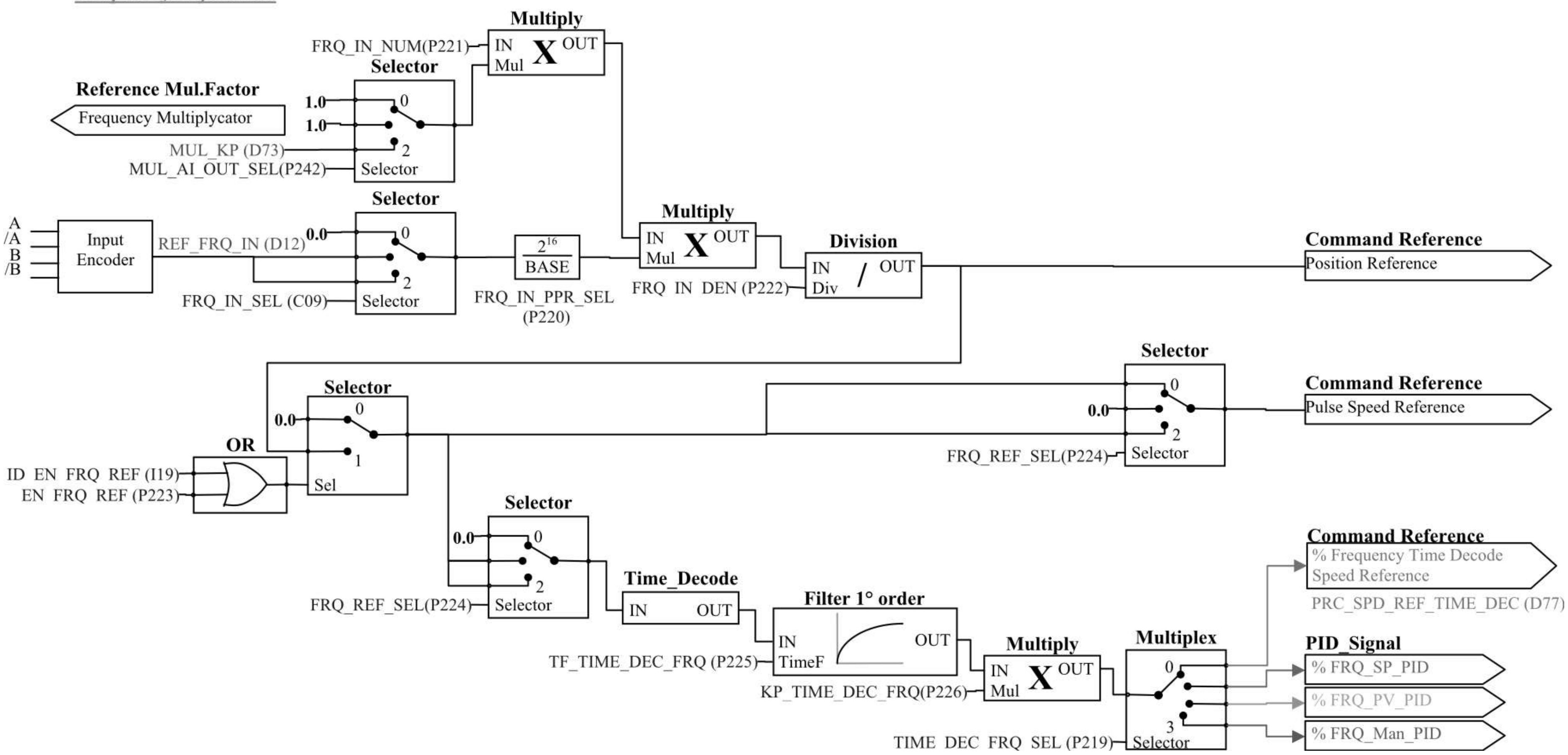
H = active x = does not matter L = not active L -> H = From Off-line to On-line

The digital potentiometer reference requires, to be enabled, activation of function **I06** after allocating an input or activating connection **P218** (P218=1) .
In the parameters **P215** and **P216** the maximum and the minimum admitted reference values can be marked for the digital potentiometer reference.

### 3.1.3 FREQUENCY SPEED REFERENCE

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| REF_FRQ_IN | D12 - Frequency in input | | | 0 | KHz | 16 |
| FRQ_REF_SEL | P224 - Frequency speed reference selection | 0 | 2 | 0 | | 1 |
| EN_FRQ_REF | P223 - Enable frequency speed reference value | 0 | 1 | 0 | | 1 |
| FRQ_IN_SEL | C09 - Frequency input setting | 0 | 3 | 1 | | 1 |
| FRQ_IN_PPR_SEL | P220 - Encoder pulses per revolution | 0 | 9 | 5 | | 1 |
| TF_TIME_DEC_FRQ | P225 - Filter time constant of frequency input decoded in time | 0.0 | 20.0 | 1.6 | ms | 10 |
| PRC_APP_FRQ_SPD_REF | D14 - Frequency speed reference value (application generated) | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_SPD_REF_TIME_DEC | D77 - Time Decode Frequency input Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| KP_TIME_DEC_FRQ | P226 - Corrective factor for frequency input decoded in time | 0.0 | 200.0 | 100 | | 163.84 |
| MAXV_VF | P88 - High precision analog speed reference value: Voltage matches max. speed | 2500 | 10000 | 10000 | mVolt | 1 |
| FRQ_IN_NUM | P221 - NUM - Frequency input slip ratio | -16383 | 16383 | 100 | | 1 |
| KP_NEG_VF | P159 - High precision analog speed reference value:VCO setting for negative voltage reference values | -16383 | 16383 | 4096 | | 1 |
| KP_POS_VF | P150 - High precision analog speed reference value:VCO setting for positive voltage reference values | -16383 | 16383 | 4096 | | 1 |
| FRQ_IN_DEN | P222 - DEN - Frequency input slip ratio | 0 | 16383 | 100 | | 1 |
| OFFSET_VF | P10 - Offset for high precision analog reference value | -19999 | 19999 | 0 | 1/100 mV | 1 |

## *Frequency References*



## 3.1.3.1 SPEED FREQUENCY REFERENCE MANAGEMENT

This speed reference in pulses can be provided in 4 different ways (alternatives to each other), that can be selected by means of connection C09.

| C09 | Description | Mode of working |
|---|---|---|
| 0 | *Analogic* | Analog reference ±10V (optional) |
| 1 | Digital encoder | 4 track frequency reference (default) |
| 2 | Digital f/s | Frequency reference (freq. and up/down) counting all edges |
| 3 | Digital f/s 1 edge | 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 **P223=**1 .
The incremental position reference is always enabled and it's possible to add an offset depending on analog and digital speed reference enable.

## 3.1.3.2 DIGITAL FREQUENCY REFERENCE

About the digital frequency reference, there are 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)

The number N of impulses/revolution for the reference is set by connection **C220**:

| N | 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 **P221** and **P222** 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:

$$f = \frac{\mathcal{X} \times N_{pulse\ revolution} \times P222}{60 \times P221}$$

and vice versa

$$\mathcal{X} = \frac{f \times 60 \times P221}{N_{pulse\ revolution} \times P222}$$

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 P221 and P222 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 |
| | P221 = P222 = 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 |
| | P221 = 50 P222 = 100 |
| The slave goes at the half speed as the master | |

| Master | Slave |
|---|---|
| N° of pulses/revolution = 512 | N° of pulses/revolution = 512 |
| P65 = 2500 rpm | P65 = 2500 rpm |
| | P221 = 100 P222 = 50 |
| The slave goes at the double speed as the master | |

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

More precisely, the signal coming from the encoder can be adapted according to the report P221/P222 and, if necessary, one of the analog input

## 3.1.3.3 FREQUENCY SPEED REFERENCE MANAGEMENT

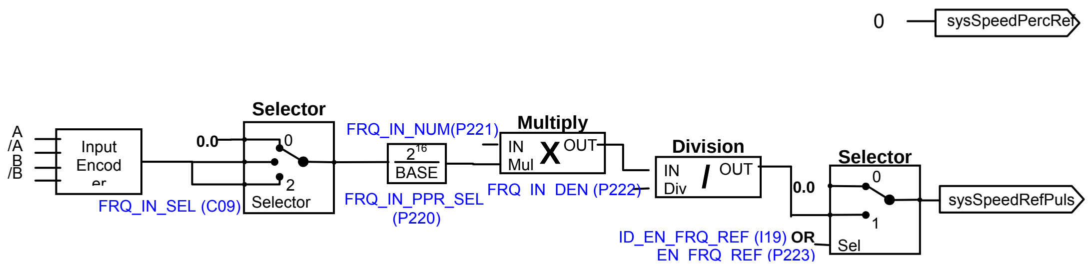
The speed reference in pulses is very accurate (no pulses is lost) but for its nature it has an irregular shape because are counted the edges every sampling period (TPWM) and this produce a speed reference with many noise. Also if the frequency input is constant, between a PWM period and another could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

There are 3 different ways to manage frequency speed reference, selectable with parameter **P224** (FRQ_REF_SEL):

| P224 | Description |
|---|---|
| **0** | Pulses reference |
| **1** | Decoded in time reference |
| **2** | Pulses and decoded in time reference |

Enabling the frequency speed reference can be done by the parameter P223 = 1 (EN_FRQ_REF) or bringing at active logic state input function I19.

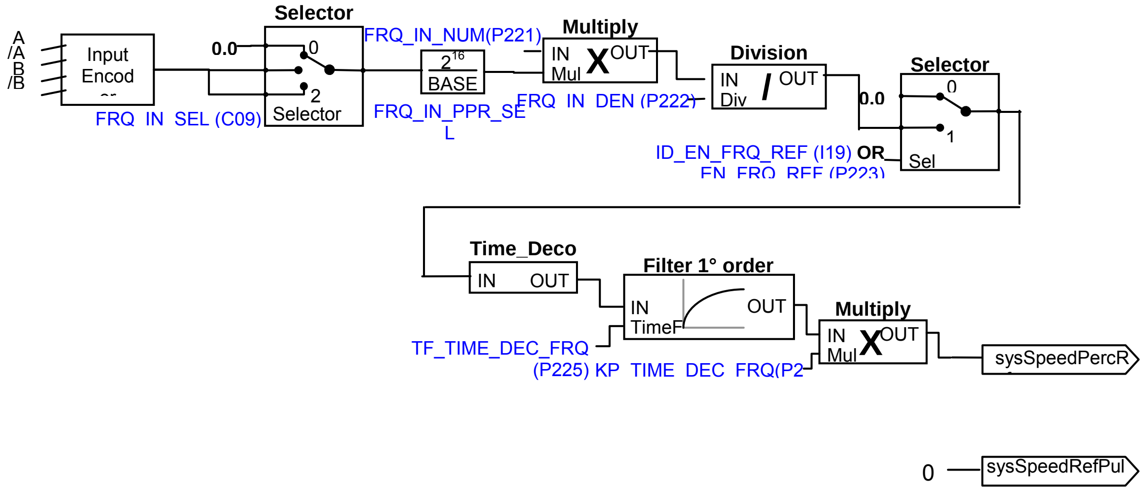
## 3.1.3.3.1 PULSES REFERENCE (P224=0)




In this mode, the speed reference is given only in pulses ensuring maximum correspondence master-slave, but with a strong granular signal especially for low frequency input.

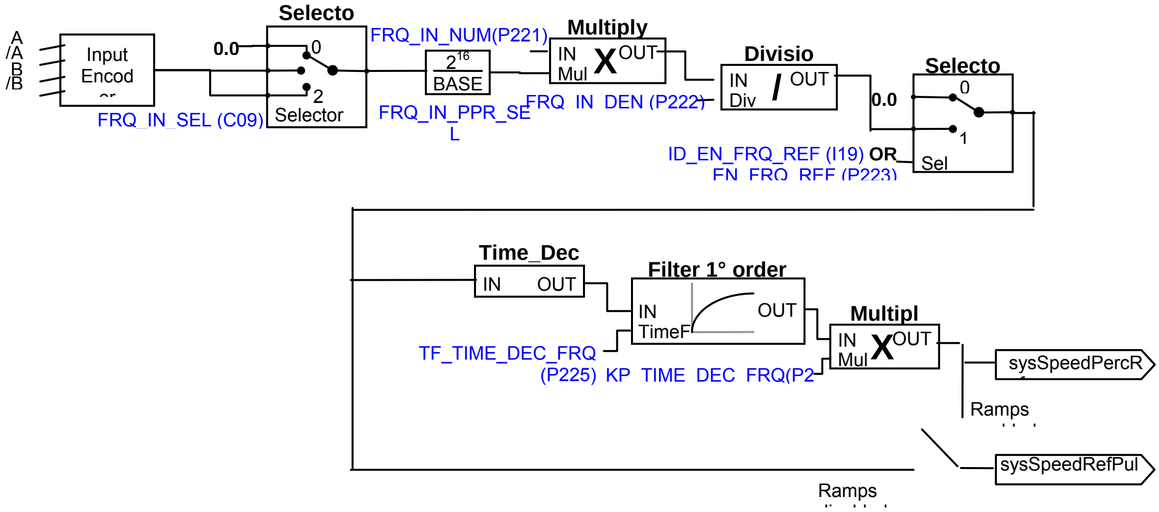
Linear ramps are not enabled.

## 3.1.3.3.2 DECODED IN TIME REFERENCE (P224=1)




In this working mode the frequency speed reference is decoded in time with maximum linearity also for very low input frequencies.
In this mode is possible to create a dynamic electrical axis, possibly with linear ramps enabled, but that is not rigid in the sense that there is no guarantee master-slave phase maintenance.

### 3.1.3.3.3 PULSES AND DECODED IN TIME REFERENCE (P224=2)




This is the most complete and powerful mode, which makes use of both references:

- the frequency speed reference decoded in time ("sysSpeedPercReference") has very good resolution also for low frequency input, thus allows high speed regulator gains
- the pulses speed reference ("sysSpeedRefPulses "), going to impose a reference to the integral part of the speed regulator, will not miss pulses, ensuring maximum precision in the master-slave electrical axes

If the linear ramps are enabled will act only after the first starting, then going to exclude themselves.

## 3.1.4 DIGITAL INPUTS CONFIGURATIONS

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:

| | | NAME | INPUT LOGIC FUNCTIONS | DEFAULT INPUT | DEFAULT STATUS |
|---|---|---|---|---|---|
| I | 00 | ID_RUN | Run command | L.I.4 | L |
| I | 01 | ID_CTRL_TRQ | Torque control | | L |
| I | 02 | ID_EN_EXT | External enable | L.I.2 | H |
| I | 03 | ID_EN_SPD_REF_AN | Enable analog reference A.I.1. | L.I.3 | L |
| I | 04 | ID_EN_TRQ_REF_AN | Enable analog reference A.I.2. | L.I.5 | L |
| I | 05 | ID_EN_JOG | Enable speed jog | L.I.7 | L |
| I | 06 | ID_EN_SPD_REF_POTD | Enable digital potentiometer speed reference | | L |
| I | 07 | ID_EN_LIM_TRQ_AN | Enable analog reference A.I.3. | | L |
| I | 08 | ID_RESET_ALR | Alarms reset | L.I.1 | L |
| I | 09 | ID_UP_POTD | digital potentiometer UP | | L |
| I | 10 | ID_DN_POTD | digital potentiometer DOWN | | L |
| I | 11 | ID_LAST_V_POTD | Load last digital potentiometer value | | L |
| I | 12 | ID_INV_SPD_REF | Invert speed reference value | L.I.6 | L |
| I | 14 | ID_EN_FLDB_REF | Enable FIELD-BUS reference values | | L |
| I | 16 | ID_EN_PAR_DB2 | Enable second parameter bank | | L |
| I | 17 | ID_EN_LP_SPZ_AXE | Enable space loop for electrical axis | | L |
| I | 18 | ID_EN_SPD_REF_FRQ_T | Enable frequency speed reference value decoded in time | | |
| I | 19 | ID_EN_SPD_REF_FRQ | Enable frequency speed reference value | | L |
| I | 22 | ID_EN_RAMP | Enable liner ramps | L.I.8 | L |
| I | 23 | ID_TC_SWT_MOT | Motor termo-switch | | L |
| I | 24 | ID_BLK_MEM_I_SPD | Freeze PI speed regulator integral memory | | L |
| I | 25 | ID_EN_OFS_LP_SPZ | Enable offset on overlap position loop reference | | L |
| I | 26 | ID_EN_SB | Enable speed regulator second bank | | L |
| I | 27 | ID_RUN | Enable Digital Setpoint PID | L.I.4 | L |
| I | 28 | | Enable Automatic PID Control | | |
| I | 29 | | Enable reference from Output PID | | |
| I | 30 | | Enable Digital Manual Setpoint PID | | |

**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 I01 :

I01 = 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

#### 3.1.4.1 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÷ I31: is the parallel of the corresponding functions that can be set at the terminal board, the serial or the fieldbus

### 3.1.5 SECOND SENSOR

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| SENSOR2_SEL | C17 - Sensor2 selection | Range<br>0<br>1 Encoder<br>2<br>3<br>4 Resolver<br>5 Resolver RDC<br>6<br>7<br>8 Sin/Cos incr<br>9<br>10 Endat 1317<br>11 Endat 1329<br>12<br>13 | | 0 | | 1 |
| RES2_POLE | P16 - Number of absolute sensor2 poles | 1 | 160 | 2 | | 1 |
| ENC2_PPR | P17 - Number of encoder2 pulses/revolution | 0 | 60000 | 1024 | pulse s/rev | 1 |
| EN_TIME_DEC_ENC2 | C18 - Enable incremental encoder2 time decode | 0 | 1 | 0 | | 1 |
| EN_INV_POS2_DIR | C20 - Invert sensor2 positive cyclic versus | 0 | 1 | 0 | | 1 |
| EN_SENSOR2_TUNE | C19 - Enable sensor2 auto-tuning | Range<br>0 No<br>1 Yes | | 0 | | 1 |
| RES2_TRACK_LOOP_BW | P48 - Tracking loop bandwidth direct decoding of resolver2 | 100 | 10000 | 1800 | rad/s | 1 |
| RES2_TRACK_LOOP_DAMP | P49 - Damp factor Traking loop resolver2 | 0.00 | 5.00 | 0.71 | | 100 |
| KP_SENS2 | P07 - Second sensor amplitude compensation | 0.0 | 200.0 | 100 | % | 163.84 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| OFFSET_SIN_SENS2 | P08 - Second sensor sine offset | -16383 | 16383 | 0 | | 1 |
| OFFSET_COS_SENS2 | P09 - Second sensor cosine offset | -16383 | 16383 | 0 | | 1 |
| HW_SENSOR2 | D62 - Sensor2 presence | | | 0 | | 1 |
| SENS2_SPD | D51 - Second sensor rotation speed | | | 0 | rpm | 1 |
| SENS2_TURN_POS | D52 - Second sensor Absolute mechanical position (on current revolution) | | | 0 | 1638 4 | 1 |
| SENS2_N_TURN | D53 - Second sensor Number of revolutions | | | 0 | 1638 4 | 1 |
| SENS2_FRQ_IN | D54 - Second sensor Frequency input | | | 0 | KHz | 16 |
| SENS2_ZERO_TOP | D56 - Sensor2 Zero Top | | | 0 | pulse s | 1 |
| EN_SINCOS_PREC_POS | C70 - Enable SinCos Analog-Digital compensation into position | 0 | 1 | 0 | | 1 |

## 3.2 OUTPUT

### 3.2.1 DIGITAL OUTPUT CONFIGURATIONS

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:

| | | NAME | OUTPUT LOGIC FUNCTIONS | DEFAULT OUTPUT |
|---|---|---|---|---|
| O | 00 | OD_DRV_READY | Drive ready | L.O.2 |
| O | 01 | OD_ALR_KT_MOT | Moto thermal alarm | |
| O | 02 | OD_SPD_OVR_MIN | Speed exceed minimum | L.O.4 |
| O | 03 | OD_DRV_RUN | Drive running | L.O.1 |
| O | 04 | OD_RUN_CW | CW / CCW | |
| O | 05 | OD_K_I_TRQ | Current/torque relay | |
| O | 06 | OD_END_RAMP | End of ramp | L.O.3 |
| O | 07 | OD_LIM_I | Drive at current limit | |
| O | 08 | OD_LIM_TRQ | Drive at torque limit | |
| O | 09 | OD_ERR_INS | Tracking incremental error > threshold (P37 ane P39) | |
| O | 10 | OD_PREC_OK | Power soft-start active | |
| O | 11 | OD_BRK | Braking active | |
| O | 12 | OD_POW_OFF | No mains power | |
| O | 13 | OD_BUS_RIG | Bus regeneration enable (Support 1 ) | |
| O | 14 | OD_IT_OVR | Motor thermal current above threshold (P96) | |
| O | 15 | OD_KT_DRV | Radiator overheating (higher than P120 threshold) | |
| O | 16 | OD_SPD_OK | Speed reached (absolute value higher than P47) | |
| O | 17 | OD_NO_POW_ACC | Power electronic card not supplied | |
| O | 18 | | | |
| O | 19 | OD_POS_INI_POL | Regulation card supplied and DSP not in reset state | |
| O | 20 | | SENS1 Absolute position available | |
| O | 21 | | Motor holding brake | |

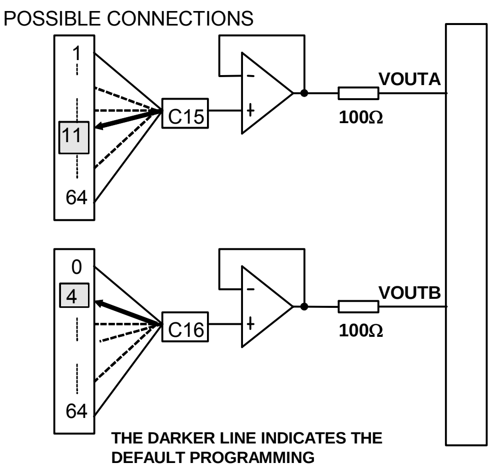
If you wish to have the logic outputs active at the low level (L) you need just configure the connection corresponding to the chosen logic function but with the value denied: for example, if you want to associate the function “ end of ramp ” to logic output 1 active low, you have to program connection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

## 3.2.2 ANALOG OUTPUTS CONFIGURATIONS

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| AO1_SEL | C15 - Meaning of programmable analog output 1 | -99 | 100 | 11 | | 1 |
| AO2_SEL | C16 - Meaning of programmable analog output 2 | -99 | 100 | 4 | | 1 |
| PRC_AO1_10V | P57 - % value of 10V for analog output A | 100.0 | 400.0 | 200 | % | 10 |
| PRC_AO2_10V | P58 - % value of 10V for analog output B | 100.0 | 400.0 | 200 | % | 10 |
| OFFSET_AO1 | P110 - Offset A/D 1 | -100.0 | 100.0 | 0 | % | 327.67 |
| OFFSET_AO2 | P111 - Offset A/D 2 | -100.0 | 100.0 | 0 | % | 327.67 |

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.



| | | OUTPUT LOGIC FUNCTIONS | DEFAULT OUTPUT |
|---|---|---|---|
| O | 00 | Actual mechanical position read by sensor[100%=180] | |
| O | 01 | Actual electrical position read by sensor(delta m) [100%=180] | |
| O | 02 | Reference speed value before ramps [% n mAX] | |
| O | 03 | Reference speed value after ramps [% n MAX] | |
| O | 04 | Rotation speed (filtered Tf= 8 TPWM, 1.6ms at 5KHz) [% n MAX] | A.0.2 |
| O | 05 | Torque request [% C NOM MOT] | |
| O | 06 | Internal value: status (MONITOR only) | |
| O | 07 | Request to current loop r torque current [% I NOM AZ] | |
| O | 08 | Request to current loop for flux current [% I NOM AZ] | |
| O | 09 | Request voltage at maximum rev. [% VNOM MOT] | |
| O | 10 | Internal value: alarms (MONITOR only) | |
| O | 11 | Current module [% I NOM AZ] | A.0.1 |
| O | 12 | Sensor 1 Zero Top [100%=180] | |
| O | 13 | U phase current reading [% I MAX AZ] | |
| O | 14 | Internal value: inputs (MONITOR only) | |
| O | 15 | Torque component of current reading [% I NOM AZ] | |
| O | 16 | Magnetizing component of current reading [% I NOM AZ] | |
| O | 17 | U phase voltage duty-cycle | |
| O | 18 | Stator voltage reference value module [% VNOM MOT] | |
| O | 19 | Modulation index [0<->1] | |
| O | 20 | Request Q axis voltage (Vq_rif) [% VNOM] | |
| O | 21 | Delivered power [% PNOM] | |
| O | 22 | Request D axis voltage (Vd_rif) [% VNOM] | |
| O | 23 | Torque produced [% C NOM MOT] | |
| O | 24 | Bus voltage [100%=900V] | |
| O | 25 | Radiator temperature reading [% 37,6°] | |
| O | 26 | Motor temperature reading [% 80°] | |
| O | 27 | Rotor flux [% NOM] | |
| O | 28 | Motor thermal current [% alarm threshold A6] | |
| O | 29 | Current limit [% I MAX AZ] | |
| O | 30 | CW maximum torque [% C NOM MOT] | |
| O | 31 | CCW maximum torque [% C NOM MOT] | |
| O | 32 | Internal value: outputs (MONITOR only) | |
| O | 33 | Internal value: inputs_hw (MONITOR only) | |
| O | 34 | V phase current reading [% I MAX AZ] | |
| O | 35 | W phase current reading [% I MAX AZ] | |
| O | 36 | Actual electrical position (alfa_fi ) [100%=180 ] | |
| O | 37 | Analog input A.I.1 [100%=16383] | |
| O | 38 | Analog input A.I.2 [100%=16383] | |
| O | 39 | Analog input A.I.3 [100%=16383] | |
| O | 40 | Sensor 2 Zero Top | |
| O | 41 | Application speed reference value ("sysSpeedPercReference") [% n MAX] | |
| O | 42 | Application torque reference value ("sysTorqueReference") [% C NOM MOT] | |
| O | 43 | Application positive torque limit ("sysMaxTorque") [% C NOM MOT] | |
| O | 44 | Frequency speed reference value from application ("sysSpeedRefPulses") [Pulses per TPWM] | |

| | | | |
|---|---|---|---|
| O | 45 | Overlapped space loop reference value from application ("sysPosRefPulses")[Pulses per TPWM] | |
| O | 46 | Amplitude to the square of sine and cosine feedback signals [1=100%] | |
| O | 47 | Sen_theta (Direct resolver and Sin/Cos Encoder) [Max amplitude = 200%] | |
| O | 48 | Cos_ theta (Direct resolver and Sin/Cos Encoder) [Max amplitude = 200%] | |
| O | 49 | Rotation speed not filtered [% n MAX] | |
| O | 50 | Delta pulses read in PWM period in frequency input [Pulses per PWM] | |
| O | 51 | Overlapped space loop memory lsw [Electrical pulses (x P67) | |
| O | 52 | Overlapped space loop memory msw [Electrical turns (x P67)] | |
| O | 53 | Incremental SIN theta Sin/Cos Encoder | |
| O | 54 | Incremental COS theta Sin/Cos Encoder | |
| O | 55 | Ended initial reset | |
| O | 56 | PTM motor thermal probe | |
| O | 57 | PTR radiator thermal probe | |
| O | 58 | Pulses read by sensor | |
| O | 59 | SENS2 Rotation speed not filtered | |
| O | 60 | SENS2 Actual position | |
| O | 61 | SENS2 Sin_theta | |
| O | 62 | SENS2 Cos_theta | |
| O | 63 | SYNC delay measured | |
| O | 64 | Application negative torque limit (“sysMaxNegative Torque”) [%C NOM MOT] | |
| O | 65 | Energy dissipated on breaking resistence [joule] | |
| O | 66 | Analog input A.I.16 bit [100%=16383] | |
| O | 68 | Stop in position target [100%=180] | |
| O | 69 | Stop in position actual position [100%=180] | |
| O | 70 | Stop in position error [100%=180] | |
| O | 71 | Stop in position o33 timer [ms] | |
| O | 85 | Setpoint PID | |
| O | 86 | Process value PID | |
| O | 87 | Component P of PID | |
| O | 88 | Component I of PID | |
| O | 89 | Component D of PID | |
| O | 90 | Error SP-PV of PID | |
| O | 91 | Output PID | |

## 3.2.3 FREQUENCY OUTPUT

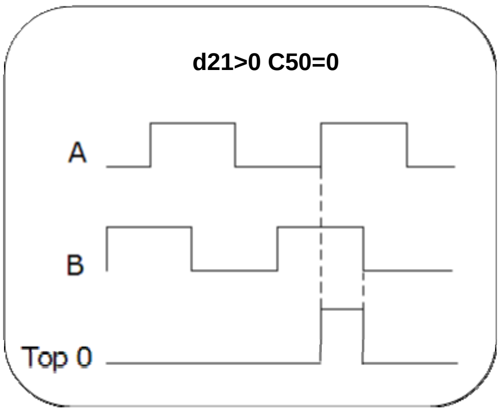
| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| ENC_OUT_ZERO_TOP | C49 - TOP zero phase for simulated encoder | 0 | 3 | 0 | | 1 |
| ENC_OUT_DIR | C50 - Invert channel B simulated encoder | 0 | 1 | 0 | | 1 |
| ENC_OUT_PPR_SEL | C51 - Choose pulses ev. simulated encoder | 0 | 11 | 5 | | 1 |
| ENC_OUT_SEL | C52 - Simulated encoder selection | 0 | 3 | 0 | | 1 |
| OPD_ENC_OUT_SEL | C54 - Incremental/absolute Simulated Encoder | 0 | 2 | 0 | | 1 |
| PRC_ENC_OUT_LOOP | P124 - Simulated encoder Kv gain multiplication coeff. | 0.0 | 100.0 | 100 | % | 327.67 |

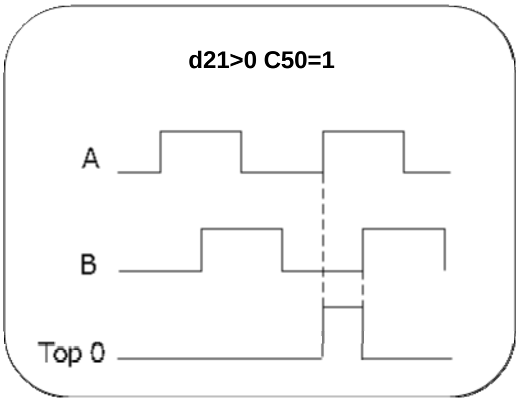
With C52 I possible select the signal for the frequency output as indicated in the follow table:

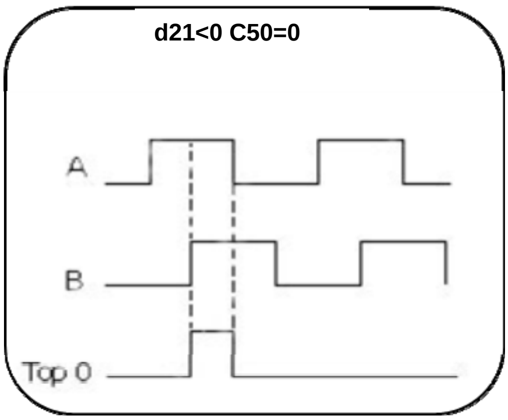
| C52 | Value | Description |
|---|---|---|
| 0 | OPD_ENC_OUT | The frequency output is the simulated encoder that can be configures conforming the follow paragraph |
| 1 | SENS1 | The frequency output is the squared signal from the motor speed (sensor 1) |
| 2 | SENS2 | The frequency output is the squared signal from the speed sensor 2 |
| 3 | FRQ_IN | The frequency output is the squared signal from the frequency input |

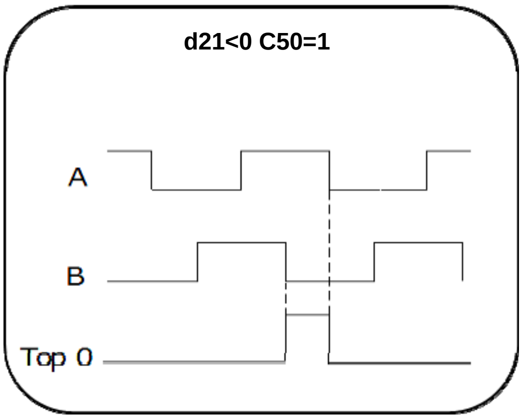
### 3.2.3.1 SIMULATED ENCODER SIGNALS

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



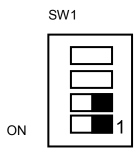
The simulated encoder outputs are all driven by a “LINE DRIVER”. Their level in the standard drive version is referred to +5V and then it is connected to the internal supply (TTL +5V).
In option (to be requested in the ordering) there is the possibility to refer the signal level to an external supply 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 <u>twisted shielded cable</u> 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, and set the SW1 switch as indicated in the follow image.**


**WARNING: for the encoder simulation with external supply, you must connect the terminal 5 (Vccin) and 6 (GND) and set the SW1 switch as indicated in the follow image.**




## 3.2.3.2 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 =1.**

| Maximum speed (rpm) x P68/2 | Pul/rev motor/(P68/2) |
|---|---|
| 400 | 65536 |
| 800 | 32768 |
| 1600 | 16384 |
| 3200 | 8192 |
| 6400 | 4096 |
| 12800 | 2048 |
| 25600 | 1024 |
| 32767 | 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 437KHz.

## 3.2.3.3 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) looses 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
By P124 (default = 100%) is possible to reduce the loop gain. This can increase the stability of the system, but reduce the speed response.

## 3.3 MOTION CONTROL

### 3.3.1 INCREMENTAL POSITION LOOP

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| FLW_ERR_MAX_LSW | P37 - Maximum tracking error (less significative part) | -32767 | 32767 | 32767 | ppr | 1 |
| POS_REG_KP | P38 - Kv position loop proportional gain | 0.0 | 100.0 | 4 | | 10 |
| FLW_ERR_MAX_MSW | P39 - Maximum tracking error (less significative part) | 0 | 32767 | 0 | rpm | 1 |
| EN_POS_REG | P239 - Enable overlapped space loop | 0 | 1 | 0 | | 1 |
| EN_POS_REG_MEM_CLR | P240 - Enable overlapped space loop memory clear in stop | 0 | 1 | 0 | | 1 |

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 **C239=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.

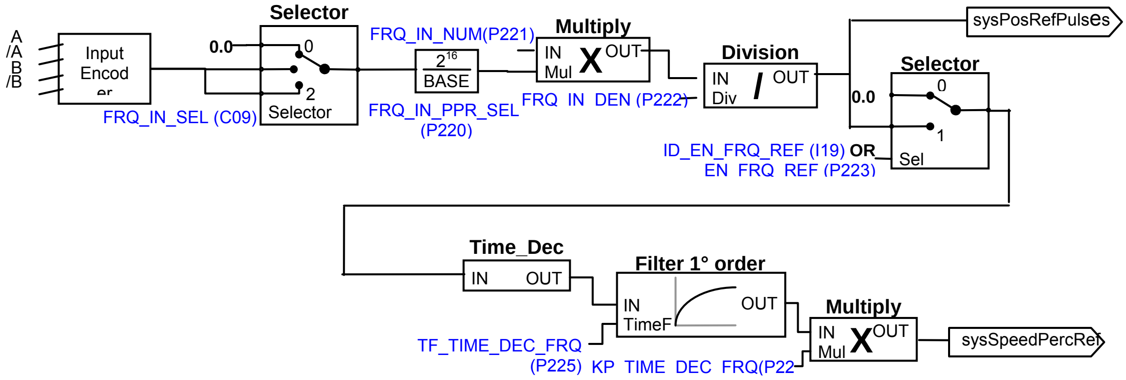
#### 3.3.1.1 FREQUENCY SPACE REFERENCE (ELECTRICAL AXES)

Managing a frequency space reference means always guarantee the same phase angle between master and slave. To do this work is necessary to enable the overlapped position loop with parameter P239 or bringing at active state input function I17.

It should then provide a speed feed-forward reference, the best solution is to use the frequency speed reference decoded in time (P224=1 and P219=0), alternatively, wanting to work in pulses, clear P224=0.

Note: Wanting to manage in space the frequency reference, it's not possible to enable pulses and decoding in time reference(P224 = 2).

The recommended block diagram is:

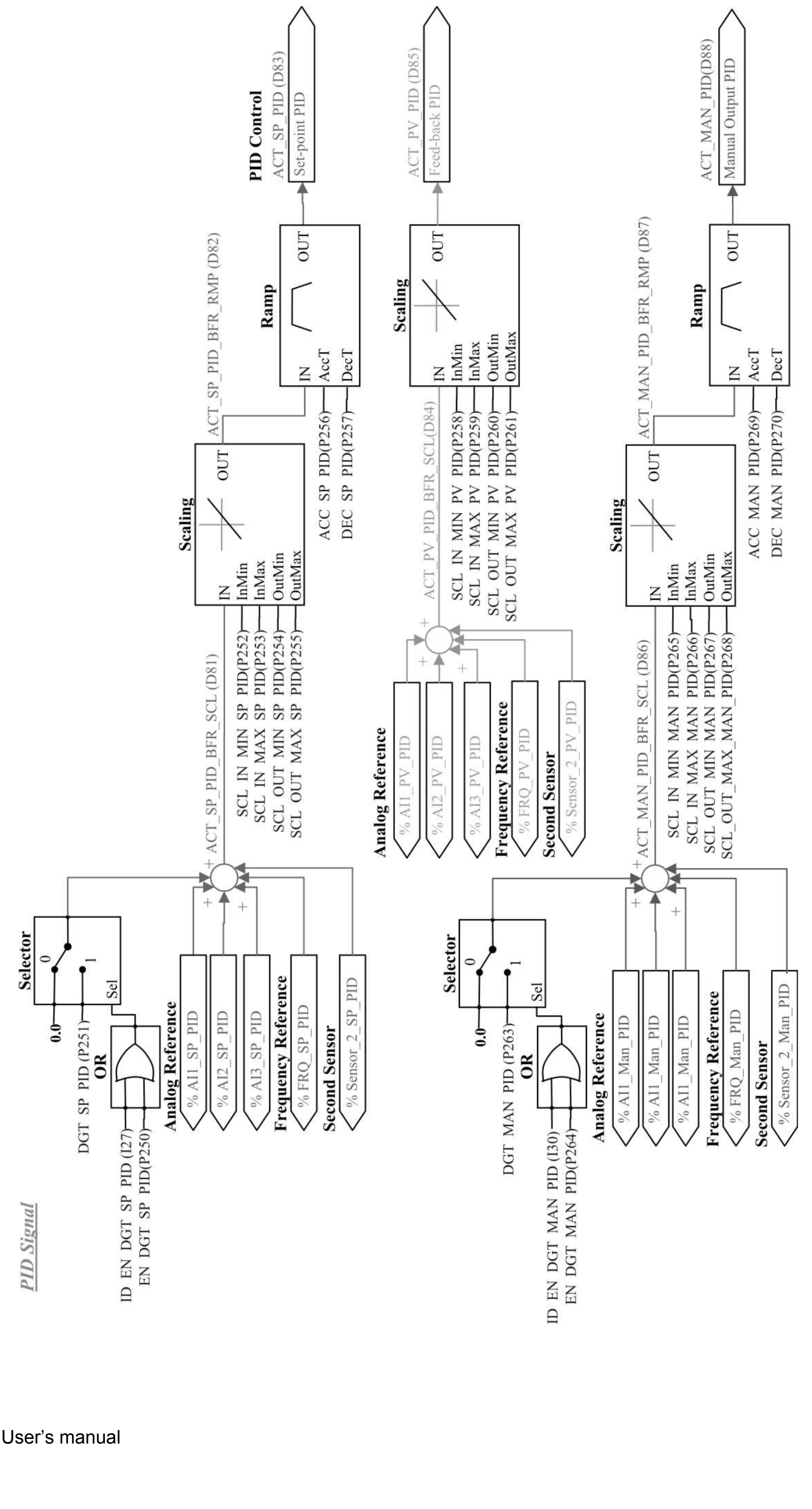



The frequency speed reference decoded in time ("sysSpeedPercReference") has to be enabled with **P223=1** o **I19=H** ,it has very good resolution also for low frequency input, thus allows high speed regulator gains

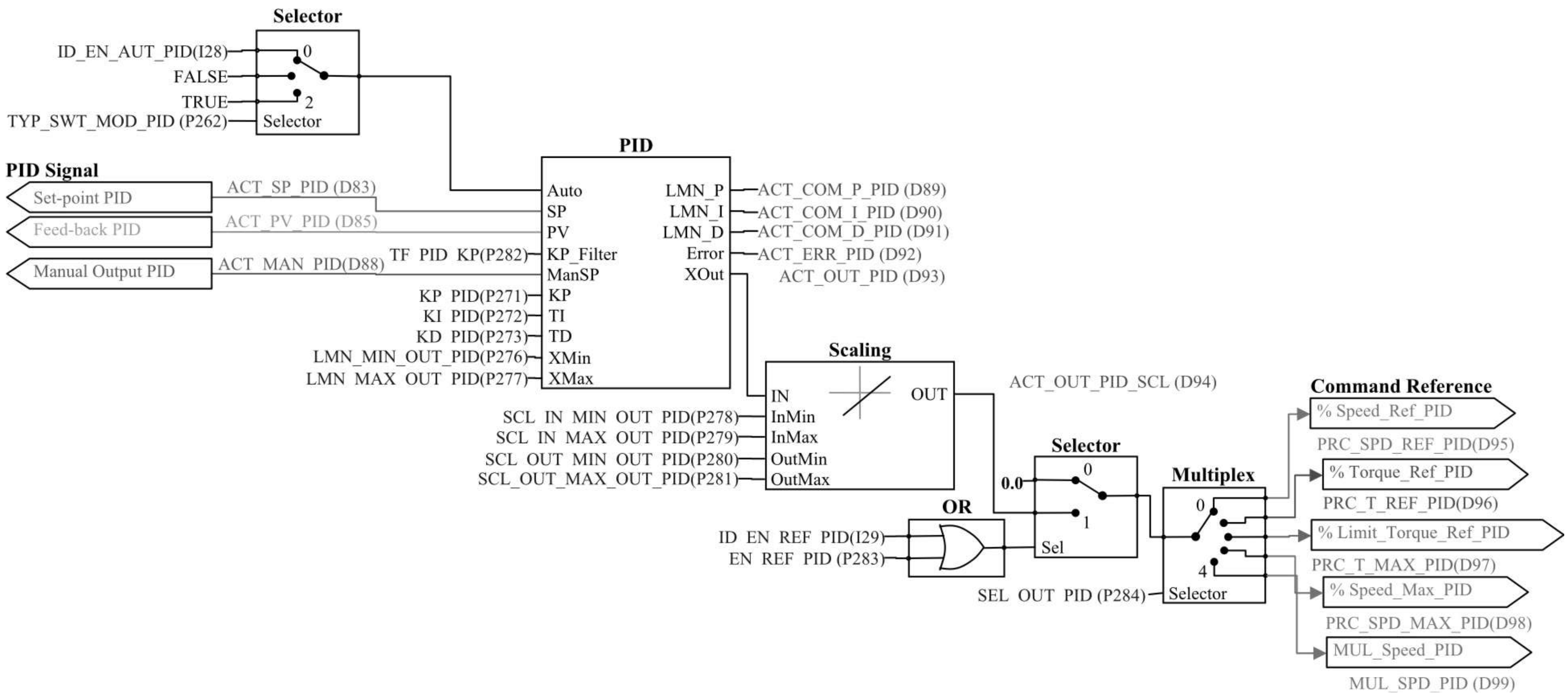
The pulses space reference ("sysPosRefPulses") has to be enabled with **C65=1** o **I17=H** from then on will not miss pulses, ensuring maximum precision in the master-slave electrical axes.

Since the overlapped position loop is enabled, it is useless enable also the linear ramps on frequency speed reference decoded in time.

## 3.3.2 PID CONTROLLER



## *PID Control*

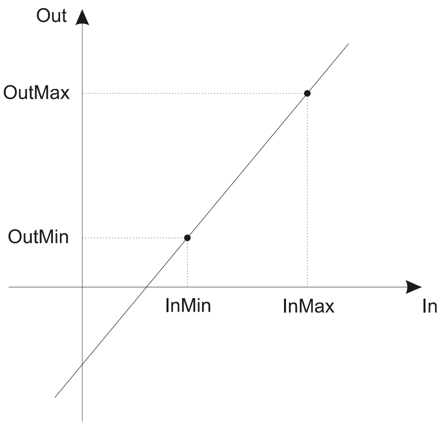


Selector
ID_EN_AUT_PID(I28)
FALSE
TRUE
TYP_SWT_MOD_PID (P262)
0
2
Selector
PID Signal
Set-point PID
Feed-back PID
Manual Output PID
ACT_SP_PID (D83)
ACT_PV_PID (D85)
ACT_MAN_PID(D88)
TF PID KP(P282)
KP PID(P271)
KI PID(P272)
KD PID(P273)
LMN_MIN_OUT_PID(P276)
LMN MAX OUT PID(P277)
PID
Auto
SP
PV
KP_Filter
ManSP
KP
TI
TD
XMin
XMax
LMN_P
LMN_I
LMN_D
Error
XOut
ACT_COM_P_PID (D89)
ACT_COM_I_PID (D90)
ACT_COM_D_PID (D91)
ACT_ERR_PID (D92)
ACT_OUT_PID (D93)
Scaling
IN
InMin
InMax
OutMin
OutMax
OUT
SCL IN MIN OUT PID(P278)
SCL IN MAX OUT PID(P279)
SCL OUT MIN OUT PID(P280)
SCL_OUT_MAX_OUT_PID(P281)
ACT_OUT_PID_SCL (D94)
OR
ID EN REF PID(I29)
EN REF PID (P283)
Selector
0.0
0
1
Sel
Multiplex
0
4
Selector
SEL OUT PID (P284)
Command Reference
% Speed_Ref_PID
PRC_SPD_REF_PID(D95)
% Torque_Ref_PID
PRC_T_REF_PID(D96)
% Limit_Torque_Ref_PID
PRC_T_MAX_PID(D97)
% Speed_Max_PID
PRC_SPD_MAX_PID(D98)
MUL_Speed_PID
MUL_SPD_PID (D99)

For a better understanding of the PID function it is useful to identify three parts of the controller structure:

1. PID input signals. In this section conditioning and setting of the analog references (see chapterxxx),Frequency reference (see chapter xxxx) and second sensor (see…) is considered and managed. The output of this part can be used as input to the PID regulator block.
2. PID Regulator Block. This is the PID regulator or controller with its parameter and setting as gains and scaling factors.
3. PID output signals . This section is used for conditioning and managing the PID regulator output signal to be used as reference input in the drive.

**PID Input signals** there considers three different possible setting of OPD Explorer: Set Point PID Regulator, Feed back PID Regulator and Manual set point PID Controller.
In all the three different setting the signals coming from the analog inputs AI1,AI2, and AI3, from the frequency input as speed reference and from the second sensor are eventually either added or compared together.
With the exception of the feedback setting the reference can be a digital set point with the appropriate configurations.
The three generated signals as from above will be then after treated thru a scaling block as here below written:




$$Out = \left[ (In - In\_min) \times \frac{(Out\_max - Out\_min)}{(In\_max - In\_min)} \right]$$

With reference to the input signals and specifically for only the manual set point and the reference set point it is possible to have an acceleration and deceleration time with the appropriate parameters. The time has to be intended from the **minimum** value to reach the set value and viceversa.
The PID regulator can work in two different ways as for the actual value of input "auto" handled with a selector set by parameter P262 and the input I28.
If signal "auto" is "false" PID output is related to the manual set-point, while if "auto" is true the PID works in automatic way.
With the following premises:

- Input "SP" is the regulation reference with PID enabled ("auto"=TRUE) displayed thru internal value "ACT_SP_PID" (D83)
- Input "PV" is the feedback signal of the regulator with PID enabled ("auto"=TRUE) displayed thru internal value "ACT_PV_PID" (D85)
- Input "KP_Filter" defines the time for the first order filter that acts only on the proportional part
- Thru input "Man_SP" it is possible to set the output value "XOUT" when PID is disabled ("auto"="False");
- The PID parameters are:
    - "KP" proportional gain
    - "TI" integral time defined in ms (if set = 0 integral gain is disabled)
    - "TD" derivative time defined in ms (if set = 0 integral gain is disabled)
- Thru inputs "XMAX" (parameter "LMN_MIN_OUT_PID" P277) and "XMIN" (parameter "LMN_MIN_OUT_PID" P276) it is possible to limit the regulation value as "XOUT". When output "XOUT" reaches its regulation limit the integral part will be freezed and blocked.

In <u>**manual mode**</u> (Auto = false) PID ouput has following value :
"**Error**" (error value displayed in D92) **= SP - PV**;
"**LMN_P**" (proportional part displayed in D89) **= 0.0**;
"**LMN_I**" (integral part displayed in D90) **= Man_SP - (KP * Error)**;
"**LMN_D**" (derivative part displayed in D91)**= 0.0**;
"**XOUT**" (PID regulator output displayed in D93) **= Man_SP**

In **automatic mode** (auto = true) ) PID ouput has following value :
"**Error**" (error value displayed in D92) = **SP - PV**;
"**LMN_P**" (proportional part displayed in D89) = **filtered (KP * Error)**;
"**LMN_I**" ((integral part displayed in D90) = **LMN_I + (KP * Error / (T_DRW_PWM * TI)**;
"**LMN_D**"( derivative part displayed in D91)=**TD*KP*(Error - Error_Last)*T_DRW_PWM**;
"**XOUT**" (PID regulator output displayed in D93) = **LMN_P + LMN_I + LMN_D**

Whereas T_DRW_PWM = 1000 / P101 with P101 = PWM frequency and Error_Last is the error value of the previous control cycle.

**N.B. In the folder "PID Controller" with the parameter "EN_PID" ( P249 - Enabling Genera PID Control) is possible to disable the PID control function. If this parameter is disabled the PIC control is not active**.

# 4 FIELDBUS

## 4.1 MODBUS PARAMETERS

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| MODBUS_ADDR | P92 - Serial identification number | 0 | 255 | 1 | | 1 |
| MODBUS_BAUD | P93 - Serial baud rate | | | 192 | Kbit/s | 1 |

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

### 4.1.1 APPLICATION CONFIGURATION

#### 4.1.1.1 NODE CONFIGURATION

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

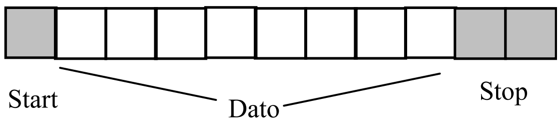
| Name | Description | Range | Default |
|---|---|---|---|
| P92 | Serial identification number | 0÷255 | 1 |
| P93 | Serial baud rate | 19,2 ; 38,4 ; 57,6 | 19,2 Kbit/s |

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

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

## 4.1.2 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 1-2 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 |
|---|---|---|
| 1 | 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.

### 4.1.2.1 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 input logical functions |
| 0320 | 32 | Standard digital outputs logical functions |
| 0340 | 32 | Applicative digital output logical functions |

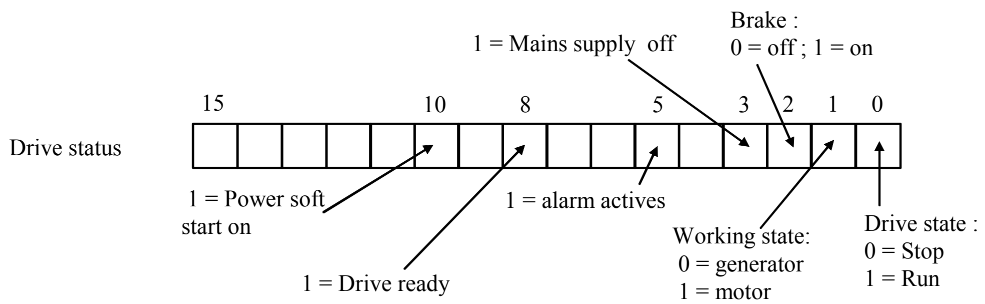
The order number of the inputs and the outputs is the one specified in the related tables (see specific description of the control’s core) .

### 4.1.2.2 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 |
| 0300 | 1 | Digital input logical functions |
| 0320 | 1 | Standard digital outputs logical functions |
| 0340 | 1 | Applicative digital output logical functions |
| 052C | 800 | Representation parameters table |
| 084C | 400 | Representation connection table |
| 0C00 | 128 | Analog outputs and monitor values |
| 0D00 | 500 | Representation extra parameters table |
| 09DC | 64 | Representation internal parameters table |

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 )

### 4.1.2.3 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 |
| 0360 | 32 | Digital inputs |

### 4.1.2.4 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 |
| 0360 | 1 | Digital input |

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

### 4.1.2.5 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 |

## 4.2 CAN OPEN

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| ID_CANOPEN | P162 - CAN BUS node ID | 1 | 127 | 1 | | 1 |
| CANOPEN_BAUD_SEL | C48 - CAN Baud rate | Range<br>0<br>1<br>2<br>3<br>4<br>5<br>6<br>7 | <br>1 M<br>800 k<br>500 k<br>250 k<br>125 k<br>50 k<br>20 k<br>10 k | 0 | | 1 |
| EN_FLDBUS_REF | P247 - Enable FIELD-BUS reference values | 0 | 1 | 0 | | 1 |
| PRC_T_REF_FLDBUS | D69 - Fieldbus Torque reference | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_T_MAX_FLDBUS | D71 - Fieldbus Torque Max reference | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_SPD_REF_FLDBUS | D75 - Fieldbus Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| SPD_REF_PULS_FLDBUS | D78 - Fieldbus Speed Reference in Pulses | | | 0 | Pulses per Tpwm | 1 |
| PRC_APP_T_REF | D10 - Torque reference value (application generated) | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_APP_T_MAX | D32 - Maximum torque imposed (application generated) | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_APP_SPD_REF | D33 - Speed reference (application generated) | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_APP_FRQ_SPD_REF | D14 - Frequency speed reference value (application generated) | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| EN_SYNC_REG | C23 - Enable CANOpen SYNC traking loop | 0 | 1 | 0 | | 1 |
| SYNC_REG_KP | P11 - CanOpen SYNC loop regulator Proportional gain | 0 | 200 | 5 | | 1 |
| SYNC_REG_TA | P12 - CanOpen SYNC loop regulator lead time constant | 0 | 2000<br>0 | 400 | | 1 |
| SYNC_DELAY | D57 - Delay from SYNC reception to Speed routine execution | | | 0 | us | 1 |
| PWM_SYNC_OFFSET | D58 - PWM offset for SYNC delay control | | | 0 | pulses | 1 |

### 4.2.1 CONFIGURATION OF THE APPLICATION

#### 4.2.1.1 CONFIGURATION OF THE NODE

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

| Name | Description | Min | Max | Default |
|---|---|---|---|---|
| ID_CANOPEN | P162 - CAN BUS node ID | 1 | 127 | 1 |
| CANOPEN_BAUD_SEL | C48 - CAN Baud rate | Range<br>0<br>1<br>2<br>3<br>4<br>5<br>6<br>7 | <br>1 M<br>800 k<br>500 k<br>250 k<br>125 k<br>50 k<br>20 k<br>10 k | 0 |

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.

#### 4.2.1.2 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 ).

### 4.2.2 MANAGED SERVICES

#### 4.2.2.1 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.

#### 4.2.2.2 PROCESS DATA OBJECT (PDO)

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

#### 4.2.2.3 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

## 4.2.2.4 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:

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

## 4.2.3 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 |

## 4.2.4 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
100Dh **Life time factor** (multiplier factor)

} their product yields the **Node life time**
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.

### 4.2.5 OBJECTS DICTIONARY : COMMUNICATION PROFILE AREA

The following objects of the communication profile are supported:

| Index (hex) | Object | Name | Type | Access |
|---|---|---|---|---|
| 1000 | VAR | Device type | UNSIGNED32 | Reading |
| 1001 | VAR | Error register | UNSIGNED8 | Reading |
| 1002 | VAR | Manufacturer status register | UNSIGNED32 | Reading |
| 1003 | ARRAY | Pre-defined error field | UNSIGNED32 | Reading |
| 1005 | VAR | COB-ID SYNC | UNSIGNED32 | Reading/writing |
| 1006 | VAR | Communication cycle period | UNSIGNED32 | Reading/writing |
| 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 |
| 100D | VAR | Life time factor | UNSIGNED8 | Reading/writing |
| 1010 | ARRAY | Store parameters | UNSIGNED32 | Reading/writing |
| 1011 | ARRAY | Restore dafault parameters | UNSIGNED32 | Reading/writing |
| 1014 | VAR | COB-ID EMCY | UNSIGNED32 | Reading/writing |
| 1015 | VAR | Inhibit Time EMCY | UNSIGNED16 | Reading/writing |
| 1018 | RECORD | Identity Object | Identity (23h) | Reading |
| 1200 | RECORD | 1st Server SDO parameter | SDO parameter | Reading/writing |
| 1201 | RECORD | 2nd Server SDO parameter | SDO parameter | Reading/writing |
| 1202 | RECORD | 3rd Server SDO parameter | SDO parameter | Reading/writing |
| 1203 | RECORD | 4th Server SDO parameter | SDO parameter | Reading/writing |
| 1400 | RECORD | 1st receive PDO parameter | PDO CommPar | Reading/writing |
| 1401 | RECORD | 2nd receive PDO parameter | PDO CommPar | Reading/writing |
| 1402 | RECORD | 3rd receive PDO parameter | PDO CommPar | Reading/writing |
| 1403 | RECORD | 4th receive PDO parameter | PDO CommPar | Reading/writing |
| 1600 | RECORD | 1st receive PDO mapping | PDO Mapping | Reading/writing |
| 1601 | RECORD | 2nd receive PDO mapping | PDO Mapping | Reading/writing |

| Index (hex) | Object | Name | Type | Access |
|---|---|---|---|---|
| 1602 | RECORD | 3rd receive PDO mapping | PDO Mapping | Reading/writing |
| 1603 | RECORD | 4th receive PDO mapping | PDO Mapping | Reading/writing |
| 1800 | RECORD | 1st transmit PDO parameter | PDO CommPar | Reading/writing |
| 1801 | RECORD | 2nd receive PDO parameter | PDO CommPar | Reading/writing |
| 1802 | RECORD | 3rd receive PDO parameter | PDO CommPar | Reading/writing |
| 1803 | RECORD | 4th receive PDO parameter | PDO CommPar | Reading/writing |
| 1A00 | RECORD | 1st transmit PDO mapping | PDO Mapping | Reading/writing |
| 1A01 | RECORD | 2nd transmit PDO mapping | PDO Mapping | Reading/writing |
| 1A02 | RECORD | 3rd transmit PDO mapping | PDO Mapping | Reading/writing |
| 1A03 | RECORD | 4th transmit PDO mapping | PDO Mapping | Reading/writing |

### 4.2.6 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 | VAR | UNSIGNED 32 | Tab_inp_dig | Actual values of the logical input's functions | Reading |
| 2011 | VAR | UNSIGNED 32 | Tab_out_dig | 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 | VAR | UNSIGNED 32 | Tab_inp_dig_field | 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 Tpwm | Reading/writing |
| 201E | ARRAY | INTEGER16 | Tab_dati_applicazione [100] | Data Area available for the application | Reading/writing |
| 201F | VAR | UNSIGNED32 | Ingressi_wr | Writing standard logical inputs | Reading/writing |
| 2020 | VAR | UNSIGNED32 | Ingressi | Writing application logical inputs | Reading |
| 2021 | VAR | UNSIGNED32 | Uscite_standard_rd | Reading standard inputs | Reading |
| 2022 | VAR | UNSIGNED16 | word_vuota | Unused Word | Reading/writing |
| 2023 | VAR | UNSIGNED32 | double_vuota | Unused Double word | Reading/writing |
| 2024 | VAR | DOMAIN | Tab_formati_extra | Formats of extra parameters | Reading |

## 4.2.6.1 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)

number of digits visualised in decimal
number of digits visualised in integer
internal representation :

| | |
|---|---|
| 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      free parameter in percent of the base: the real value is = (internal
3rd word = 8190      representation divided by the base)*100
4th word = 4095
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      reserved parameter proportional to the base : the real value is
3rd word = 1000      internal representation divided by the base
4th word = 10
if the current value is 400→ (400/10) = 40,0%
the variation range is included between 0,5 and 100%

## 4.2.6.2 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)

Number of digits visualised in decimal
Number of digits visualised in integer
Internal representation :

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

Parameter type:

| | |
|---|---|
| 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

## 4.2.6.3 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)

- number of digits visualised in decimal
- number of digits visualised in integer
- internal representation :

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

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

1st word = 0x1131
2nd word = 0000 free parameter in percent of the base: the real value is = (internal
3rd word = 8190 representation divided by the base)*100
4th word = 4095
5th word = 4095

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%

## 4.2.6.4 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)

internal representation :

| | |
|---|---|
| 1 | Direct value /2 to the power of… |
| 2 | Percent with base 4095 |
| 3 | Percent with base 32767 |
| 4 | Percent with base 16383 |

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

## 4.2.6.5 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)

internal representation :

| | |
|---|---|
| 2 | Percent with base 4095 |
| 3 | Percent with base 32767 |
| 4 | Percent with base 16383 |

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%

## 4.2.6.6 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.

### 4.2.6.7 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.

### 4.2.6.8 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.

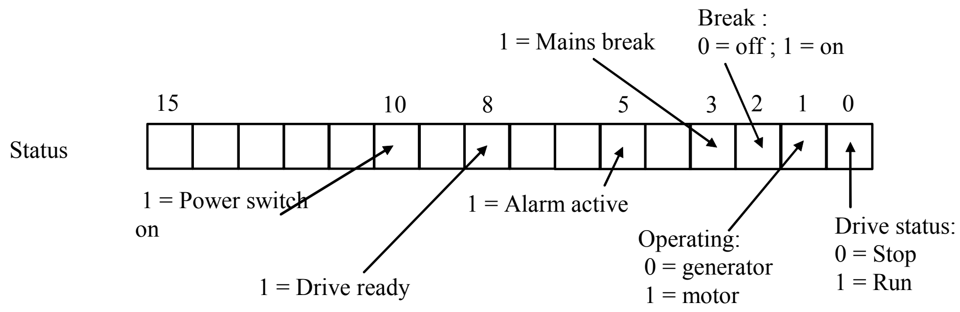
### 4.2.6.9 OUTPUT LOGIC FUNCTIONS (OBJECTS 2011H, 2015H, 2023H)

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

## 4.2.6.10 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.

## 4.2.6.11 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 to16384; 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%

# 5 GENERIC PARAMETERS

## 5.1 KEYS

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| RES_PAR_KEY | P60 – Access key to reserved parameters | 0 | 65535 | 0 | | 1 |
| TDE_PAR_KEY | P99 – Access key to TDE parameters | 0 | 19999 | 0 | | 1 |

P60 and P99 are two parameter that if correctly set allow some reserved parameter (only at a standstill). In particular:

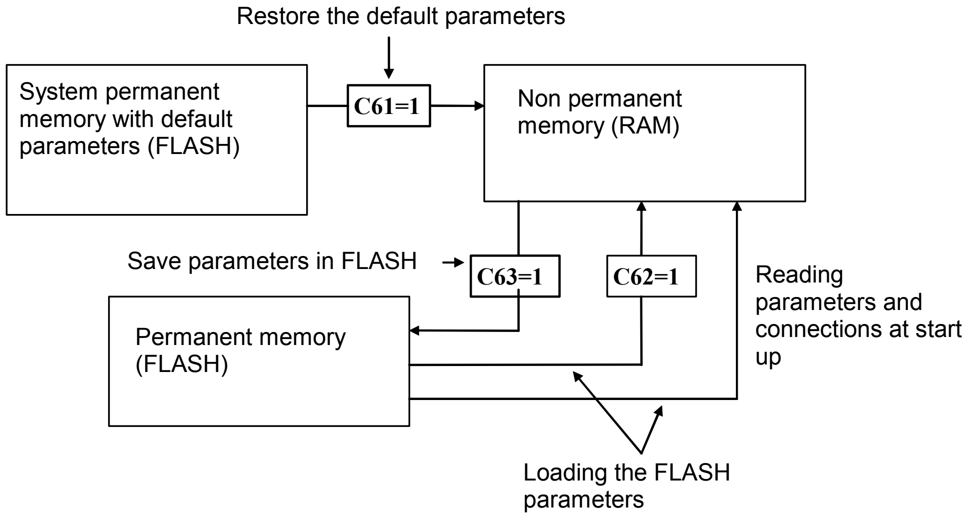
- If the value of P60 is the same of the key is possible to modify the reserved parameters
- If the value of P99 is the same of the key is possible to modify the TDE parameters

## 5.2 DATA STORING

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| DEF_PAR_RD | C61 - Read default parameters | 0 | 1 | 0 | | 1 |
| EEPROM_PAR_RD | C62 - Read parameters from EEPROM | 0 | 1 | 0 | | 1 |
| EEPROM_PAR_WR | C63 - Save parameters in EEPROM | 0 | 1 | 0 | | 1 |
| PAR_ACT_BANK | C60 - Parameter bank active | 0 | 1 | 0 | | 1 |

### 5.2.1 STORAGE AND RECALL OF THE WORKING PARAMETERS

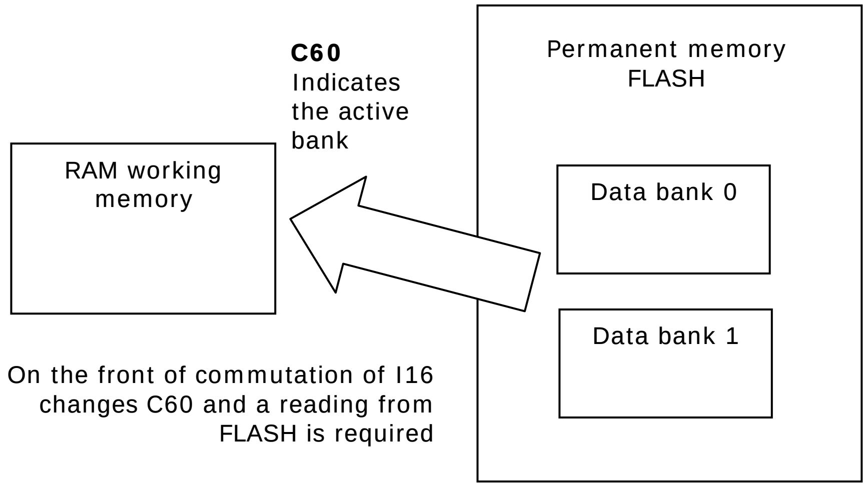
The drive has three types of memory:
The non permanent work memory (RAM), where the parameters become used for operation and modified parameters become stored; such parameters become lost due to the lack of feeding regulation.
The permanent work memory (FLASH), where the actual working parameters become stored to be used in sequence (C63=1, Save Parameters on FLASH).
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.**

## 5.2.1.1 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

## 5.3 DIGITAL COMMANDS AND CONTROL

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| SW_RUN_CMD | C21 - Run software enable | 0 | 1 | 1 | | 1 |
| EN_STOP_MIN_SPD | C28 - Stop with minimum speed | 0 | 1 | 0 | | 1 |
| DRV_SW_EN | C29 - Drive software enable | 0 | 1 | 1 | | 1 |
| ALL_RESET | C30 - Reset alarms | 0 | 1 | 0 | | 1 |
| ALL_COUNT_RESET | C44 - Reset alarm counters | 0 | 2 | 0 | | 1 |
| EN_BRAKE_R_PROT | C71 - Enable braking resistance protection | 0 | 1 | 0 | | 1 |
| EN_STO_ONLY_SIG | C73 - Enable Safety STOP only like signaling | 0 | 1 | 0 | | 1 |
| EN_BOOT | C98 - Enable boot mode | 0 | 1 | 0 | | 1 |
| SPD_ISR | D45 - Speed routine duration | | | 0 | us | 64 |
| I_ISR | D46 - Current routine duration | | | 0 | us | 64 |
| SPD_ISR | D45 - Speed routine duration | | | 0 | us | 64 |

### 5.3.1 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 an 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).
<u>Keep in mind that the “Alarm reset” is achieved by the active front of the signal, not on the active level.</u>

### 5.3.2 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 given also via serial line or field-bus. See for details the Standard Application Manual.

### 5.3.3 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 disable, 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).
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.

### 5.3.4 SAFETY STOP

The OPEN drive converters have the possibility to give the separated IGBT supply. 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**

#### 5.3.4.1 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 **A13.1**, 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".
- Reset the converter alarms for eliminate the alarm A13.The normal converter state is recovered.
- After 500ms the converter is able to start the Soft start sequence

#### 5.3.4.2 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

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.

# 6 ALARMS

## 6.1 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.
The alarm indication are divide in 16 categories (A0÷A15) and for each alarm can be present code to identify better the alarm (AXX.YY)

### 6.1.1 MALFUNCTIONS WITHOUT AN ALARM: TROUBLESHOOTING

| MALFUNCTION | POSSIBLE CAUSES | CORRECTIVE ACTION |
|---|---|---|
| Motor does not run | RUN command not given | Check operating status of input I00 |
| | 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<br><br>Check any contactors upstream and downstream of drive are closed |
| Motor does not turn | 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<br><br>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.<br><br>Increase motor size or use a larger frequency drive |

## 6.1.2 MALFUNCTIONS WITH AN ALARM: TROUBLESHOOTING

| ALARM | | DESCRIPTION | CORRECTIVE ACTION |
|---|---|---|---|
| A0.0 | Over –current alarm | It has been measured a current greater than its limit | Check if in a transient state the active current reference is increased to high values in a short time. Eventually increase the current limit regulator gain. |
| A0.1 | Motor in stall | Drive worked in torque or current limit for a time equal to P186 seconds | If the motor has to work in limit for a long time, disable this alarm set C82=0 or lengthen the limit time admitted increasing P186.<br>The motor is in stall because it has not been given sufficient voltage boost at low frequencies: increase the parameter P172.<br>The start-up load is too high: reduce it or increase the rating of motor and drive. |
| A1.0 | Loaded default parameters | EEPROM data related to a different core | It's possible to reset this alarm but keep attention: now all parameters have its default value. |
| A1.1 | EEPROM Read failure | A Check Sum error occurred while the EEPROM was reading the values. Default values loaded automatically. | Try rereading the values with the EEPROM<br>. The reading may have been disturbed in some way. If the problem continues contact TDE as there must a memory malfunction. |
| A1.2 | EEPROM Write failure | When data is being written in the EEPROM the required values are always shown afterwards: an alarm triggers if differences are detected. | Try rewriting the values in the EEPROM<br>. The information may have been disturbed in some way.<br>If the problem continues contact TDE as there must be a memory malfunction. |
| A1.3 | EEPROM Read and write failure | Alarms A1.1 and A1.2 appears | There are some problems with EEPROM. |
| A2.0 | Motor not fluxed | Magnetic flux (d27) is below the minimum flux set in P52. | Check that the motor is properly connected to the drive.<br><br>Try to increase parameter P29 (machine magnetizing waiting time) and reduce P52 if necessary as this specifies the minimum flux alarm threshold.<br><br>Check d27 to ensure that the flux increases when RUN is enabled. |
| A3.0 | Power failure | 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.<br><br>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. |
| A4.0 | Application alarm | This alarm is application specific. Please refer to specific documentation | |
| A5.0 | Motor temperature too high | Connection C46 runs a range of motor heat probes. If C46=1 or 2, a PTC/NTC is being used and its Ohm value (**d41**) has breached the safety threshold (**P95).** If C46 = 3 a digital input has been configured to I23 logical input function and this input is in not active state. If C46=4, a KTY84 is being used: the temperature reading (**d26**) must be higher than the maximum temperature (**P91**). | Check the temperature reading in d26 and then check the motor. With a KTY84, 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. |

| ALARM | | DESCRIPTION | CORRECTIVE ACTION |
|---|---|---|---|
| A5.1 | Radiator temperature too high | 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.<br><br>Check parameter P118 is set correctly. |
| A5.2 | Brake resistance adiabatic energy protection | The Adiabatic Energy dissipated on Braking resistance during the time selected in **P144** has overcame the threshold set in KJoule in **P142** | Check the correct setting of parameters P140, P142 and P144 compared to the Resistance plate. Check the correct dimensioning of Braking Resistance Maximum Power related to maximum speed, load inertia and braking time. |
| A5.3 | Brake resistance dissipated power | The Average Power dissipated on Braking has overcome the threshold set in Watt in **P146** | Check the correct setting of parameters P140, P146 and P148 compared to the Resistance plate. Check the correct dimensioning of Braking Resistance Average Power related to maximum speed, load inertia and braking time |
| A5.4 | Motor thermal probe not connected | Thermal probe not detected the presence. | Verify the presence of the connection of the probe and that it is correct. |
| A6.0 | Motor $I^2t$ thermal alarm | 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.<br><br>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). |
| A7.0 | Auto-tuning test unfinished | The RUN command was disabled during a test. Run command switched off too early. | Reset the alarms and repeat the test by re-enabling it. |
| A8.0 | Missing enable logic input from the field | A digital input has been configured to I02 logical input function and this input is in not active state | The external safety switch has cut in disabling drive enable. Restore and reset.<br><br>The connection has been broken. Check and eliminate the fault.<br><br>Input function has been assigned, but enable has not been given. Authorise or do not assign the function. |
| A8.1 | Watchdog alarm LogicLab | A LogicLab watchdog alarm on slow cycle appears | Check if the LogicLab slow task duration is greater than 500 ms and try to reduce this execution time |
| A8.2 | Fast task LogicLab too long | The logicLab fast task is too long in time | Try to reduce the LogicLab fast task execution time under admitted limit.<br>Please refer to the specific documentation. |
| A8.3 | Application out of service | There is no valid application running in the drive | Reload the application using OPDExplorer |
| A9.0 | Hardware board and firmware are incompatible | Feedback option card and drive firmware<br><br>incompatible | Check internal values **d62** and **d63** for the firmware and option card codes. There must be some irregularity. |
| A9.1 | Sensor presence | Sensor not connected | Check the connection towards the sensor. |
| A9.2 | Overspeed (more than 10 consecutive Tpwm) | 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. |

| ALARM | | DESCRIPTION | CORRECTIVE ACTION |
|---|---|---|---|
| A10.0 | DC Bus under minimum threshold admitted | 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.<br><br>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. |
| A10.1 | Emergency bracking on main supply lost | With connection C34= 3 was been select the emergency brake when main supply is lost. This has occurred | Try to understand why main supply is lost. |
| A11.1 | HW detection | Intermediate drive circuit voltage (DC Bus see **d24**) has exceeded the maximum analog thresold value. | The safety switch cuts in mainly due to excessively short braking times. The best solution is to lengthen the braking times.<br><br>An overvoltage in the mains may also trigger the safety switch.<br><br>If the drive is fitted with a braking circuit, check that the resistance value is not too high to absorb the peak power.<br><br>If the resistor is not too hot, check the resistor and connection continuity and ensure that the circuit functions correctly. |
| A11.2 | SW detection | Intermediate drive circuit voltage (DC Bus see **d24**) has exceeded the maximum value (**P107**). | |
| A11.3 | HW + SW detection | A11.0 and A11.1 appears | |
| A12.0 | Software alarm | C29 different from 1 | Check and enable connection C29 “Drive software enable” |
| A12.1 | Run whitout power soft start | RUN without Power Soft start | Check why the Power Soft start isn’t enabled |
| A12.2 | Run with T.radiator too high | RUN with Trad>P119 | Check the radiator temperature (d25) |
| A12.3 | Comunication problems with power card | Problems in the communication with the power card | Please contact TDEMacno assistance |
| A13.0 | Rectifier bridge problem | 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.<br><br>Try switching off and then back on, measuring the DC Bus level (with the monitor or tester).<br><br>If the problem repeats, contact TDE as there must be a soft start circuit malfunction. |
| A13.1 | Safe Torque Off | Safe Torque Off: +24Vare missing in connectors S1 and S3. For this reason it’s enabled certified STOP function | Bring +24V to connectors S1 and S3.<br><br>If the user want to use the Safe Torque Off function without alarms, it’s necessary to set C73=1. |
| A14.0 | Motor phase inverted | During autotuning was been detected that motor phase are not connected in the same order of feedback | Swap over two phases and repeat the connection tests. |
| A14.1 | Motor not connected | During autotuning was been detected that drive and motor aren’t connected properly | Check motor phases |
| A15.0 | Wrong number of Motor/Sensor poles | Motor/sensor parameters being written | Number of motor poles (P67) set incorrectly or more sensor poles (P68) than motor poles have been set. |
| A15.1 | Simulated encoder pulses | Simulated Encoder pulses | Number of revolutions per pulse selected (C51) is not compatible with the maximum speed (P65). See “Feedback Option” enclosure. |

| ALARM | | DESCRIPTION | CORRECTIVE ACTION |
|---|---|---|---|
| A15.3 | Wrong Sensor pulses number read in Autotest | An error occurred during the “Sensor and motor poles” test. | See specific test description in the “Feedback Option” enclosure. |

## MiniOPD’s Specific Alarms

**Date:03/12/2010**

The new MiniOPD consists of 2 fast-communicating microprocessors. One microprocessor is located in the Regulation board (as in standard OPDs); the second one is located in the Power board.
Thanks to this new configuration, the MiniOPD features some types of alarms that are not included in the OPD series. These alarms have been renamed, so as to guarantee maximum compatibility with those who already use the OPD series.

MiniOPD’s specific alarms are listed in Table 1:

| Alarm | | Description |
|---|---|---|
| A.10.0 | | Minimum voltage of Power circuit |
| A.10.5 | | Overcurrent alarm detected by Power board |
| A.10.6 | | Communication alarm: communication fault with Power board |
| A.10.7 | | Alarm due to Power board fault (Micro’s watchdog) |
| A.10.8 | | Alarm due to wrong power supply in the Power board (15V wrong) |
| A.10.15 | | Alarm - Brake (hardware) |

**Table 1**

These alarms take the form of sub-alarms of alarm A.10, to indicate that they all depend on the Power board.
If Alarm A.10.0 – Minimum Voltage of Power Circuit – occurs first, followed by a second alarm from the Power board (typically a Communication Alarm or 15V Wrong Power Supply Alarm), the latter alarms are not shown by the Drive, as they are a direct consequence of alarm A.10.0.

# 7 DISPLAY

## 7.1 PHYSICAL DISPOSITION

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

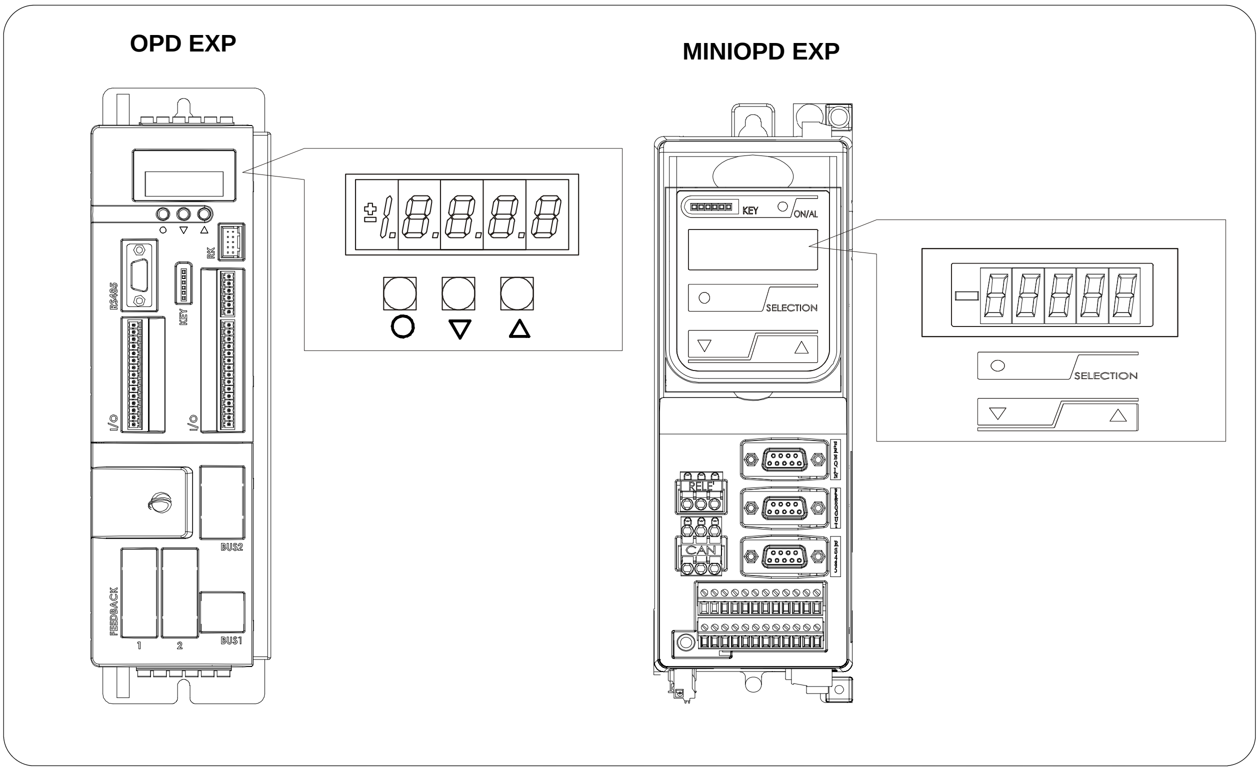



**FIG. 1** (Physical disposition)

## 7.2 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**)
- Application Parameters (**APP**)
- Connections (**CON)**
- Internal dimensions (**INT**)
- Allarms (**ALL**)
- Digital Input (**INP**)
- Digital Output (**OUT**)

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

### 7.2.1 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 (Online), other only to converter not in run (offline), **reserved**, modifiable only offline 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 offline. The characteristics of each parameter are recognizable from the **code of identification** as under:

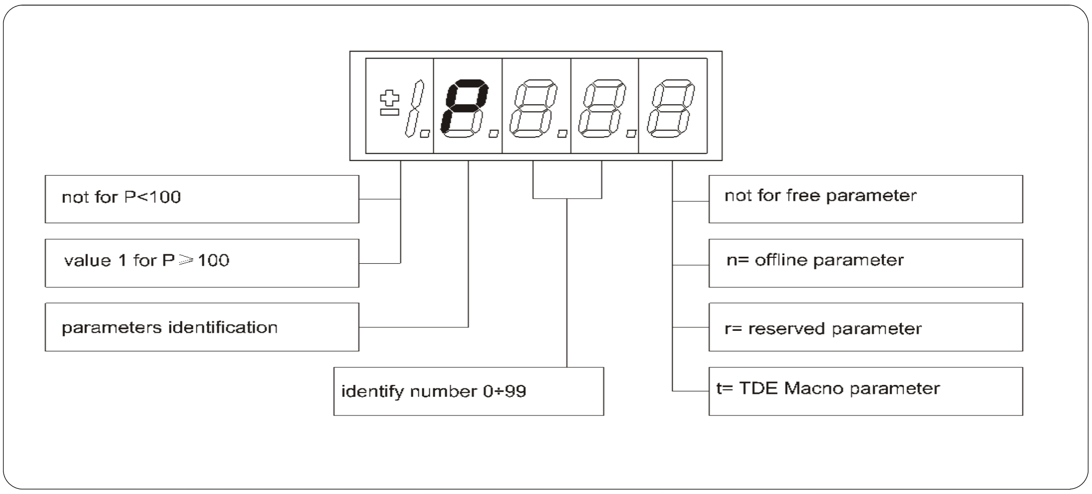



**FIG. 2** (Parameters PAR)

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

### 7.2.2 APPLICATION PARAMETERS (APP)

For their definition refer to the description of the parameters. They are distinguished in free parameters, some modifiable always (Online), other only to converter not in run (offline), reserved, modifiable only offline 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 offline. The characteristics of each parameter are recognizable from the code of identification as under:

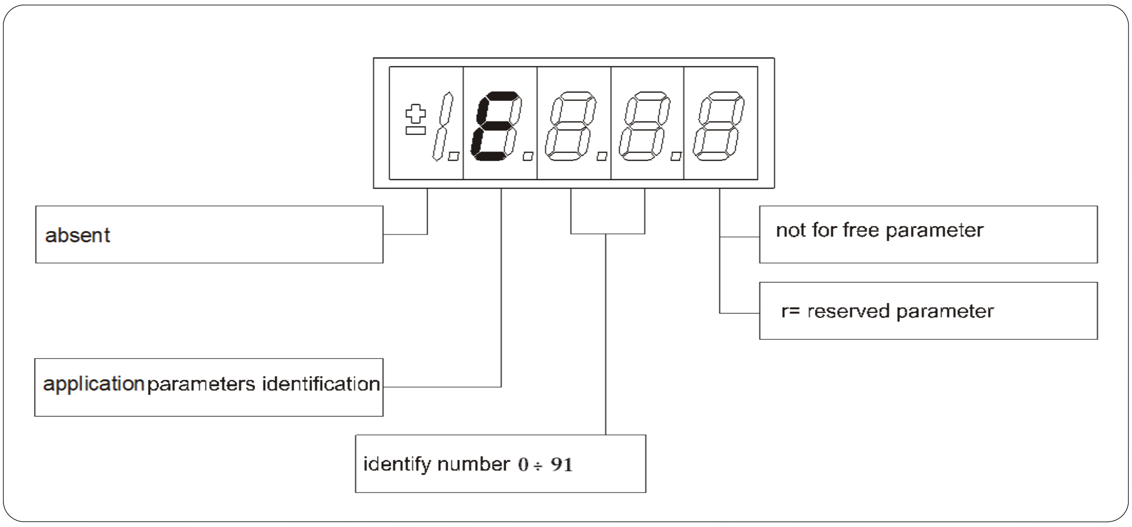



**FIG. 3** (Application Parameters PAR)

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

### 7.2.3 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 (Online), other with converter in stop (offline) and **reserved**, modifiable only offline and after access code to the reserved parameters (P60).

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

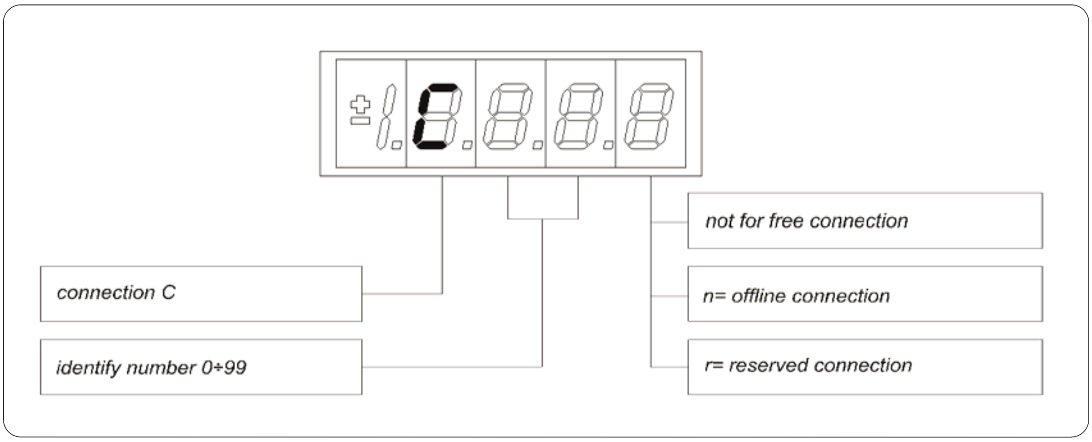



**FIG. 4** (Connections CON)

### 7.2.4 ALLARMS (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 actived 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 ex. **A03.L = 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).

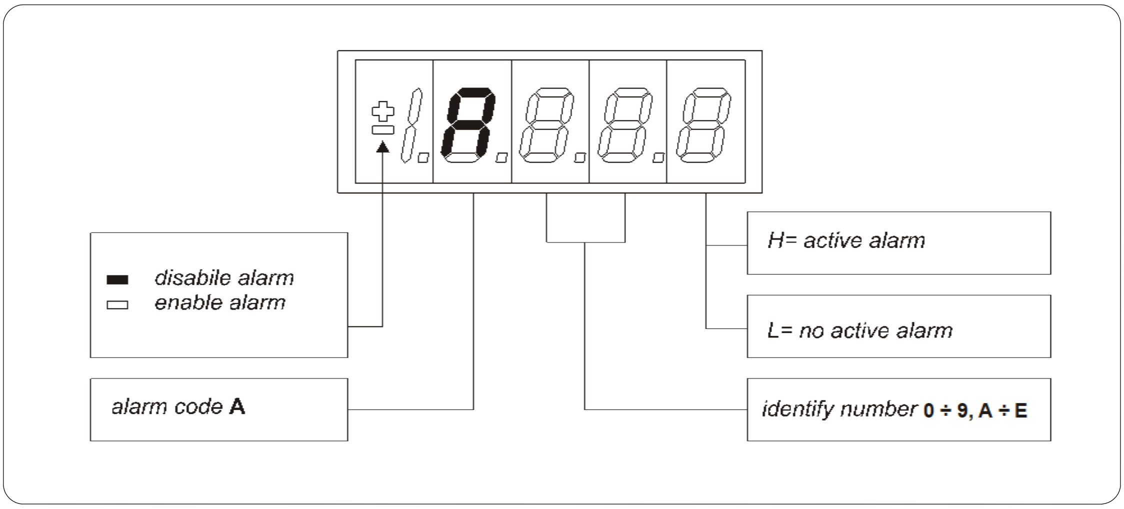



**FIG. 5** (Allarms ALL)

### 7.2.5 INTERNAL VALUES (INT)

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 actived 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:

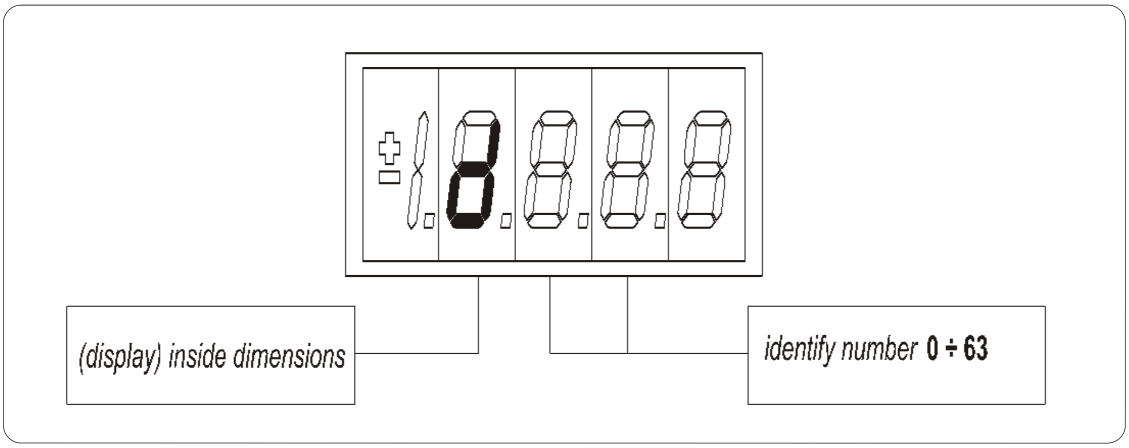



**FIG. 6** (Internal Values INT)

### 7.2.6 LOGIC 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.

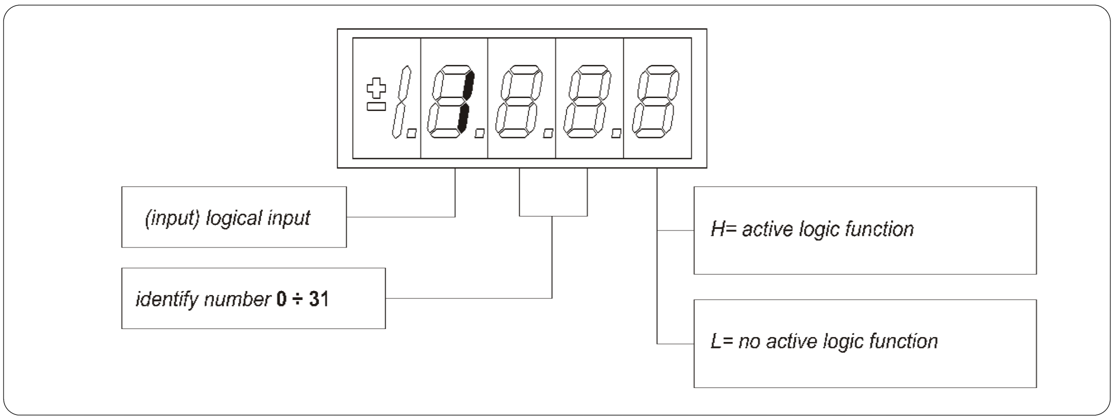



**FIG. 7** (Logics functions of input INP)

### 7.2.7 LOGIC 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:

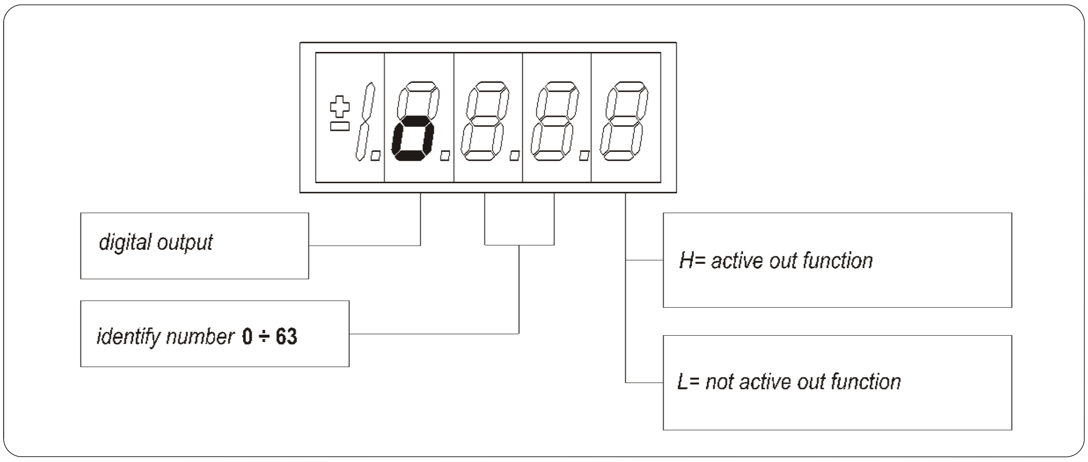



**FIG. 8** (Logics functions of output OUT)

### 7.3 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).

## 7.4 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
APP = application parameters
CON = internal connections
INT= internal dimensions
ALL= allarm
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 undermenu pressing “S”; the reentry to the mainmenu 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.

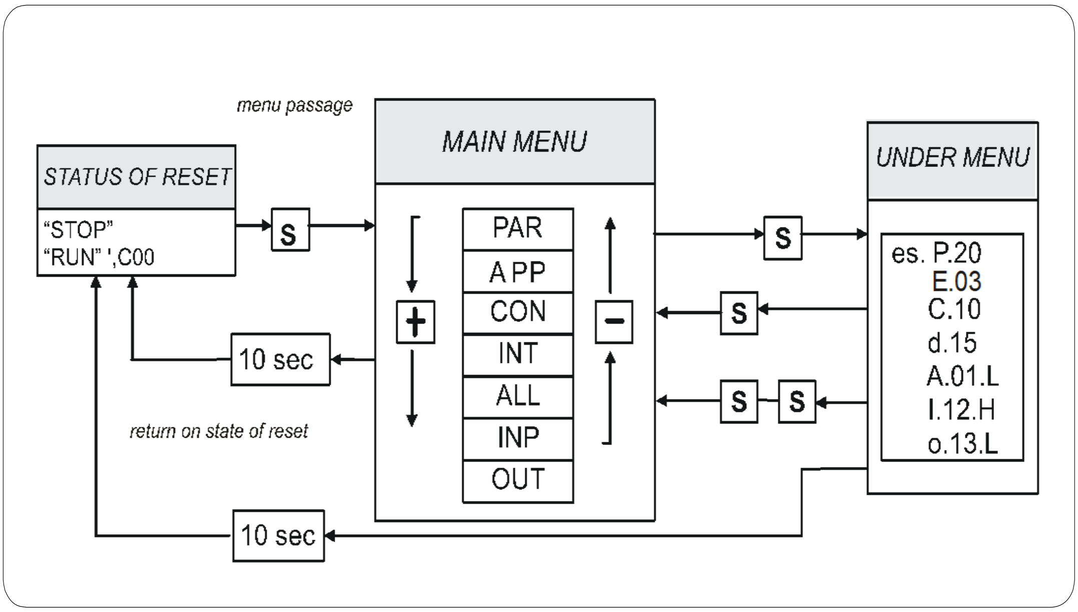



**FIG. 9** (Main Menu)

### 7.4.1 UNDER-MENU OF PARAMETERS, APPLICATION PARAMETERS AND CONNECTIONS MANAGEMENT (PAR, APP E CON)

From “**PAR**” or “**CON**” You enter into the undermenu 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 (offline); all the reserved parameters are of type “**n**” modifiable only by stop (offline). If You pressed the key “**S**” comes visualized the value of the parameter or of the connection that may be read; at this point repress “**S**” once You return to the undermenu 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.

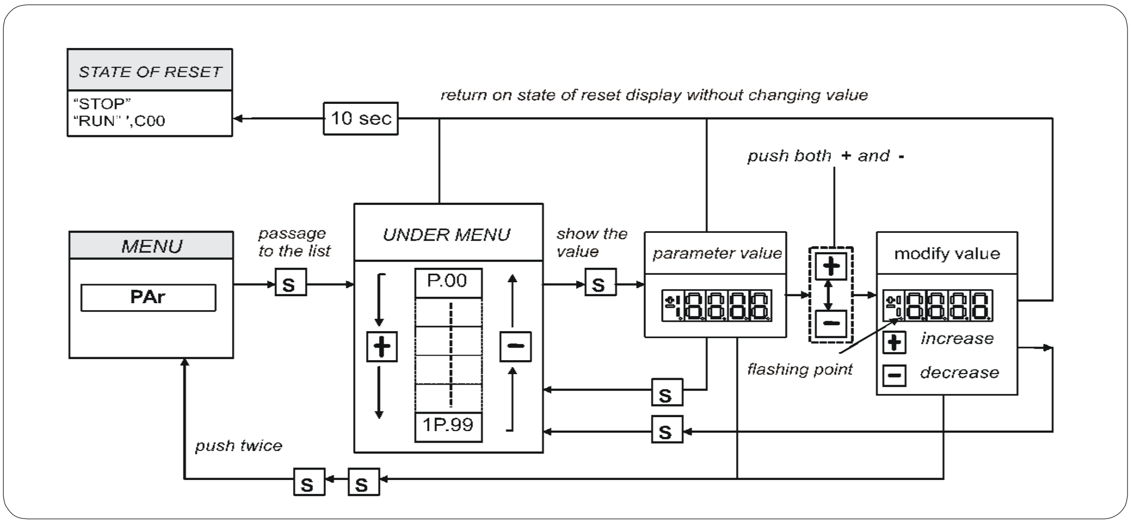



**FIG. 10** (Submenu management parameters PAR)

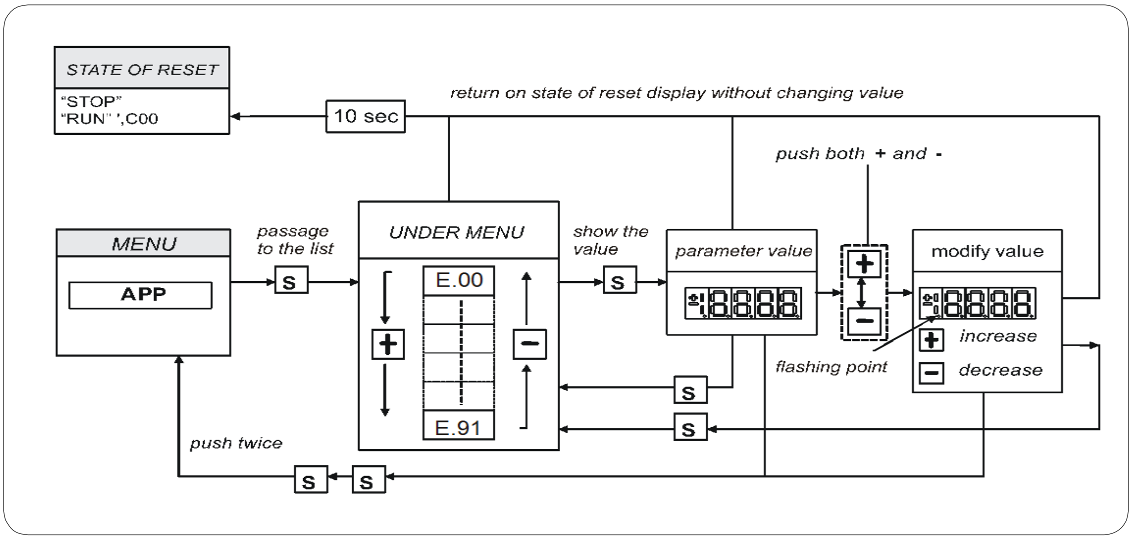



**FIG. 11** (Submenu management application parameters APP)

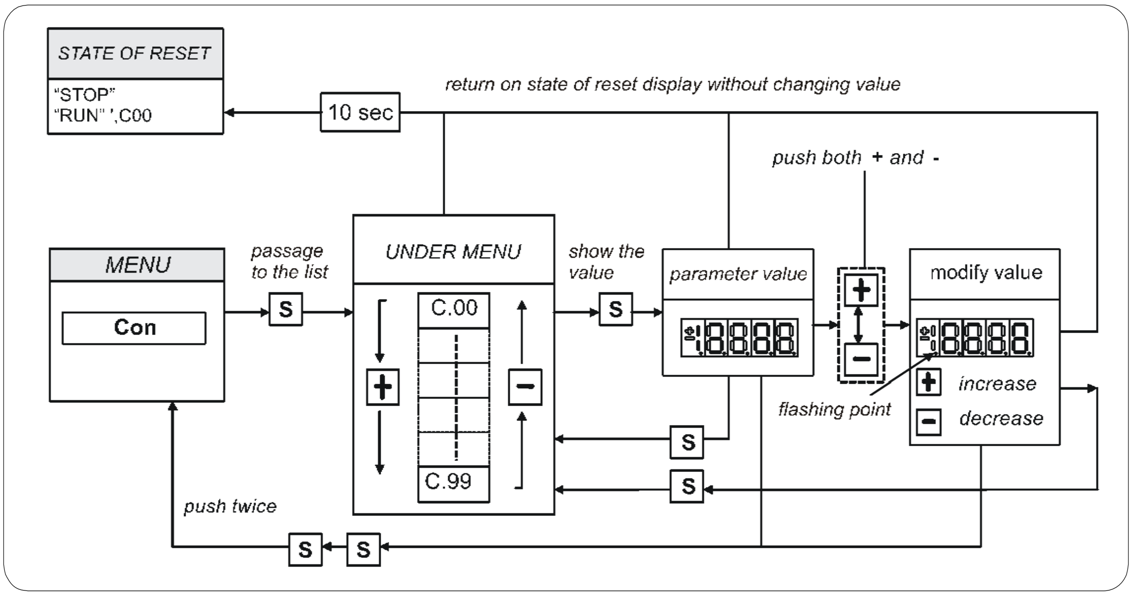



**FIG. 12** (Submenu management connections CON)

## 7.4.2 VISUALIZATION OF THE INTERNAL DIMENSIONS (INT)

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

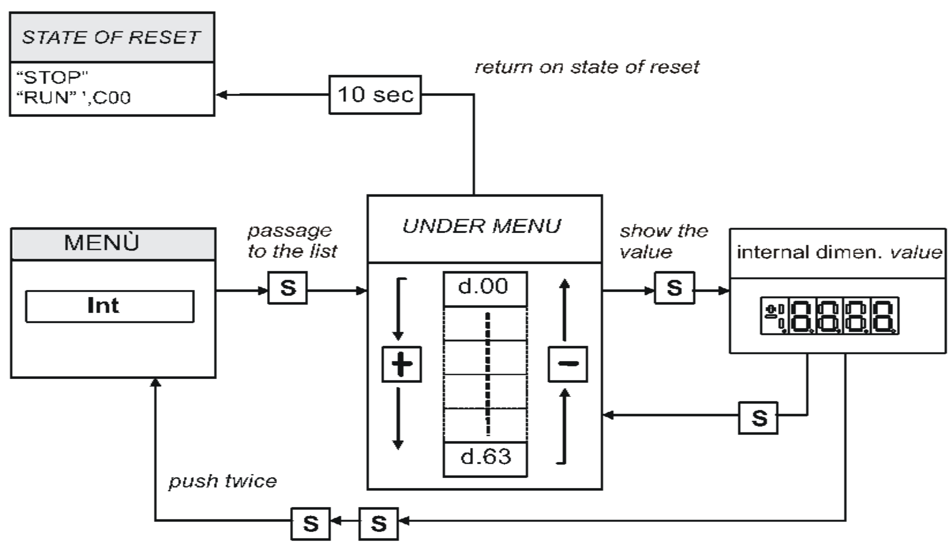



**FIG. 13** (Visualization of the internal dimensions INT)

## 7.4.3 ALARMS (ALL)

From ALL You enter into of undermenu list of the alarms pressing “S”. From the corresponding undermenu 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 undermenu and You return operative the select made pressing "S", from the menu and from the undermenu You turn automatically to the status of rest after a time closed to 10 seconds.

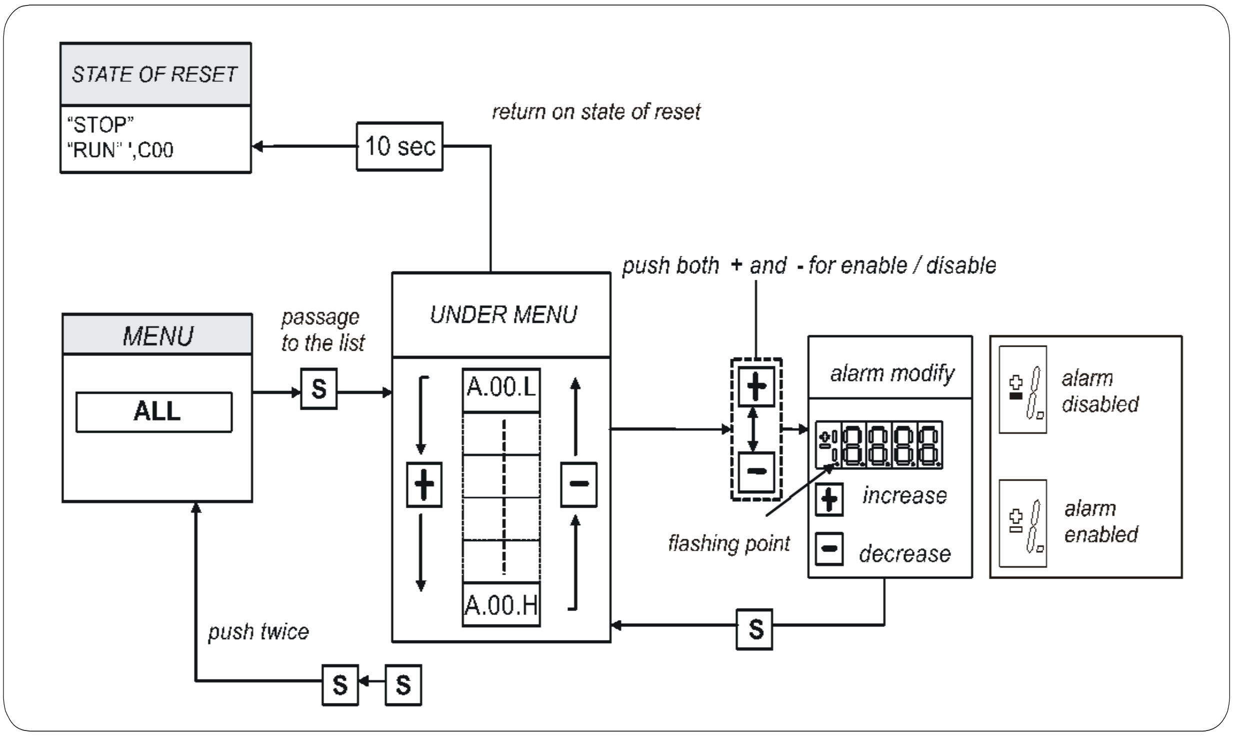



**FIG. 14** (Alarms ALL)

### 7.4.4 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 undermenu 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**".

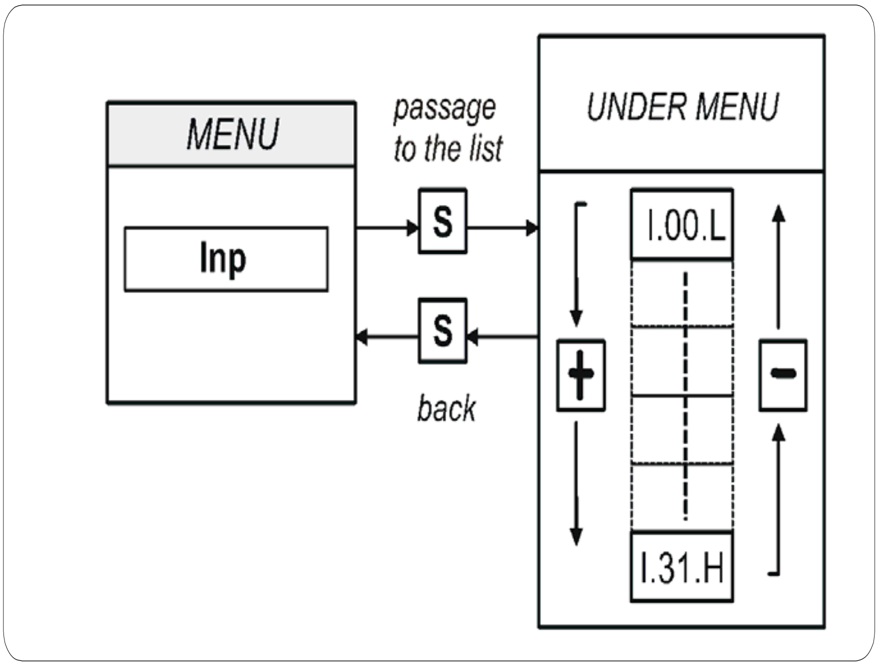



**FIG. 15** (Digital input INP)

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; L= active alarm |
| I | 30 | / MAXV | H= OK; L= active alarm |
| I | 31 | / MAINS SUPPLY OFF | H= OK; L= active alarm |

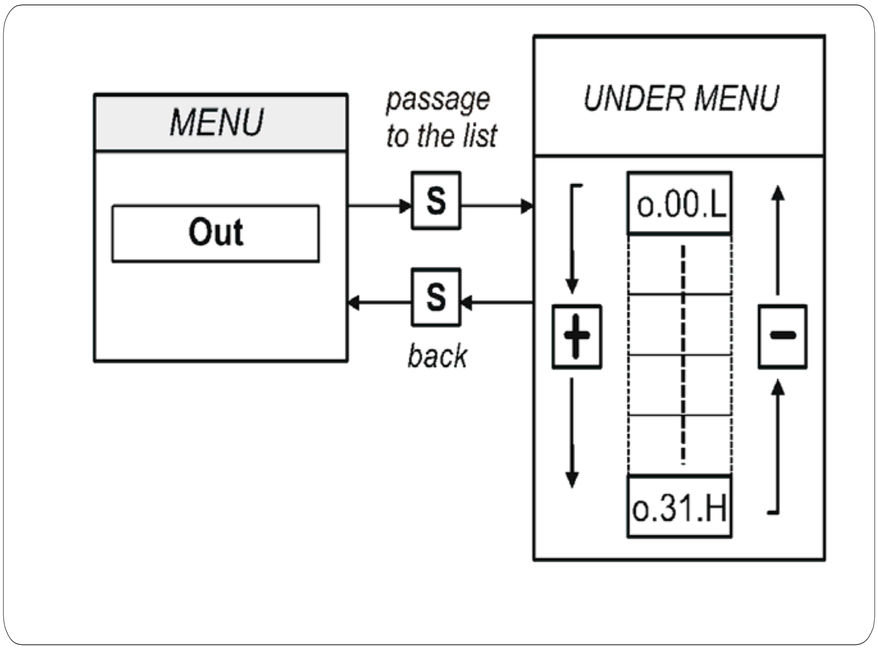



**FIG. 16** (Digital output OUT)

## 7.5 PROGRAMMING KEY

The programming key device allows to transfer parameters from and to the Drive inverter or between inverters. The data are stored in a EPROM type memory, so **battery backup is not necessary**. The switch put on the key upper front side allows to protect the stored data against possible writing procedures.

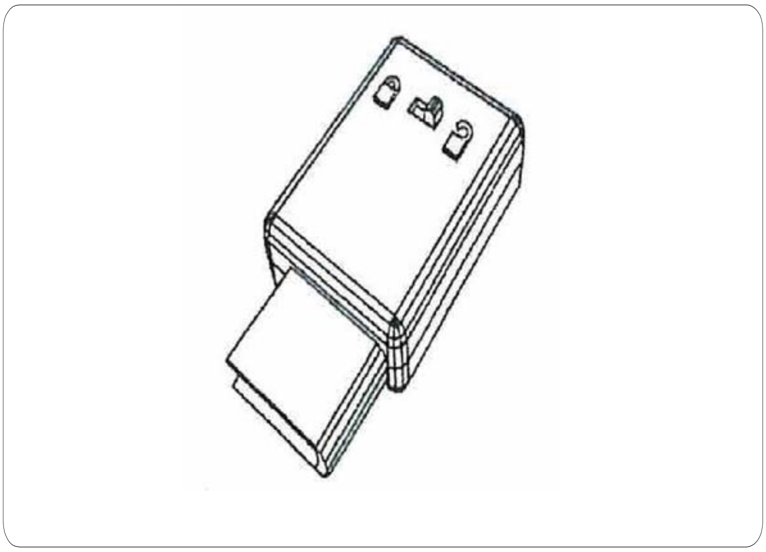


**FIG. 17** (Keypad)

**Use method**:

**Parameter transmission from the key to the inverter:**

a) Plug the key into the suitable connector;
b) Select, via the keypad ▼ and ▲, the "**Load**" function and press "**S**".

During the data transfer the "**RUNN**" indication is displayed.
If the key contains invalid parameters, the factory preset parameters will be used and the message "**Err**", will be dispalyed for 4 s. Otherwise, data will be permanently stored and the confirmation message "**donE**" will be displayed for 2 s.

**Parameter transmission from the inverter to the key:**

a) Plug the key into the suitable connector;
c) Select, via keypad ▼ and ▲, the "**Save**" function and press "**S**".

If the key is write-protected. The control is interrupted and the message "**Prot**" is displayed for 4 s. Otherwise, inverter parameters are stored on the key and, at the end of the operation, the message "**RUNN**" and the message "**donE**" will be displayed for 2 s to confirm the operation.

# 8 LIST OF PARAMETERS

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| KP_AI1 | P01 - Corrective factor for analog reference 1 (AUX1) | -400.0 | 400.0 | 100 | % | 10 |
| OFFSET_AI1 | P02 - Corrective offset for analog reference 1 (AUX1) | -100.0 | 100.0 | 0 | % | 163.84 |
| KP_AI2 | P03 - Corrective factor for analog reference 2 (AUX2) | -400.0 | 400.0 | 100 | % | 10 |
| OFFSET_AI2 | P04 - Corrective offset for analog reference 2 (AUX2) | -100.0 | 100.0 | 0 | % | 163.84 |
| KP_AI3 | P05 - Corrective factor for analog reference 3 (AUX3) | -400.0 | 400.0 | 100 | % | 10 |
| OFFSET_AI3 | P06 - Corrective offset for analog reference 3 (AUX3) | -100.0 | 100.0 | 0 | % | 163.84 |
| KP_SENS2 | P07 - Second sensor amplitude compensation | 0.0 | 200.0 | 100 | % | 163.84 |
| OFFSET_SIN_SENS2 | P08 - Second sensor sine offset | -16383 | 16383 | 0 | | 1 |
| OFFSET_COS_SENS2 | P09 - Second sensor cosine offset | -16383 | 16383 | 0 | | 1 |
| OFFSET_VF | P10 - Offset for high precision analog reference value | -19999 | 19999 | 0 | 1/100 mV | 1 |
| SYNC_REG_KP | P11 - CanOpen SYNC loop regulator Proportional gain | 0 | 200 | 5 | | 1 |
| SYNC_REG_TA | P12 - CanOpen SYNC loop regulator lead time constant | 0 | 20000 | 400 | | 1 |
| KP_AI16 | P13 - Corrective factor for 16 bit analog reference (AUX16) | -400.0 | 400.0 | 100 | % | 10 |
| OFFSET_AI16 | P14 - Corrective offset for 16 bit analog reference (AUX16) | -100.0 | 100.0 | 0 | % | 163.84 |
| TF_LI6-7-8 | P15 - I06,07,08 logical inputs digital filter | 0.0 | 20.0 | 2.2 | ms | 10 |
| RES2_POLE | P16 - Number of absolute sensor2 poles | 1 | 160 | 2 | | 1 |
| ENC2_PPR | P17 - Number of encoder2 pulses/revolution | 0 | 60000 | 1024 | pulses/rev | 1 |
| PRC_CW_SPD_REF_MAX | P18 - Max. CW speed reference value limit | -105.0 | 105.0 | 105.02 | % MOT_SPD_MAX | 163.84 |
| PRC_CCW_SPD_REF_MAX | P19 - Max. CCW speed reference value limit | -105.0 | 105.0 | 105.02 | % MOT_SPD_MAX | 163.84 |
| CW_ACC_TIME | P21 - CW acceleration time | 0.01 | 199.9 9 | 10 | s | 100 |
| CW_DEC_TIME | P22 - CW deceleration time | 0.01 | 199.9 9 | 10 | s | 100 |
| CCW_ACC_TIME | P23 - CCW acceleration time | 0.01 | 199.9 9 | 10 | s | 100 |
| CCW_DEC_TIME | P24 - CCW deceleration time | 0.01 | 199.9 9 | 10 | s | 100 |
| TF_RND_RAMP | P25 - Rounded filter time constant | 0.1 | 20.0 | 5 | s | 10 |
| I_RELAY_THR | P26 - Current/power relay cut-in threshold | 0.2 | 150.0 | 100 | % | 40.96 |
| TF_I_RELAY | P27 - Filter time constant for current/power relay | 0.1 | 10.0 | 1 | s | 10 |
| MOT_WAIT_DEMAGN | P28 - Motor demagnetization waiting time | 0 | 3000 | 0 | ms | 1 |
| MOT_WAIT_MAGN | P29 - Motor magnetization waiting time | 50 | 3000 | 300 | ms | 1 |
| DEC_TIME_EMCY | P30 - Emergency brake deceleration time | 0.01 | 199.9 9 | 10 | s | 100 |
| END_SPD_REG_KP | P31 - KpV final speed regulator proportional gain | 0.1 | 400.0 | 4 | | 10 |
| END_SPD_REG_TI | P32 - TiV final speed regulator lead time constant | 0.1 | 3000. 0 | 80 | ms | 10 |
| END_SPD_REG_TF | P33 - TfV final speed regulator (filter) time constant | 0.0 | 25.0 | 0.8 | ms | 10 |
| START_SPD_REG_TF | P34 - TfV initial speed regulator (filter) time constant | 0.0 | 25.0 | 0.8 | ms | 10 |
| PRC_FLX_REF | P35 - Flux Reference | 0.0 | 120.0 | 100 | % MOT_FLX_NOM | 40.96 |
| V_REF_COEFF | P36 - Kv Max operating voltage multiply factor | 0.0 | 100.0 | 100 | | 327.67 |
| FLW_ERR_MAX_LSW | P37 - Maximum tracking error (less significative part) | -32767 | 32767 | 32767 | ppr | 1 |
| POS_REG_KP | P38 - Kv position loop proportional gain | 0.0 | 100.0 | 4 | | 10 |
| FLW_ERR_MAX_MSW | P39 - Maximum tracking error (less significative part) | 0 | 32767 | 0 | rpm | 1 |
| PRC_DRV_I_PEAK | P40 - Current limit | 0.0 | 200.0 | 200 | % DRV_I_NOM | 40.96 |
| PRC_MOT_T_MAX | P41 - Maximum torque at full load | 0.0 | 400.0 | 400.0 | % MOT_T_NOM | 40.96 |
| PRC_DRV_CW_T_MAX | P42 - Maximum torque in the positive direction of rotation | 0.0 | 400.0 | 400.0 | % MON_T_NOM | 40.96 |
| PRC_DRV_CCW_T_MAX | P43 - Maximum torque in the negative | -400.0 | -0.0 | -400.0 | % MOM_T_NOM | 40.96 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| | direction of rotation | | | | | |
| PRC_SPD_THR_GAIN_CHG | P44 - End speed for speed PI gain change | 0.0 | 100.0 | 0 | % MOT_SPD_MAX | 163.84 |
| START_SPD_REG_KP | P45 - KpV initial speed PI proportional gain | 0.1 | 400.0 | 4 | | 10 |
| START_SPD_REG_TI | P46 - TiV initial speed PI lead time constant | 0.1 | 3000.0 | 80 | ms | 10 |
| DO_SPD_REACH_THR | P47 - Speed threshold for logic output o.16 | 0.0 | 100.0 | 0 | % MOT_SPD_MAX | 163.84 |
| RES2_TRACK_LOOP_BW | P48 - Tracking loop bandwidth direct decoding of resolver2 | 100 | 10000 | 1800 | rad/s | 1 |
| RES2_TRACK_LOOP_DAMP | P49 - Damp factor Traking loop resolver2 | 0.00 | 5.00 | 0.71 | | 100 |
| DO_SPD_MIN_THR | P50 - Minimum speed for relay | 0.0 | 100.0 | 2.0 | % MOT_SPD_MAX | 163.84 |
| PRC_MOT_SPD_MAX | P51 - Maximum speed for alarm | 0.0 | 125.0 | 120.0 | % MOT_SPD_MAX | 163.83 |
| PRC_FLX_MIN | P52 - Minimum Flux admitted | 0.0 | 100.0 | 2 | % MOT_FLX_NOM | 40.96 |
| DRV_I_NOM | P53 - Rated drive current | 0.0 | 3000.0 | 0 | A | 10 |
| PRC_AO1_10V | P57 - % value of 10V for analog output A | 100.0 | 400.0 | 200 | % | 10 |
| PRC_AO2_10V | P58 - % value of 10V for analog output B | 100.0 | 400.0 | 200 | % | 10 |
| HYST_DO_SPD | P59 - Minimum and maximum speed reached output hysteresis | 0.0 | 100.0 | 1.0 | % MOT_SPD_MAX | 163.84 |
| RES_PAR_KEY | P60 - Access Key to reserved parameters | 0 | 65535 | 0 | | 1 |
| PRC_MOT_I_NOM | P61 - Rated motor current ( I NOM MOT) | 10.0 | 100.0 | 100 | % DRV_I_NOM | 327.67 |
| MOT_V_NOM | P62 - Rated motor voltage | 100.0 | 1000.0 | 380 | Volt | 10 |
| MOT_F_NOM | P63 - Rated motor frequency | 10.0 | 1000.0 | 50.0 | Hz | 10 |
| PRC_MOT_V_MAX | P64 - Max. operating voltage | 1.0 | 200.0 | 100 | % MOT_V_NOM | 40.96 |
| MOT_SPD_MAX | P65 - Max. operating speed (n MAX) | 50 | 60000 | 2000 | RPM | 1 |
| MOT_COS_PHI | P66 - Nominal power factor | 0.500 | 1.000 | 0.894 | | 1000 |
| MOT_POLE_NUM | P67 - Number of motor poles | 1 | 12 | 4 | | 1 |
| RES_POLE | P68 - Number of absolute sensor poles | 1 | 12 | 2 | | 1 |
| ENC_PPR | P69 - Number of encoder pulses/revolution | 0 | 60000 | 1024 | pulses/rev | 1 |
| PRC_MOT_I_THERM | P70 - Motor thermal current | 10.0 | 110.0 | 100 | % PRC_MOT_I_NOM | 10 |
| MOT_TF_THERM | P71 - Motor thermal time constant | 30 | 2400 | 180 | s | 1 |
| PRC_MOT_I_T_NOM | P72 - Nominal torque current | 5.0 | 100.0 | 95.2 | % PRC_MOT_I_NOM | 327.67 |
| PRC_MOT_I_FLX_NOM | P73 - Nominal flux current | 5.0 | 100.0 | 30.2 | % PRC_MOT_I_NOM | 327.67 |
| T_ROTOR | P74 - Rotor time constant Tr | 10 | 10000 | 182 | ms | 1 |
| T_STATOR | P75 - Stator time constant Ts | 0.0 | 50.0 | 8.5 | ms | 10 |
| PRC_DELTA_VRS | P76 - Voltage drop due to stator resistor | 1.0 | 25.0 | 2.0 | % MOT_V_NOM | 327.67 |
| PRC_DELTA_VLS | P77 - Voltage drop due to leakage inductance | 5.0 | 100.0 | 20.0 | % MOT_V_NOM | 327.67 |
| MOT_T_NOM | P78 - Nominal motor torque | 0.5 | 3000.0 | 0.0 | Nm | 10 |
| TEST_CONN_FEEDBACK | P79 - Connection tests: Encoder: pulses counted, Resolver or Sin Cos Enc: time reading | -19999 | 19999 | 0 | | 0 |
| V_REG_KP | P80 - Kpi voltage regulator proportional gain | 0.1 | 100.0 | 9.1 | | 10 |
| V_REG_TF | P82 - Tfi voltage regulator (filter) time constant | 0.0 | 1000.0 | 11 | ms | 10 |
| I_REG_KP | P83 - Kpc current regulator proportional gain | 0.1 | 100.0 | 2.6 | | 10 |
| I_REG_TI | P84 - Tic current regulator lead time constant | 0.0 | 1000.0 | 8.5 | ms | 10 |
| I_REG_TF | P85 - Tfc current regulator (filter) time constant | 0.0 | 25.0 | 0 | ms | 10 |
| DCBUS_REG_KP | P86 - Kp3 Bus control proportional gain | 0.05 | 10.00 | 3.5 | | 100 |
| MAIN_SUPPLY | P87 - Main Supply voltage | 180.0 | 780.0 | 400 | V rms | 10 |
| MAXV_VF | P88 - High precision analog speed reference value: Voltage matches max. speed | 2500 | 10000 | 10000 | mVolt | 1 |
| RES_TRACK_LOOP_BW | P89 - Tracking loop bandwidth direct decoding of resolver | 100 | 10000 | 1800 | rad/s | 1 |
| RES_TRACK_LOOP_DAMP | P90 - D Traking loop bandwidth | 0.00 | 5.00 | 0.71 | | 100 |
| MOT_TEMP_MAX | P91 - Maximum motor temperature (if read with PT100) | 0.0 | 150.0 | 130 | °C | 10 |
| MODBUS_ADDR | P92 - Serial identification number | 0 | 255 | 1 | | 1 |
| MODBUS_BAUD | P93 - Serial baud rate | | | 192 | Kbit/s | 1 |
| MOT_PRB_RES_THR | P95 - Motor NTC or PTC resistance value for alarm | 0 | 19999 | 1500 | Ohm | 1 |
| PRC_MOT_DO_TEMP_THR | P96 - Motor thermal logic output 14 cut-in threshold | 0.0 | 200.0 | 100 | % PRC_MOT_I_THERM | 40.96 |
| DCBUS_MIN_MAIN_LOST | P97 - Minimum voltage level for forced mains off | 100.0 | 1200.0 | 425 | V | 10 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| DCBUS_REF_MAIN_LOST | P98 - Voltage reference value in Support 1 | 220.0 | 1200.0 | 600 | V | 10 |
| TDE_PAR_KEY | P99 - Access key to TDE parameters | 0 | 19999 | 0 | | 1 |
| RES_PAR_KEY_VAL | P100 - Value of access key to reserved parameters | 0 | 19999 | 95 | | 1 |
| DRV_F_PWM | P101 - PWM frequency | 1000 | 16000 | 5000 | Hz | 1 |
| PRC_DEAD_TIME_CMP | P102 - Dead time compensation | 0.0 | 100.0 | 22.0 | ‰ PRC_MOT_V_MAX | 32.76 |
| PRC_DRV_I_MAX | P103 - Drive limit current | 0.0 | 800.0 | 200 | % DRV_I_NOM | 40.96 |
| T_RAD | P104 - Radiator time constant | 10.0 | 360.0 | 80 | s | 10 |
| KP_DCBUS | P105 - Corrective factor for Bus voltage | 80.0 | 200.0 | 100 | % | 10 |
| DCBUS_MIN | P106 - Minimum voltage of DC Bus | 220.0 | 1200.0 | 400 | V | 10 |
| DCBUS_MAX | P107 - Maximum voltage of DC Bus | 350.0 | 1200.0 | 800 | V | 10 |
| DCBUS_BRAKE_ON | P108 - Bus voltage threshold for brake ON | 350.0 | 1200.0 | 770 | V | 10 |
| DCBUS_BRAKE_OFF | P109 - Bus voltage threshold for brake OFF | 350.0 | 1200.0 | 760 | V | 10 |
| OFFSET_AO1 | P110 - Offset A/D 1 | -100.0 | 100.0 | 0 | % | 327.67 |
| OFFSET_AO2 | P111 - Offset A/D 2 | -100.0 | 100.0 | 0 | % | 327.67 |
| DRV_I_PEAK | P113 - Maximum drive current | 0.0 | 3000.0 | 0 | A | 10 |
| PRC_I_TEST_CONN | P114 - Current in connection tests for UVW, Poles and reading Rs | 0.0 | 100.0 | 100 | % DRV_I_NOM | 327.67 |
| KP_MOT_THERM_PRB | P115 - Multiplication factor for motor PTC/NTC/PT100 analog reference value | 0.00 | 200.00 | 100 | | 163.84 |
| T_JUNC | P116 - Junction time constant | 0.1 | 10.0 | 3.5 | s | 10 |
| KP_DRV_THERM_PRB | P117 - Multiplication factor for radiator PTC/NTC analog reference value | 0.00 | 200.00 | 100 | | 163.84 |
| DRV_TEMP_MAX | P118 - Max. temperature permitted by radiator PTC/NTC | 0.0 | 150.0 | 90 | °C | 10 |
| DRV_START_TEMP_MAX | P119 - Max. temperature permitted by radiator PTC/NTC for start-up | 0.0 | 150.0 | 75 | °C | 10 |
| DRV_DO_TEMP_THR | P120 - Radiator temperature threshold for logic output o.15 | 0.0 | 150.0 | 80 | °C | 10 |
| TEST3-4_ACC_TIME | P121 - Test 3 and 4 acceleration time | 0.01 | 199.99 | 6.8 | s | 100 |
| MOD_INDEX_MAX | P122 - Max. modulation index | 0.500 | 0.995 | 0.98 | | 1000 |
| DCBUS_REF | P123 - Smart brake voltage cut-in level | 300.0 | 1200.0 | 750 | V | 10 |
| PRC_ENC_OUT_LOOP | P124 - Simulated encoder Kv gain multiplication coeff. | 0.0 | 100.0 | 100 | % | 327.67 |
| PRC_V_REF_DCBUS | P125 - Voltage reference function of DC bus | 0.0 | 100.0 | 96.0 | % | 327.67 |
| PRC_I_REG_KP_COEFF | P126 - KpI Corrective coeff. estimated Kp for current loops | 0.0 | 200.0 | 100 | % | 40.96 |
| PRC_V_REG_KP_COEFF | P127 - KpV Corrective coeff. estimated Kp for voltage loops | 0.0 | 200.0 | 100 | % | 40.96 |
| MOT_V0 | P128 - Voltage motor at nominal speed with no load | 0.0 | 100.0 | 100.0 | % MOT_V_NOM | 327.67 |
| PRC_I_TEST_DELTA_VLS | P129 - Test current to establish VLS | 0.0 | 100.0 | 30.0 | % | 327.67 |
| TEST_SPD_T_MAX | P130 - Torque during start-up test | 0.0 | 100.0 | 100 | % MOT_T_NOM | 40.96 |
| K_FLX45 | P131 - Magnetic characteristic point 1 | 0.0 | 120.0 | 90.2 | % | 40.96 |
| TEST_SPD_MAX | P132 - Speed during start-up test | -100.00 | 100.00 | 100 | % MOT_SPD_MAX | 163.84 |
| K_FLX55 | P133 - Magnetic characteristic point 2 | 0.0 | 120.0 | 90.5 | % | 40.96 |
| TEST_SPD_SPACE_MAX | P134 - Maximum revolutions during start-up test | 0.00 | 3000.0 | 100 | revolutions | 10 |
| K_FLX65 | P135 - Magnetic characteristic point 3 | 0.0 | 120.0 | 91.1 | % | 40.96 |
| PRC_MOT_FRICTION | P136 - Friction torque | 0.0 | 100.0 | 0 | % MOT_T_MOM | 40.96 |
| K_FLX75 | P137 - Magnetic characteristic point 4 | 0.0 | 120.0 | 91.8 | % | 40.96 |
| KP_REG_THERM_PRB | P138 - Multiplication factor for regulation card thermal probe | 0.00 | 200.00 | 100 | | 163.84 |
| K_FLX82 | P139 - Magnetic characteristic point 5 | 0.0 | 120.0 | 92.7 | % | 40.96 |
| BRAKE_R | P140 - Braking resistance | 1 | 1000 | 82 | Ohm | 1 |
| K_FLX88 | P141 - Magnetic characteristic point 6 | 0.0 | 120.0 | 94.2 | % | 40.96 |
| BRAKE_R_MAX_EN | P142 - Braking resistance Maximum adiabatic Energy | 0.0 | 500.0 | 4.5 | KJoule | 10 |
| K_FLX93 | P143 - Magnetic characteristic point 7 | 0.0 | 120.0 | 95.8 | % | 40.96 |
| BRAKE_R_MAX_EN_TIME | P144 - Time measure of Braking resistance adiabatic Energy | 0 | 30000 | 2000 | ms | 1 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| K_FLX97 | P145 - Magnetic characteristic point 8 | 0.0 | 120.0 | 98.1 | % | 40.96 |
| BRAKE_R_MAX_POWER | P146 - Maximum Power dissipated on Braking resistance | 0.0 | 600.0 | 1.5 | KWatt | 100 |
| K_FLX100 | P147 - Magnetic characteristic point 9 | 0.0 | 120.0 | 100.0 | % | 40.96 |
| K_FLX102 | P149 - Magnetic characteristic point 10 | 0.0 | 120.0 | 102.0 | % | 40.96 |
| KP_POS_VF | P150 - High precision analog speed reference value:VCO setting for positive voltage reference values | -16383 | 16383 | 4096 | | 1 |
| PRC_DEAD_TIME_CMP_XB | P151 - Xb = cubic coupling zone amplitude | 0.0 | 50.0 | 0.0 | % DRV_I_NOM | 163.84 |
| PRC_DEAD_TIME_CMP_YC | P152 - Yc = compensation at rated drive current | 50.0 | 100.0 | 100 | % DEAD_TIME_COMP | 327.67 |
| PRC_DEAD_TIME_CMP_X0 | P153 - Xoo = dead zone amplitude | 0.0 | 50.0 | 0 | % DRV_I_NOM | 163.84 |
| PW_SOFT_START_TIME | P154 - Soft start enabling time | 150 | 19999 | 500 | ms | 1 |
| OVR_LOAD_T_ENV | P155 - Ambient temperature reference value during overload | 0.0 | 150.0 | 40 | °C | 10 |
| DRV_F_PWM_CARATT | P156 - PWM frequency for drive definition | 1000 | 16000 | 5000 | Hz | 1 |
| DEAD_TIME | P157 - Dead time duration | 0.0 | 20.0 | 4 | µs | 10 |
| PRC_I_DECOUP | P158 - Corrective coefficient for decoupling terms | 0.0 | 200.0 | 0 | % | 40.96 |
| KP_NEG_VF | P159 - High precision analog speed reference value:VCO setting for negative voltage reference values | -16383 | 16383 | 4096 | | 1 |
| I_DELAY_COMP | P160 - PWM delay compensation on the currents | -800.0 | 800.0 | 40 | % TPWM | 40.96 |
| V_DELAY_COMP | P161 - PWM delay compensation on the voltages | -800.0 | 800.2 | 50.0 | % TPWM | 40.96 |
| ID_CANOPEN | P162 - CAN BUS node ID | 1 | 127 | 1 | | 1 |
| KP_SINCOS1_CHN | P164 - Resolver or Incremental Sin/Cos sine and cosine signal amplitude compensation | 0.0 | 200.0 | 100 | % | 163.84 |
| OFFSET_SIN1 | P165 - Resolver or Incremental Sin/Cos sine offset | -16383 | 16383 | 0 | | 1 |
| OFFSET_COS1 | P166 - Resolver or Incremental Sin/Cos cosine offset | -16383 | 16383 | 0 | | 1 |
| DRV_E_CARATT | P167 - Characterization voltage | 200.0 | 780.0 | 400 | V rms | 10 |
| SPD_REG_KD_TF2 | P168 - Second order feedforword filter | 0.0 | 1000.0 | 0.0 | ms | 10 |
| START_TIME | P169 - Start up time | 0 | 19999 | 10 | ms | 1 |
| PRC_VF_SLIP_CMP | P170 - Slip motor compensation | 0.0 | 400.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| VF_TF_SLIP_CMP | P171 - Slip compensation factor filter | 0.0 | 150.0 | 35.0 | ms | 10 |
| PRC_VF_BOOST | P172 - Stator voltage drop compensation | 0.0 | 400.0 | 70.0 | % PRC_DELTA_VRS | 40.96 |
| PRC_VF_DCJ_I_MAX | P173 - Current limit during continuous braking | 0.0 | 100.0 | 100.0 | % DRV_I_NOM | 40.96 |
| PRC_VF_DCJ_F_MAX | P174 - Continuous breaking maximum frequency limit | 0.0 | 100.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| PRC_VF_CHR_V1 | P175 - V/f characteristic point 1 voltage | 0.0 | 100.0 | 0.0 | % PRC_MOT_V_MAX | 40.96 |
| PRC_VF_CHR_F1 | P176 - V/f characteristic point 1 frequency | 0.0 | 100.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| PRC_VF_CHR_V2 | P177 - V/f characteristic point 2 voltage | 0.0 | 100.0 | 0.0 | % PRC_MOT_V_MAX | 40.96 |
| PRC_VF_CHR_F2 | P178 - V/f characteristic poitn 2 frequency | 0.0 | 100.0 | 0.0 | % PRC_MOT_F_MAX | 40.96 |
| DB1_START | P179 - Dead zone 1 initial speed | 0 | 30000 | 0 | rpm | 1 |
| DB1_END | P180 - Dead zone 1 final speed | 0 | 30000 | 0 | rpm | 1 |
| DB2_START | P181 - Dead zone 2 initial speed | 0 | 30000 | 0 | rpm | 1 |
| DB2_START | P182 - Dead zone 2 final speed | 0 | 30000 | 0 | rpm | 1 |
| PRC_VF_V_REG_D | P183 - Voltage regulator derivative coefficient multiplying term | 0.0 | 100.0 | 100.0 | % | 327.67 |
| PRC_VF_FSTART_SEARCH | P184 - Initial search frequency with rotating motor | 0.0 | 100.0 | 100.0 | % PRC_MOT_F_MAX | 40.96 |
| PRC_VF_FMIN_SEARCH | P185 - Minimum search frequency with rotating motor | 0.0 | 100.0 | 2.9 | % PRC_MOT_F_MAX | 40.96 |
| VF_STALL_TIME | P186 - Working time during limit | 1 | 100 | 30 | s | 40.96 |
| PRC_VF_V_MAX_STATIC | P187 - Vs amplitude maximum static value | 0.0 | 100.0 | 97.5 | % PRC_MOT_V_MAX | 327.67 |
| VF_TI_ENGY | P188 - Energy saving regulator filter time constant | 100 | 2000 | 400 | ms | 1 |
| PRC_VF_FLX_MIN_ENGY | P189 - Energy saving admissible minimum flux | 0.0 | 100.0 | 20.0 | % MOT_FLX_NOM | 40.96 |
| VF_TF_I_MAX_AL | P190 - Current alarm filter | 0.0 | 150.0 | 10.0 | ms | 10 |
| PRC_VF_T_MAX_SEARCH | P191 - Torque limit during fly restart | 0.0 | 100.0 | 150.0 | % DRV_T_NOM | 40.96 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| DEAD_TIME_HW | P198 - Dead time hardware duration | 0.0 | 20.0 | 0.0 | µs | 10 |
| MIN_PULSE | P199 - Minumum command pulse duration | 0.0 | 20.0 | 1.0 | µs | 10 |
| EN_AI1 | P200 - Enable analog reference value A.I.1 | 0 | 1 | 0 | | 1 |
| EN_AI2 | P201 - Enable analog reference value A.I.2 | 0 | 1 | 0 | | 1 |
| EN_AI3 | P202 - Enable analog reference value A.I.3 | 0 | 1 | 0 | | 1 |
| AI1_SEL | P203 - Meaning of analog input A.I.1 | 0 | 4 | 0 | | 1 |
| AI2_SEL | P204 - Meaning of analog input A.I.2 | 0 | 4 | 1 | | 1 |
| AI3_SEL | P205 - Meaning of analog input A.I.3 | 0 | 4 | 2 | | 1 |
| TF_TRQ_REF_AN | P206 - Filter time constant for analog torque reference value | 0.0 | 20.0 | 0 | ms | 10 |
| EN_AI16 | P207 - Enable analog reference value A.I.16 | 0 | 1 | 0 | | 1 |
| AI16_SEL | P208 - Meaning of analog input A.I.16 | 0 | 4 | 0 | | 1 |
| PRC_SPD_JOG | P211 - Digital speed reference value (JOG1) | -100.00 | 100.00 | 0 | % MOT_SPD_MAX | 163.84 |
| EN_SPD_JOG | P212 - Enable jog speed reference | 0 | 1 | 0 | | 1 |
| PRC_START_DG_POT | P213 - Motor potentiometer starting speed | -100.0 | 100.0 | 2.00 | % MOT_SPD_MAX | 163.84 |
| EN_MEM_DG_POT | P214 - Load final digital potentiometer reference value | 0 | 1 | 0 | | 1 |
| PRC_MAX_REF_DG_POT | P215 - CW motor potentiometer speed reference value | -105.0 | 105.0 | 105.02 | % MOT_SPD_MAX | 163.84 |
| PRC_MIN_REF_DG_POT | P216 - CCW motor potentiometer speed reference value | -105.0 | 105.0 | -105.02 | % MOT_SPD_MAX | 163.84 |
| DG_POT_RAMPS | P217 - Digital potentiometer acceleration time | 0.3 | 1999.9 | 50 | s | 10 |
| EN_DG_POT | P218 - Enable motor potentiometer reference value(A.I.4) | 0 | 1 | 0 | | 1 |
| TIME_DEC_FRQ_SEL | P219 - Meaning of frequency speed reference value decoded in time | 0 | 3 | 0 | | 1 |
| FRQ_IN_PPR_SEL | P220 - Encoder pulses per revolution | 0 | 9 | 5 | | 1 |
| FRQ_IN_NUM | P221 - NUM - Frequency input slip ratio | -16383 | 16383 | 100 | | 1 |
| FRQ_IN_DEN | P222 - DEN - Frequency input slip ratio | 0 | 16383 | 100 | | 1 |
| EN_FRQ_REF | P223 - Enable frequency speed reference value | 0 | 1 | 0 | | 1 |
| FRQ_REF_SEL | P224 - Frequency speed reference selection | 0 | 2 | 0 | | 1 |
| TF_TIME_DEC_FRQ | P225 - Filter time constant of frequency input decoded in time | 0.0 | 20.0 | 1.6 | ms | 10 |
| KP_TIME_DEC_FRQ | P226 - Corrective factor for frequency input decoded in time | 0.0 | 200.0 | 100 | | 163.84 |
| SB_MOT_SPD_MAX | P227 - Second bank Max. operating speed | 50 | 30000 | 3000 | rpm | 1 |
| SB_SPD_REG_KP | P228 - Second bank KpV speed regulator proportional gain | 0.1 | 400.0 | 6 | | 10 |
| SB_SPD_REG_TI | P229 - Second bank TiV speed regulator lead time constant | 0.1 | 3000.0 | 30 | ms | 10 |
| SB_SPD_REG_TF | P230 - Second bank TfV speed regulator (filter) time constant | 0.0 | 25.0 | 0.4 | ms | 10 |
| SB_CW_ACC_TIME | P231 - Second bank CW acceleration time | 0.01 | 199.99 | 10 | s | 100 |
| SB_CW_DEC_TIME | P232 - Second bank CW deceleration time | 0.01 | 199.99 | 10 | s | 100 |
| SB_CCW_ACC_TIME | P233 - Second bank CCW acceleration time | 0.01 | 199.99 | 10 | s | 100 |
| SB_CCW_DEC_TIME | P234 - Second bank CCW deceleration time | 0.01 | 199.99 | 10 | s | 100 |
| SB_ON | P235 - Second bank active | 0 | 1 | 0 | | 1 |
| EN_LIN_RAMP | P236 - Enable linear ramp | 0 | 1 | 0 | | 1 |
| EN_INV_SPD_REF | P237 - Invert reference signal software | 0 | 1 | 0 | | 1 |
| EN_I_CNTRL | P238 - Enable only current control | 0 | 1 | 0 | | 1 |
| EN_POS_REG | P239 - Enable overlapped space loop | 0 | 1 | 0 | | 1 |
| EN_POS_REG_MEM_CLR | P240 - Enable overlapped space loop memory clear in stop | 0 | 1 | 0 | | 1 |
| MUL_AI_IN_SEL | P241 - Multiplication factor selection | 0 | 4 | 0 | | 1 |
| MUL_AI_OUT_SEL | P242 - Multiplication factor target | 0 | 2 | 0 | | 1 |
| MUL_AI_MAX | P243 - Max analog input value for multiplication factor | -180.00 | 180.00 | 100.0 | % A.I. | 163.84 |
| MUL_AI_MIN | P244 - Min analog input value for multiplication factor | -180.00 | 180.00 | 0.0 | % A.I. | 163.84 |
| MUL_KCF_MAX | P245 - Multiplication factor with max analog input (MUL_AI_MAX) | -100.0 | 100.0 | 1.0 | | 100 |
| MUL_KCF_MIN | P246 - Multiplication factor with min analog input (MUL_AI_MAX) | -100.0 | 100.0 | -1.0 | | 100 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| EN_FLDBUS_REF | P247 - Enable FIELD-BUS reference values | 0 | 1 | 0 | | 1 |
| STR_MUL_AI | P248 - Storing input multilpicative factor | 0 | 2 | 0 | | 1 |
| EN_STOP_POS | P255 - Enabling Stop in position | 0 | 2 | 0 | | 1 |
| STOP_POS_CMD | P256 - Stop in position comand selection | 0 | 1 | 0 | | 1 |
| EN_STOP_POS_GBOX | P257 - Enabling Stop in position after gearbox | 0 | 1 | 0 | | 1 |
| ZERO_TOP_SEL | P258 - Stop in position comand selection | 0 | 1 | 0 | | 1 |
| PRC_SPD_INDEX | P259 - Indexing speed reference value | 0.00 | 100.00 | 2.0 | % MOT_SPD_MAX | 163.84 |
| STOP_POS0 | P260 - Target 0 Stop in position | 0.00 | 100.00 | 0 | % 360 degree | 163.84 |
| STOP_POS1 | P261 - Target 1 Stop in position | 0.00 | 100.00 | 0 | % 360 degree | 163.84 |
| STOP_POS2 | P262 - Target 2 Stop in position | 0.00 | 100.00 | 0 | % 360 degree | 163.84 |
| STOP_POS3 | P263 - Target 3 Stop in position | 0.00 | 100.00 | 0 | % 360 degree | 163.84 |
| ANG_MOV | P264 - Angular movement Stop in position | -50.00 | 50.00 | 0 | % 360 degree | 163.84 |
| POS_WINDOW | P265 - Position Reached window | 0.00 | 50.00 | 0.15 | % 360 degree | 163.84 |
| TIME_WINDOW | P266 - Time on Position Reached window | 0 | 19999 | 10 | ms | 1 |
| PRC_SPD_MIN_AUTO | P267 - Minimum speed for automatic stop | 0.00 | 100.00 | 1.0 | % MOT_SPD_MAX | 163.84 |
| SPD_MIN_HYST | P268 - Minimum speed hysteresis | 0.00 | 100.00 | 0.0 | % MOT_SPD_MAX | 163.84 |
| GBOX_NUM | P269 - Gearbox NUM | 0 | 16384 | 100 | | 1 |
| GBOX_DEN | P270 - Gearbox DEN | 0 | 16384 | 100 | | 1 |
| EN_PID | P271 - Enabling PID Control | 0 | 1 | 0 | | 1 |
| DGT_SP_PID | P272 - Digital Setpoint PID | -200.0 | 200.0 | 0.0 | % | 163.84 |
| SEL_SP_PID | P273 - PID Setpoint selection | 0 | 6 | 0 | | 1 |
| SEL_PV_PID | P274 - PID Process value selection | 0 | 6 | 1 | | 1 |
| KP_PID | P275 - KP proportional gain | -200.0 | 200.0 | 1.00 | | 163.84 |
| TF_PID_KP | P276 - Filter time constant component P PID | 0.0 | 20.0 | 0.4 | ms | 10 |
| TI_PID | P277 - TI Integral time | 0 | 19999 | 0 | ms | 1 |
| TD_PID | P278 - TD Derivative time | 0 | 19999 | 0 | ms | 1 |
| LMN_MIN_OUT_PID | P279 - Limit Min value of output PID | -200.0 | 200.0 | -100.0 | % | 163.84 |
| LMN_MAX_OUT_PID | P280 - Limit Max value of output PID | -200.0 | 200.0 | 100.0 | % | 163.84 |
| EN_REF_PID | P281 - Enabling PID Reference | 0 | 1 | 0 | | 1 |
| SEL_OUT_PID | P282 - PID Output selection | 0 | 7 | 0 | | 1 |
| EN_HLD_BRAKE | P289 - Enable Motor Holding brake | 0 | 1 | 0 | | 1 |
| HLD_BRAKE_DIS_DLY | P290 - Motor holding brake disable delay at start | 0 | 19999 | 0 | ms | 1 |
| HLD_BRAKE_EN_DLY | P291 - Motor holding brake enable delay at stop | 0 | 19999 | 0 | ms | 1 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| SENSOR_SEL | C00 - Speed sensor | 0 | 13 | 1 | | 1 |
| LI1_SEL | C01 - Meaning of logic input 1 | -1 | 31 | 8 | | 1 |
| LI2_SEL | C02 - Meaning of logic input 2 | -1 | 31 | 2 | | 1 |
| LI3_SEL | C03 - Meaning of logic input 3 | -1 | 31 | 3 | | 1 |
| LI4_SEL | C04 - Meaning of logic input 4 | -1 | 31 | 0 | | 1 |
| LI5_SEL | C05 - Meaning of logic input 5 | -1 | 31 | 4 | | 1 |
| LI6_SEL | C06 - Meaning of logic input 6 | -1 | 31 | 12 | | 1 |
| LI7_SEL | C07 - Meaning of logic input 7 | -1 | 31 | 5 | | 1 |
| LI8_SEL | C08 - Meaning of logic input 8 | -1 | 31 | 22 | | 1 |
| FRQ_IN_SEL | C09 - Frequency input setting | 0 | 3 | 1 | | 1 |
| LO1_SEL | C10 - Meaning of logic output 1 | -64 | 63 | 3 | | 1 |
| LO2_SEL | C11 - Meaning of logic output 2 | -64 | 63 | 0 | | 1 |
| LO3_SEL | C12 - Meaning of logic output 3 | -64 | 63 | 6 | | 1 |
| LO4_SEL | C13 - Meaning of logic output 4 | -64 | 63 | 2 | | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| DISPLAY_SEL | C14 - Display selection | 0 | 127 | 0 | | 1 |
| AO1_SEL | C15 - Meaning of programmable analog output 1 | -99 | 100 | 11 | | 1 |
| AO2_SEL | C16 - Meaning of programmable analog output 2 | -99 | 100 | 4 | | 1 |
| SENSOR2_SEL | C17 - Sensor2 selection | 0 | 13 | 0 | | 1 |
| EN_TIME_DEC_ENC2 | C18 - Enable incremental encoder2 time decode | 0 | 1 | 0 | | 1 |
| EN_SENSOR2_TUNE | C19 - Enable sensor2 auto-tuning | 0 | 1 | 0 | | 1 |
| EN_INV_POS2_DIR | C20 - Invert sensor2 positive cyclic versus | 0 | 1 | 0 | | 1 |
| SW_RUN_CMD | C21 - Run software enable | 0 | 1 | 1 | | 1 |
| LEM_SEL | C22 - LEM selection | 0 | 1 | 1 | | 1 |
| EN_SYNC_REG | C23 - Enable CANOpen SYNC traking loop | 0 | 1 | 0 | | 1 |
| DC_BUS_FULL_SCALE | C24 - DC Voltage drive full scale | 0 | 2 | 0 | V | 1 |
| RES2_DDC_BW | C25 - Second Resolver DDC bandwidth | 0 | 1 | 0 | Hz | 1 |
| EN_RND_RAMP | C27 - Rounded ramp | 0 | 1 | 0 | | 1 |
| EN_STOP_MIN_SPD | C28 - Stop with minimum speed | 0 | 1 | 0 | | 1 |
| DRV_SW_EN | C29 - Drive software enable | 0 | 1 | 1 | | 1 |
| ALL_RESET | C30 - Reset alarms | 0 | 1 | 0 | | 1 |
| EN_MOT_THERMAL_ALL | C32 - Motor thermal switch ' Block drive' | 0 | 1 | 1 | | 1 |
| MOT_THERM_CURV_SEL | C33 - Auto-ventilated thermal motors | 0 | 3 | 0 | | 1 |
| MAIN_LOST_SEL | C34 - Managing mains failure | 0 | 3 | 0 | | 1 |
| ALL_RST_ON_MAIN | C35 - Automatic alarm reset when mains back on | 0 | 1 | 0 | | 1 |
| EN_PW_SOFT_START | C37 - Enable soft start | 0 | 1 | 1 | | 1 |
| MAGN_SEL | C38 - Motor Magnetization selection | 0 | 2 | 0 | | 1 |
| EN_TEST_CONN | C41 - Enable sensor and motor phase tests | 0 | 1 | 0 | | 1 |
| EN_AUTOTUNING | C42 - Enable auto-tunings | 0 | 3 | 0 | | 1 |
| ALL_COUNT_RESET | C44 - Reset alarm counters | 0 | 2 | 0 | | 1 |
| RECT_BRIDGE_SEL | C45 - Rectification bridge 0 = diodes, 1 = semicontrolled | 0 | 1 | 0 | | 1 |
| MOT_THERM_PRB_SEL | C46 - Enable motor thermal probe management (PT100/PTC/NTC) | 0 | 4 | 1 | | 1 |
| EN_DCBUS_MAX_CTRL | C47 - Enable smart brake | 0 | 1 | 0 | | 1 |
| CANOPEN_BAUD_SEL | C48 - CAN Baud rate | 0 | 7 | 0 | | 1 |
| ENC_OUT_ZERO_TOP | C49 - TOP zero phase for simulated encoder | 0 | 3 | 0 | | 1 |
| ENC_OUT_DIR | C50 - Invert channel B simulated encoder | 0 | 1 | 0 | | 1 |
| ENC_OUT_PPR_SEL | C51 - Choose pulses ev. simulated encoder | 0 | 11 | 5 | | 1 |
| ENC_OUT_SEL | C52 - Simulated encoder selection | 0 | 4 | 0 | | 1 |
| EN_TEST_SPD | C53 - Enable test of start-up time | 0 | 2 | 0 | | 1 |
| OPD_ENC_OUT_SEL | C54 – Internal Simulated Encoder selection | 0 | 2 | 0 | | 1 |
| I_RELAY_SEL | C55 - Current relay output | 0 | 2 | 0 | | 1 |
| I_OVR_LOAD_SEL | C56 - Current overload | 0 | 3 | 3 | | 1 |
| DRV_THERM_PRB_SEL | C57 - Enable radiator heat probe management (PTC/NTC) | 0 | 1 | 1 | | 1 |
| DIS_I_DECOUP | C59 - Disable dynamic decoupling + feedfoward | 0 | 1 | 0 | | 1 |
| PAR_ACT_BANK | C60 - Parameter bank active | 0 | 1 | 0 | | 1 |
| DEF_PAR_RD | C61 - Read default parameters | 0 | 1 | 0 | | 1 |
| EEPROM_PAR_RD | C62 - Read parameters from EEPROM | 0 | 1 | 0 | | 1 |
| EEPROM_PAR_WR | C63 - Save parameters in EEPROM | 0 | 1 | 0 | | 1 |
| EN_FLDBUS | C64 - Enable fieldbus manage | 0 | 3 | 0 | | 1 |
| RES_DDC_BW | C66 - Resolver DDC bandwidth | 0 | 1 | 0 | Hz | 1 |
| RES_CARR_FRQ_RATIO | C67 - Resolver carrier frequency | -3 | 3 | 0 | | 1 |
| EN_SENSOR_TUNE | C68 - Enable sensor auto-tuning | 0 | 1 | 0 | | 1 |
| EN_TF2_SPD_REG | C69 - Enable 2nd order filter on speed regulator | 0 | 1 | 0 | | 1 |
| EN_SINCOS_PREC_POS | C70 - Enable SinCos Analog-Digital compensation into position | 0 | 1 | 0 | | 1 |
| EN_BRAKE_R_PROT | C71 – Enable braking resistance protection | 0 | 1 | 0 | | 1 |
| EN_SPD_REG_D | C72 - Enable feedforward | 0 | 1 | 0 | | 1 |
| EN_STO_ONLY_SIG | C73 - Enable Safety STOP only like signaling | 0 | 1 | 0 | | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| EN_TIME_DEC_ENC | C74 - Enable incremental encoder time decode | 0 | 1 | 0 | | 1 |
| DIS_DEF_START_AUTO | C75 - Disable Autotuning starting from default values | 0 | 1 | 0 | | 1 |
| EN_INV_POS_DIR | C76 - Invert positive cyclic versus | 0 | 1 | 0 | | 1 |
| EN_SPD_REG_MEM_CORR | C77 - Enable PI speed gains compenstation | 0 | 1 | 0 | | 1 |
| EN_NOT_LI | C79 - Enable negative logic for digital inputs | 0 | 255 | 0 | | 1 |
| EN_VF_CNTL | C80 - Enable V/f control | 0 | 1 | 0 | | 1 |
| EN_DB | C81 - Enable dead zones | 0 | 2 | 0 | | 1 |
| VF_EN_STALL_ALL | C82 - Enable stall alarm | 0 | 1 | 1 | | 1 |
| VF_EN_DCJ | C83 - Enable dc brake | 0 | 1 | 0 | | 1 |
| VF_EN_SEARCH | C84 - Enable search during motor rotation | 0 | 1 | 0 | | 1 |
| VF_EN_OPEN_LOOP | C85 - Enable open loop working state | 0 | 2 | 0 | | 1 |
| VF_EN_ENGY | C86 - Enable energy saving | 0 | 1 | 0 | | 1 |
| VF_EN_BYPASS | C87 - Enable flux angle bypass - frequency input | 0 | 1 | 0 | | 1 |
| VF_EN_CHR_AUTOSET | C88 - Calculate V/f characteristic nominal knee | 0 | 1 | 0 | | 1 |
| EN_BOOT | C98 - Enable boot mode | 0 | 1 | 0 | | 1 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| FW_REV | D00 - Software version | | | 0 | | 256 |
| ACTV_POW | D01 - Active power delivered | | | 0 | kW | 16 |
| PRC_TOT_APP_SPD_REF | D02 - Speed reference value before ramp | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_END_SPD_REF | D03 - Speed reference value after ramp | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_MOT_SPD | D04 - Speed reading | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_T_REF | D05 - Torque request | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_IQ_REF | D07 - Request torque current Iq rif | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| PRC_ID_REF | D08 - Request magnetizing current Id rif | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| V_REF | D09 - Voltage reference value at max. rev. | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| PRC_APP_T_REF | D10 - Torque reference value (application generated) | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| MOT_I | D11 - Current module | | | 0 | A rms | 16 |
| REF_FRQ_IN | D12 - Frequency in input | | | 0 | KHz | 16 |
| EL_FRQ | D13 - Rotor flux frequency | | | 0 | Hz | 16 |
| PRC_APP_FRQ_SPD_REF | D14 - Frequency speed reference value (application generated) | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_IQ | D15 - Current torque component | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| PRC_ID | D16 - Current magnetizing component | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| MOT_V | D17 - Stator voltage reference value module | | | 0 | V rms | 16 |
| PRC_MOT_V | D18 - Stator voltage reference value module | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| MOD_INDEX | D19 - Modulation index | -100 | 100 | 0 | | 40.96 |
| PRC_VQ_REF | D20 - Vq rif | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| MOT_SPD | D21 - Motor rotation speed | | | 0 | rpm | 1 |
| PRC_VD_REF | D22 - Vd rif | -100 | 100 | 0 | % MOT_V_NOM | 40.96 |
| MOT_POS | D23 - Actual position | | | 0 | ±16384 | 1 |
| DC_BUS | D24 - Bus voltage | | | 0 | V | 16 |
| DRV_TEMP | D25 - Radiator temperature reading | | | 0 | °C | 16 |
| MOT_TEMP | D26 - Motor temperature | | | 0 | °C | 16 |
| MOT_FLX | D27 - Motor Flux | | | 0 | % MOT_FLX_NOM | 40.96 |
| PRC_DRV_I_THERM | D28 - Motor thermal current | -100 | 100 | 0 | % soglia All | 40.96 |
| PRC_DRV_I_MAX | D29 - Current limit | -100 | 100 | 0 | % DRV_I_NOM | 40.96 |
| PRC_DRV_T_MAX | D30 - Maximum torque | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_DRV_I_T_MAX | D31 - Maximum torque by current limit | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_APP_T_MAX | D32 - Maximum torque imposed (application generated) | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| PRC_APP_SPD_REF | D33 - Speed reference (application generated) | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| SLI_FREQ | D34 - Slip frequency | -20 | 20.0 | 0 | Hz | 40.96 |
| PRC_MOT_T | D35 - Actual torque produced | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| MOT_TURN_POS | D36 - Absolute mechanical position (on current revolution) | | | 0 | ±16384 | 1 |
| MOT_N_TURN | D37 - Number of revolutions | | | 0 | | 1 |
| OFFSET_SINCOS_ENC | D38 - Compensation Sin/Cos analog/digital term | | | 0 | pulses | 1 |

| Name | Description | Min | Max | Default | UM | Scale |
|---|---|---|---|---|---|---|
| SENSOR_FRQ_IN | D39 - Input frequency | | | 0 | kHz | 16 |
| REG_CARD_TEMP | D40 - Regulation card temperature | | | 0 | °C | 16 |
| MOT_PRB_RES | D41 - Thermal probe resistance | | | 0 | Ohm | 1 |
| AI1 | D42 - Analog Input AI1 | -100 | 100 | 0 | % | 163.84 |
| AI2 | D43 - Analog Input AI2 | -100 | 100 | 0 | % | 163.84 |
| AI3 | D44 - Analog Input AI3 | -100 | 100 | 0 | % | 163.84 |
| SPD_ISR | D45 - Speed routine duration | | | 0 | us | 64 |
| I_ISR | D46 - Current routine duration | | | 0 | us | 64 |
| I_LOOP_BAND | D47 - Current loop bandwidth | | | 0 | Hz | 1 |
| PRC_APP_T_MIN | D48 - Minimum torque limit by application | -100 | 100 | 0 | % MOT_T_NOM | 40.96 |
| WORK_HOURS | D49 - Work Hours | | | 0 | hours | 1 |
| SENS2_SPD | D51 - Second sensor rotation speed | | | 0 | rpm | 1 |
| SENS2_TURN_POS | D52 - Second sensor Absolute mechanical position (on current revolution) | | | 0 | 16384 | 1 |
| SENS2_N_TURN | D53 - Second sensor Number of revolutions | | | 0 | 16384 | 1 |
| SENS2_FRQ_IN | D54 - Second sensor Frequency input | | | 0 | KHz | 16 |
| SENS1_ZERO_TOP | D55 - Sensor1 Zero Top | | | 0 | pulses | 1 |
| SENS2_ZERO_TOP | D56 - Sensor2 Zero Top | | | 0 | pulses | 1 |
| SYNC_DELAY | D57 - Delay from SYNC reception to Speed routine execution | | | 0 | us | 1 |
| PWM_SYNC_OFFSET | D58 - PWM offset for SYNC delay control | | | 0 | pulses | 1 |
| SERIAL_NUMBER | D59 - Drive Serial Number | | | 0 | | 1 |
| FLD_CARD | D60 - Fieldbus Card | | | 0 | | 1 |
| APPL_REV | D61 - Application Revision | | | 0 | | 40.96 |
| HW_SENSOR2 | D62 - Sensor2 presence | | | 0 | | 1 |
| HW_SENSOR1 | D63 - Sensor1 presence | | | 0 | | 1 |
| REF_AI1 | D64 - Reference from Analog Input AI1 | -100 | 100 | 0 | % | 163.84 |
| REF_AI2 | D65 - Reference from Analog Input AI2 | -100 | 100 | 0 | % | 163.84 |
| REF_AI3 | D66 - Reference from Analog Input AI3 | -100 | 100 | 0 | % | 163.84 |
| PRC_SPD_REF_DG_POT | D67 - Digital Potentiometer Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_T_REF_AN | D68 - Analog Torque reference from Application | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_T_REF_FLDBUS | D69 - Fieldbus Torque reference | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_T_MAX_AN_POS | D70 - Analog Positive Torque Max from Application | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_T_MAX_FLDBUS | D71 - Fieldbus Torque Max reference | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| PRC_SPD_TOT_AN | D72 - Speed reference from AI1 + AI2 + AI3 | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| MUL_KP | D73 - Multiplication factor | -100.0 | 100.0 | 0 | % | 16 |
| PRC_SPD_REF_AN | D74 - Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_SPD_REF_FLDBUS | D75 - Fieldbus Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_SPD_REF_JOG | D76 - Jog Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| PRC_SPD_REF_TIME_DEC | D77 - Time Decode Frequency input Speed reference | -100 | 100 | 0 | % MOT_SPD_MAX | 163.84 |
| SPD_REF_PULS_FLDBUS | D78 - Fieldbus Speed Reference in Pulses | | | 0 | Pulses per Tpwm | 1 |
| REF_AI16 | d79 Reference from analog Input AI16 | | | | % | 163.84 |
| PRC_T_MAX_AN_NEG | D80 - Analog Negative Torque Max from Application | -400 | 400 | 0 | % MOT_T_NOM | 40.96 |
| ACT_SP_PID | d85 Actual Setpoint PID | | | | % | 163.84 |
| ACT_PV_PID | d86 Actual Feed-back PID | | | | % | 163.84 |
| ACT_COM_P_PID | d87 Actual Componente P of PID | | | | % | 163.84 |
| ACT_COM_I_PID | d88 Actual Componente I of PID | | | | % | 163.84 |
| ACT_COM_D_PID | d89 Actual Componente D of PID | | | | % | 163.84 |
| ACT_ERR_PID | d90 Actual Errore SP-PV of PID | | | | % | 163.84 |
| ACT_OUT_PID | d91 Actual Output PID | | | | % | 163.84 |

TDE MACNO
s.p.a. tecnologie digitali elettroniche

Via dell'Oreficeria, 41 - 36100 VICENZA - Italy
Tel. +39 0444 343555 - Fax +39 0444 343509
www.tdemacno.it