OPEN DRIVE

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Common functions

INDEX

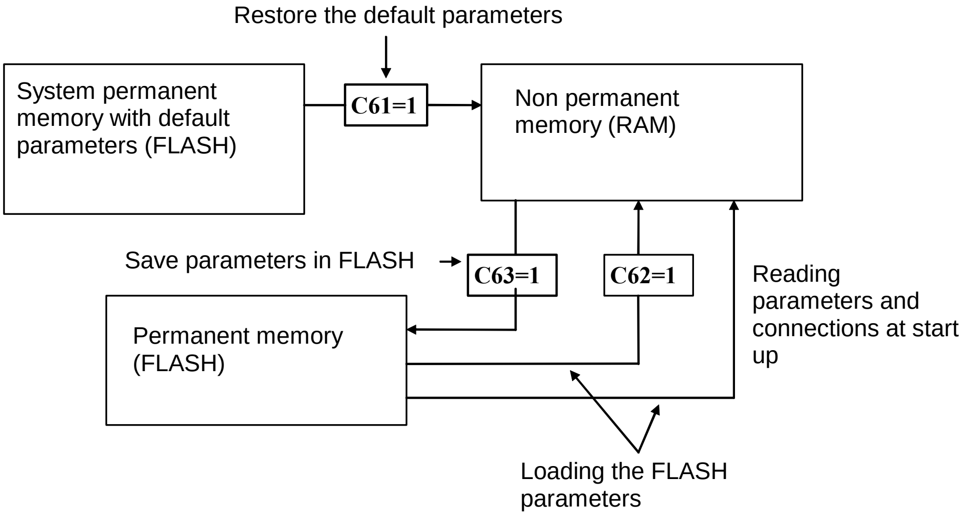
The standard functions of the OPEN DRIVE are common to all versions of the product.

1 Storage and recall of the working parameters

The drive has three types of memory:

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

When switched on, the drive transfers the permanent memory parameters on to the working memory in order to work. If the modifications carry out on the parameters, they become stored in the work memory and therefore become lost in the break of feeding rather than being saved in the permanent memory.
If after the work memory modifications wants to return to the previous security, it is acceptable to load on such a memory, a permanent memory parameter (Load FLASH Parameter C62=1).
If for some reason the parameters in FLASH change, it is necessary to resume the default parameters (C61=1 Load Default Parameters), to make the appropriate corrections and then save them in the permanent working parameter (C63=1).
It is possible to save the data in the permanent memory also at drive switched on/RUN, while the loading may only be affected aside with drive switched off/STOP, after having opened the key to reserved parameters.



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

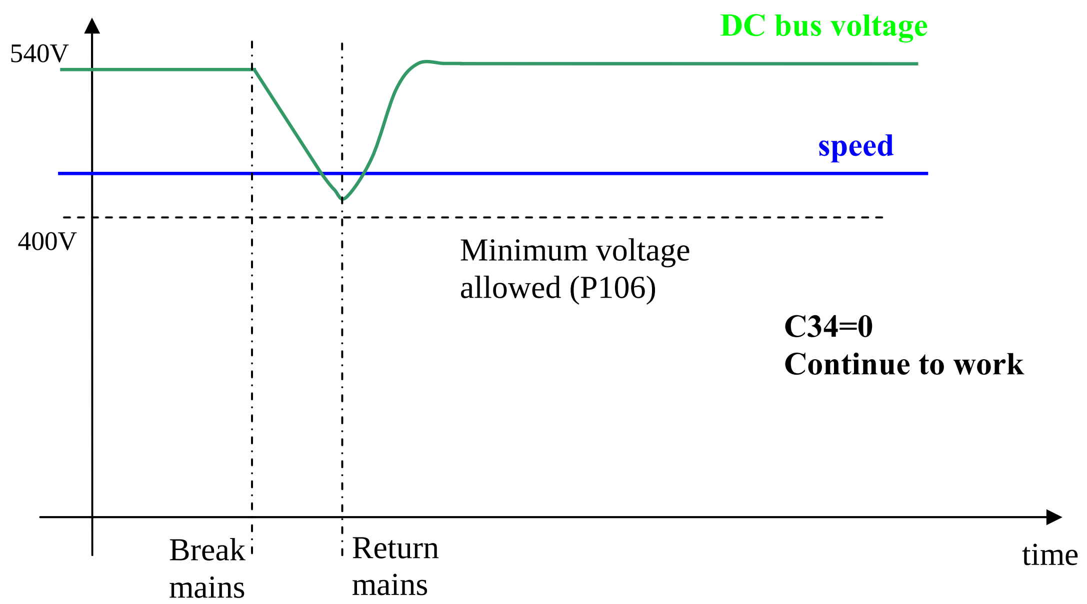
2 Voltage break control for mains feeding

The mains break control is configurable through the following connections:

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

2.1 *Continuing to work (C34=0; default)*

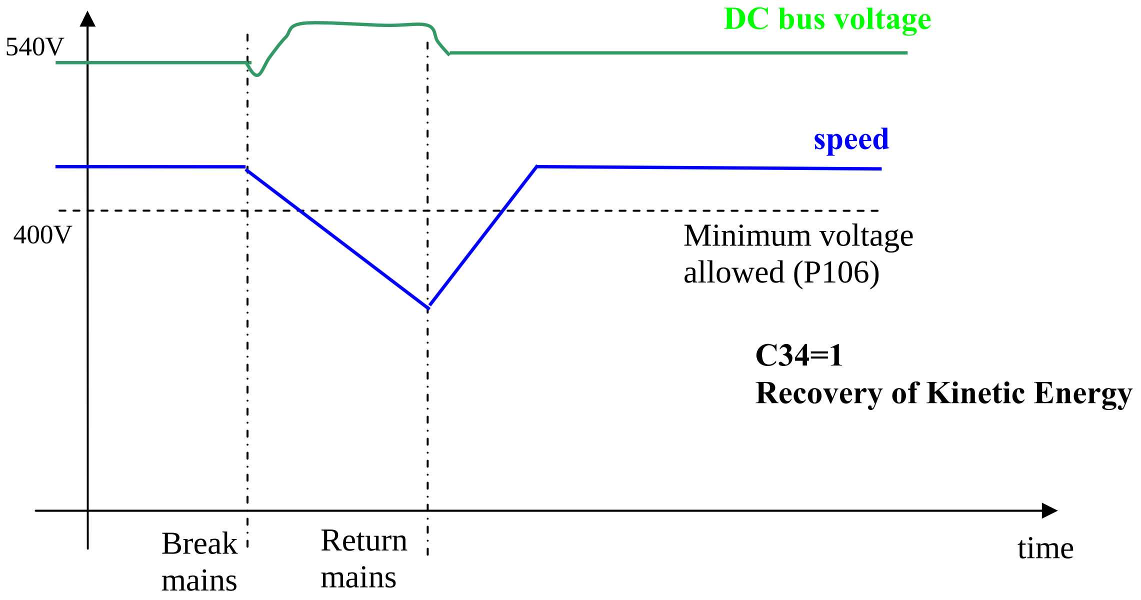
This operating procedure is adapted to those applications in which it is fundamental to have unchanged working conditions in each situation. Setting C34=0 the drive, even if the mains supply voltage is no longer available, continues to work as though nothing has been modified over the control, pulling the energy from the present capacitor to the inner drive. This way making the intermediate voltage of the DC Bus will begin to go down depending on the applied load; when it reaches the minimum tolerated value (in parameter P106) the drive goes into alarm A10 of minimum voltage and leaves to go to the motor in free evolution.
Therefore, this function will allow exceeding short-term mains break out (tenths/hundredths of milliseconds on the basis of the applied load) without changing the motor operation in any way.



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

2.2 *Recovery of Kinetic Energy (C34=1)*

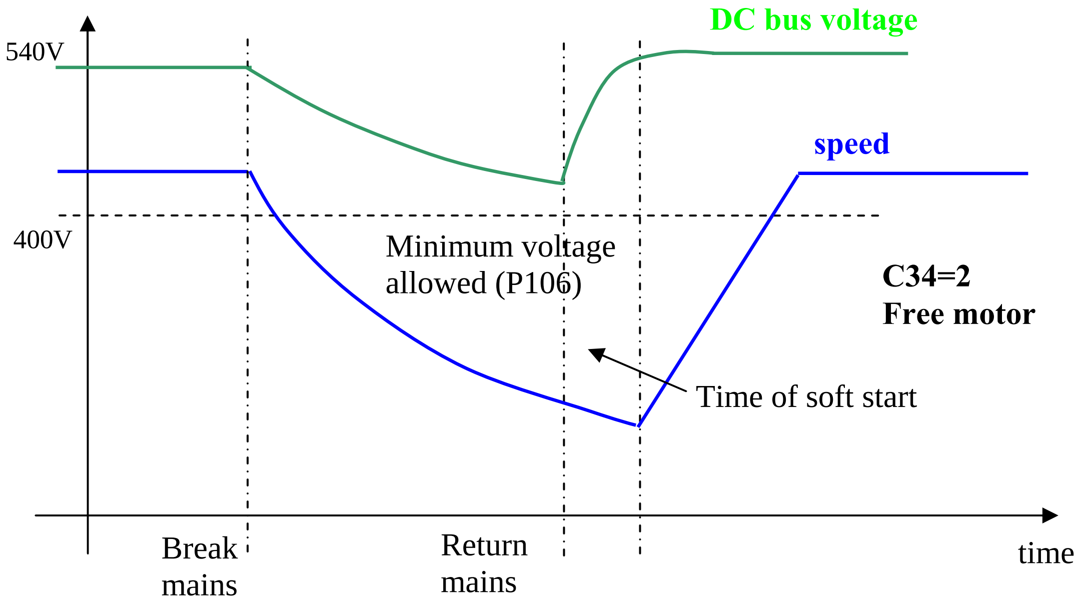
This operating procedure is adapted to those applications in which it is temporarily possible to reduce the speed of rotation to confront the mains break. This function particularly adapts in the case of fewer applied motors and with high energy.
The qualification of such a function is obtained setting C34=1.
During the mains break out, the voltage control of the DC Bus is achieved using a proportional regulator, with fixed proportional gain set in P86 (default=3.5), that controls the DC Bus voltage d24, compare it with the threshold in P98 (default=600V) and functions on the torque limits d30 of the motor that, in time, will slow down to work in recovery. Such regulation, when qualified (C34=1), at mains break out (o.L.12=H) or if the DC Bus voltage goes below the threshold set in P97 (425V), replaces the normal regulation (o.L.13=H) and is excluded when mains supply is on.



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

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

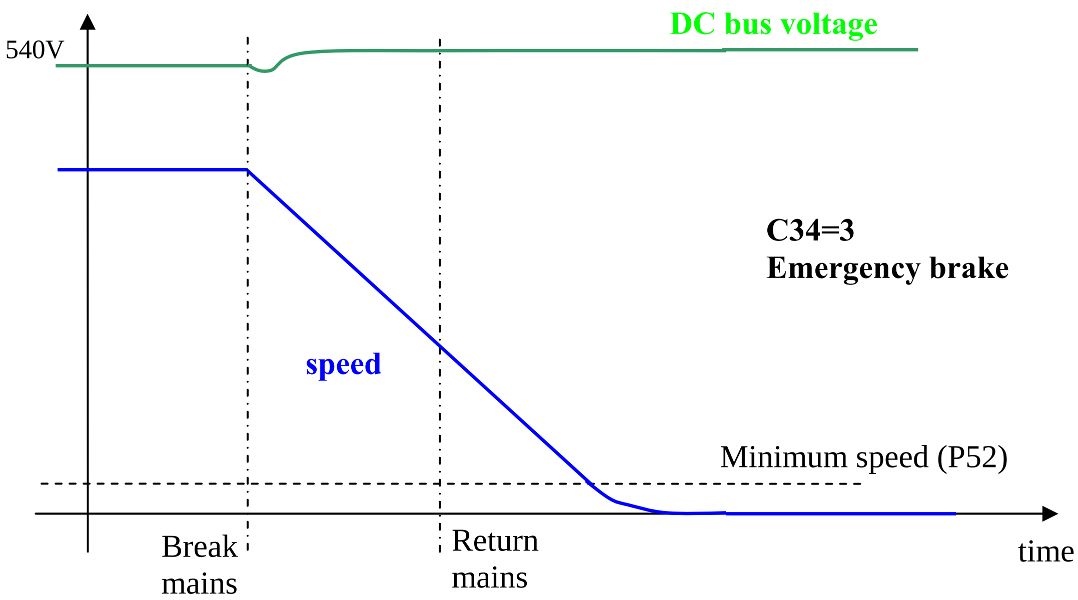
This operating procedure is adapted to those applications in which it is fundamental to not go into alarm in the case of mains break out and is temporarily prepared to disable the power in order for the motor to resume when the mains returns.
The qualification of such a function is obtained setting C34=2.
When there is a mains break or if the voltage of the Bus goes below the threshold set in P97r (425 V), the drive is immediately switched off, the motor rotates in free evolution and the Bus capacitors slowly discharges. If the mains returns in a few seconds, a fast recovery of the motor is carried out in a way in which the working regulation of the machine is resumed.



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

2.4 *Emergency brake (C34=3)*

This particular control is adapted to those applications in which the machine may be stopped with an emergency brake in case of mains breaks.
Under this circumstance, the linear ramps becomes qualified and the ramp time is imposed with the parameter P30. When the minimum speed is reached, alarm A10 of minimum voltage starts and the motor is left rotating in free evolution. If in the meantime the mains returns, the emergency brake will be not interrupted.

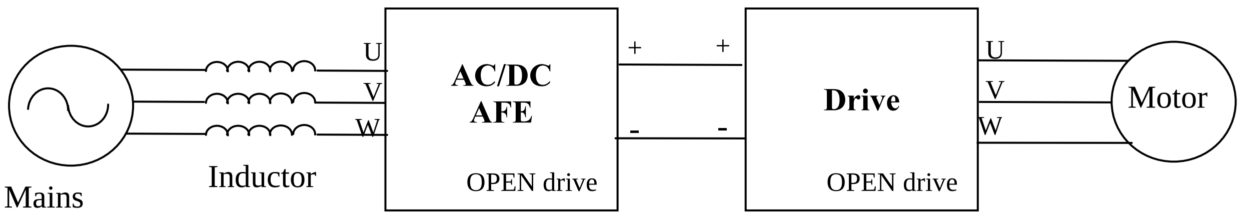


3 Braking management

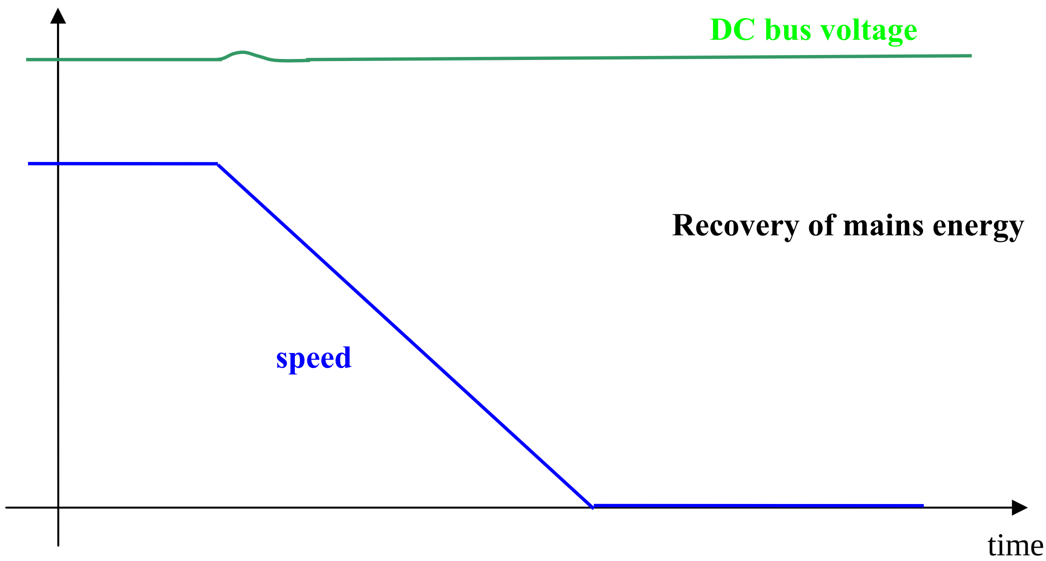
The drive is in a position to work on four quadrants, therefore is also in a position to manage the motor recovery Energy. There are three different, possible controls:

3.1 *Recovery mains energy*

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

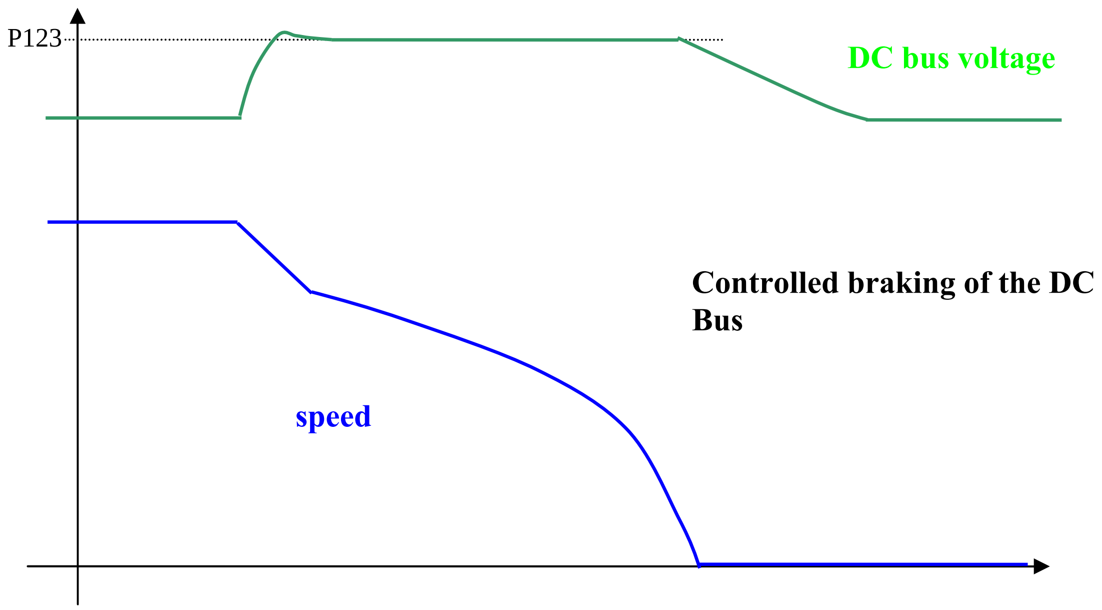


The use of an AC/DC AFE permits a controlled voltage level of the intermediate power (DC Bus) and raises to best control the motors winded to a voltage close to the line voltage. The drive's dynamic behavior results in a way that optimizes the work as motor or generator.
There is a possibility to connect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



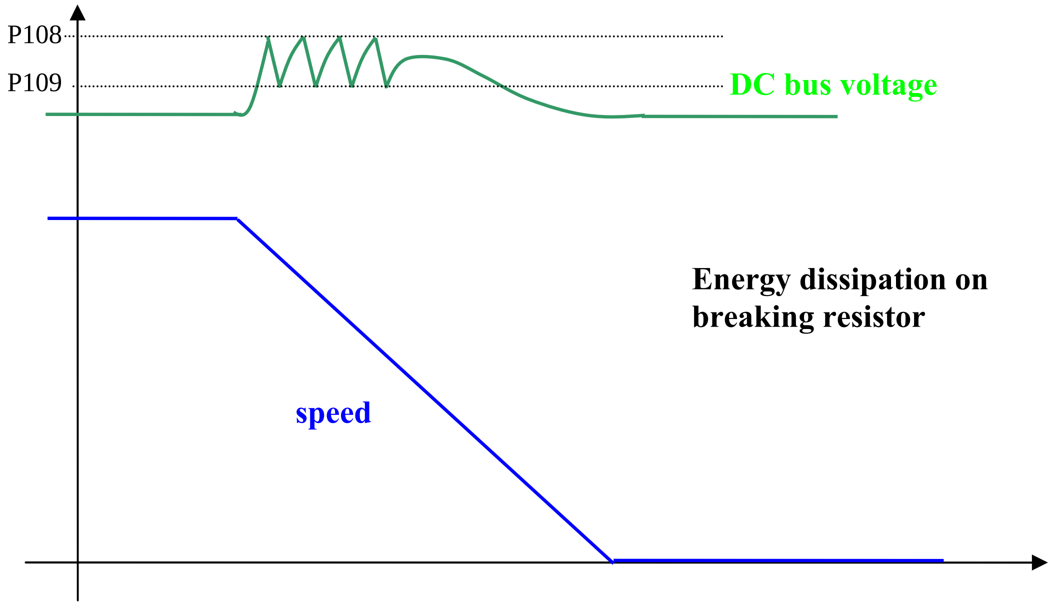
3.2 *Braking with DC Bus control (C47=1)*

A further possibility of recovery control of kinetic energy exists: if the outer braking resistance is not present (or is not working properly), it is possible to enable (setting **C47=1**) the braking with DC Bus control. This function, when the Bus voltage reaches the threshold set in **P123**, limits the maximum admitted regenerated torque, slowing down the motor. In practice, the motor will slow down in minimum time thus the over voltage alarm does not start.
This function is not active by default (C47=0) in a way to leave the intervention of the braking circuit.



3.3 *Kinetic energy dissipation on 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.

3.3.1 Braking Resistance Thermal protection

The Braking Resistance Thermal protection protects the resistance both from Energy peaks and from average Power that have to be dissipated.
It's possible to enable this protection setting **C72=1**, by default this function is disabled.

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

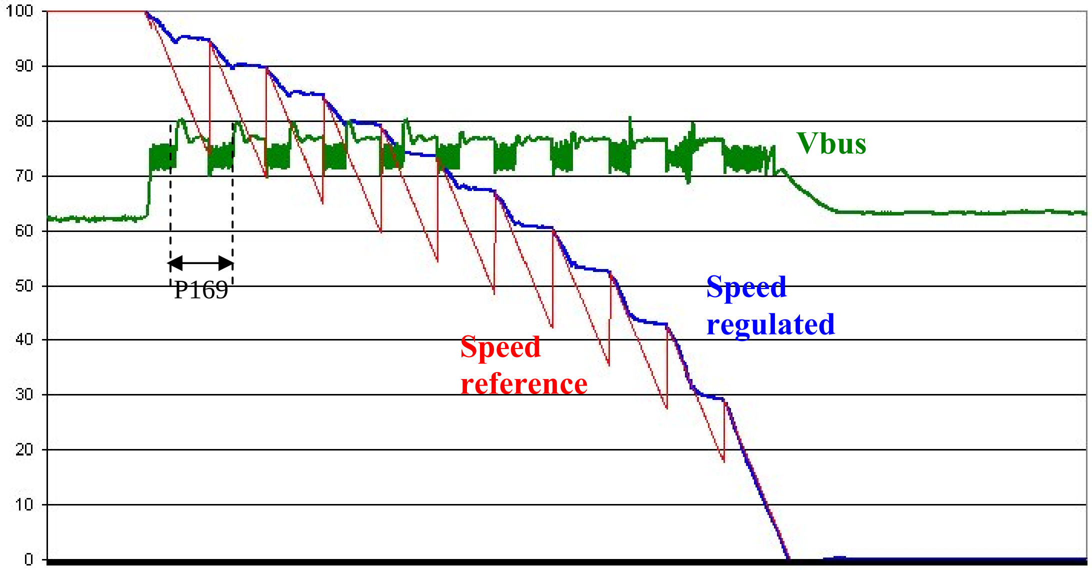
PAR	DESCRIPTION	RANGE	DEFAULT	UNIT	Internal rappr.
P167	Braking resistance value	1 ÷ 1000	82	Ohm	1
P168	Braking resistance Maximum Adiabatic Energy	0.0 ÷ 500.0	4.5	KJoule	10
P169	Time to test the Maximum Adiabatic Energy	1 ÷ 30000	2000	ms	1

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

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

NB: this function has two possible uses:

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



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

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

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

4 Power soft start

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

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

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

Mains supply presence: in case the presence of alternated mains supply voltage becomes noticed once (at soft start) with the logic power input **MAINS_OFF=H,** from that moment the control refers only to the **MAINS_OFF** to check the mains presence. Otherwise, in the case of drive feeding with a continuous direct voltage on the DC Bus, it is possible to begin the soft start, even if the measured voltage on the DC Bus exceeds the indicated value in P97.
Mains break out: the mains break becomes noticed either when the MAINS_OFF signal is monitored (if this went to the high logic level at least one time during the soft start) either monitoring directly the DC Bus voltage with minimum threshold setup in P97.

The function of "Soft start enable" may be assigned to one of the logic input thus to enable or disable the soft start through an external contact.
The power fault alarm (power fault A03), that checks drive over current, insert the soft start limiting current.
The soft start follows the following criteria:

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

From default PR.ON=1 and C37=1 thus connecting the drive to the mains supply, the power is enable immediately with the soft charging of the capacitors.
The soft start charge of the intermediate circuit capacitors lasts a preset time set in P154, after this time the voltage level is checked to verify the voltage level reached: if this is below the minimum (P97), the soft start alarm starts.

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

4.1 *Safety Stop*

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

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

4.1.1 Machine safety (C73=0)

Setting **C73=0** (default) the Safety STOP is compatible with EN945-1 specification against accidental starts. When this input is at low logical level the IGBT power bridge isn't supplied and the motor couldn't run more than 180°/motor poles couple for brushless motor (for asynchronous motors the movement is zero), also if there is a brake in the power bridge.
The converter signals this state with the alarm **A13 d49=1**, the output **o17 "Power electronic not supplied"** goes at high level, the output o0 "Drive ready" goes at low level and the Power Soft start command is taken off.
To recover the normal converter state, follow this steps:

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

4.1.2 Power part enable input (C73=1)

Setting **C73=1** the Safety STOP is like a Power part enable input. Like in the preceding case, when this input is at low logical level the IGBT power bridge isn't supplied and the motor couldn't run more than 180°/motor poles couple for brushless motor (for asynchronous motors the movement is zero), also if there is a brake in the power bridge.
The converter signals this state with the output **o17 "Power electronic not supplied"** that goes at high level, the Power Soft start command is taken off, but unlike before no alarms goes at active state. To recover the normal converter state, follow this steps:

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

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

5 Sequences of drive switch on and switch off

5.1 *Drive ready*

The Drive Ready condition (**o.L.0=H**) is given by alarms are not active and at the same time both the software and hardware enables:
* The software enable, given by state of the connection **C29**, (C29=1 of default).
* The external enable (the function of the input is assigned to the default input L.I.2)
If an enable is missing or an alarm is active, the ready drive signal goes into 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>

5.2 *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 *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.

6 Thermal protections hardware

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

6.1 *Thermal protection drive*

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

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

6.2 *Motor thermal protection*

The drive can manage the motor thermal probe. For the correct wiring of the probe, make reference to the installation manual.
The connection C46 selects the type of probe used:

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

7 Current/power relay

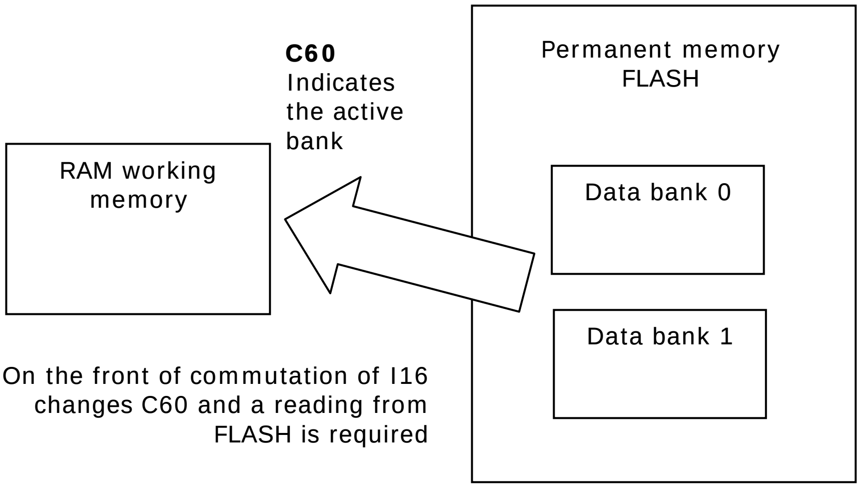
The drive is in the position to control a logic output of current/power relay.
The connection C55 serves to select the type of monitored values:

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

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

8 Active bank parameters

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



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

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