

Applications Tde Macno

User's manual

Starter application n°26



Cod. MW00801E00 V_1.3



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1 OPERATION

The *STARTER* function for asynchronous motor was implemented to control the sensorless inverter motor maintaining the possibility, once this function is enabled, to directly 'connect' the motor to the mains while 'disconnecting' thus the inverter.

This feature provides the hardware structure of a sensorless inverter to which it is added a card for reading the synchronisms (AFE type) by installing the card CS4S0016 on the second feedback slot.

By enabling the *STARTER* function (**E65=1** or **I27-Enable Sync Function=H**), the mains frequency (typically 50 or 60 Hz) is calculated by reading the three input voltages. By means of **E66** (or **I28-Enable Mains Frequency Reference**), such frequency is given to the motor as speed reference.

The *phase control* is performed by a *PI type control* ($K_p=\mathbf{E55}$, $T_i=\mathbf{E56}$, $T_f=\mathbf{E57}$). It can be enabled via a **E67 (I29- Enable Mains Phase Control)** connection.

The error angle (between *reference angle* = angle calculated by the mains + ALFA_STAR and the inverter output angle) is continuously monitored by the control. If such error is lower than 2.7 degrees for a time greater than or equal to 10ms, an output **O37**– Mains Phase Locked is enabled.

The input **I30** (or **E68 - SW Mains ByPass Output Enable**) enables the mains connection (with the inverter bypass) that takes place using the function **O38 - Locked output Enabled**. The output **O38** is used to control a (fast) bypass contactor, the inverter disables the gear and the motor is powered directly by the mains.

Remark: the application software *Starter for Asynchronous Motor* produces a speed reference that, if the phase control is disabled (**E67=0** and **I29=L**), is carried out with or without the inclusion of ramps, according to the user's choice. The ramps are excluded automatically, if the phase control is enabled.

2 PARAMETRI APPLICATIVO STARTER

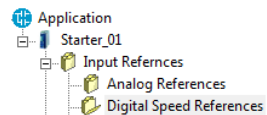
2.1 INPUT REFERENCES

2.1.1 Analog References

Name	Description	Min	Max	Default	UM	Scale
EN_AI1	E00 - Enable analog reference value A.I.1			0		1
REF_AI1	D64 - Reference from Analog Input AI1	-100.00	100.00	0	%	100
AI1_SEL	E03 - Meaning of analog input A.I.1			0		1
EN_AI2	E01 - Enable analog reference value A.I.2			0		1
REF_AI2	D65 - Reference from Analog Input AI2	-100.00	100.00	0	%	100
AI2_SEL	E04 - Meaning of analog input A.I.2			1		1
EN_AI3	E02 - Enable analog reference value A.I.3			0		1
REF_AI3	D66 - Reference from Analog Input AI3	-100.00	100.00	0	%	100
AI3_SEL	E05 - Meaning of analog input A.I.3			2		1
EN_AI16	E07 - Enable analog reference value A.I.16			0		1
REF_AI16	D79 - Reference from analog Input AI16			0		1
AI16_SEL	E08 - Meaning of analog input A.I.16			0		1
TF_TRQ_REF_AN	E06 - 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	-400.00	400.00	0	% MOT_T_NOM	100
PRC_T_MAX_AN_NEG	D80 - Analog Negative Torque Max from Application			0		1
PRC_T_MAX_AN_POS	D70 - Analog Positive Torque Max from Application	-400.00	400.00	0	% MOT_T_NOM	100
MUL_AI_IN_SEL	E41 - Multiplication factor selection			0		1

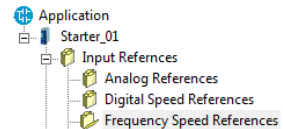
Name	Description	Min	Max	Default	UM	Scale
MUL_AI_OUT_SEL	E42 - Multiplication factor target			0		1
MUL_AI_MAX	E43 - Max analog input value for multiplication factor	-180.00	180.00	100.00		100
MUL_AI_MIN	E44 - Min analog input value for multiplication factor	-180.00	180.00	0.00		100
MUL_KCF_MAX	E45 - Multiplication factor with max analog input (MUL_AI_MAX)	-100.00	100.00	1.00		100
MUL_KCF_MIN	E46 - Multiplication factor with min analog input (MUL_AI_MIN)	-100.00	100.00	-1.00		100
PRC_SPD_TOT_AN	D72 - Speed reference from AI1 + AI2 + AI3 + AI6	-100.00	100.00	0	% MOT_SPD_MAX	100
STR_MUL_AI	E48 - Storing input multiplicative factor			0		1
MUL_KP	D73 - Multiplication factor	-100.00	100.00	0		100
PRC_SPD_REF_AN	D74 - Speed reference	-100.00	100.00	0	% MOT_SPD_MAX	100

2.1.2 Digital Speed References

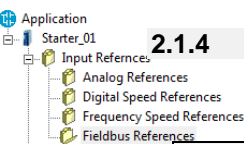


Name	Description	Min	Max	Default	UM	Scale
PRC_SPD_JOG	E11 - Digital speed reference value (JOG1)	-100.00	100.00	0	% MOT_SPD_MAX	100
EN_SPD_JOG	E12 - Enable jog speed reference			0		1
PRC_SPD_REF_JOG	D76 - Jog Speed reference	-100.00	100.00	0	% MOT_SPD_MAX	100
PRC_START_DG_POT	E13 - Motor potentiometer starting speed	-100.00	100.00	2.00	% MOT_SPD_MAX	100
EN_MEM_DG_POT	E14 - Load final digital potentiometer reference value			0		1
PRC_MAX_REF_DG_POT	E15 - CW motor potentiometer speed reference value	-105.00	105.00	105.00	% MOT_SPD_MAX	100
PRC_MIN_REF_DG_POT	E16 - CCW motor potentiometer speed reference value	-105.00	105.00	-105.00	% MOT_SPD_MAX	100
DG_POT_RAMPS	E17 - Digital potentiometer acceleration time	0.3	1999.9	5.0	s	10
EN_DG_POT	E18 - Enable motor potentiometer reference value(A.I.4)			0		1
PRC_SPD_REF_DG_POT	D67 - Digital Potentiometer Speed reference	-100.00	100.00	0	% MOT_SPD_MAX	100

2.1.3 Frequency Speed Reference



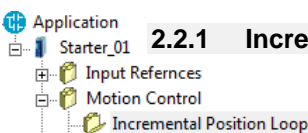
Name	Description	Min	Max	Default	UM	Scale
FRQ_IN_PPR_SEL	E20 - Encoder pulses per revolution			5		1
FRQ_IN_NUM	E21 - NUM - Frequency input slip ratio	-16383	16383	100		1
FRQ_IN_DEN	E22 - DEN - Frequency input slip ratio	1	16383	100		1
EN_FRQ_REF	E23 - Enable frequency speed reference value			0		1
FRQ_REF_SEL	E24 - Frequency speed reference selection			0		1
TF_TIME_DEC_FRQ	E25 - Filter time constant of frequency input decoded in time	0.0	20.0	1.6	ms	10
KP_TIME_DEC_FRQ	E26 - Corrective factor for frequency input decoded in time	0.00	200.00	100.00		100
PRC_SPD_REF_TIME_DEC	D77 - Time Decode Frequency input Speed reference	-100.00	100.00	0	% MOT_SPD_MAX	100
MUL_AI_MIN	E44 - Min analog input value for multiplication factor	-180.00	180.00	0.00		100



2.1.4 Fieldbus References

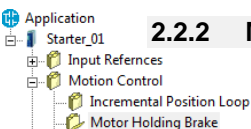
Name	Description	Min	Max	Default	UM	Scale
EN_FLDBUS_REF	E47 - Enable FIELD-BUS reference values			0		1
PRC_T_REF_FLDBUS	D69 - Fieldbus Torque reference	-400.00	400.00	0	% MOT_T_NOM	100
PRC_T_MAX_FLDBUS	D71 - Fieldbus Torque Max reference	-400.00	400.00	0	% MOT_T_NOM	100
PRC_SPD_REF_FLDBUS	D75 - Fieldbus Speed reference	-100.00	100.00	0	% MOT_SPD_MAX	100
SPD_REF_PULS_FLDBUS	D78 - Fieldbus Speed Reference in Pulses			0		1

2.2 MOTION CONTROL



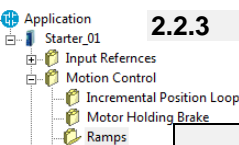
2.2.1 Incremental Position Loop

Name	Description	Min	Max	Default	UM	Scale
EN_POS_REG	E39 - Enable overlapped space loop			0		1
EN_POS_REG_MEM_CLR	E40 - Enable overlapped space loop memory clear in stop			0		1



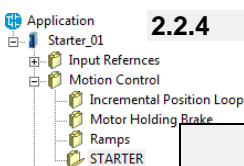
2.2.2 Motor Holding Brake

Name	Description	Min	Max	Default	UM	Scale
EN_HLD_BRAKE	E89 - Enable motor holding brake	0	1	0		1
HLD_BRAKE_DIS_DLY	E90 - Motor holding brake disable delay at start	0	19999	0	ms	1
HLD_BRAKE_EN_DLY	E91 - Motor holding brake enable delay at stop	0	19999	0	ms	1



2.2.3 Ramps

Name	Description	Min	Max	Default	UM	Scale
EN_LIN_RAMP	E36 - Enable linear ramp			1		1

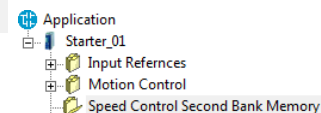


2.2.4 STARTER

Name	Description	Min	Max	Default	UM	Scale
SW_SFUNCT	E65 - SW Starter function enable			0		1
SW_MFREQ	E66 - SW Mains frequency enable			0		1
SW_PHCTL	E67 - SW Mains phase contrl enable			0		1
SW_LOCKOUT	E68 - SW Mains by-pass output enable			0		1
ALFA_STAR	E60 - Alfa star	-180.0	180.0	0		10
KP_FASE	E55 - Phase reg Kp	1	100	4		10
TI_FASE	E56 - Phase reg Ti	10	30000	300		10
TF_FASE	E57 - Phase reg Tf	0	3000	0		10
OFFSET01	E70 - Offset channel 01	-100.0	100.0	0		100
OFFSET02	E71 - Offset channel 02	-100.0	100.0	0		100
MULTIPLCH	E72 - Mult factor CH1/CH2	0.0	200.0	0		100

Name	Description	Min	Max	Default	UM	Scale
EN_AUTOCH	E73 – Enable autotuning			0		1
TIME_CMASK	E75 – Settle time	0	120	0	s	1
LOCK_TIME	E76 – Wait time after phase locked	0	1000	10	ms	1

2.3 SPEED CONTROL SECOND BANK MEMORY



Name	Description	Min	Max	Default	UM	Scale
SB_MOT_SPD_MAX	E27 - Second bank Max. operating speed	50	30000	3000	rpm	1
SB_SPD_REG_KP	E28 - Second bank KpV speed regulator proportional gain	0.1	400.0	6.0		10
SB_SPD_REG_TI	E29 - Second bank TiV speed regulator lead time constant	0.1	3000.0	30.0	ms	10
SB_SPD_REG_TF	E30 - Second bank TfV speed regulator (filter) time constant	0.0	25.0	0.4	ms	10
SB_CW_ACC_TIME	E31 - Second bank CW acceleration time	0.01	199.99	10.00	s	100
SB_CW_DEC_TIME	E32 - Second bank CW deceleration time	0.01	199.99	10.00	s	100
SB_CCW_ACC_TIME	E33 - Second bank CCW acceleration time	0.01	199.99	10.00	s	100
SB_CCW_DEC_TIME	E34 - Second bank CCW deceleration time	0.01	199.99	10.00	s	100
SB_ON	E35 - Second bank active			0		1

3 LOGIC INPUTS AND OUTPUTS OF THE APPLICATION

INPUT LOGIC FUNCTION		Default STATUS	LOGIC
I27	Enable Sync Function	L	or E65
I28	Enable Mains Frequency Reference	L	or E66
I29	Enable Mains Phase Control	L	or E67
I30	Enable Output Switch Off	L	or E68

OUTPUT LOGIC FUNCTION		Default STATUS	
O33	Synchro Enabled Function	L	
O34	Mains Frequency Reference	L	
O35	Phase Control Enabled	L	
O36	Mains Frequency Locked	L	
O37	Mains Phase Locked	L	
O38	Locked Output Enabled	L	

4 AUTOTUNING OF THE INPUT SIGNAL (GRID SYNCHRONIZATION)

The mains synchronism signals must be appropriately calibrated in terms of offset and width. To do this, an autotuning function is available. This function (that can be enabled by means of **E73**) has to be performed only once, when the inverter is switched on for the first time, when the connector with the mains synchronisms is properly fed. This function has to be enabled with the Drive not in Alarm status (otherwise the function is not carried out), and preferably in idle position. By enabling **E73=TRUE** the function is carried out (with a duration of 5 seconds), thereafter **E73** is reset to FALSE automatically. The calculated values (**E70**, **E71**, and **E72**) must be stored in the EEPROM memory of the Drive.

5 FUNCTIONAL DIAGRAM

The diagram below shows the Starter mode of operation.

Index	Scale	Description
68	Perc. 16384	V1line
69	Perc. 16384	V2line
70	Perc. 4096	OutVel
71	Perc. 4096	ErrPhase
72	Perc. 4096	OutPhase

+ Add		- Remove								
Index	Name	Format	Conf. type	PLC type	Unit	Def. value	Min	Max	Description	
64	REF_AI1	xxx.yy	REAL	INT	%	0	-100.00	100.00	D64 - Reference from Analog Input AI1	
65	REF_AI2	xxx.yy	REAL	INT	%	0	-100.00	100.00	D65 - Reference from Analog Input AI2	
66	REF_AI3	xxx.yy	REAL	INT	%	0	-100.00	100.00	D66 - Reference from Analog Input AI3	
67	PRC_SPD_REF_DG_POT	xxx.yy	REAL	INT	% MOT_SPD_0		-100.00	100.00	D67 - Digital Potentiometer Speed reference	
68	PRC_T_REF_AN	xxx.yy	REAL	INT	% MOT_T_NO 0		-400.00	400.00	D68 - Analog Torque reference from Application	
69	PRC_T_REF_FLDBUS	xxx.yy	REAL	INT	% MOT_T_NO 0		-400.00	400.00	D69 - Fieldbus Torque reference	
70	PRC_T_MAX_AN_POS	xxx.yy	REAL	INT	% MOT_T_NO 0		-400.00	400.00	D70 - Analog Positive Torque Max from Application	
71	PRC_T_MAX_FLDBUS	xxx.yy	REAL	INT	% MOT_T_NO 0		-400.00	400.00	D71 - Fieldbus Torque Max reference	
72	PRC_SPD_TOT_AN	xxx.yy	REAL	INT	% MOT_SPD_0		-100.00	100.00	D72 - Speed reference from AI1 + AI2 + AI3 + AI16	
73	MUL_KP	xxx.yy	REAL	INT		0	-100.00	100.00	D73 - Multiplication factor	
74	PRC_SPD_REF_AN	xxx.yy	REAL	INT	% MOT_SPD_0		-100.00	100.00	D74 - Speed reference	
75	PRC_SPD_REF_FLDBUS	xxx.yy	REAL	INT	% MOT_SPD_0		-100.00	100.00	D75 - Fieldbus Speed reference	
76	PRC_SPD_REF_JOG	xxx.yy	REAL	INT	% MOT_SPD_0		-100.00	100.00	D76 - Jog Speed reference	
77	PRC_SPD_REF_TIME_DE	xxx.yy	REAL	INT	% MOT_SPD_0		-100.00	100.00	D77 - Time Decode Frequency input Speed reference	
78	SPD_REF_PULS_FLDBUS		INT	INT		0			D78 - Fieldbus Speed Reference in Pulses	
79	REF_AI16		INT	INT		0			D79 - Reference from analog Input AI16	
80	PRC_T_MAX_AN_NEG		INT	INT		0			D80 - Analog Negative Torque Max from Application	
81	FREQUENCY_M	xxxxx	REAL	INT	Hz	0	-200.0	200.0	D81 - Frequency	
82	MAINS_V	xxx.yy	REAL	INT	%	0	-200	200	D82 - Mains Voltage (filtered)	

6 CONTROL DIAGRAM

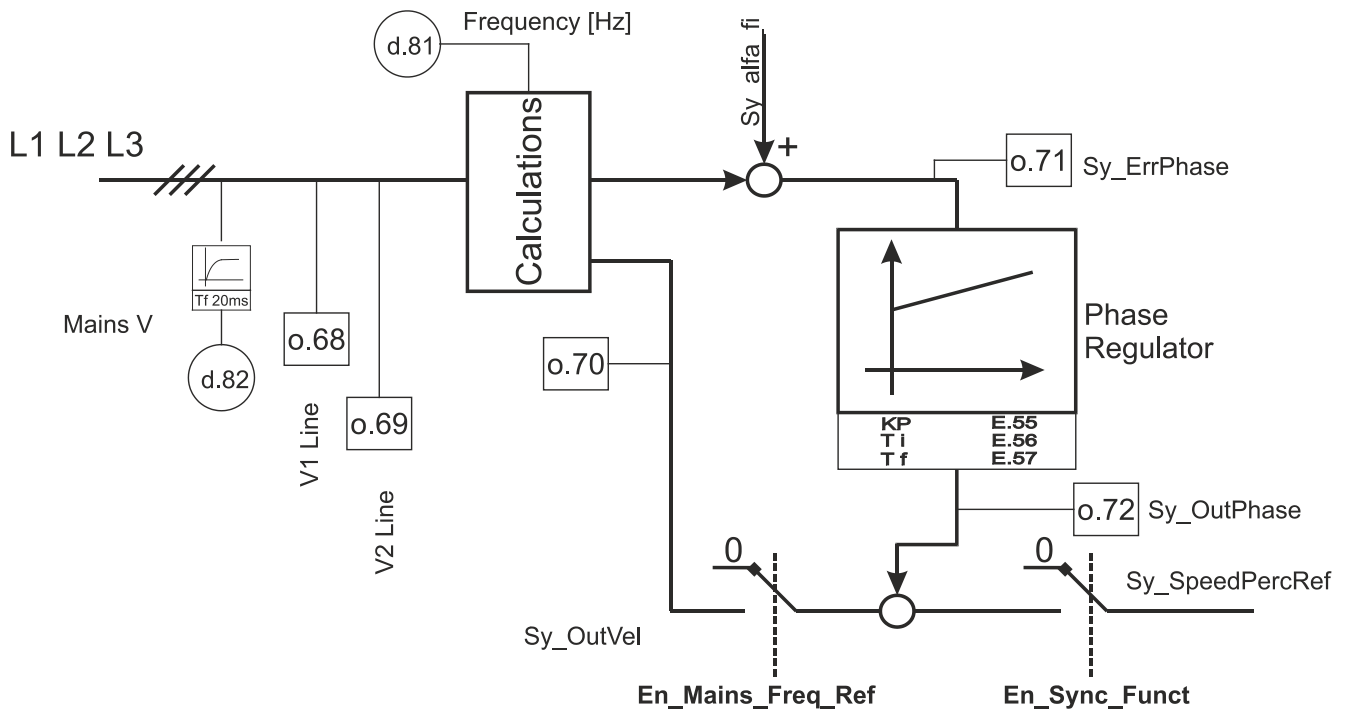


Figure 1: Starter Control Diagram

7 MEASUREMENTS

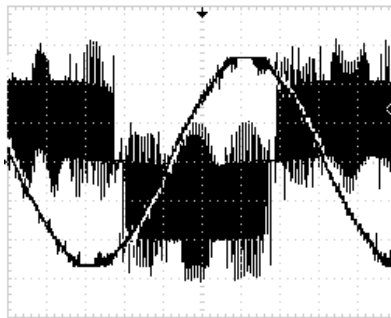


Figure 2: Phase-phase mains voltage and inverter output voltage (PWM) with phase not connected to the mains voltage (Frequency Locked = TRUE, Phase Locked = FALSE)

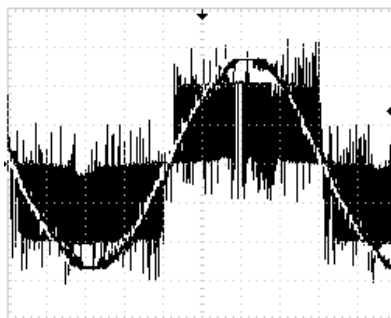


Figure 3: Phase-phase mains voltage and inverter output voltage (PWM) with phase connected to the mains voltage (Frequency Locked = TRUE, Phase Locked = TRUE)

8 STARTER SCHEMATIC

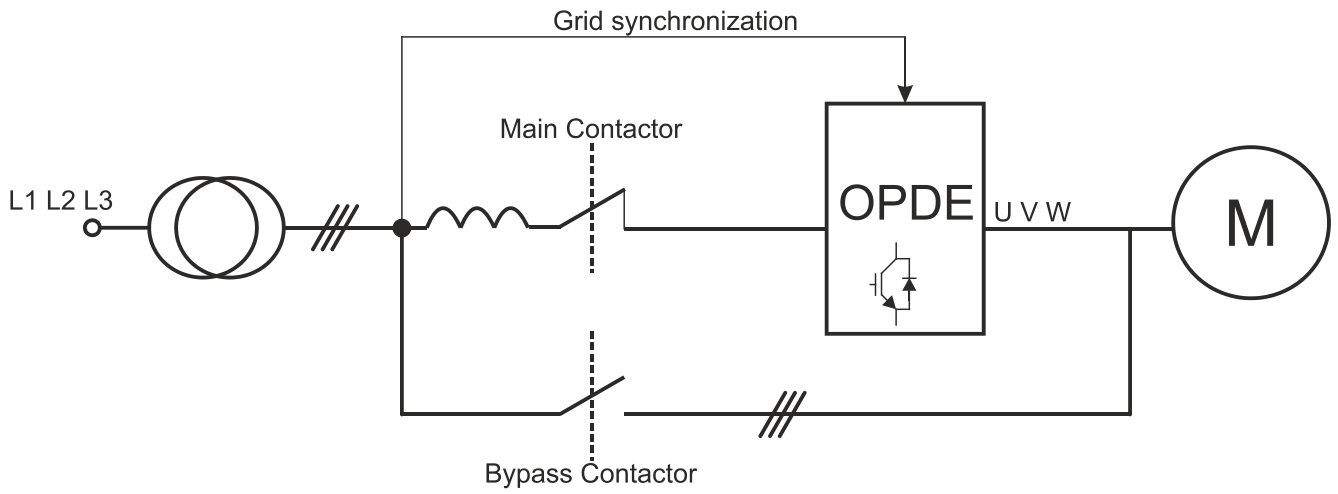


Figure 4: Starter Schematic

9 STARTER: CONNECTIONS DIAGRAM

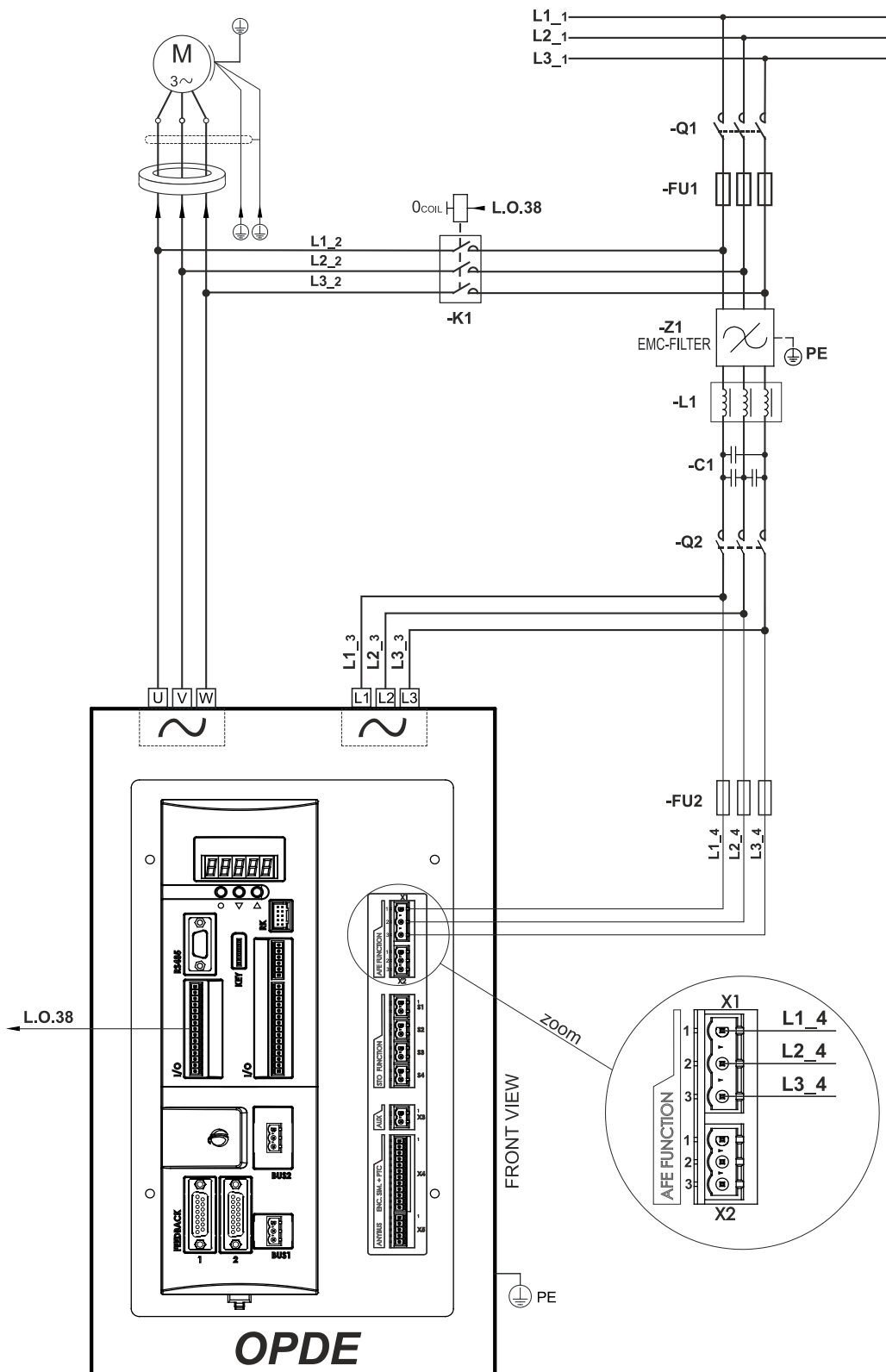


Figure 5: Connections diagram



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