Motors | Automation | Energy | Transmission & Distribution | Coatings

Medium Voltage Frequency Inverter

MVW3000

User Manual

User Manual

Series: MVW3000

Language: English

Document Number: 10004823674 / 03

Build 2246*

Publication Date: 07/2022

The information below describes the revisions of this manual.

Revision	Description
00	First edition
01	General revision
02	Model update and general revision
03	Inclusion of MVW3000 G2 information and general revision

Contents

1 SAFETY NOTICES

This manual contains the necessary information for the correct use of the MVW3000 inverter.

It was written to be used by people with proper technical training or qualification to operate this kind of equipment.

This manual describes all the functions and part of the parameters of the MVW3000, but it is not intended to present all possible applications of the MVW3000. WEG is not liable for applications not described in this manual.

This product is not intended for applications whose function is to ensure the physical integrity and/or the life of people, or any other application where failure of the MVW3000 can create a risk to the physical integrity and/or life of people. The designer who applies the MVW3000 must provide ways to ensure the safety of the installation even in the event of a drive failure.

1.1 SAFETY NOTICES IN THE MANUAL

Throughout this manual the following safety notes are used:

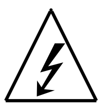
DANGER!
Failure to observe the procedures recommended in this warning may lead to death, serious injuries and/or considerable material damages.

WARNING!
Failure to observe the procedures recommended in this warning may lead to material damages.

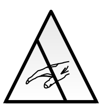
NOTE!
The text intents to supply important information for the correct understanding and good operation of the product.

1.2 SAFETY NOTICES ON THE PRODUCT

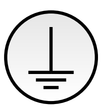
The following symbols are attached to the product, serving as safety notices:



High voltages are present.



Components sensitive to electrostatic discharge. Do not touch them.



Mandatory connection to the protective earth (PE).

⏚	Connection of the shield to the ground.
⚠	Hot surface.

1.3 PRELIMINARY RECOMMENDATIONS

DANGER!
Only qualified personnel familiar with the MVW3000 frequency inverter and associated equipment should plan or implement the installation, start-up and subsequent maintenance of this equipment.
These personnel must follow all the safety instructions included in this manual and/or defined by local regulations.
Failure to comply with these instructions can lead to death, serious injuries or considerable material damage.

NOTE!
For the purposes of this manual, qualified personnel are those trained to be able to:

1. Install, ground, energize and operate the MVW3000 according to this manual and the effective legal safety procedures;
2. Use the protection equipments according to the established standards;
3. Give first aid services.

DANGER!
Always disconnect the input power before touching any electrical component associated to the inverter.
Many components can remain charged with high voltages or remain in movement (fans) even after that AC power is disconnected or switched off.
Wait at least 10 minutes to assure a total discharge of the capacitors.
Always connect the equipment frame to the protection earth (PE) at the suitable connection point.

WARNING!
A preliminary shutdown is indicated by the neon lamps mounted on the HVM2 (High Voltage Monitoring) board. In addition, the board indicates residual voltages on the panel.
For detailed instructions on de-energizing, see Section 6.6 SAFE DE-ENERGIZATION INSTRUCTIONS on page 6-28.

WARNING!
Electronic boards have components sensitive to electrostatic discharges. Do not touch directly on components or connectors. If necessary, touch the grounded metallic frame before or use an adequate grounded wrist strap.

Do not execute any withstand voltage test on the inverter!
If it is necessary consult WEG.

NOTE!
Frequency inverter may interfere with other electronic equipment. In order to reduce these effects, take the precautions recommended.

NOTE!
Read the full User Manual before installing or operating the inverter.

DANGER!
This product was not designed to be used as a safety device. Additional measures must be taken so as to avoid material damages and personal injuries.
The product was manufactured under strict quality control; however, if installed in systems in which a failure may cause risks of material damages or personal injuries, additional external safety devices must be installed to ensure the safety in case of a product failure, preventing accidents.

WARNING!
When in operation, electric energy systems, such as transformers, converters, motors and cables, generate electromagnetic fields (EMF). Therefore, there is risk for people with pacemakers or implants that stay close to such systems. Thus, such people must stay at least 2 meters away from such machines.

2 GENERAL INFORMATION

This chapter provides information about the contents of this manual, describes the main features of the MVW3000 and explains how to identify its components. In addition, information on receipt, storage and preventive maintenance of the product is provided.

2.1 ABOUT THIS MANUAL

This manual has 10 chapters in a logical sequence for the user to install and operate the MVW3000:

The User Manual provides information about the MVW3000 medium voltage inverter. This document is arranged in dedicated and specific chapters to explain the proper handling, installation, care, troubleshooting, adaption to applications and functionalities of the equipment.

The characteristics and recommendations contained in this manual were based on models of the standard MVW3000. However, it is possible to develop and provide customized solutions according to your customers' needs and specific applications.

The MVW3000 product can be customized (engineered) to meet the needs and technical specifications of our customers. Sizes, technical recommendations, performance data and the need to add optional components may vary in relation to the information contained in this document.

The customer will receive the User Manual, the Programming Manual (both available for download at **www.weg.net**) and a detailed design related to the product. This design contains all the electrical, mechanical and interface/installation information with other equipment of the MVW3000.

The MVW3000, as well as other WEG products, is in constant evolution in relation to both its internal parts (hardware) and its programming (software/firmware). Any question about the equipment and its documentation can be answered by means of WEG communication channels.

WEG is not liable for the improper use of the information contained in this manual.

2.2 MVW3000 IDENTIFICATION LABEL

The identification label of the MVW3000 is located inside the product control panel. This label describes important information about the inverter.
An example of an identification label for the MVW3000 is shown in Figure 2.1 on page 2-2.

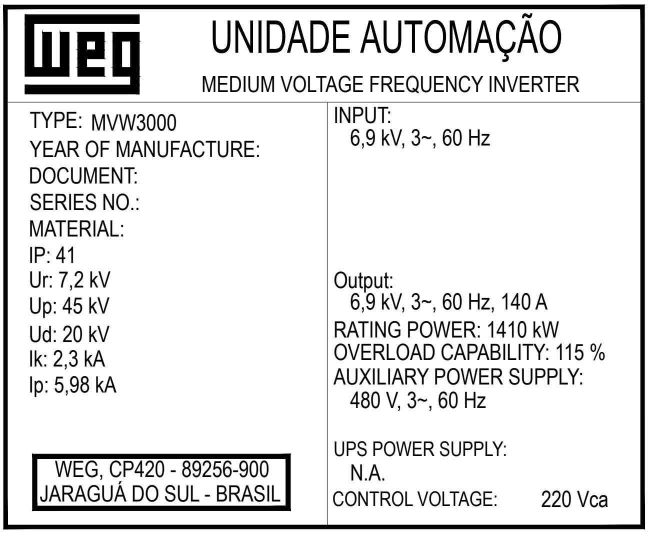


Figure 2.1: *MVW3000 identification label (example)*

2.3 RECEIVING AND STORAGE

The MVW3000 is supplied with the power cells separated from the panel and packed in a set of three cells per package. The package is composed of an OSB (wood by-product) frame and injected foam shims. An identification label is affixed to the outside of the package, identical to the label affixed to the side of the inverter. Confront the content of this label with the purchase order.
To open the cell packaging, see the procedure described in Section 6.1.5 Unpacking on page 6-8. If the cells of the MVW3000 will not be installed on the panel soon, store them in a clean and dry place (temperature between -25 °C and 50 °C and humidity below 80%), covered for protection against dust accumulation and water splashes. It is recommended to replace the silica gel every three months.
The MVW3000 panel has a dehumidifier module, which must remain turned on in case of storage for over thirty days.
The MVW3000 panel is supplied in a package composed of cardboard and wood. The guidance for handling, transportation, mechanical and electric installation is presented in the Chapter 6 INSTALLATION, CONNECTION, ENERGIZATION AND PREVENTIVE MAINTENANCE on page 6-1.

2.4 HOW TO SPECIFY THE MVW3000 MODEL

Table 2.1: *Code example of the MVW3000*

Legenda	Linha	1	2	3	4	5	6	7	8	9	10	11	12	13
Code example(1)	MVW3000	A0140	V063	T5A	066	N	36	P	A	S	F	R	D	F1

1		2		3		4		5		6	7		8		9		10		11		12		13	
Rated output current		**Rated output voltage**		**Input transformer**		**Rated input voltage(2)**		**Transf. certification**		**Number of pulses**	**Manual language**		**Cooling type**		**Input switchgear**		**Capacitor type**		**Cell type**		**Rectifier type**		**Filter type**	
40 A	A0040	1150 V	V011	Al 50 Hz	T5A	1150 V	011	UL	U	18	English	E	Air	A	Not included	N	Film	F	Default	S	Diode	D	No	F0
50 A	A0050	2300 V	V023	Al 60 Hz	T6A	2300 V	023	No UL	N	24	Spanish	S			Included	S			Bypass	B			Type 1	F1
60 A	A0060	3300 V	V033	Cu 50 Hz	T5C	3000 V	030			30	Portuguese	P							Redundant	R			Type 2	F2
70 A	A0070	4160 V	V041	Cu 60 Hz	T6C	3300 V	033			36													Type 3	F3
80 A	A0080	5500 V	V055			4160 V	041			42														
90 A	A0090	6300 V	V063			4800 V	048			48														
100 A	A0100	6900 V	V069			5500 V	055			54														
110 A	A0110	7200 V	V072			6000 V	060			60														
125 A	A0125	8000 V	V080			6300 V	063			66														
140 A	A0140	9000 V	V090			6600 V	066			72														
160 A	A0160	10000 V	V100			6900 V	069			90														
180 A	A0180	11000 V	V110			7200 V	072			108														
200 A	A0200	12000 V	V120			8000 V	080			126														
225 A	A0225	13200 V	V132			8400 V	084			144														
265 A	A0265	13800 V	V138			10000 V	100			162														
310 A	A0310					11000 V	110			180														
340 A	A0340					12000 V	120			198														
400 A	A0400					12400 V	124			216														
450 A	A0450					13200 V	132																	
500 A	A0500					13800 V	138																	
550 A	A0550																							
600 A	A0600																							
760 A	A0760																							
800 A	A0800																							
855 A	A0855																							
950 A	A0950																							
1045 A	A1045																							
1140 A	A1140																							

(1) For all available models, see Table 2.3 on page 2-6 to Table 2.17 on page 2-13;
(2) Reference values. For other values see **www.weg.net**.

Table 2.2: General specifications

POWER SUPPLY	Voltage	1150 - 13800 V (±10%, -20% with output power derating) (Default values in Table 2.1 on page 2-2 and on request)
	Frequency	50 or 60 Hz ±5% (other values on request)
	Voltage imbalance between phases	< 3%
	Cos φ	> 0,95
	Overvoltage category	Category III
AUXILIARY SUPPLY	Voltages (three-phase)	220, 380, 400, 415, 440, 460, 480 V standard (525 V and other values optional)
	Frequency	50 or 60 Hz (±5%)
	Voltage imbalance between phases	< 3%
PROTECTION DEGREE	Default	NEMA 1, IP21
	Optional	IP41 and IP42
DIMENSION	Width/Height/ Depth (mm)	16 different frames. For all the frames available, see Figure 4.3 on page 4-3 and Table 4.2 on page 4-3 to Table 4.16 on page 4-6
ENVIRONMENTAL CONDITIONS	Temperature	0 a 40 °C (up to 50 °C with derating of 2.5% / °C in the output current)
	Humidity	5 to 90% without condensation
	Altitude	0 to 1000 m (up to 4000 m with 10% / 1000 m reduction in the output current
	Pollution degree	2 (nonconductive pollution)
CONFORMAL COATING	Class	3C3 (other classes under request)
FINISHING	Color	RAL7035 (light grey) (other colors under request)
CONTROL	Microprocessor	32 bits
	Control method	Sinusoidal PWM
	Control types	Scalar (Imposed Voltage - V/f), Vector (encoder and sensorless)
	IGBT switching frequency	500 Hz
	Output voltage switching frequency	2*n*500 Hz , where n=number of cells in series; Values of the models in tables Table 10.2 on page 10-3 to Table 10.16 on page 10-9
	Frequency variation	0 a 120 Hz
	Permissible overload	115% for 60 s every 10 minutes (Higher Overloads under request)
PERFORMANCE	Efficiency	Above 96.5% (with aluminum transformer) Above 97.0% (with copper transformer)
	Speed control	▪ V/f: Setting 1% of the rated speed with slip compensation; Resolution: 1 rpm (reference via HMI keypad).
		▪ Sensorless: Setting: 0.5% of the rated speed; Speed variation range:
		▪ With sensor (use EBA, EBB or EBC board): Setting: ±0.01% of the rated speed with 14-bit analog input (EBA); ±0.01% of the rated speed with digital reference (keypad, serial, Fieldbus, electronic potentiometer, multispeed); 0.1% of the rated speed with 10-bit analog input.

INPUTS OUTPUTS	Analog	▪ 2 programmable differential inputs (10 bits): 0 to 10 V, 0 to 20 mA or 4 to 20 mA; ▪ 1 programmable bipolar input (14 bits): -10 V to +10 V, 0 to 20 mA or 4 to 20 mA; ▪ 1 programmable isolated input (10 bits): 0 to 10 V, 0 to 20 mA or 4 to 20 mA; ▪ 2 programmable outputs (11 bits): 0 to 10 V; ▪ 2 bipolar programmable outputs (14 bits): -10 to +10 V; ▪ 2 programmable isolated outputs (11 bits): 0 to 20 mA or 4 to 20 mA.
	Digital Analog Relay Transistor	▪ 8 programmable isolated inputs : 24 Vdc ▪ 1 programmable isolated input: 24 Vdc; ▪ 1 programmable isolated input: 24 Vdc (for motor PTC thermistor); ▪ 5 programmable outputs, contacts NA/NF (NO/NC): 240 Vac, 1 A; ▪ 2 programmable isolated open collector outputs NO: 24 Vdc, 50 mA.
COMMUNICATION	Serial Interface Fieldbus Networks	RS-232 (point to point)
		RS-485, isolated, via EBA or EBB board (multipoint up to 30 inverters)
		Modbus RTU (incorporated software) via RS-485 serial interface
		Profibus DP or DeviceNet via additional KFB kits
		Ethernet and Profinet
SAFETY	Protections (records of the last 100 faults/alarms with date and time)	See faults in the Programming Manual available for download on the website: **www.weg.net**
COMPLIANCE/ STANDARDS	Electromagnetic Compatibility	2014/30/EU – EMC Directive
		EN 61800-3 Standard (EMC - Emission and Immunity)
	CEI - IEC 61800	Adjustable Speed Electrical Power Drive System
		Part 4 - General Requirements
		Part 5 - Safety Requirements
HUMAN-MACHINE INTERFACE	Control	Start/Stop, Parameter Setting (Programming of general functions)
		Increase/Decrease speed
		JOG, rotation direction inversion and Local/Remote selection
	Supervision (Reading)	Speed reference (rpm)
		Motor speed (rpm)
		Value proportional to speed (E.g.: m/min)
		Motor output frequency (Hz)
		DC link voltages (V)
		Torque on the motor (%)
		Output power (kW)
		Hours of energized product (h)
		Operation time (h)
		Motor output current (A)
		Motor output voltage (V)
		Inverter status
		Status of digital inputs
		State of the transistor digital outputs
		State of the relay outputs
		Value of the analog inputs
		Last 100 errors in memory c\ date and time
		Fault/alarm messages

AVAILABLE FEATURES/ FUNCTIONS	Optional items	Fieldbus network communication kits (installation inside the inverter)
		SUPERDRIVE kit with RS-232 serial communication interface (Inverter - PC)
		Kit Ethernet
		Frame kit for remote interface
		PLC2
CERTIFICATIONS	CE(1)	
	EAC(1)	
	UKCA(1)	
	UL(1)	

(1) For models with certifications, consult WEG.

2.4.1 Available Models

The MVW3000 line of medium voltage inverters offers different models, classified according to their voltage levels and rated current of the power cells. Different models of the MVW3000 may have distinct frames, which are presented in tables Table 2.3 on page 2-6 to Table 2.17 on page 2-13 with their respective codes. For design aspects of the available frames, see, Chapter 4 TECHNICAL DATA on page 4-1, Figure 4.3 on page 4-3 and tables Table 4.2 on page 4-3 to Table 4.16 on page 4-6.

Table 2.3: *1150 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1)		Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
			HP	kW				
MVW3000 A0040 V011	1150	40	90	70	2.43	2.07	4000 CFM 6800 m³/h	A1
MVW3000 A0050 V011		50	110	80	2.99	2.55		
MVW3000 A0060 V011		60	130	100	3.74	3.19		
MVW3000 A0070 V011		70	160	120	4.30	3.67		
MVW3000 A0080 V011		80	180	130	4.87	4.15		B1
MVW3000 A0090 V011		90	200	150	5.61	4.79		
MVW3000 A0100 V011		100	220	170	6.18	5.27		
MVW3000 A0110 V011		110	250	180	6.74	5.74		
MVW3000 A0125 V011		125	280	210	7.86	6.70		
MVW3000 A0140 V011		140	310	230	8.80	7.50		
MVW3000 A0160 V011		160	360	270	9.92	8.46		C1
MVW3000 A0180 V011		180	400	300	11.23	9.57		
MVW3000 A0200 V011		200	450	330	12.54	10.69		
MVW3000 A0225 V011		225	500	370	14.04	11.97	4200 CFM 7140 m³/h	D1
MVW3000 A0265 V011		265	590	440	16.66	14.20		
MVW3000 A0310 V011		310	690	520	19.46	16.60		E1
MVW3000 A0340 V011		340	760	570	21.33	18.19		
MVW3000 A0400 V011		400	890	670	25.08	21.38	3800 CFM 6460 m³/h	F1
MVW3000 A0450 V011		450	1000	750	28.26	24.10		
MVW3000 A0500 V011		500	1120	830	31.44	26.81		G1
MVW3000 A0550 V011		550	1230	910	34.43	29.36		
MVW3000 A0600 V011		600	1340	1000	37.62	32.08		
MVW3000 A0760 V011		760	Upon request	Upon request	Upon request	Upon request	Upon request	2xF1
MVW3000 A0800 V011		800						
MVW3000 A0855 V011		855						
MVW3000 A0950 V011		950						2xG1
MVW3000 A1045 V011		1045						
MVW3000 A1140 V011		1140						

Table 2.4: 2300 V models

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1)		Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
			HP	kW				
MVW3000 A0040 V023	2300	40	180	130	4.87	4.15	4000 CFM 6800 m³/h	A2
MVW3000 A0050 V023		50	220	170	6.18	5.27		
MVW3000 A0060 V023		60	270	200	7.49	6.38		
MVW3000 A0070 V023		70	310	230	8.80	7.50		
MVW3000 A0080 V023		80	360	270	9.92	8.46		B2
MVW3000 A0090 V023		90	400	300	11.23	9.57		
MVW3000 A0100 V023		100	450	330	12.54	10.69		
MVW3000 A0110 V023		110	490	370	13.66	11.65		
MVW3000 A0125 V023		125	560	420	15.72	13.40		
MVW3000 A0140 V023		140	630	470	17.59	15.00		
MVW3000 A0160 V023		160	710	530	20.02	17.07	8000 CFM 13595 m³/h	C2
MVW3000 A0180 V023		180	800	600	22.64	19.31		
MVW3000 A0200 V023		200	890	670	25.08	21.38		
MVW3000 A0225 V023		225	1000	750	28.26	24.10	8400 CFM 14275 m³/h	D2
MVW3000 A0265 V023		265	1180	880	33.31	28.40		
MVW3000 A0310 V023		310	1380	1030	38.74	33.03		E2
MVW3000 A0340 V023		340	1520	1130	42.67	36.38		
MVW3000 A0400 V023		400	1790	1330	50.15	42.77	7600 CFM 12915 m³/h	F2
MVW3000 A0450 V023		450	2010	1500	56.33	48.03		
MVW3000 A0500 V023		500	2230	1660	62.88	53.62		G2
MVW3000 A0550 V023		550	2460	1830	68.87	58.72		
MVW3000 A0600 V023		600	2680	2000	75.42	64.31		
MVW3000 A0760 V023		760	Upon request	Upon request	Upon request	Upon request	Upon request	2xF2
MVW3000 A0800 V023		800						
MVW3000 A0855 V023		855						
MVW3000 A0950 V023		950						2xG2
MVW3000 A1045 V023		1045						
MVW3000 A1140 V023		1140						

Table 2.5: 3300 V models

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1)		Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
			HP	kW				
MVW3000 A0040 V033	3300	40	260	190	7.11	6.06	8000 CFM 13595 m³/h	A3
MVW3000 A0050 V033		50	320	240	8.98	7.66		
MVW3000 A0060 V033		60	380	290	10.67	9.10		
MVW3000 A0070 V033		70	450	330	12.54	10.69		
MVW3000 A0080 V033		80	510	380	14.41	12.29		B3
MVW3000 A0090 V033		90	580	430	16.09	13.72		
MVW3000 A0100 V033		100	640	480	17.97	15.32		
MVW3000 A0110 V033		110	700	530	19.84	16.92		
MVW3000 A0125 V033		125	800	600	22.46	19.15		
MVW3000 A0140 V033		140	900	670	25.08	21.38		
MVW3000 A0160 V033		160	1030	760	28.82	24.58		C3
MVW3000 A0180 V033		180	1150	860	32.19	27.45		
MVW3000 A0200 V033		200	1280	950	35.93	30.64		
MVW3000 A0225 V033		225	1440	1070	40.42	34.47	8400 CFM 14275 m³/h	D3
MVW3000 A0265 V033		265	1700	1270	47.53	40.53		
MVW3000 A0310 V033		310	1990	1480	55.77	47.55		E3
MVW3000 A0340 V033		340	2180	1620	61.20	52.18		
MVW3000 A0400 V033		400	2560	1910	72.05	61.44	11400 CFM 19375 m³/h	F3
MVW3000 A0450 V033		450	2880	2150	81.03	69.10		
MVW3000 A0500 V033		500	3200	2390	90.20	76.92		G3
MVW3000 A0550 V033		550	3520	2630	99.00	84.42		
MVW3000 A0600 V033		600	3840	2860	107.98	92.08		
MVW3000 A0760 V033		760	Upon request	Upon request	Upon request	Upon request	Upon request	2xF3
MVW3000 A0800 V033		800						
MVW3000 A0855 V033		855						
MVW3000 A0950 V033		950						2xG3
MVW3000 A1045 V033		1045						
MVW3000 A1140 V033		1140						

Table 2.6: *4160 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power[1]		Dissipated power[2] [kW]	Dissipated power[3] [kW]	Flow[4]	Frame size
			HP	kW				
MVW3000 A0040 V041	4160	40	320	240	8.98	7.66	8000 CFM 13595 m³/h	A4
MVW3000 A0050 V041		50	400	300	11.23	9.57		
MVW3000 A0060 V041		60	480	360	13.47	11.49		
MVW3000 A0070 V041		70	570	420	15.91	13.56		
MVW3000 A0080 V041		80	650	480	18.15	15.48		B4
MVW3000 A0090 V041		90	730	540	20.40	17.39		
MVW3000 A0100 V041		100	810	600	22.64	19.31		
MVW3000 A0110 V041		110	890	660	24.89	21.22		
MVW3000 A0125 V041		125	1010	750	28.45	24.26		
MVW3000 A0140 V041		140	1130	840	31.63	26.97		
MVW3000 A0160 V041		160	1290	960	36.31	30.96	12000 CFM 20395 m³/h	C4
MVW3000 A0180 V041		180	1450	1080	40.80	34.79		
MVW3000 A0200 V041		200	1620	1200	45.29	38.62		
MVW3000 A0225 V041		225	1820	1350	50.90	43.41	12600 CFM 21415 m³/h	D4
MVW3000 A0265 V041		265	2140	1590	60.07	51.22		
MVW3000 A0310 V041		310	2500	1870	70.37	60.00		E4
MVW3000 A0340 V041		340	2750	2050	77.10	65.75		
MVW3000 A0400 V041		400	3230	2410	90.77	77.40	15200 CFM 25830 m³/h	F4
MVW3000 A0450 V041		450	3630	2710	102.18	87.13		
MVW3000 A0500 V041		500	4040	3010	113.78	97.02		G4
MVW3000 A0550 V041		550	4440	3310	124.83	106.44		
MVW3000 A0600 V041		600	4850	3610	136.24	116.17		
MVW3000 A0760 V041		760	Upon request	Upon request	Upon request	Upon request	Upon request	2xF4
MVW3000 A0800 V041		800						
MVW3000 A0855 V041		855						
MVW3000 A0950 V041		950						2xG4
MVW3000 A1045 V041		1045						
MVW3000 A1140 V041		1140						

Table 2.7: *5500 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power[1]		Dissipated power[2] [kW]	Dissipated power[3] [kW]	Flow[4]	Frame size
			HP	kW				
MVW3000 A0040 V055	5500	40	430	320	11.98	10.21	12000 CFM 20395 m³/h	A5
MVW3000 A0050 V055		50	530	400	14.97	12.77		
MVW3000 A0060 V055		60	640	480	17.97	15.32		
MVW3000 A0070 V055		70	750	560	20.96	17.87		
MVW3000 A0080 V055		80	850	640	23.95	20.43		B5
MVW3000 A0090 V055		90	960	720	26.95	22.98		
MVW3000 A0100 V055		100	1070	800	29.94	25.53		
MVW3000 A0110 V055		110	1170	880	32.75	27.93		
MVW3000 A0125 V055		125	1330	990	37.43	31.92		
MVW3000 A0140 V055		140	1500	1110	42.11	35.91		
MVW3000 A0160 V055		160	1710	1270	48.10	41.01	16000 CFM 27190 m³/h	C5
MVW3000 A0180 V055		180	1920	1430	54.08	46.12		
MVW3000 A0200 V055		200	2140	1590	60.07	51.22		
MVW3000 A0225 V055		225	2400	1790	67.37	57.45	16800 CFM 28550 m³/h	D5
MVW3000 A0265 V055		265	2830	2110	79.72	67.98		
MVW3000 A0310 V055		310	3310	2470	93.01	79.31		E5
MVW3000 A0340 V055		340	3630	2710	101.99	86.97		
MVW3000 A0400 V055		400	4270	3180	120.15	102.45	19000 CFM 32290 m³/h	F5
MVW3000 A0450 V055		450	4810	3580	135.12	115.22		
MVW3000 A0500 V055		500	5340	3980	150.09	127.98		G5
MVW3000 A0550 V055		550	5870	4380	165.25	140.91		
MVW3000 A0600 V055		600	6410	4770	180.22	153.67		
MVW3000 A0760 V055		760	Upon request	Upon request	Upon request	Upon request	Upon request	2xF5
MVW3000 A0800 V055		800						
MVW3000 A0855 V055		855						
MVW3000 A0950 V055		950						2xG5
MVW3000 A1045 V055		1045						
MVW3000 A1140 V055		1140						

Table 2.8: 6300 V models

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1) HP	Motor rated power(1) kW	Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
MVW3000 A0040 V063	6300	40	490	360	13.66	11.65	12000 CFM 20395 m³/h	A6
MVW3000 A0050 V063		50	610	460	17.22	14.68		
MVW3000 A0060 V063		60	730	550	20.59	17.55		
MVW3000 A0070 V063		70	860	640	23.95	20.43		
MVW3000 A0080 V063		80	980	730	27.51	23.46		B6
MVW3000 A0090 V063		90	1100	820	30.88	26.33		
MVW3000 A0100 V063		100	1220	910	34.43	29.36		
MVW3000 A0110 V063		110	1350	1000	37.62	32.08		
MVW3000 A0125 V063		125	1530	1140	43.04	36.70		
MVW3000 A0140 V063		140	1710	1280	48.10	41.01		
MVW3000 A0160 V063		160	1960	1460	55.02	46.92	16000 CFM 27190 m³/h	C6
MVW3000 A0180 V063		180	2200	1640	61.76	52.66		
MVW3000 A0200 V063		200	2450	1820	68.87	58.72		
MVW3000 A0225 V063		225	2750	2050	77.29	65.91	16800 CFM 28550 m³/h	D6
MVW3000 A0265 V063		265	3240	2420	91.33	77.87		
MVW3000 A0310 V063		310	3790	2830	106.67	90.96		E6
MVW3000 A0340 V063		340	4160	3100	116.97	99.74		
MVW3000 A0400 V063		400	4890	3650	137.55	117.29	22800 CFM 38745 m³/h	F6
MVW3000 A0450 V063		450	5500	4100	154.77	131.97		
MVW3000 A0500 V063		500	6120	4560	171.99	146.65		G6
MVW3000 A0550 V063		550	6730	5010	189.20	161.33		
MVW3000 A0600 V063		600	7340	5470	206.61	176.17		
MVW3000 A0760 V063		760	Upon request	Upon request	Upon request	Upon request	Upon request	2xF6
MVW3000 A0800 V063		800						
MVW3000 A0855 V063		855						
MVW3000 A0950 V063		950						2xG6
MVW3000 A1045 V063		1045						
MVW3000 A1140 V063		1140						

Table 2.9: 6900 V models

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1) HP	Motor rated power(1) kW	Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
MVW3000 A0040 V069	6900	40	540	400	14.97	12.77	12000 CFM 20395 m³/h	A6
MVW3000 A0050 V069		50	670	500	18.71	15.96		
MVW3000 A0060 V069		60	800	600	22.64	19.31		
MVW3000 A0070 V069		70	940	700	26.39	22.50		
MVW3000 A0080 V069		80	1070	800	30.13	25.69		B6
MVW3000 A0090 V069		90	1210	900	33.87	28.88		
MVW3000 A0100 V069		100	1340	1000	37.62	32.08		
MVW3000 A0110 V069		110	1470	1100	41.36	35.27		
MVW3000 A0125 V069		125	1670	1250	46.97	40.05		
MVW3000 A0140 V069		140	1880	1400	52.77	45.00		
MVW3000 A0160 V069		160	2140	1600	60.07	51.22	16000 CFM 27190 m³/h	C6
MVW3000 A0180 V069		180	2410	1800	67.75	57.77		
MVW3000 A0200 V069		200	2680	2000	75.42	64.31		
MVW3000 A0225 V069		225	3010	2250	84.78	72.29	16800 CFM 28550 m³/h	D6
MVW3000 A0265 V069		265	3550	2650	99.75	85.06		
MVW3000 A0310 V069		310	4150	3090	116.78	99.58		E6
MVW3000 A0340 V069		340	4560	3390	128.01	109.15		
MVW3000 A0400 V069		400	5360	3990	150.65	128.46	22800 CFM 38745 m³/h	F6
MVW3000 A0450 V069		450	6030	4490	169.55	144.58		
MVW3000 A0500 V069		500	6700	4990	188.46	160.70		G6
MVW3000 A0550 V069		550	7370	5490	207.36	176.81		
MVW3000 A0600 V069		600	8040	5990	226.07	192.77		
MVW3000 A0760 V069		760	Upon request	Upon request	Upon request	Upon request	Upon request	2xF6
MVW3000 A0800 V069		800						
MVW3000 A0855 V069		855						
MVW3000 A0950 V069		950						2xG6
MVW3000 A1045 V069		1045						
MVW3000 A1140 V069		1140						

***Table 2.10:** 7200 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power[1]		Dissipated power[2] [kW]	Dissipated power[3] [kW]	Flow[4]	Frame size
			HP	kW				
MVW3000 A0040 V072	7200	40	560	420	15.72	13.40	14000 CFM 23790 m^3/h	A7
MVW3000 A0050 V072		50	700	520	19.65	16.76		
MVW3000 A0060 V072		60	840	620	23.39	19.95		
MVW3000 A0070 V072		70	980	730	27.51	23.46		
MVW3000 A0080 V072		80	1120	830	31.44	26.81		B7
MVW3000 A0090 V072		90	1260	940	35.37	30.16		
MVW3000 A0100 V072		100	1400	1040	39.30	33.51		
MVW3000 A0110 V072		110	1540	1150	43.23	36.86		
MVW3000 A0125 V072		125	1750	1300	49.22	41.97		
MVW3000 A0140 V072		140	1960	1460	55.02	46.92		
MVW3000 A0160 V072		160	2240	1670	62.88	53.62	20000 CFM 33985 m^3/h	C7
MVW3000 A0180 V072		180	2520	1870	70.55	60.16		
MVW3000 A0200 V072		200	2800	2080	78.60	67.02		
MVW3000 A0225 V072		225	3150	2340	88.52	75.48	21000 CFM 35685 m^3/h	D7
MVW3000 A0265 V072		265	3700	2760	104.05	88.73		
MVW3000 A0310 V072		310	4330	3230	121.83	103.89		E7
MVW3000 A0340 V072		340	4750	3540	133.62	113.94		
MVW3000 A0400 V072		400	5590	4170	157.20	134.05	24700 CFM 41975 m^3/h	F7
MVW3000 A0450 V072		450	6290	4690	177.04	150.96		
MVW3000 A0500 V072		500	6990	5210	196.69	167.72	26600 CFM 45200 m^3/h	G7
MVW3000 A0550 V072		550	7690	5730	216.15	184.31		
MVW3000 A0600 V072		600	8390	6250	235.80	201.07		

***Table 2.11:** 8000 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power[1]		Dissipated power[2] [kW]	Dissipated power[3] [kW]	Flow[4]	Frame size
			HP	kW				
MVW3000 A0040 V080	8000	40	620	460	17.40	14.84	14000 CFM 23790 m^3/h	A7
MVW3000 A0050 V080		50	780	580	21.71	18.51		
MVW3000 A0060 V080		60	930	690	26.20	22.34		
MVW3000 A0070 V080		70	1090	810	30.50	26.01		
MVW3000 A0080 V080		80	1240	930	35.00	29.84		B7
MVW3000 A0090 V080		90	1400	1040	39.30	33.51		
MVW3000 A0100 V080		100	1550	1160	43.60	37.18		
MVW3000 A0110 V080		110	1710	1270	48.10	41.01		
MVW3000 A0125 V080		125	1940	1450	54.65	46.60		
MVW3000 A0140 V080		140	2170	1620	61.20	52.18		
MVW3000 A0160 V080		160	2490	1850	69.99	59.68	20000 CFM 33985 m^3/h	C7
MVW3000 A0180 V080		180	2800	2080	78.60	67.02		
MVW3000 A0200 V080		200	3110	2310	87.40	74.52		
MVW3000 A0225 V080		225	3500	2600	98.44	83.94	21000 CFM 35685 m^3/h	D7
MVW3000 A0265 V080		265	4120	3070	115.66	98.62		
MVW3000 A0310 V080		310	4820	3590	135.31	115.38		E7
MVW3000 A0340 V080		340	5280	3930	148.59	126.71		
MVW3000 A0400 V080		400	6210	4630	174.79	149.05	24700 CFM 41975 m^3/h	F7
MVW3000 A0450 V080		450	6990	5210	196.69	167.72		
MVW3000 A0500 V080		500	7770	5790	218.59	186.39	26600 CFM 45200 m^3/h	G7
MVW3000 A0550 V080		550	8540	6360	240.29	204.90		
MVW3000 A0600 V080		600	9320	6940	262.19	223.57		

Table 2.12: *9000 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1)		Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
			HP	kW				
MVW3000 A0040 V090	9000	40	700	520	19.65	16.76	16000 CFM 27190 m³/h	A8
MVW3000 A0050 V090		50	870	650	24.52	20.90		
MVW3000 A0060 V090		60	1050	780	29.38	25.05		
MVW3000 A0070 V090		70	1220	910	34.43	29.36		
MVW3000 A0080 V090		80	1400	1040	39.30	33.51		B8
MVW3000 A0090 V090		90	1570	1170	44.17	37.66		
MVW3000 A0100 V090		100	1750	1300	49.22	41.97		
MVW3000 A0110 V090		110	1920	1430	54.08	46.12		
MVW3000 A0125 V090		125	2180	1630	61.20	52.18		
MVW3000 A0140 V090		140	2450	1820	68.87	58.72		
MVW3000 A0160 V090		160	2800	2080	78.60	67.02	22000 CFM 37385 m³/h	C8
MVW3000 A0180 V090		180	3150	2340	88.52	75.48		
MVW3000 A0200 V090		200	3500	2600	98.44	83.94		
MVW3000 A0225 V090		225	3930	2930	110.42	94.15	23100 CFM 39255 m³/h	D8
MVW3000 A0265 V090		265	4630	3450	130.25	111.07		
MVW3000 A0310 V090		310	5420	4040	152.34	129.90		E8
MVW3000 A0340 V090		340	5940	4430	167.12	142.50		
MVW3000 A0400 V090		400	6990	5210	196.69	167.72	30400 CFM 51660 m³/h	F8
MVW3000 A0450 V090		450	7860	5860	221.02	188.46		
MVW3000 A0500 V090		500	8740	6510	245.72	209.53		G8
MVW3000 A0550 V090		550	9610	7160	270.42	230.59		
MVW3000 A0600 V090		600	10490	7810	294.94	251.50		

Table 2.13: *10000 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1)		Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
			HP	kW				
MVW3000 A0040 V100	10000	40	780	580	21.71	18.51	18000 CFM 30590 m³/h	A9
MVW3000 A0050 V100		50	970	720	27.32	23.30		
MVW3000 A0060 V100		60	1170	870	32.75	27.93		
MVW3000 A0070 V100		70	1360	1010	38.18	32.55		
MVW3000 A0080 V100		80	1550	1160	43.60	37.18		B9
MVW3000 A0090 V100		90	1750	1300	49.22	41.97		
MVW3000 A0100 V100		100	1940	1450	54.65	46.60		
MVW3000 A0110 V100		110	2140	1590	60.07	51.22		
MVW3000 A0125 V100		125	2430	1810	68.31	58.25		
MVW3000 A0140 V100		140	2720	2030	76.54	65.27		
MVW3000 A0160 V100		160	3110	2310	87.40	74.52	22000 CFM 37385 m³/h	C9
MVW3000 A0180 V100		180	3500	2600	98.44	83.94		
MVW3000 A0200 V100		200	3880	2890	109.11	93.03		
MVW3000 A0225 V100		225	4370	3250	122.77	104.68	25200 CFM 42825 m³/h	D9
MVW3000 A0265 V100		265	5150	3830	144.66	123.35		
MVW3000 A0310 V100		310	6020	4480	169.37	144.42		E9
MVW3000 A0340 V100		340	6600	4920	185.65	158.30		
MVW3000 A0400 V100		400	7770	5790	218.59	186.39	34200 CFM 58115 m³/h	F9
MVW3000 A0450 V100		450	8740	6510	245.72	209.53		
MVW3000 A0500 V100		500	9710	7230	273.04	232.82		G9
MVW3000 A0550 V100		550	10680	7960	300.37	256.12		
MVW3000 A0600 V100		600	11650	8680	327.88	279.58		

Table 2.14: *11000 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1)		Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
			HP	kW				
MVW3000 A0040 V110	11000	40	850	640	23.95	20.43	18000 CFM 30590 m³/h	A10
MVW3000 A0050 V110		50	1070	800	29.94	25.53		
MVW3000 A0060 V110		60	1280	950	35.93	30.64		
MVW3000 A0070 V110		70	1500	1110	42.11	35.91		
MVW3000 A0080 V110		80	1710	1270	48.10	41.01		B10
MVW3000 A0090 V110		90	1920	1430	54.08	46.12		
MVW3000 A0100 V110		100	2140	1590	60.07	51.22		
MVW3000 A0110 V110		110	2350	1750	66.06	56.33		
MVW3000 A0125 V110		125	2670	1990	74.86	63.83		
MVW3000 A0140 V110		140	2990	2230	84.22	71.81		
MVW3000 A0160 V110		160	3420	2550	96.19	82.02	26000 CFM 44185 m³/h	C10
MVW3000 A0180 V110		180	3840	2860	107.98	92.08		
MVW3000 A0200 V110		200	4270	3180	120.15	102.45		
MVW3000 A0225 V110		225	4810	3580	135.12	115.22	29400 CFM 49960 m³/h	D10
MVW3000 A0265 V110		265	5660	4220	159.26	135.80		
MVW3000 A0310 V110		310	6620	4930	186.21	158.78		E10
MVW3000 A0340 V110		340	7260	5410	204.36	174.26		
MVW3000 A0400 V110		400	8540	6360	240.29	204.90	38000 CFM 64575 m³/h	F10
MVW3000 A0450 V110		450	9610	7160	270.42	230.59		
MVW3000 A0500 V110		500	10680	7960	300.37	256.12		G10
MVW3000 A0550 V110		550	11750	8750	330.50	281.82		
MVW3000 A0600 V110		600	12820	9550	360.63	307.51		

Table 2.15: *12000 V models*

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1)		Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
			HP	kW				
MVW3000 A0040 V120	12000	40	930	690	26.20	22.34	20000 CFM 33985 m³/h	A11
MVW3000 A0050 V120		50	1170	870	32.75	27.93		
MVW3000 A0060 V120		60	1400	1040	39.30	33.51		
MVW3000 A0070 V120		70	1630	1220	45.85	39.10		
MVW3000 A0080 V120		80	1860	1390	52.40	44.68		B11
MVW3000 A0090 V120		90	2100	1560	58.95	50.27		
MVW3000 A0100 V120		100	2330	1740	65.50	55.85		
MVW3000 A0110 V120		110	2560	1910	72.05	61.44		
MVW3000 A0125 V120		125	2910	2170	81.97	69.90		
MVW3000 A0140 V120		140	3260	2430	91.89	78.35		
MVW3000 A0160 V120		160	3730	2780	104.99	89.52	28000 CFM 47580 m³/h	C11
MVW3000 A0180 V120		180	4190	3120	117.90	100.53		
MVW3000 A0200 V120		200	4660	3470	131.00	111.70		
MVW3000 A0225 V120		225	5240	3910	147.47	125.75	33600 CFM 57095 m³/h	D11
MVW3000 A0265 V120		265	6170	4600	173.67	148.09		
MVW3000 A0310 V120		310	7220	5380	203.24	173.30		E11
MVW3000 A0340 V120		340	7920	5900	222.70	189.90		
MVW3000 A0400 V120		400	9320	6940	262.19	223.57	41800 CFM 71030 m³/h	F11
MVW3000 A0450 V120		450	10490	7810	294.94	251.50		
MVW3000 A0500 V120		500	11650	8680	327.88	279.58		G11
MVW3000 A0550 V120		550	12820	9550	360.63	307.51		
MVW3000 A0600 V120		600	13980	10420	393.38	335.43		

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Table 2.16: 13200 V models

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1) HP	Motor rated power(1) kW	Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
MVW3000 A0040 V132	13200	40	1030	760	28.82	24.58	22000 CFM 37385 m³/h	A12
MVW3000 A0050 V132		50	1280	950	35.93	30.64		
MVW3000 A0060 V132		60	1540	1150	43.23	36.86		
MVW3000 A0070 V132		70	1790	1340	50.34	42.93		
MVW3000 A0080 V132		80	2050	1530	57.45	48.99		B12
MVW3000 A0090 V132		90	2310	1720	64.94	55.37		
MVW3000 A0100 V132		100	2560	1910	72.05	61.44		
MVW3000 A0110 V132		110	2820	2100	79.35	67.66		
MVW3000 A0125 V132		125	3200	2390	90.20	76.92		
MVW3000 A0140 V132		140	3590	2670	100.87	86.01		
MVW3000 A0160 V132		160	4100	3060	115.47	98.46	28000 CFM 47580 m³/h	C12
MVW3000 A0180 V132		180	4610	3440	129.69	110.59		
MVW3000 A0200 V132		200	5130	3820	144.10	122.88		
MVW3000 A0225 V132		225	5770	4300	162.25	138.35	33600 CFM 57095 m³/h	D12
MVW3000 A0265 V132		265	6790	5060	190.89	162.77		
MVW3000 A0310 V132		310	7950	5920	223.64	190.70		E12
MVW3000 A0340 V132		340	8710	6490	245.16	209.05		
MVW3000 A0400 V132		400	10250	7640	288.39	245.91	45600 CFM 77490 m³/h	F12
MVW3000 A0450 V132		450	11530	8590	324.51	276.71		
MVW3000 A0500 V132		500	12820	9550	360.63	307.51		G12
MVW3000 A0550 V132		550	14110	10500	396.75	338.31		
MVW3000 A0600 V132		600	15380	11460	432.87	369.10		

Table 2.17: 13800 V models

Models	Nominal voltage [V]	Rated current [A]	Motor rated power(1) HP	Motor rated power(1) kW	Dissipated power(2) [kW]	Dissipated power(3) [kW]	Flow(4)	Frame size
MVW3000 A0040 V138	13800	40	1070	800	30.13	25.69	22000 CFM 37385 m³/h	A12
MVW3000 A0050 V138		50	1340	1000	37.62	32.08		
MVW3000 A0060 V138		60	1610	1200	45.29	38.62		
MVW3000 A0070 V138		70	1880	1400	52.77	45.00		
MVW3000 A0080 V138		80	2140	1600	60.07	51.22		B12
MVW3000 A0090 V138		90	2410	1800	67.75	57.77		
MVW3000 A0100 V138		100	2680	2000	75.42	64.31		
MVW3000 A0110 V138		110	2950	2200	82.72	70.53		
MVW3000 A0125 V138		125	3350	2500	94.13	80.27		
MVW3000 A0140 V138		140	3750	2790	105.55	90.00		
MVW3000 A0160 V138		160	4290	3190	120.52	102.77	28000 CFM 47580 m³/h	C12
MVW3000 A0180 V138		180	4820	3590	135.68	115.69		
MVW3000 A0200 V138		200	5360	3990	150.65	128.46		
MVW3000 A0225 V138		225	6030	4490	169.55	144.58	33600 CFM 57095 m³/h	D12
MVW3000 A0265 V138		265	7100	5290	199.68	170.27		
MVW3000 A0310 V138		310	8310	6190	233.56	199.15		E12
MVW3000 A0340 V138		340	9110	6790	256.20	218.46		
MVW3000 A0400 V138		400	10720	7990	301.49	257.08	45600 CFM 77490 m³/h	F12
MVW3000 A0450 V138		450	12060	8980	339.29	289.32		
MVW3000 A0500 V138		500	13400	9980	376.91	321.39		G12
MVW3000 A0550 V138		550	14740	10980	414.71	353.63		
MVW3000 A0600 V138		600	16080	11980	452.33	385.70		

(1) The motor powers are only illustrative, and the correct inverter selection must be done as a function of the rated current of the motor to be used, as well as the overloads related to the application.
Derating factors can be applied as a result of operation in altitude (over 1000m), extreme temperatures (over 40°C) or low output frequencies (under 10Hz).
The motor rated output takes into account the operation with 0.87 power factor and 97% efficiency at full load;
(2) Dissipated power considering a transformer with aluminum winding and operation under the conditions of note (1).
The dissipated power with the filter is obtained with the multiplication by 1.002597;
(3) Dissipated power considering a transformer with copper winding and operation under the conditions of note (1).
The dissipated power with the filter is obtained with the multiplication by 1.002597;
(4) Reference values. Practical values depend on the final project.

NOTES:
1 hp = 0,746 kW
1 kW = 3412.14 BTU/hour for the dissipated power.
1 m^3/h = 0,5885 CFM

Figure 2.2: *MVW3000 panel general view (Frame B10)*

3 PRODUCT CHARACTERISTICS

A brief theoretical explanation about the operation of the MVW3000 and a simplified electrical diagram of the power cells and their connections are shown below. At the end, the basic operation of the control system is described.

The MVW3000 is a frequency inverter designed to control medium voltage motors at rated values of 1.15 kV to 13,8 kV and for a power range from 85 HP to 16215 HP (for other models, see **www.weg.net**). Based on a topology where low voltage cells (< 1000 V) are connected in series to form each inverter phase, its modular assembly allows different configurations if it is necessary to drive high power motors.

NOTE!
The characteristics described in this manual are based on standard MVW3000 models to be applied on 6.6 kV motors. Therefore, the MVW3000 used in the general illustrations will contain 18 low voltage power cells (six in series per phase). Notice that the MVW3000 can be engineered to meet the needs and technical specifications of our customers. Contact out technical team for more details.

3.1 INPUT TRANSFORMER

The MVW3000 inverter has an input transformer, because the cascade cell topology demands the feeding of each cell to be insulated from each other. This transformer is built so as to meet the different functions for the MVW3000, such as the necessary insulation for the power cells, cancellation of the harmonic current coming from the cell input rectifiers, and it also has an auxiliary winding responsible for the system pre-charge.

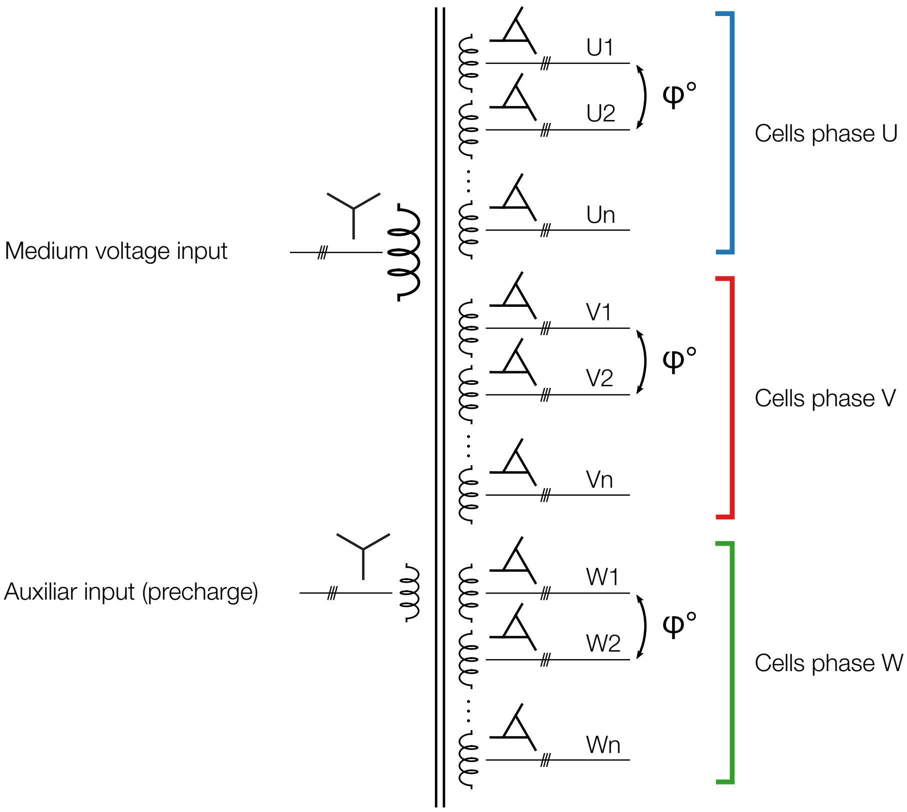


Figure 3.1: *Input phase-shifting transformer diagram*

The transformer configuration is extended star – delta, with phase-shifting angles $\varphi°$ between the secondary windings of the same phase. The main primary windings (star connection) and the auxiliary input windings (also star) do not present phase shifting between each other.

The transformer is designed according to the number of cells used on the inverter. 3x3xn windings (number of motor phases x number of cell input phases x number of cells per phase) form n isolated secondary windings that process 1/(3n) of the converter rated power, totalizing one secondary winding per cell.
The number of secondary windings depends on the number of cells. The Table 3.1 on page 3-2 shows the number of secondary windings of the main transformer needed to feed the cells.

Table 3.1: *Number of isolated secondary windings per voltage level*

Output voltage [kV]	1.15	2.3	3.3	4.16	5.5-6	6.3-6.9	7.2-8	9	10	11	12	13.2-13.8
Secondary windings quantity	3	6	9	12	15	18	21	24	27	30	33	36

3

The transformer secondary windings have phase-shifting designed according to the number of cells and the specified harmonic level, and it may be engineered upon the customer's request. The phase-shifting helps cancel the harmonic components coming from the non-controlled semiconductor devices. As each cell has a 6-pulse diode rectifier at the input, and the secondary windings have a phase-shifting between each other, the transformer primary winding perceives multiples of six in its windings.

The bigger the number of pulses, the smaller the phase-shifting angle between the secondary windings, and the smaller the harmonic distortion rate observed by the transformer primary winding. Smaller phase-shifting angles imply more complex manufacture and parameter control of the transformer. Thus, a good complexity-performance ratio is sought.

For the 18-cell MVW3000, the 36-pulse transformer is used, offering good cost effectiveness with great performance regarding harmonic component cancellation and lower cost in comparison to transformers with more pulses.

Table 3.2 on page 3-2 contains the possible configurations of the input transformer for different numbers of cells installed on the panel of the MVW3000.

Table 3.2: *Number of pulses that can be obtained in relation to the number of cells*

Motor voltage	Cells per phase	Total cells	Default number of pulses	Number of redundant pulses N + 1
1150 V	1	3	18(1)	36(1), 18
2300 V	2	6	36(1), 18	54, 18(1)
3300 V	3	9	54 ,18(1)	72, 36, 24(1)
4160 V	4	12	72, 36, 24(1)	90, 30(1)
5500-6000 V	5	15	90, 30(1)	108, 54, 36(1)
6300-6900 V	6	18	108, 54, 36(1)	126, 42(1)
7200-8000 V	7	21	126, 42(1)	144, 72, 48(1)
9000 V	8	24	144, 72, 48(1)	162, 54(1)
10000 V	9	27	162, 54(1)	180, 90, 60(1)
11000 V	10	30	180, 90, 60(1)	180, 90, 60(1)
12000 V	11	33	198, 66(1)	216, 108, 72(1)
13200-13800 V	12	36	216, 108, 72(1)	216, 108, 72(2)

(1) Default option;
(2) Cell redundancy (N + 1) only for model 13200 V, model 13800 V, without redundancy.

Figure 3.2 on page 3-3 shows the connection points for the power cell inputs, in this case phases R, S and T. The windings, with a rated voltage of 690 or 710 Vrms process 1/18 of the inverter rated power, in the case of the 18-cell MVW3000 .

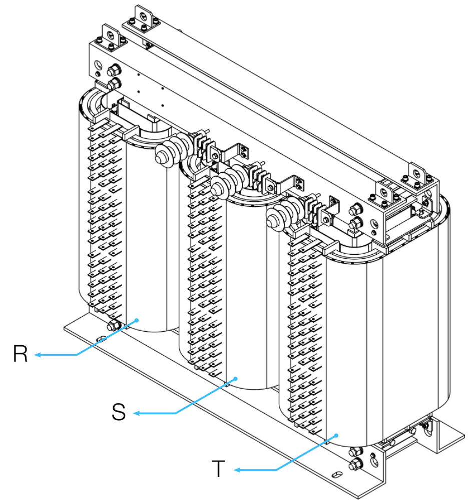


Figure 3.2: *Input transformer of the 18-cell MVW3000 (frame B6)*

The cells that form the U, V and W phases are physically connected to the main transformer, as shown in Figure 3.3 on page 3-3. Depending on the model, these connections may vary. For further information, see the specific design.

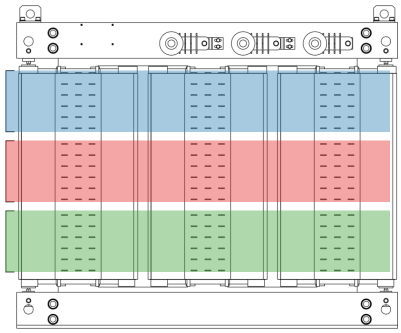


Figure 3.3: *Cell connection area of each phase*

The transformer has its own panel, being fully integrated to the MVW3000. For more details on the panels, see Chapter 4 TECHNICAL DATA on page 4-1, Figure 4.3 on page 4-3 and tables Table 4.2 on page 4-3 to Table 4.16 on page 4-6.

3.2 POWER CELLS

The power cells used in the arms of the MVW3000, are single-phase low voltage inverters (output voltage 690 or 710 Vrms), in a topology known as H bridge or full bridge. A basic diagram of the power cell circuit can be seen in Figure 3.4 on page 3-4. Each cell has its own main transformer secondary winding (three-phase) power supply, which ensures the medium voltage isolation of the inverter.

The input three-phase voltages of the modules are then rectified by a Graetz bridge using non-controlled semiconductor devices (diodes), forming an own DC link (direct current) with the addition of the capacitors to the cell (represented by symbol C1).

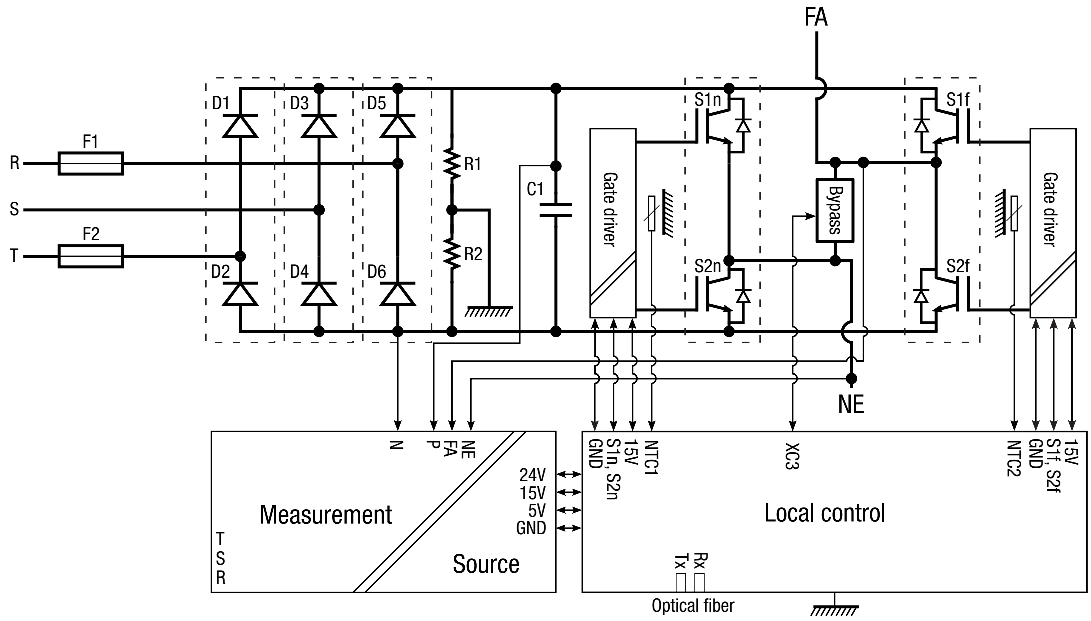


Figure 3.4: *Basic diagram of a power cell*

IGBT (Insulated Bipolar Gate Transistor) controlled semiconductor devices are used to implement the inverter H bridge; thus, each power cell has four IGBTs in the configuration shown above. During operation, the voltage between FA and NE output terminals has three possible voltage levels. Considering that the DC link voltage of each cell is Vdc and that only two IGBTs can be operating simultaneously (due to short circuit protection, the two IGBTs of each arm cannot be conducting simultaneously), when S1f and S2n are operating, the voltage between FA and NE will be +Vdc, whereas if S1n and S2f start operating, the voltage between FA and NE will be –Vdc. If S1n and S1f or S2n and S2f are turned on, the voltage, in both cases, will be equal to zero.

To protect the modules, two fuses (F1 and F2) are connected to the input of phases R and T, as shown in Figure 3.4 on page 3-4. In case a module presents some fault, the bypass system, when available, will be responsible for circumventing the fault, removing it from the series and allowing the operation to continue.

When that occurs, control strategies will be applied so that the load remains operating. For further information, see Chapter 8 SPECIAL FUNCTIONS on page 8-1 in Section 8.3 CELL BYPASS on page 8-5.

Each power cell has one local control module. This module communicates with the main control module by means of an fiber optic interface, necessary to obtain – in addition to the insulation degree required for the communication – noise immunity, greater robustness and reliability, which are necessary characteristics for the application. The local control makes acquisitions and monitors relevant magnitudes for the cell operation.

Some of the monitored magnitudes are the income line voltages of the power cell, temperature of the diode modules and IGBTs, voltage of the DC link capacitors, voltage of the cell power supplies, among others.

The local control is also responsible for local drives, such as the switching of the IGBTs and the triggering of the bypass system. In case the cell presents readings out of the expected operation standards, for example, temperatures close to damaging the semiconductors, overvoltage on the DC link, or other faults monitored by the control, the bypass system may be activated for protection against a possible cell failure or for the removal of a damaged cell from operation.

3.3 CELL CONNECTION

To form a three-phase output, a number "n" of power cells, operating at 690 or 710 "Vrms, are grouped in series per phase. The cell sets that represent phases U, V and W are connected in star, with a floating neutral common to the phases, as indicated in Figure 3.5 on page 3-5

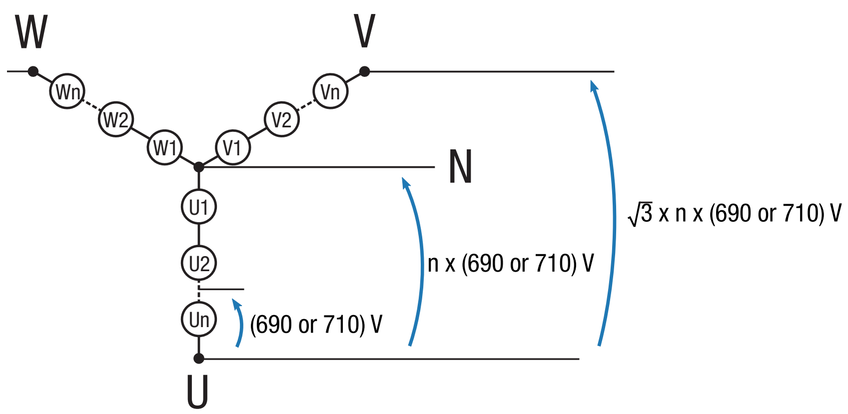


Figure 3.5: *Cell-to-phase connection diagram*

Figure 3.6 on page 3-5 shows the transformer, the input switchgear and the secondary winding connected to each cell. This association in series of the power cells allows obtaining more voltage levels at the inverter output. Locally, each cell produces three voltage levels; however, at the inverter three-phase output, it is possible to obtain 2n+1 levels on the phase voltage and 4n + 1 levels on the line voltage.

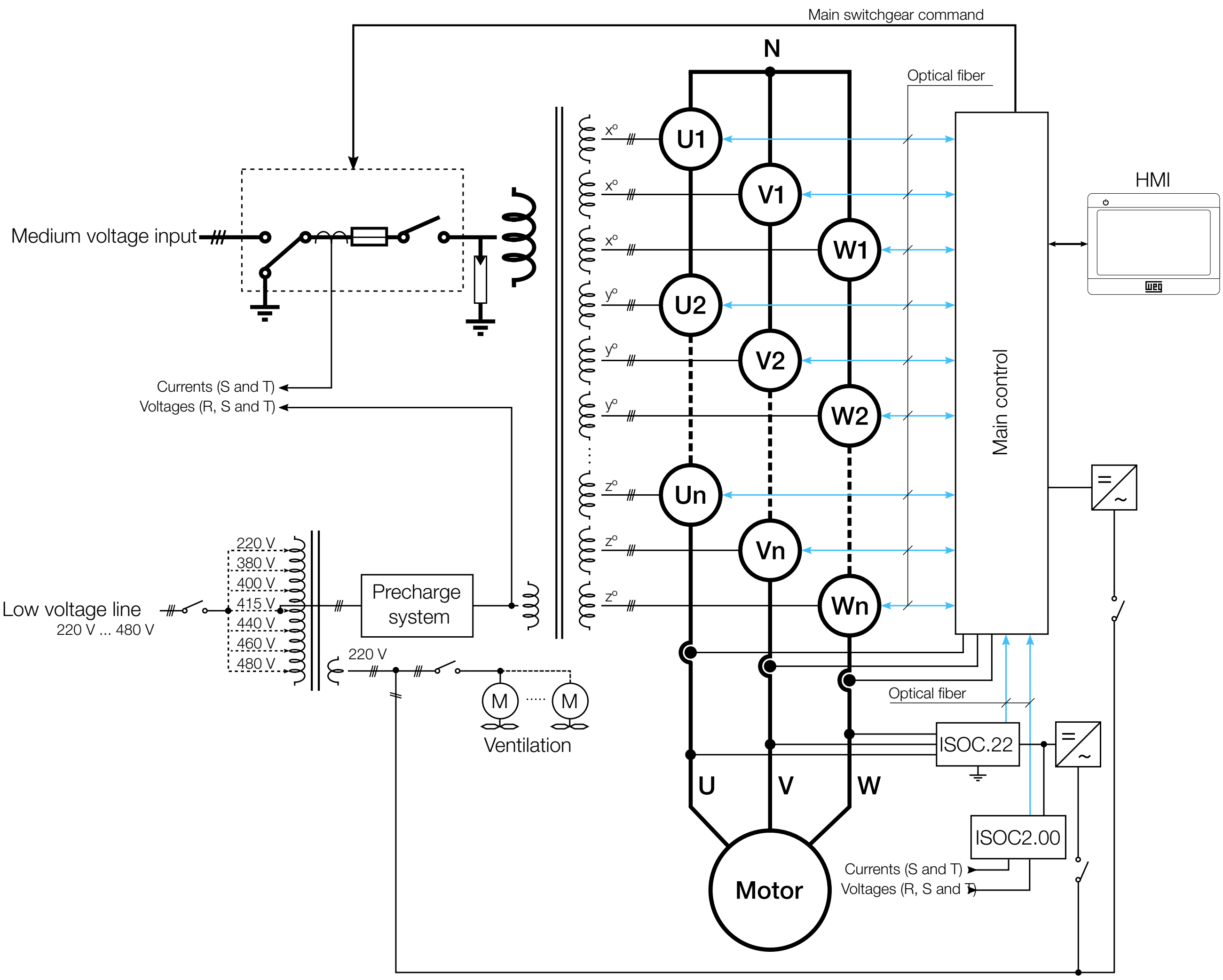


Figure 3.6: *MVW3000 simplified diagram for n power cells*

This effect occurs, because the voltage of each phase is instantaneously given by the addition of the voltages at terminals FA and NE of each cell pertaining to the analyzed phase. Figure 3.7 on page 3-6 illustrates the sum of the voltages of each cell to form the phase voltage in one 9-cell MVW3000 (3 per phase).

Therefore, increasing the number o cells per phase, in addition to allowing driving motors with higher voltages and powers, provides a better sinusoidal shaped wave. Thus, the converter provides a smaller THD (total harmonic distortion) rate and lower noise and vibration levels on the motor, operating with high efficiency.

Figure 3.6 on page 3-5 also shows the medium voltage input switchgear, the low voltage auxiliary winding to pre-charge the capacitors of the cells and the fiber optic interface between the main control and the local control of the power cells.

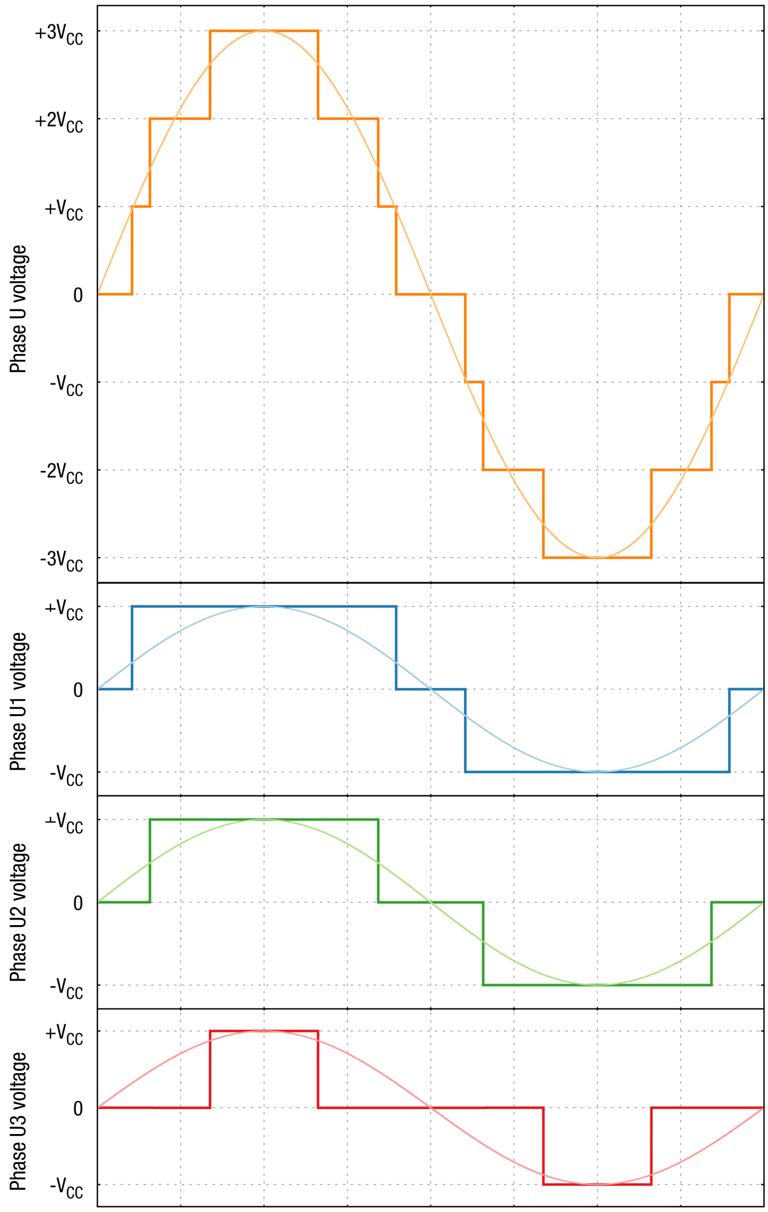


Figure 3.7: *Wave form of the phase voltage for a CHB of 3 cells per phase*

3.4 CONTROL

The MVW3000 has protections against overload, short circuit, current limitation, under and overvoltage, overtemperature, ground fault and monitoring of the individual faults of each power cell. The control type can be selected by the user between: scalar control (constant V/f ratio) or vector control (sensorless or with feedback by speed sensor).

The MVW3000 inverter uses the PWM modulation technique (Pulse Width Modulation); from the direct voltage of each independent DC links, it synthesizes an alternate voltage with variable frequency and amplitude at the output terminals. The medium voltage level is obtained at the inverter output terminals with the association of "n" low voltage cells in series.

For further information on the central control, see Section 4.3 CONTROL RACK on page 4-9.

3

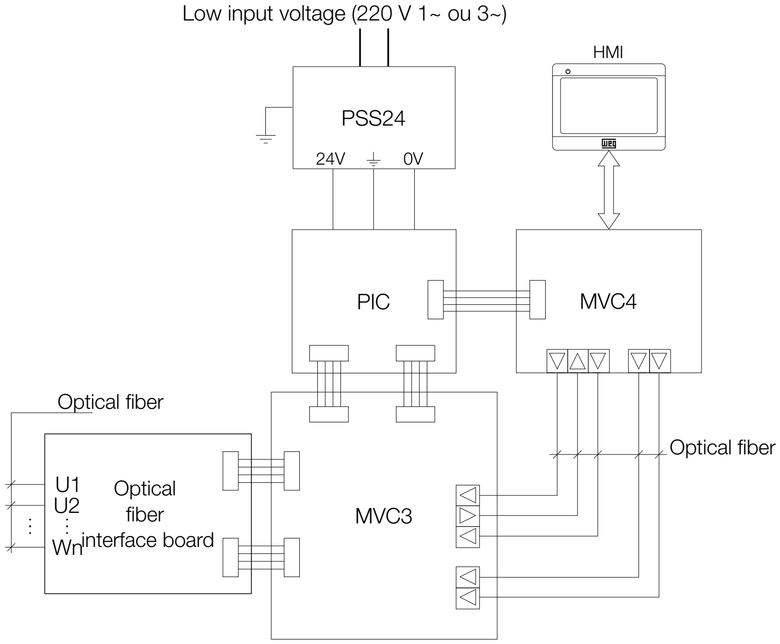


Figure 3.8: *Central control simplified diagram*

The output currents of the three phases (motor currents) are measured using the Hall-effect CTs (current transformers). Those current signals are sent to the central control board. The measurement is done to be displayed on the HMI and to implement the inverter control and protection functions.

The pre-charge is carried out by means of a current limiting system and an auxiliary winding of the input transformer, which is activated at the start of the MVW3000. In order to prevent high starting current levels on the inverter, activation of protection systems or even damages to its own components, the cell capacitors must be pre-charged through and auxiliary winding of the input transformer. The auxiliary power supply also feeds the control circuit and the panel cooling fans.

4 TECHNICAL DATA

This chapter contains technical information on the MVW3000, details on the panel, input transformer, power and control cells. In addition, further information is provided about the output filters available for the MVW3000.
The MVW3000 complies with the international standards, such as harmonic limits, contained in IEEE-519 and G5/4-1 standards, and also electromagnetic emission limits (EMC), contained in IEC61800-3 standard.

4.1 MVW3000 PANEL

The MVW3000 is assembled as coupled panels forming distinct compartments. These compartments consist of one or more columns for power cells, one or more columns for transformers and, optionally, for the input safety devices, such as fuses and the input circuit breaker/contactor. There are also models in which a transformer is placed together with the power cells. The panel column contains the control boards and user interface. An example for the MVW3000 is illustrated in Figure 4.1 on page 4-1 with the doors closed and in Figure 4.2 on page 4-2 with the doors open, where a MVW3000 with frame B10 is shown.

4

Figure 4.1: *Closed panel of the 30-cell MVW3000 (Frame B10)*

The medium voltage cables that feed the inverter cells come from the secundaries of the input transformer. The number of cables and conductor diameter varies according to the number and current of the cells installed on the MVW3000.

Each cell receives the input supply from an independent secondary winding insulated from the main transformer. The control compartment is in the upper compartment of the right panel, housing the main control, user interface, HMI, command and signaling, which are exclusively powered by low voltage circuits.

The inverter three-phase medium voltage output is located in the compartment below the control, and such compartment can also be used to install optional output filters.

The standard panels of the models equipped with input protection and drive systems feature medium voltage fuses to protect the system against short circuit. The fuses must match the rated voltage of the input medium voltage circuit.

Table 4.1 on page 4-2 lists the fuse models recommended for the standard inverters where the input and output voltage are the same; for applications in which the input and output voltage values are different, the fuse model will be informed upon request.

Table 4.1: *Recommended fuses*

Inverter Rated Current (A)	Fuse
40 - 60	3R
70 - 100	5R
110 - 160	12R
180 - 310	18R
340	24R
> 340	On request(*)

(*) For currents above 340 A the use of input switchgear with protection relay is recommended.

The standard panels supplied for the MVW3000 are suitable to be connected to medium voltage circuits capable of providing a maximum short-circuit current to meet the installation requirements and informed in the specific design and on the product nameplate.

For requirements above such short circuit capacity, the product will be supplied in a special panel according to the application. For further details, consult WEG.

4.1.1 Panel Constructive Aspects

The panel is made with steel sheets painted and processed (cut, drilled, bent, chemically treated, painted and finished) by WEG or accredited manufacturers, ensuring quality in every step of the manufacturing process. The inverter parts that are not painted are zinc plated or have another suitable treatment in order to assure their resistance against corrosion.

Figure 4.2: *Panel of the 30-cell MVW3000 (frame B10)*

The MVW3000 panel can be supplied with different protection ratings, such as IP21, IP41, IP42 or others, according to the requirements of the installation environment, the specifications and the customer's needs.

The panel is cooled by forced convection. Air enters through the louvers positioned on the front doors of the panel, passes through the windings of the transformer and also through the power sinks located in each of the power cells. The hot air is exhausted from the top of the panel, where the fans are installed, enabling maintenance without opening the inverter doors.

Filter cleaning or replacement can be done by removing the external grid with no need to open the doors and to interrupt the inverter operation. The internal grid with openings smaller than 10 mm,prevents the access to the medium voltage compartment.

The medium voltage compartments (input rectifier and inverter) are mechanically and electrically interlocked in order to prevent the access to all the components that are able to present electric shock danger. Only after closing the transformer and inverter panel doors it is possible to open the grounding system and close the input switch disconnector. For inverter models that do not have integrated input switchgear, it is recommended that the customer implement an interlocking system between the switchgear and the master switch provided by the inverter.

Figure 4.3 on page 4-3 shows an example of the MVW3000 design with the dimensions listed in tables Table 4.2 on page 4-3 to Table 4.16 on page 4-6.

In case the doors are unlocked, the inverter will prevent the operation and turn off the input circuit breaker. The control panel is powered by an auxiliary three-phase supply (220 V – 480 V) that can be locked to prevent its activation.

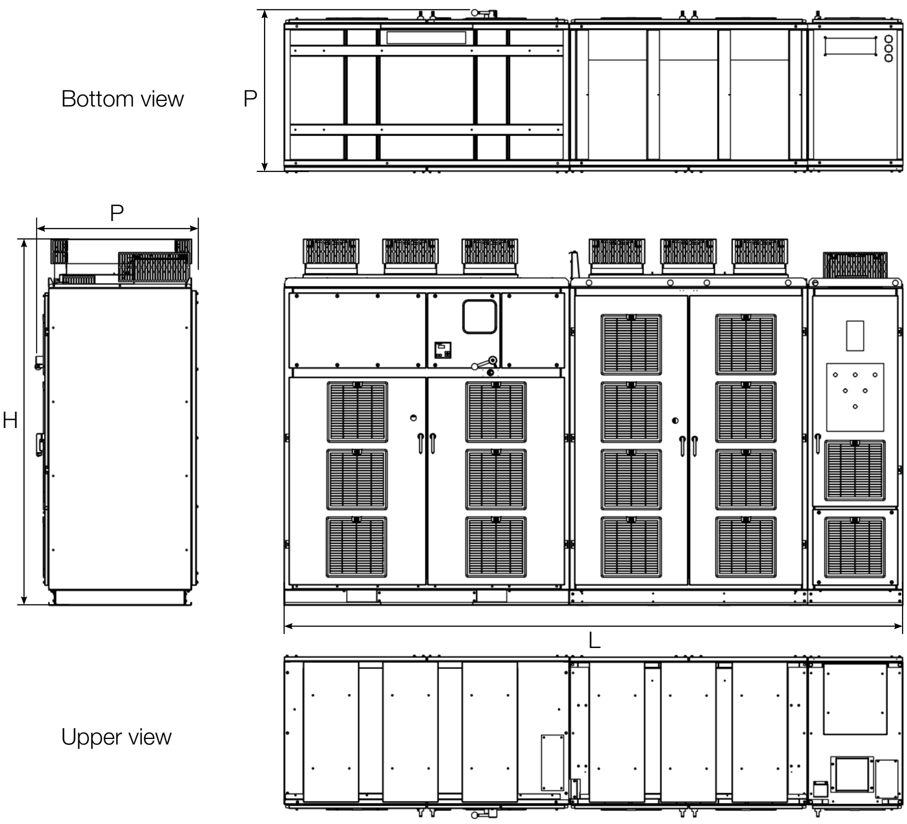


Figure 4.3: *Panel Constructive Aspects*

Tables Table 4.2 on page 4-3 to Table 4.16 on page 4-6 list the physical size and mass of the panels for the highest current that each respective frame withstands.
It is worth mentioning that the dimensions may vary according to the input voltage and output voltage.

Table 4.2: *Available frame sizes for the MVW3000 of 1150 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A1	2400	2405	1220	1500
B1				1800
C1				2100
D1	2600		1320	2450
E1				2800
F1	3900	2640	1620	3400
G1				4050
2xF1	Upon request	Upon request	Upon request	Upon request
2xG1				

Table 4.3: Available frame sizes for the MVW3000 of 2300 V and respective panel values

<table>
<tr><th>Frame size</th><th>L(*) [mm]</th><th>H(*) [mm]</th><th>P(*) [mm]</th><th>Weight(*) [kg]</th></tr>
<tr><td>A2</td><td rowspan="3">2400</td><td rowspan="5">2405</td><td rowspan="3">1220</td><td>1900</td></tr>
<tr><td>B2</td><td>2500</td></tr>
<tr><td>C2</td><td>3150</td></tr>
<tr><td>D2</td><td rowspan="2">2600</td><td rowspan="2">1320</td><td>3800</td></tr>
<tr><td>E2</td><td>4500</td></tr>
<tr><td>F2</td><td>3900</td><td rowspan="2">2640</td><td rowspan="2">1620</td><td>6450</td></tr>
<tr><td>G2</td><td>4100</td><td>7750</td></tr>
<tr><td>2xF2</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td></tr>
<tr><td>2xG2</td></tr>
</table>

Table 4.4: Available frame sizes for the MVW3000 of 3300 V and respective panel values

<table>
<tr><th>Frame size</th><th>L(*) [mm]</th><th>H(*) [mm]</th><th>P(*) [mm]</th><th>Weight(*) [kg]</th></tr>
<tr><td>A3</td><td rowspan="3">3900/3500(1)</td><td rowspan="5">2405</td><td rowspan="3">1220</td><td>2850</td></tr>
<tr><td>B3</td><td>3800</td></tr>
<tr><td>C3</td><td>4650</td></tr>
<tr><td>D3</td><td rowspan="2">4400/3900(1)</td><td rowspan="2">1320</td><td>5800</td></tr>
<tr><td>E3</td><td>6850</td></tr>
<tr><td>F3</td><td>4600</td><td rowspan="2">2665</td><td rowspan="2">1620</td><td>8500</td></tr>
<tr><td>G3</td><td>5000</td><td>10450</td></tr>
<tr><td>2xF3</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td></tr>
<tr><td>2xG3</td></tr>
</table>

(1) Dimentions of MVW3000 G2 series.

Table 4.5: Available frame sizes for the MVW3000 of 4160 V and respective panel values

<table>
<tr><th>Frame size</th><th>L(*) [mm]</th><th>H(*) [mm]</th><th>P(*) [mm]</th><th>Weight(*) [kg]</th></tr>
<tr><td>A4</td><td rowspan="3">3900/3500(1)</td><td rowspan="4">2405</td><td rowspan="3">1220</td><td>3150</td></tr>
<tr><td>B4</td><td>4350</td></tr>
<tr><td>C4</td><td>5450</td></tr>
<tr><td>D4</td><td rowspan="2">4400/3900(1)</td><td rowspan="2">1320</td><td>6800</td></tr>
<tr><td>E4</td><td>2625</td><td>8150</td></tr>
<tr><td>F4</td><td>5200</td><td rowspan="2">2665</td><td rowspan="2">1620</td><td>10250</td></tr>
<tr><td>G4</td><td>5600</td><td>12750</td></tr>
<tr><td>2xF4</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td></tr>
<tr><td>2xG4</td></tr>
</table>

(1) Dimentions of MVW3000 G2 series.

Table 4.6: Available frame sizes for the MVW3000 of 5500 V and respective panel values

<table>
<tr><th>Frame size</th><th>L(*) [mm]</th><th>H(*) [mm]</th><th>P(*) [mm]</th><th>Weight(*) [kg]</th></tr>
<tr><td>A5</td><td rowspan="3">3900</td><td rowspan="4">2405</td><td rowspan="3">1220</td><td>3650</td></tr>
<tr><td>B5</td><td>5200</td></tr>
<tr><td>C5</td><td>6600</td></tr>
<tr><td>D5</td><td rowspan="2">4600</td><td rowspan="2">1320</td><td>8400</td></tr>
<tr><td>E5</td><td>2625</td><td>10050</td></tr>
<tr><td>F5</td><td rowspan="2">5950</td><td rowspan="2">2665</td><td rowspan="2">1620</td><td>12850</td></tr>
<tr><td>G5</td><td>16200</td></tr>
<tr><td>2xF5</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td><td rowspan="2">Upon request</td></tr>
<tr><td>2xG5</td></tr>
</table>

Table 4.7: *Available frame sizes for the MVW3000 of 6300 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A6	3900	2405	1220	3900
B6	3900	2405	1220	5700
C6	3900	2405	1220	7350
D6	4600	2405	1320	9350
E6	4800	2625	1320	11300
F6	6300	2665	1620	14550
G6	6600	2665	1620	18350
2xF6	Upon request	Upon request	Upon request	Upon request
2xG6	Upon request	Upon request	Upon request	Upon request

Table 4.8: *Available frame sizes for the MVW3000 of 6900 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A6	3900	2405	1220	4050
B6	3900	2405	1220	6050
C6	3900	2405	1220	7800
D6	4600	2405	1320	10000
E6	4800	2625	1320	12100
F6	6300	2640	1620	15650
G6	6600	2640	1620	19700
2xF6	Upon request	Upon request	Upon request	Upon request
2xG6	Upon request	Upon request	Upon request	Upon request

Table 4.9: *Available frame sizes for the MVW3000 of 7200 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A7	4700	2405	1220	5450
B7	4700	2405	1220	7500
C7	4900	2405	1220	9350
D7	5600	2405	1320	11750
E7	5900	2625	1320	14000
F7	8000	2640	1620	17750
G7	10500	2640	1620	22050

Table 4.10: *Available frame sizes for the MVW3000 of 8000 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A7	4700	2405	1220	5700
B7	4700	2405	1220	7950
C7	4900	2405	1220	10000
D7	5600	2405	1320	12600
E7	5900	2625	1320	15100
F7	8000	2640	1620	19100
G7	10500	2640	1620	23950

Table 4.11: *Available frame sizes for the MVW3000 of 9000 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A8	5600	2405	1220	6000
B8	5800	2405	1220	8600
C8	6000	2405	1220	10900
D8	6900	2405	1320	13850
E8	6900	2625	1320	16550
F8	10850	2640	1620	21150
G8	10850	2640	1620	26550

Table 4.12: *Available frame sizes for the MVW3000 of 10000 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A9	5600	2405	1320	6350
B9	5800			9200
C9	6000			11850
D9	8000			15050
E9	8400	2625		18050
F9	11200	2640	1620	23200
G9				29200

Table 4.13: *Available frame sizes for the MVW3000 of 11000 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A10	5600	2405	1320	6750
B10	5800			9800
C10	6000			12700
D10	8400			16250
E10	8800	2625		19550
F10	11800	2640	1620	25150
G10				31750

Table 4.14: *Available frame sizes for the MVW3000 of 12000 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A11	5600	2500	1320	7050
B11	6300			10500
C11				13650
D11	8400			17400
E11	8800	2750		21050
F11	12150		1620	27250
G11	13150			34400

Table 4.15: *Available frame sizes for the MVW3000 of 13200 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A12	6400	2500	1320	7450
B12	6600			11250
C12	6900			14700
D12	9200			18750
E12		2750		22850
F12	13500		1620	29600
G12	14500			37500

Table 4.16: *Available frame sizes for the MVW3000 of 13800 V and respective panel values*

Frame size	L(*) [mm]	H(*) [mm]	P(*) [mm]	Weight(*) [kg]
A12	6400	2500	1220	7650
B12	6600			11550
C12	6900			15150
D12	9200		1320	19400
E12		2750		23650
F12	13500		1620	30650
G12	14500			38900

(*) Default values for frames with input rated voltage equal to the output rated voltage. For further information, see the **WEG**.

NOTE!
The values presented in tables Table 4.2 on page 4-3 to Table 4.16 on page 4-6 are standard values; however, they may change due to the special characteristics of the product:

- Input Switchgear;
- Output filter;
- Transformer characteristics;
- 2 input protection fuses;
- Special grounding and safety systems.

4.2 POWER CELLS

4.2.1 Constructive Aspects

The power cells of the same MVW3000 have seven frame models available. Information on models and dimensions of the power cells can be found in Table 4.17 on page 4-7 , as well as an illustration example of frame B in Figure 4.4 on page 4-7 .

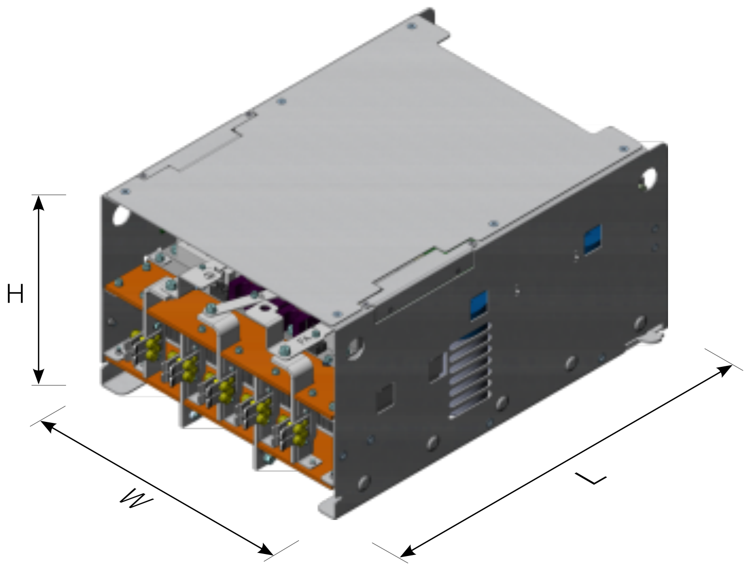


Figure 4.4: *Dimensions of the cell of power of MVW3000*

Table 4.17: *Dimensions of the different frames available*

Frame size	Current [A]	H = Height [mm]	W = Width [mm]	L = Length [mm]	Mass [kg]
A	70	255	356	595	26
B	140	255	356	595	30
C	200	255	356	595	40
D	265	255	406	682	53
E	340	255	406	682	58
F	450	505	297	870	87
G	600	505	297	870	92

The power cells may also contain a bypass system, at the costumer's discretion, which provides greater safety and robustness for the applications. Thus, a power cell of the standard MVW3000 contains:

- 5, 9, 12, 17 or 22 capacitors (according to the model);
- 6 diodes with blocking voltage of 1,6 kV;
- 4 IGBTs with blocking voltage of 1.7 kV (frames F and G models have parallel modules);
- 1 heatsink for heat exchange;
- 2 gate driver electronic boards;
- 1 switched-mode power supply electronic board;
- 1 local control electronic board with fiber optic interface;
- 2 input protection fuses;
- 2 temperature sensors.

The listed items can be found in Figure 4.5 on page 4-8 and Figure 4.6 on page 4-9.

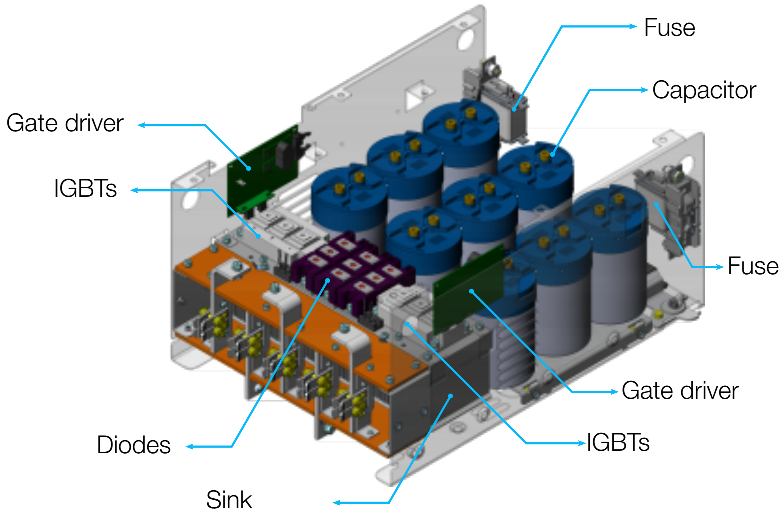


Figure 4.5: *Position of the components of the MVW3000 140 A power cell*

The mechanical structure of each cell is basically formed by galvanized steel plates, and it is easy to install due to the connection clamp system and the insertion and extraction mechanism present in the the set.

As the connection and mounting of the cell to the MVW3000 requires only one tool (shipped with the product), a cell can be changed in few minutes, reducing downtime. More information on installing and replacing cells can be found in Chapter 6 INSTALLATION, CONNECTION, ENERGIZATION AND PREVENTIVE MAINTENANCE on page 6-1.

4.2.2 Power cell boards and connections

The electrical connection inside the cell is done by means of laminated busbars, insulated between each other by means of insulating material compatible with the applied voltage level.

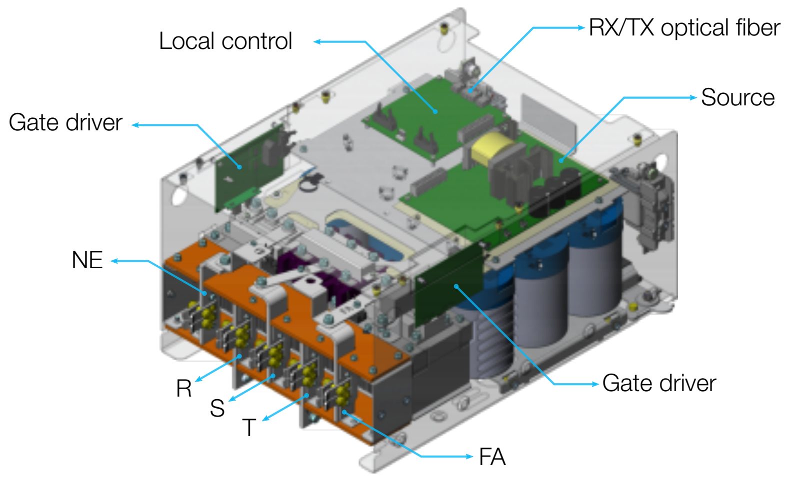


***Figure 4.6:** Standard power cell boards and connections of the MVW3000 (frame B)*

The local control and power supply electronic boards are in the upper part of the cell, above the laminated busbars, insulated and fastened to a metal base. The serial communication between the cell and the main control module occurs by means of the local control board via the fiber optic interface.

The modulation signals leave the local control and go to the gate driver boards via multiway flat cables. The power supply provides the voltages of: 5 V, 15 V, -15 V, 24 V that feed all the cell control part (local control, gate drivers and bypass system).

The celll connection to the link is carried out by means of clamps, located in the back part of the cell. There are five connections per cell, connecting it to the transformer three-phase secondary winding (terminals R, S and T) and to the serial circuit of the phase applied by terminals FA and NE (phase and neutral).

WARNING!
Electronic boards have components sensitive to electrostatic discharges. Do not touch directly on components or connectors. If necessary, touch the grounded metallic frame before or use na adequate grounded wrist strap.

4.3 CONTROL RACK

For the control power supply, the auxiliary voltage (220 - 480 Vac) should be available and connected to the specific terminal strip, located in the control panel. The provided transformer has taps for different voltages in the primary winding and supplies 220 Vac in the secondary winding to feed all the low voltage circuits and exhaust fans present in the product.

The MVW3000 control rack has four electronic boards, grouped in a mechanical assembly that improves the view and access to the analog, digital and fiber optic interfaces. For this assembly Figure 4.7 on page 4-10 shows boards MVC3, MVC4, PIC2 or PIC3 and FOI4 or CIB.

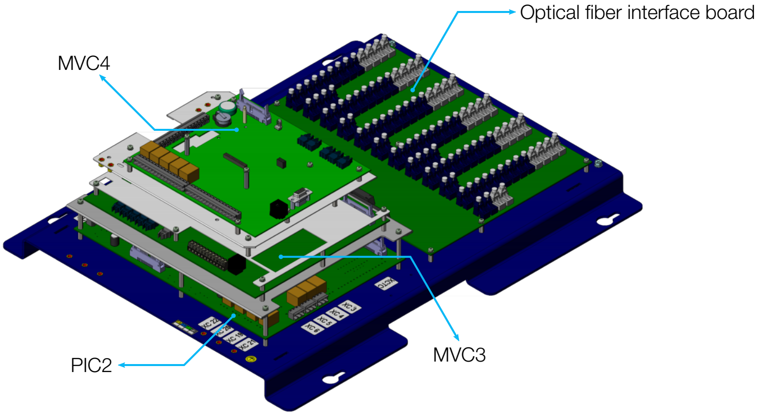


Figure 4.7: *MVW3000 standard control rack*

4

The control rack is powered with 24 Vdc by the PSS24 power supply, whose input is single-phase or three-phase 220 V. The control rack is composed by the interface and power supply board (PIC2 or PIC3), one control board (MVC3), an user's function board (MVC4) and a fiber optic interface board (FOI4 or CIB). The MVC3 board is responsible for the motor and inverter control, and the MVC4 board performs the user interface tasks. Both boards are powered with isolated low voltages provided by the PIC2 or PIC3 board, where there are also opto-isolated digital inputs and relay outputs (220 Vac) for internal use of the MVW3000.

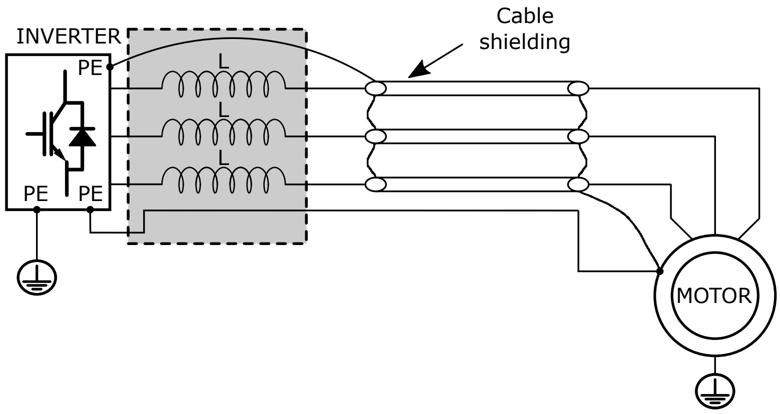
Optional Fieldbus communication and function expansion boards (EBA, EBB or EBC) can be connected to the MVC4 control board. Signals are connected between the MVC3 board and the power cells by means of fiber optic cables through the interface board (FOI4 or CIB).

WARNING!
Electronic boards have components sensitive to electrostatic discharges. Do not touch directly on components or connectors. If necessary, touch the grounded metallic frame before or use na adequate grounded wrist strap.

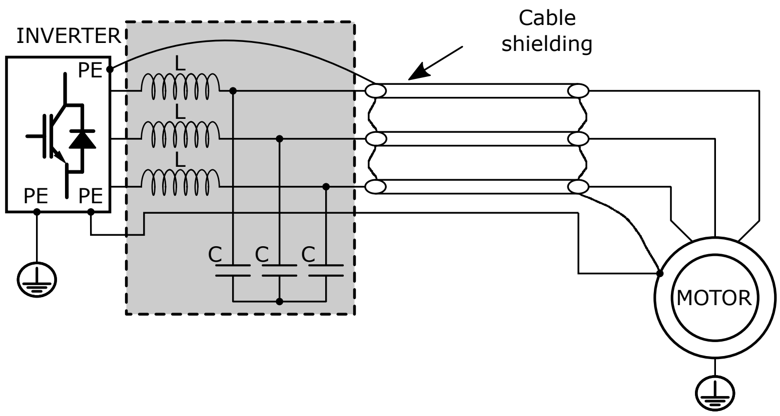
4.4 OUTPUT FILTERS

Depending on the installation conditions, it may be necessary to add an output filter. For drives with cables between 200 and 1000 m, it is recommended to use type 1 output filter on the motor phases. For drives with long cables (above 1000 m) or for motors not able to operate with PWM modulation (retrofitting applications), it is recommended to use type 2 or 3 filter (contact WEG). Figure 4.8 on page 4-11 (a) and (b) illustrate type I and II filters, respectively.

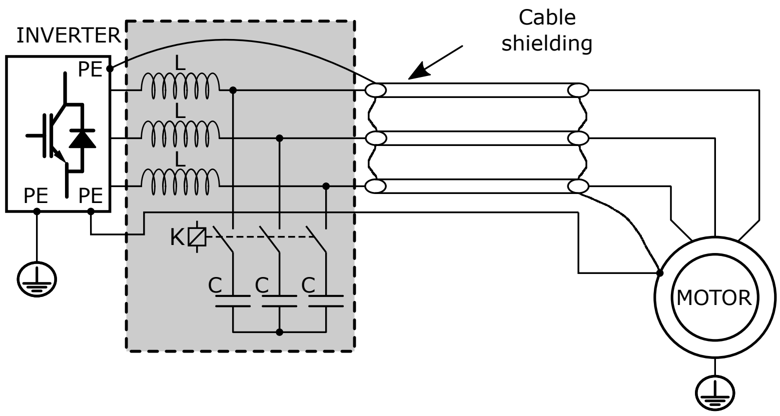
The available filter models follow the voltage and current values informed in tables Table 2.3 on page 2-6 to Table 2.17 on page 2-13.



(a) Filter Type I



(b) Filter Type II



(c) Filter type III

Figure 4.8: *Output filters for MVW3000 inverters*

The Table 4.18 on page 4-12 shows the filter type according to the voltage and length of the cables between inverter and motor.

Table 4.18: Recommended filter type.

Motor use with inverter			
Motor voltager	Output cable length		
	d ≤ 200 m	200 m < d ≤ 1000 m	d > 1000 m
≤ 3.3 kV	none	Type 1	Type 3
4.16 kV ... 6.9 kV	none	Type 1	Type 2
> 6.9 kV	none	none	Type 2
Motor not prepared/retrofitted			
Motor voltage	Output cable length		
	d ≤ 200 m	200 m < d ≤ 1000 m	d > 1000 m
≤ 6.9 kV	Type 2	Type 2	Type 2
> 6.9 kV	Type 1	Type 1	Type 2

5 SUPPORTED MOTORS

This chapter presents the types of motors compatible with the MVW3000 and the respective control strategies.

5.1 INDUCTION MOTOR

The MVW3000 is a high performance product designed for speed and torque control of three-phase induction motors. Motors of this type can be controlled by the following control strategies:

- Scalar control (V/f);
- Vector control (for details, see Section 7.3 INCREMENTAL ENCODER on page 7-14);
- Vector control without encoder ('sensorless').

For more detailed information on the controls, refer to the Programming Manual available at **www.weg.net**.

5.2 SYNCHRONOUS MOTOR

In order to allow driving synchronous motors, the MVW3000 introduces a number of software functions and new hardware elements for commanding and controlling these motors.

Figure 5.1 on page 5-1 presents the general diagram for driving the synchronous motor using the MVW3000. For more details on the excitation control system and the direct connection of the motor to the line, refer to the electrical project of the inverter.

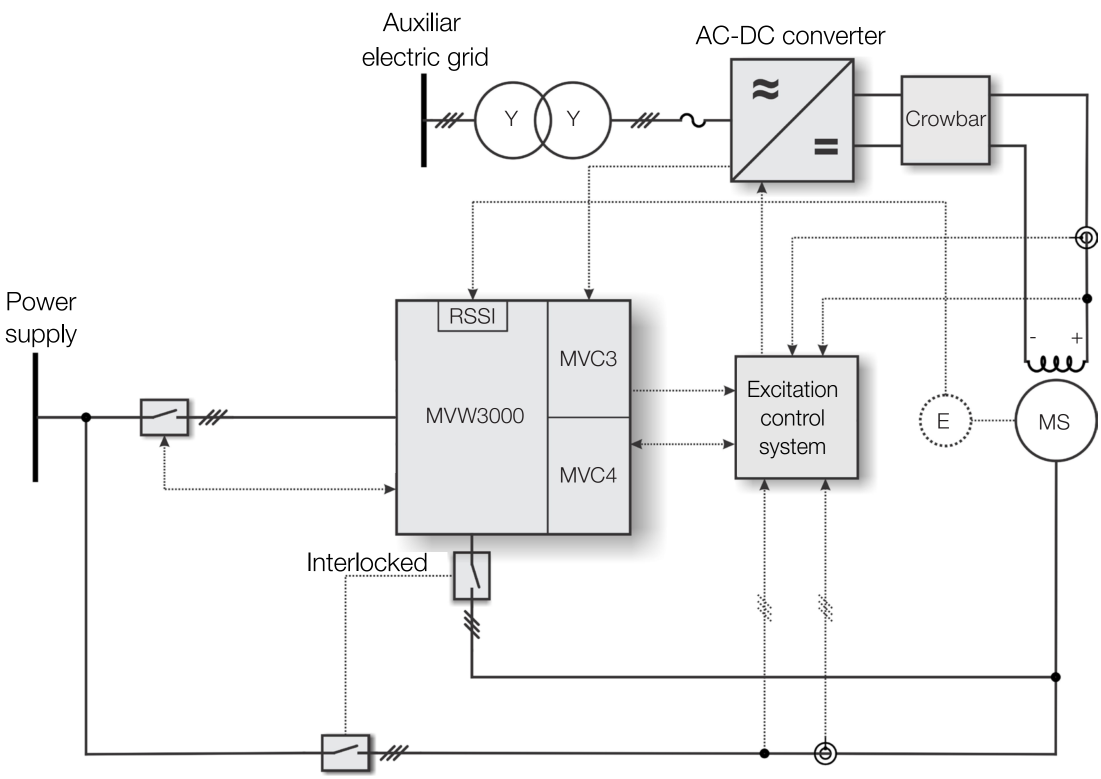


Figure 5.1: *General diagram of the inverter for synchronous motor*

5.2.1 ABSOLUTE ENCODER WITH RSSI BOARD

In synchronous machine drive applications, it is necessary to use an absolute encoder so as to obtain the exact rotor position in relation to the stator, since the incremental encoder is not able to provide such information.

5.2.1.1 Absolute Encoder

The control of synchronous motors requires the use of an absolute encoder (available for the models shown in Table 5.1 on page 5-2 with 13 and 14 bits), which must observe the following specifications:

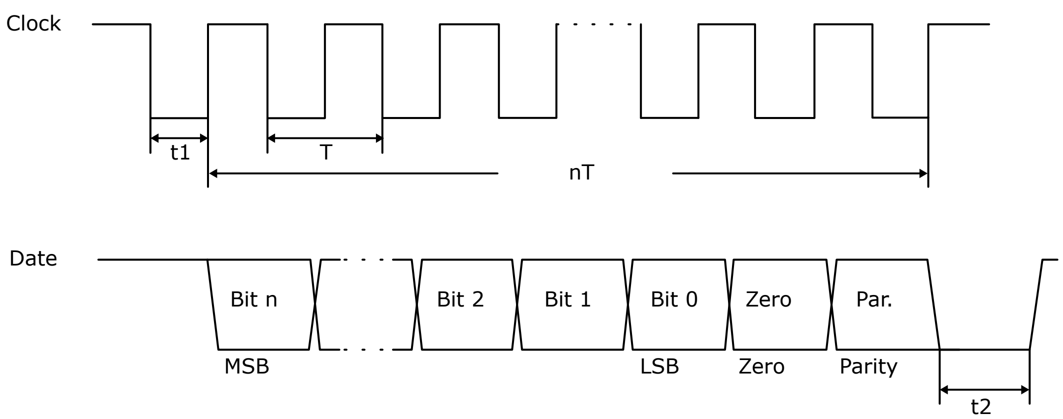


Figure 5.2: *Example of Clock specification and data transfer to the absolute encoder*

Table 5.1: *Encoder recommendations for use in the MVW3000*

Manufacturer	Encoder Model	Quantity of bits	Zero bit	Parity bit
Leine Linde	ISA647100150	13	Yes	No
Baumer	MHAP 400 B5 XXXXSB14EZ D	14	Yes	Yes

When mounting the encoder next to the motor, it is recommended:

- Coupling the encoder directly to the motor shaft (using a flexible coupling, however without torsional flexibility);
- Both the encoder metallic housing and shaft must be electrically isolated from the motor (minimum spacing: 3 mm).

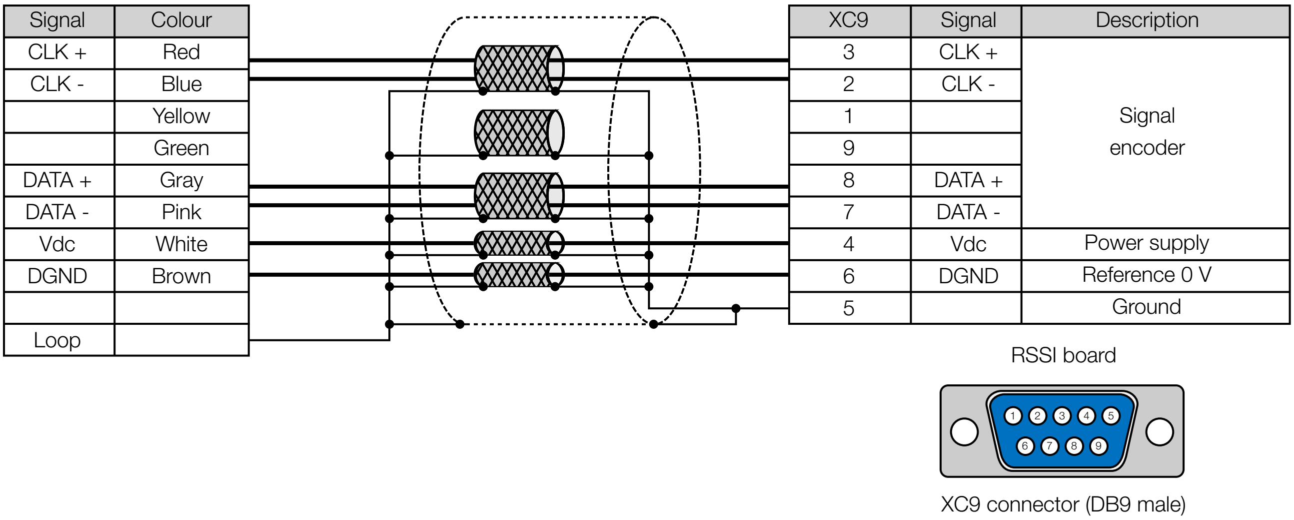
Use good quality flexible couplings that avoid mechanical oscillations or backlash.

5.2.1.2 RSSI Board

The use of absolute encoder implies the need for an SSI data interface (Synchronous Serial Interface) between the encoder and the inverter. The RSSI board was developed for the encoder specification previously described. This board needs to be powered with 24 V in direct current, consumes up to 700 mA and has the following characteristics:

- RS485 communication channel for data transmission and clock according to SSI standard with absolute encoder;
- 2 fiber optic communication channels for use with up to two MVC3 control boards and fiber optic interface board.

For electrical connection, use shielded cables, keeping them at least 25 cm away from the other cables (power, control etc.). Preferably, inside a metallic conduit, as shown in Figure 5.3 on page 5-3 .



Signal	Colour
CLK +	Red
CLK -	Blue
	Yellow
	Green
DATA +	Gray
DATA -	Pink
Vdc	White
DGND	Brown
Loop	

XC9	Signal	Description
3	CLK +	Signal encoder
2	CLK -	
1		
9		
8	DATA +	
7	DATA -	
4	Vdc	Power supply
6	DGND	Reference 0 V
5		Ground

Figure 5.3: *RSSI - Encoder connection cable*

The connections to the encoder and to the MVC3 boards and fiber optic interface board, and components of the RSSI board are shown in Figure 5.4 on page 5-3 and Figure 5.5 on page 5-3 , respectively.

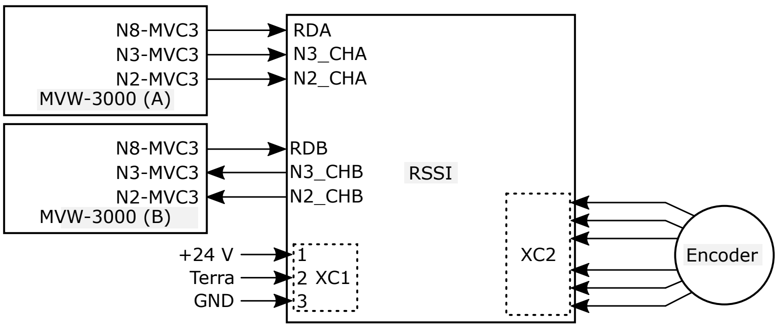


Figure 5.4: *Connection diagram*

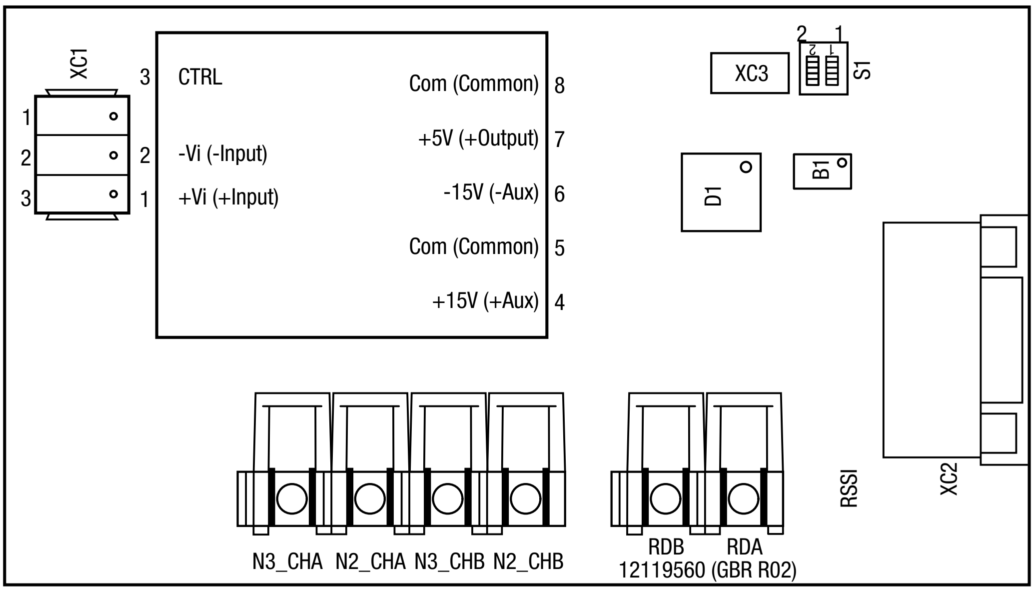


Figure 5.5: *RSSI Board*

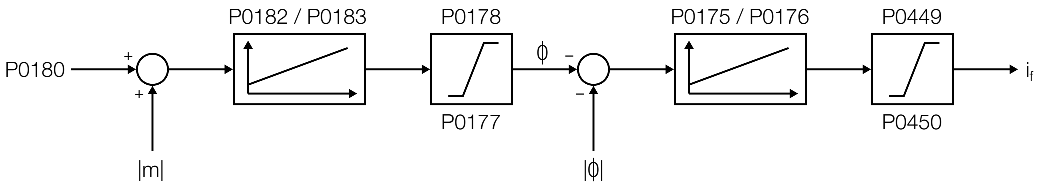
5.2.2 FIELD SET (DC WITH BRUSHES)

The field excitation of the synchronous motor can be done through an AC-DC converter that presents the possibility of being controlled by a control loop, and that has an input for current reference and presents an analogue output with the information of its output current (feedback for the MVW3000).

Specifications:
Current reference input AC-DC: 0 to 10 V (CA-CC 5 V = 1 PU, observe P0462);
Feedback of the output current for the MVW3000: 0 to 10 V (MVW3000 5 V = 1 PU, observe P0462 and P0744).

NOTE!
The MVC3 board has only voltage signals, in order to use current signals an external current transducer must be used.

Example of configuration of the field current reference and paremeter setting of the inverter is presented in Figure 5.6 on page 5-4 , the parameters presented are described in the Programming Manual available at **www.weg.net**.



|m| = Modulation index
0 = Stator flux
|ϕ| = Stator flux, module
i_f = Field current reference

Figure 5.6: *Parameters used by the inverter in the calculation of the of the field current reference*

NOTE!
Information presented in Chapter 5 SUPPORTED MOTORS on page 5-1 of this manual refers to the operation of synchronous machines with DC excitation and with brushes.
In order to drive synchronous machines with other types of excitation, consult WEG.

6 INSTALLATION, CONNECTION, ENERGIZATION AND PREVENTIVE MAINTENANCE

This chapter describes the preventive maintenance and electrical and mechanical installation procedures for the MVW3000. The presented guidance and suggestions must be followed in order to assure the proper inverter operation.

WARNING!
The handling of the MVW3000 and its mechanical and electrical installation must be carried out by persons trained and qualified by WEG.

STORAGE OF THE MVW3000 PANEL AND POWER CELLS:

- After receiving the equipment, remove the plastic film in order to prevent moisture condensation;
- Do not store exposed to sunshine and to temperatures above 40 °C (104 °F);
- Store in a clean and protected place with the air relative humidity not above 80%;
- During all the storage period the conditions mentioned earlier must be satisfied, but when components are stored for more than one year, measures must be taken to dehumidify the storage location;
- When using equipment after a long storage period, verify whether the equipment is free of scratches, dirt, rust and other damages;
- The inverter performance and reliability can be impaired if the inverter or the power arms were stored in an environment out of the conditions listed previously;

DANGER!

- The procedures recommended in this warning have the purpose of protecting the user from death, severe personal injury and considerable property damage;
- Power supply isolating switches: equipment for isolating the inverter power and auxiliary supplies must be planed. They must cut off the inverter supplies (e.g., during installation maintenance tasks);
- This equipment cannot be used as emergency stop mechanism;
- Make sure that the power supply is disconnected before starting the wiring;
- The following information is intended to be a example for a proper installation. Comply with applicable local regulations for electrical installations.

6.1 MECHANICAL INSTALLATION

6.1.1 Environmental Conditions

The inverter installation location is an important factor to assure good performance and high product reliability. The inverter must be installed in an environment free of:

- Direct exposure to sunlight, rain, high humidity, or sea-air;
- Inflammable or corrosive gases or liquids;
- Excessive vibration, dust or metallic particles and oil mist.

Allowed environmental conditions:

- Temperature: from de 0 °C to 40 °C - nominal conditions;
- From 40 °C to 50 °C current reduction of 2,5% for each Celsius degree above 40 °C;
- Relative humidity: from 5% to 90% non-condensing;
- Altitude: up to 1000 m (3.300 ft) - nominal conditions (no derating required).
- From 1000 m to 4000 m, 1% current derating for each 100 m above 1000 m;
- Pollution degree: 2 (according to IEC/UL standards). Non-conductive pollution only;
- Condensation shall not originate conduction through the accumulated residues.

The MVW3000 medium voltage inverter is provided as a panel, and its dimensions are shown in tables Table 4.2 on page 4-3 to Table 4.16 on page 4-6. According to the components assembled in each panel division and their function, this whole panel results in the inseparable union of four functions: switching and protection circuit, phase-shifting transformer, power cells and main control.

The inverter power arms are supplied separately in their own packing.
For the MVW3000G2 series, the inverter power arms are supplied inserted in their respective compartments.

6.1.2 Handling Recommendations

The inverter package must be removed only at the installation site, where the panel will be operated. Before hoisting or moving the panel, locate the hoisting eyes and fragile spots in the documentation that comes with the product. Follow the instructions that come with the panel.

6.1.3 Hoisting

Make sure that the equipment used to lift the inverter panel and cells is suitable for its geometry and mass (valid for a maximum current of each respective frame), as shown in Table 6.1 on page 6-2. For the cell values of each frame, see Table 4.17 on page 4-7.

Table 6.1: *Panel mass (approximate; values may vary depending on the current supported)*

Frame size	Inverter Panel Mass + Cells [kg]	Panel mass + transformer [kg]	Control Panel [kg]	Total Mass [kg]
A1	100	950	450	1500
B1	100	1250	450	1800
C1	150	1500	450	2100
D1	200	1800	450	2450
E1	200	2150	450	2800
F1	300	2650	450	3400
G1	300	3300	450	4050
A2	200	1250	450	1900
B2	200	1850	450	2500
C2	250	2450	450	3150
D2	350	3000	450	3800
E2	350	3700	450	4500
F2	1300	4700	450	6450
G2	1300	6000	450	7750

Frame size	Inverter Panel Mass + Cells [kg]	Panel mass + transformer [kg]	Control Panel [kg]	Total Mass [kg]
A3	900	1500	450	2850
B3	900	2450	450	3800
C3	1000	3200	450	4650
D3	1250	4050	500	5800
E3	1300	5050	500	6850
F3	1550	6450	500	8500
G3	1600	8350	500	10450
A4	950	1750	450	3150
B4	1000	2900	450	4350
C4	1100	3900	450	5450
D4	1400	4900	450	6800
E4	1450	6200	450	8150
F4	1800	7950	450	10250
G4	1850	10400	450	12750
A5	1050	2150	450	3650
B5	1100	3650	450	5200
C5	1250	4900	450	6600
D5	1550	6350	500	8400
E5	1600	7950	500	10050
F5	2050	10300	500	12850
G6	2150	13500	500	16200
A6(1)	1100	2350	450	3900
B6(1)	1200	4050	450	5700
C6(1)	1350	5550	450	7350
D6(1)	1700	7150	500	9350
E6(1)	1800	9000	500	11300
F6(1)	2350	11700	500	14550
G6(1)	2400	15450	500	18350
A6(2)	1100	2500	450	4050
B6(2)	1200	4400	450	6050
C6(2)	1350	6000	450	7800
D6(2)	1700	7800	500	10000
E6(2)	1800	9800	500	12100
F6(2)	2350	12800	500	15650
G6(2)	2400	16800	500	19700
A7(3)	1800	3200	450	5450
B7(3)	1900	5150	450	7500
C7(3)	2100	6800	450	9350
D7(3)	2600	8650	500	11750
E7(3)	2700	10800	500	14000
F7(1)	3350	13900	500	17750
G7(1)	3450	18100	500	22050
A7(4)	1800	3450	450	5700
B7(4)	1900	5600	450	7950
C7(4)	2100	7450	450	10000
D7(4)	2600	9500	500	12600
E7(4)	2700	11900	500	15100
F7(4)	3350	15250	500	19100
G7(4)	3450	20000	500	23950

Frame size	Inverter Panel Mass + Cells [kg]	Panel mass + transformer [kg]	Control Panel [kg]	Total Mass [kg]
A8	2000	3650	450	6450
B8	2000	6150	450	8600
C8	2200	8250	450	10900
D8	2800	10550	500	13850
E8	2850	13200	500	16550
F8	3600	17050	500	21150
G8	3700	22350	500	26550
A9	1950	3950	450	6350
B9	2050	6700	450	9200
C9	2350	9050	450	11850
D9	2950	11600	500	15050
E9	3050	14500	500	18050
F9	3850	18850	500	23200
G9	4000	24700	500	29200
A10	2050	4250	450	6750
B10	2150	7200	450	9800
C10	2450	9800	450	12700
D10	3100	12650	500	16250
E10	3200	15850	500	19550
F10	4100	20550	500	25150
G10	4250	27000	500	31750
A11	2100	4500	450	7050
B11	2250	7800	450	10500
C11	2600	10600	450	13650
D11	3250	13650	450	17400
E11	3400	17150	450	21050
F11	4400	22350	450	27250
G11	4550	29350	450	34400
A12(5)	2200	4800	450	7450
B12(5)	2350	8450	450	11250
C12(5)	2700	11550	450	14700
D12(5)	3400	14850	500	18750
E12(5)	3550	18800	500	22850
F12(5)	4650	24450	500	29600
G12(5)	4800	32200	500	37500
A12(6)	2200	5000	450	7650
B12(6)	2350	8750	450	11550
C12(6)	2700	12000	450	17250
D12(6)	3400	15500	500	19400
E12(6)	3550	19600	500	23650
F12(6)	4650	25500	500	30650
G12(6)	4800	33600	500	38900

Notes:
(1) For models with voltage from 6000 V to 6300 V;
(2) For models with voltage from 6600 V to 6900 V;
(3) For models with voltage of 7200 V;
(4) For models with voltage of 8000 V;
(5) For models with voltage of 13200 V;
(6) For models with voltage of 13800 V.

Observe the gravity center and ensure that the hoisting mechanism is adequate and safe. Use the configuration showed in the Table 6.1 on page 6-2 .

The cables or chains used for hoisting must be at a minimum angle of 45° regarding the horizontal plane.

Hoisting must be done in a slow and stable manner. Before starting make sure the entire pass is clear of obstacles. If any change or damage to the panel structure is found, abort the lifting and reposition the cables or chains, as shown in Figure 6.1 on page 6-6.

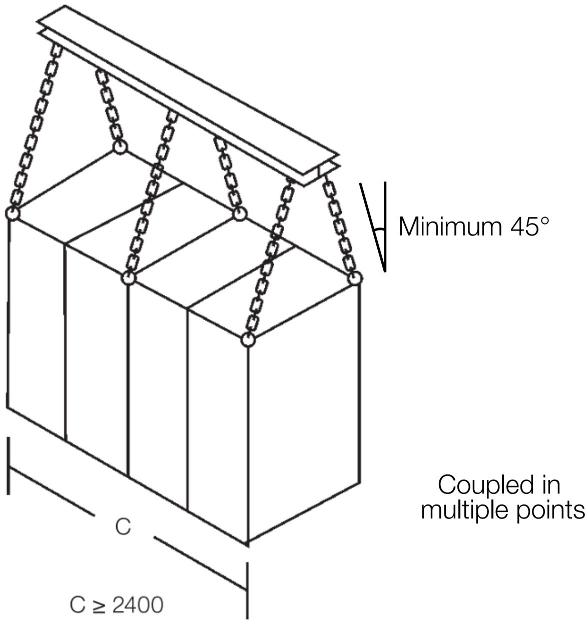


Figure 6.1: *Recommended hoisting mechanism for the panel movement*

WARNING!
During lifting, connect chains or cables to all available hoisting points on the panel.

6.1.4 Moving

When cranes or pulleys are used, make sure that the movements are slow and smooth, so that the panel and the arms do not suffer excessive swings and vibration.

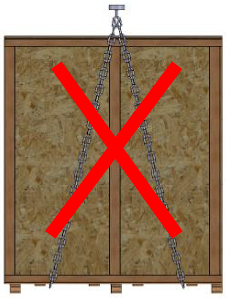
When using hydraulic carts, forklifts, rollers or other handling equipment, distribute the mechanical support points of such equipment from one end of the panel to the other, avoiding applying pressure on fragile areas. Make sure that all the panel doors are closed and locked, and that the door handles are in protected position.
The use of forklift and cranes with chains is illustrated in Figure 6.2 on page 6-7.

The transformer panel door must be handled with forklift only. For information about the transformer mass, see Table 6.1 on page 6-2.

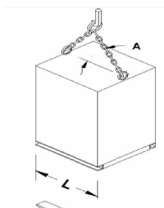
- Forklift
- Hoist with rocker

(a)

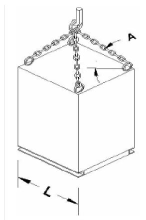
HOISTING AND MOVEMENTS BELOW THE BOX IS PROHIBITED



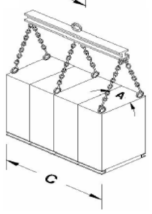
(b)



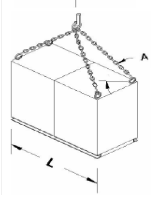
- Individual two (2) points



- Individual four (4) points



- Coupled in multiple points



- Coupled in four (4) points

A -Min.45º C >2400mm L <2400mm

(c)

Figure 6.2: *MVW3000 movement procedure*

NOTE!

LIFT TRANSFORMER PANEL ONLY WITH THE FORKLIFT

6.1.5 Unpacking

Use proper tools to unpack the MVW3000.panel and its arms. During this process, make sure that all the items listed in the documentation that comes with the product are present and in perfect conditions. Contact your local WEG representative in case of any irregularity.

Removes the package of the cells carefully, because they have fragile components (electronic boards, fiber optic connectors, busbars, wiring, etc.). Avoid touching these components! The arms must always be handled through their external metallic frame.

While opening the package, inspect the arms for transportation damage. While opening the package, check if there are damages to the product. Do not to install the cells in case you suspect any damage.

Remove all packing material (plastic, wood, polystyrene foam, metal, nails, bolts, nuts, etc.) that might have remained inside the inverter panel or in the arms.

WARNING!
If any component presents problems (damages) it is recommended to:

- Stop the unpacking immediately;
- Contact the carrier and formally fill in a complaint with the problem found;
- Take pictures of the damaged parts.

The package of the standard power cells to transport up to three cells is shown in Figure 6.3 on page 6-9 .

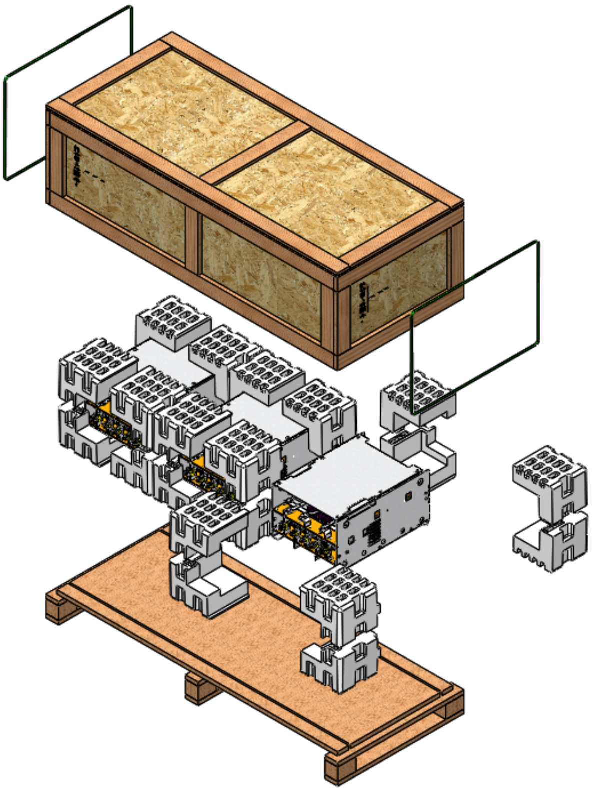


Figure 6.3: *Standard power cell with package*

For air transport, extra reinforcements have been installed, which need to be removed when unpacking the product according to the following procedure:

1. Remove the two upper shutters from the cell panel to access the upper bracket screws: Figure 6.4 on page 6-10 - image 1;
2. Remove the screws that secure the upper brackets: Figure 6.4 on page 6-10 - image 2;
3. After removing the upper transport brackets, mount the lifting brackets with the same screws: Figure 6.4 on page 6-10 - image 3;
4. On the transformer panel, remove the rear transport bracket: Figure 6.4 on page 6-10 - image 4;
5. Also remove the two front brackets from the transformer panel: Figure 6.4 on page 6-10 - image 5;
6. Reinstall the front covers and shutters: Figure 6.4 on page 6-10 - image 6;
7. Reinstall the rear cladding: Figure 6.4 on page 6-10 - image 7.

Figure 6.4: *Procedure to remove the air transport reinforcements from the MVW3000*

6.1.6 Panel coupling

The coupling of the MVW3000 must follow the described procedure:

1. Position the columns side by side so that they are aligned in the direction of depth, according to Figure 6.5 on page 6-11 - image 1;
2. Use the screws, washers and nuts that come with the product in the separate item box in the eight available coupling holes, Figure 6.5 on page 6-11 - image 2;
3. Mount the screws according to the sequence shown in Figure 6.5 on page 6-11 - image 3 and apply a torque of 19 Nm:

1 M8x20 screw;
2 Washer;
3 M8 nut;

4. Screw, nut and washer mounted as shown in Figure 6.5 on page 6-11 - image 4.

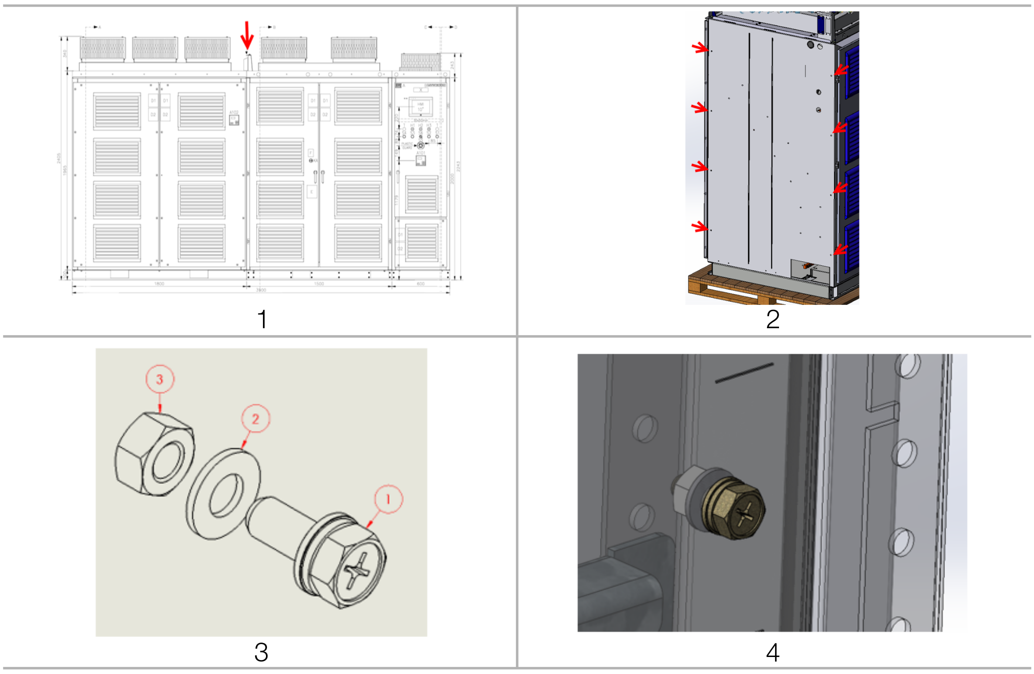


Figure 6.5: *Procedure for coupling the MVW3000*

6.1.7 Positioning/Mounting

The panel of the MVW3000 must be positioned on a smooth and level surface, thus avoiding mechanical instability, door misalignment, among other problems.

WARNING!
Some models of the MVW3000 are shipped with some parts disassembled.
All disassembled parts must be properly assembled during the commissioning.

The permanent operation position must allow heat radiation from all the surfaces and the necessary ventilation for its operation. The front area of the panel must not be blocked in order to allow the full opening of the panel doors, the insertion and withdrawal of the inverter cells and the installation and/or handling of the power and control cables.
Figure 6.6 on page 6-12 shows the fixation of the panels to the floor. For guidance, refer to the customer's specific project.

Tables Table 4.2 on page 4-3 to Table 4.16 on page 4-6 indicate the dimensions of the available panels.

WARNING!
Make sure there is access for the electric connections:

- Input cables for the MVW3000 panel and output to the motor;
- Protection of the transformer and motor;
- Digital and analog inputs and outputs;
- Commands and states of the input switchgear when it is supplied separately from the MVW3000 panel. It is necessary to allow space behind the panel for back access to the internal components during the product installation.

Comments:
(1) Guiding instructions, consult client specific project;
(2) Panel base ground fixation points;
(3) All dimensions in millimeters (mm), unless otherwise noted.

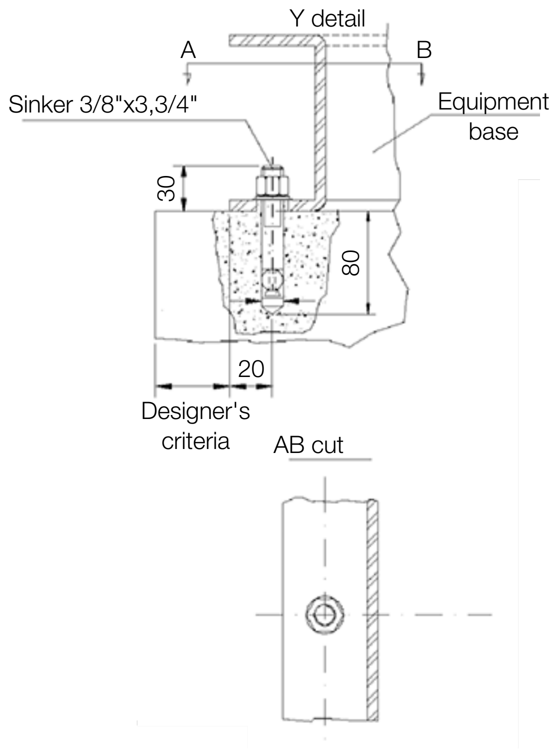


Figure 6.6: *Anchoring the MVW3000 panel to the floor*

NOTE!
Recommendations for anchoring the panel may vary for the several MVW3000models. For more information refer to the specific project documentation.

6.1.8 Insertion of the Power Cells

The power cells must be inserted with the aid of the cart, as shown in Figure 6.7 on page 6-13, and according to the following procedure.

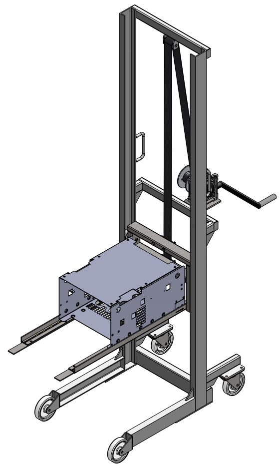


Figure 6.7: *Cart for inserting / withdrawing / moving the power cells*

Figure 6.8 on page 6-14 shows the steps for inserting the cell into the inverter in the following order:

1. Rotate the crank handle until the trolley reaches the floor level. Position the cell on the cart tray - image 1;
2. Bring the cart close to the panel, lift the cell to the required height - image 2;
3. Attach the cart tray to the panel support - image 3;
4. Check that the tray has fitted correctly and lock the cart wheels - image 4;
5. Push the cell observing the alignment with the panel support until the cell touches the stop - image 5;
6. Fit the two insertion handles on the cell pins in the position indicated - image 6;
7. Position the lever so that its smaller hole is concentric with the cell insertion pin - image 7;
8. Rotate the two handles simultaneously until they are parallel to each other and the cell is in the screwing position with the panel support - image 8;
9. Remove the two levers and fasten the cell to the panel support with the two locking screws. Torque: 8 Nm - imagem 9;
10. Lift the cart tray until it uncouples from the cell support and move the cart away from the panel.

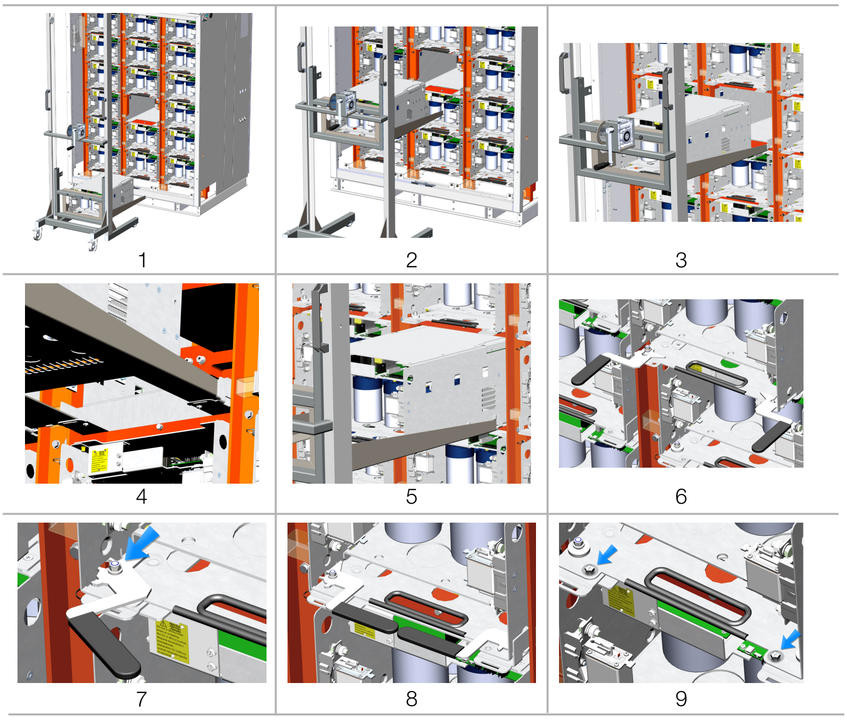


Figure 6.8: Details of the cell insertion step

6

WARNING!
The transport of the power cell must be carried out with the cell near the ground, as shown in Figure 6.8 on page 6-14 - image 1.

6.1.9 Electrical and Fiber Optic Connections on the Power Cells

After the power cells are inserted (phases U, V and W), connect them to the fiber optic cables, according to the labels located on the cells and cables. See Figure 6.9 on page 6-14 for more details.

The cable identifications are shown in tables Table 6.2 on page 6-15 to Table 6.3 on page 6-15.

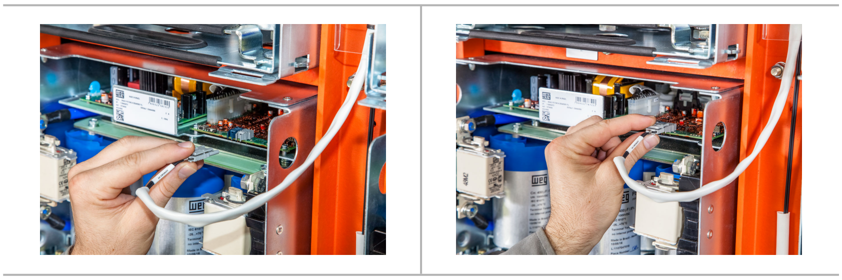


Figure 6.9: Detail of the steps to install the fiber optic cable in the power cell

WARNING!
The fiber optic cables must be handled with caution, in order not to fold, bend, squeeze or cut them. In order to insert or remove the cables, pull or push the connectors only – never the fiber.

NOTE!
In order to withdraw the power cells, follow the procedures described in the previous sections in the reverse order. Remove the fiber optic cable before removing the cell.

Table 6.2: *Identification of fiber optic cables - inverters with 3, 6, 9 and 12 cells*

Power cell connection	Connection to main control	Function
U1	N5_UA	RX
	N1_UA	TX
U2	N6_UA	RX
	N2_UA	TX
U3	N7_UA	RX
	N3_UA	TX
U4	N8_UA	RX
	N4_UA	TX
V1	N5_VA	RX
	N1_VA	TX
V2	N6_VA	RX
	N2_VA	TX
V3	N7_VA	RX
	N3_VA	TX
V4	N8_VA	RX
	N4_VA	TX
W1	N5_WA	RX
	N1_WA	TX
W2	N6_WA	RX
	N2_WA	TX
W3	N7_WA	RX
	N3_WA	TX
W4	N8_WA	RX
	N4_WA	TX

Table 6.3: *Identification of fiber optic cables - inverters with 15, 18, 21, 24, 27, 30, 33 and 36 cells*

Power cell connection	Connection to main control	Function
U1	CIB U: NR1	RX
	CIB U: NT1	TX
U2	CIB U: NR2	RX
	CIB U: NT2	TX
U3	CIB U: NR3	RX
	CIB U: NT3	TX
U4	CIB U: NR4	RX
	CIB U: NT4	TX
U5	CIB U: NR5	RX
	CIB U: NT5	TX
U6	CIB U: NR6	RX
	CIB U: NT6	TX
U7	CIB U: NR7	RX
	CIB U: NT7	TX
U8	CIB U: NR8	RX
	CIB U: NT8	TX
U9	CIB U: NR9	RX
	CIB U: NT9	TX
U10	CIB U: NR10	RX
	CIB U: NT10	TX
U11	CIB U: NR11	RX
	CIB U: NT11	TX
U12	CIB U: NR12	RX
	CIB U: NT12	TX
V1	CIB V: NR1	RX
	CIB V: NT1	TX

Power cell connection	Connection to main control	Function
V2	CIB V: NR2	RX
	CIB V: NT2	TX
V3	CIB V: NR3	RX
	CIB V: NT3	TX
V4	CIB V: NR4	RX
	CIB V: NT4	TX
V5	CIB V: NR5	RX
	CIB V: NT5	TX
V6	CIB V: NR6	RX
	CIB V: NT6	TX
V7	CIB V: NR7	RX
	CIB V: NT7	TX
V8	CIB V: NR8	RX
	CIB V: NT8	TX
V9	CIB V: NR9	RX
	CIB V: NT9	TX
V10	CIB V: NR10	RX
	CIB V: NT10	TX
V11	CIB V: NR11	RX
	CIB V: NT11	TX
V12	CIB V: NR12	RX
	CIB V: NT12	TX
W1	CIB W: NR1	RX
	CIB W: NT1	TX
W2	CIB W: NR2	RX
	CIB W: NT2	TX
W3	CIB W: NR3	RX
	CIB W: NT3	TX
W4	CIB W: NR4	RX
	CIB W: NT4	TX
W5	CIB W: NR5	RX
	CIB W: NT5	TX
W6	CIB W: NR6	RX
	CIB W: NT6	TX
W7	CIB W: NR7	RX
	CIB W: NT7	TX
W8	CIB W: NR8	RX
	CIB W: NT8	TX
W9	CIB W: NR9	RX
	CIB W: NT9	TX
W10	CIB W: NR10	RX
	CIB W: NT10	TX
W11	CIB W: NR11	RX
	CIB W: NT11	TX
W12	CIB W: NR12	RX
	CIB W: NT12	TX

6.2 ELECTRICAL INSTALLATION

6.2.1 Power Section

The power cables that connect the mains input to the MVW3000 and those that connect the inverter panel to the medium voltage motor (Figure 6.13 on page 6-21) must be specific for medium voltage applications and sized for the rated currents.

Table 6.4: *Recommended power cables cross section (copper) [AWG]*

	Power cables [mm²]: R, S, T, U, V, W	Maximum Current [A]
Single cable	10	71
	16	96
	25	126
	35	157
	50	189
	70	241
	95	292
	120	337
	150	384
	185	438
	240	514
Two cables	2x50*	302
	2x70*	386
	2x95*	467
	2x120*	539
	2x150*	614
	2x185*	701
	2x240*	822
Three cables	3x95*	613
	3x120*	708
	3x150*	806
	3x185*	920
	3x240*	1079
Four	4x120*	876
	4x150*	998
	4x185*	1139
	4x240*	1336
Five	5x185*	1314
	5x240*	1542

(*) It is recommended that parallel cable connections be made by means of auxiliary busbars.

NOTE!
For the correct size of the power cables indicated in Table 6.4 on page 6-17 , the cable length and ambient temperature must be considered, as recommended in the local norms and standards for electrical installations.

Table 6.5: *Recommended gauges for power and grounding cables (copper)*

Power wiring gauge (section S) [mm2]	Minimum gauge of the grounding wiring (section S) (PE) [mm2]
S < 16	S
16 < S < 35	16
35 < S	S / 2

NOTE!
The values of the gauges available in Table 6.4 on page 6-17 and in Table 6.5 on page 6-17 are for guidance only. The proper sizing of the cables must consider the installation conditions, applicable standards and maximum permissible voltage drop.

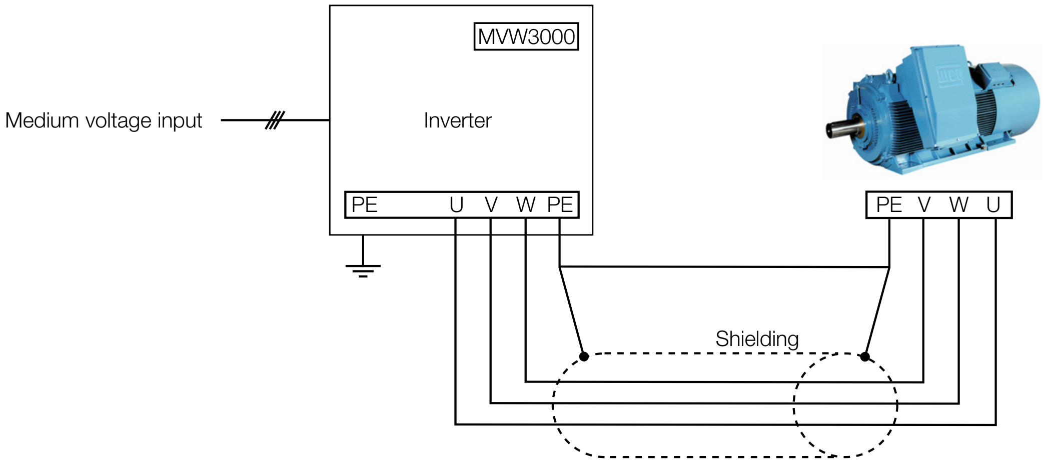


Figure 6.10: *Power and ground connections*

The MVW3000 connection cables must withstand the phase-ground and phase-phase peak voltage indicated in Table 6.6 on page 6-18 for standard and special operation (valid for models with and without redundancy). The cables were chosen so as not to exceed more than 20% of the rated value.

WARNING!
It is recommended to connect the inverter with shielded power cables.
Local medium voltage cable insulation norms and standards must be observed.

6

Table 6.6: *Minimum insulation voltage of the power cables*

Rated output voltage [kV]	Minimum insulation voltage				
	Standard operation:			Special operation (2)	
	Phase-ground peak voltage [V]	Phase-phase peak voltage [V]	Cable insulation recommendation [kV](1)	Phase-ground and phase-phase peak voltage [V]	Cable insulation recommendation [kV](1)
1.15	1553	1863	1.8/3	1863	1.8/3
2.3	2484	3726	1.8/3	3726	3.6/6
3.3	3416	5589	3.6/6	5589	3.6/6
4.16	4347	7452	3.6/6	7452	6/10
5.5	5279	9315	3.6/6	9315	6/10
6.3	6210	11178	6/10	11178	8.7/15
6.9	6210	11178	6/10	11178	8.7/15
7.2	7142	13041	6/10	13041	8.7/15
8	7142	13041	6/10	13041	8.7/15
9	8073	14904	6/10	14904	12/20
10	9005	16767	6/10	16767	12/20
11	9936	18630	8.7/15	18630	12/20
12	10868	20493	8.7/15	20493	12/20
13.2	11799	22356	8.7/15	22356	15/25
13.8	11799	22356	8.7/15	22356	15/25

(1) According to ABNT NBR 7286 standard. Effective values (rms).
(2) Possibility of continuous operation with a short-circuit between one phase and the ground.

Use proper connectors for the power connections and the shield connections to the grounding bar.

Tighten the connections to the proper torque, as indicated in Table 6.7 on page 6-18.

Table 6.7: *Power connections cable lugs and tightening torque*

Cable Lug	Torque [Nm] ±20%
M8	22
M10	43
M12	75

DANGER!
It is mandatory to connect the inverter to a protection ground (PE). The grounding connection must follow the local regulations. Use at least conductors with the wire gauge indicated in the Table 6.5 on page 6-17. Connect it to a specific grounding rod or to the general grounding point (resistance ≤ 10 Ω).

6.2.2 Input Switchgear

The input switchgear, which may be a circuit breaker or contactor, can only be driven by the MVW3000. The circuit breaker circuits are powered by the MVW3000. The following signals, provided by the circuit breaker, are necessary for its operation:

READY (Closed contact = ready): System ready to be operated.
ON (Closed contact = ON): Contactor/circuit breaker status ON.
OFF (Closed contact = OFF): Contactor/circuit breaker status OFF.
TRIP (Open contact = defect): It indicates a defect in the driving system or actuation of the protection circuit.

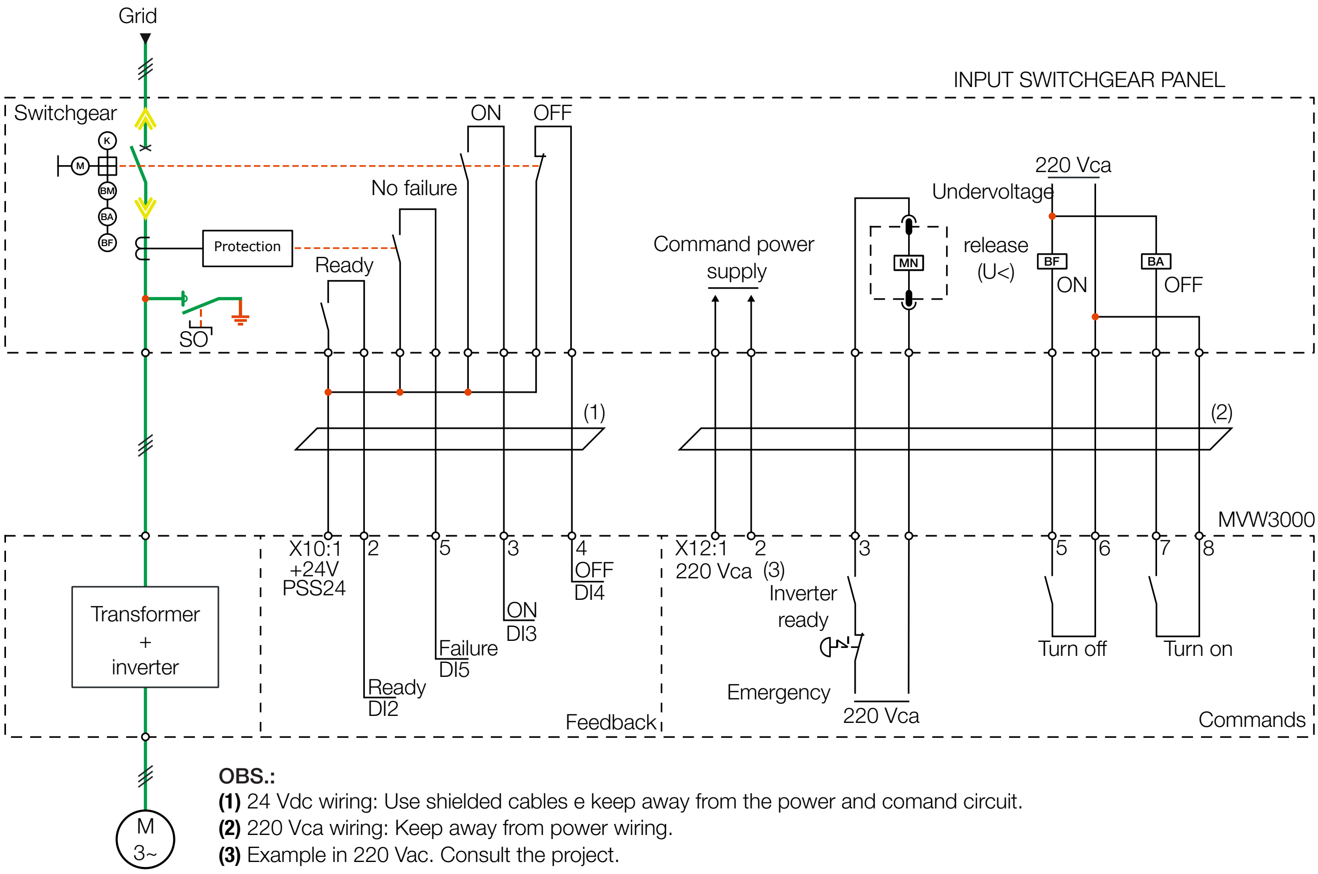
NOTE!
These signals must be dry contacts (potential free).
Emergency circuits must be associated to the **READY** signal and never to the **TRIP** signal.

NOTE!
When the switching circuit is supplied by third parties, it is strongly recommended that the MVW3000 door lock key be blocked together with the circuit breaker/contactor when it is in the non-grounded position.

NOTE!
The connection strips of Figure 6.11 on page 6-20 and Figure 6.12 on page 6-20 (X10 and X12) may change according to the project. Always refer to the project that comes with the product.

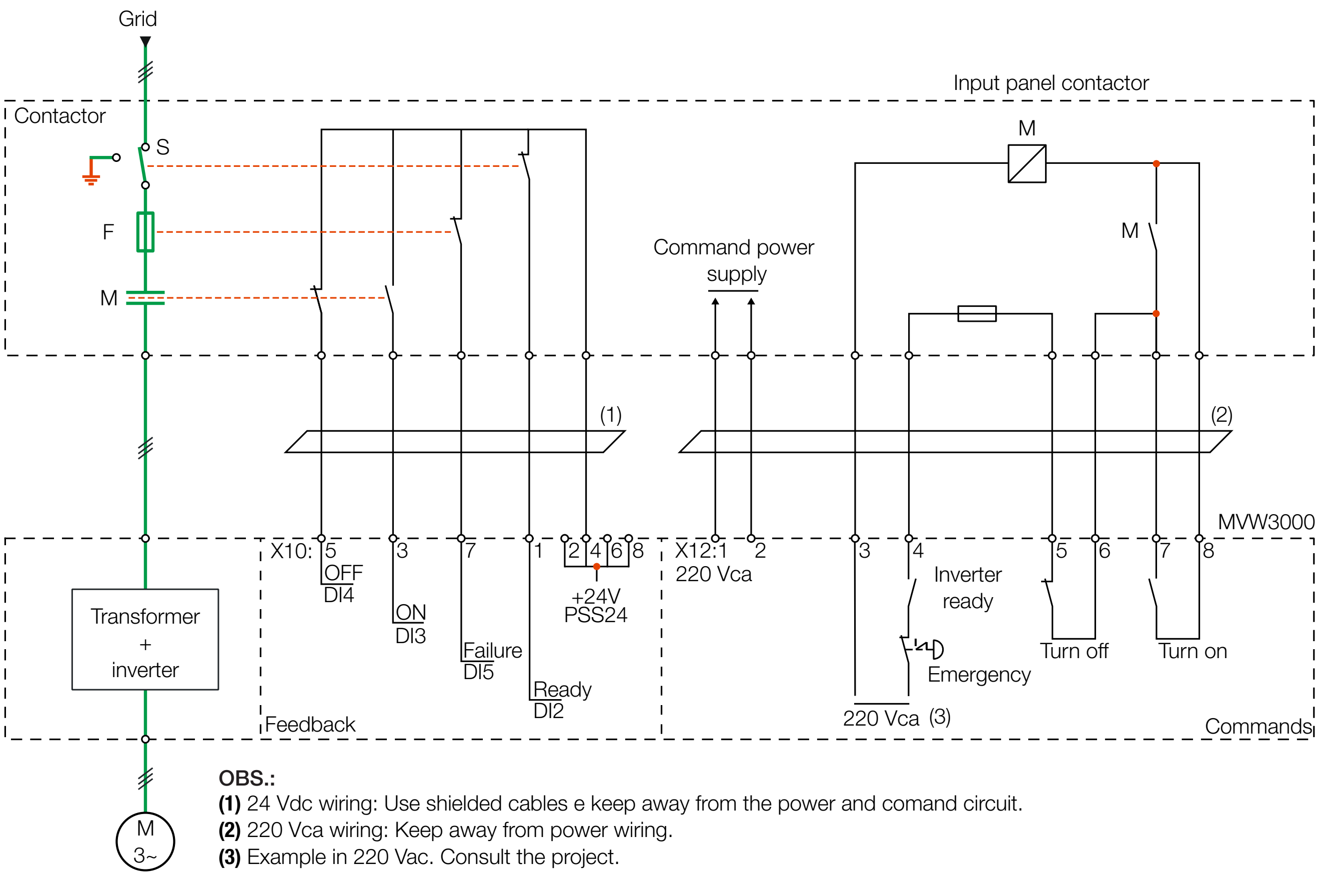
WARNING!
The input circuit breaker must only be closed by the inverter, otherwise the transformer and the inverter may be damaged.
It is highly recommended that the grounding switch of the input switchgear be connected to the "ready" signal. Operating the inverter pre-charge system with the switchgear grounded may damage the inverter.

DANGER!
Although the inverter commands the opening of the circuit breaker, there is no guarantee of its opening. In order to open the medium voltage cabinets for maintenance, follow all the procedures of safe de-energization (refer to the Section 6.6 SAFE DE-ENERGIZATION INSTRUCTIONS on page 6-28).



OBS.:
(1) 24 Vdc wiring: Use shielded cables e keep away from the power and comand circuit.
(2) 220 Vca wiring: Keep away from power wiring.
(3) Example in 220 Vac. Consult the project.

__Figure 6.11:__ Connections of the inverter input circuit breaker for situations in which it is supplied separately



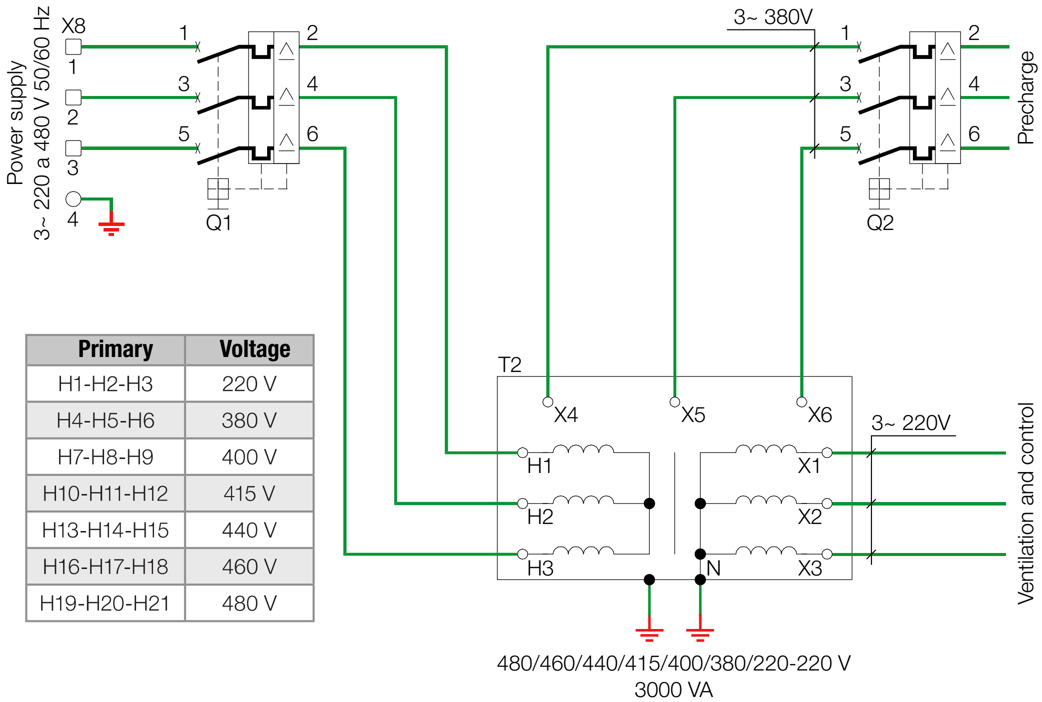
OBS.:
(1) 24 Vdc wiring: Use shielded cables e keep away from the power and comand circuit.
(2) 220 Vca wiring: Keep away from power wiring.
(3) Example in 220 Vac. Consult the project.

__Figure 6.12:__ Connections of the inverter input contactor for situations in which it is supplied separately

6.2.3 Low Voltage Auxiliary Supply

Control column power supply nominal voltage selection

An auxiliary voltage supply (220 - 480 Vac) should be available in the installation. This voltage must be wired to the terminal strip present in the control column. The command transformer (T1) taps must be selected according to the available auxiliary voltage. For more details, refer to the MVW3000 electrical project.



Primary	Voltage
H1-H2-H3	220 V
H4-H5-H6	380 V
H7-H8-H9	400 V
H10-H11-H12	415 V
H13-H14-H15	440 V
H16-H17-H18	460 V
H19-H20-H21	480 V

Figure 6.13: *Auxiliary power supply example (3000 VA transformer)*

NOTE!
The values indicated in Figure 6.13 on page 6-21 are default. For other values see the WEG.

6.3 POWER-UP IN OPERATION

This chapter contains the following information:

- How to check and prepare the inverter before power-up;
- How to perform the power-up and check its success.
- How to operate the inverter when installed according to the standard project (refer to the Section 6.2 ELECTRICAL INSTALLATION on page 6-16 and the attached electric project);
- How to de-energize the inverter safely.

DANGER!
Residual voltages are indicated by the neon lamps on the HVM2 (High Voltage Monitoring) board. It is essential to observe those lamps during energization/de-energization!

6.3.1 Pre-power Checks

The inverter must have already been installed according to the Chapter 6 INSTALLATION, CONNECTION, ENERGIZATION AND PREVENTIVE MAINTENANCE on page 6-1. Even when the inverter electric project is different from the suggested one in the attachment, the following recommendations are applicable.

DANGER!

- Always disconnect all the power supplies before making any connections.
- Although the inverter commands the opening of the input cubicle, there is no guarantee of its opening and neither that no voltages are present.

In order to open the medium voltage cabinets, follow all the safe de-energization procedures.

1. Check that all the power, grounding and control connections are correct and firm;
2. Check the inside of the panel and remove all material residues left in the MVW3000 panel;
3. Check the motor connections and whether the voltage and current are according to the inverter.
4. If possible, mechanically disconnect the motor from the load; otherwise, make sure that spin in any direction (forward/reverse) will not cause damage to the machine or personal hazards;
5. Close and lock the panel doors.

6.3.2 Initial Power-up (Parameter Settings)

After the preparation for power-up, the inverter can be energized, according to the following steps:

Make sure:

1. The auxiliary power supply voltage and the medium voltage supply line voltage are available in the input switchgear. Check that the low voltage auxiliary power supply voltage that feeds the control panel is within the allowed range (rated voltage +10% / -15%);
2. The control panel circuit breakers are installed according to the electrical project. Then closes the door of the control panel;
3. The emergency button is not activated;
4. The control panel was energized, the switch-disconnector of the control panel auxiliary power supply is closed, and check the initialization of the main control through the HMI;
5. The first power-up was successful, the initialization process was completed and the status of the HMI is indicating inverter ready.

6.3.3 Start-up

This section describes the inverter start-up with HMI operation. The considered control mode is V/f 60 Hz.

DANGER!

- High voltages may be present even after the power supply disconnection;
- The following sequence is valid for the standard MVW3000 inverter. The inverter should have already been installed and programmed, according to Chapter 6 INSTALLATION, CONNECTION, ENERGIZATION AND PREVENTIVE MAINTENANCE on page 6-1 .

6.3.3.1 Start-up with HMI Operation and V/f 60 Hz Control Mode

1. Apply power to the panel close the disconnector switch at the control column power supply input;
2. Once the control panel is energized, the main control board will go into the initialization process, and the HMI will show the message "booting":
   After the control has finished its initialization (approximately 10 seconds), the message "Inverter in Undervoltage" is presented on the HMI.
   At this moment the inverter is in undervoltage state (DC link is discharged) and the "ready to start" pilot light at the control column door is on, indicating that it is already possible to initiate the inverter pre-charge;
3. Ready to initiate the pre-charge and power section energization.

   On the MVW3000, the command to start the DC link pre-charge must be performed manually:

   - With the ready to energize indicating light turned on, press the ON button;
   - Wait until the pre-charge is finished (approximately 15 seconds). During the pre-charge the pilot light must remain on;
   - Once the pre-charge is successfully completed, the pre-charge indicating light (PRECHARGE) will turn off and the Energized light will turn on, indicating the input switchgear was successfully closed;
   - The "inverter ready" message is displayed on the HMI.

NOTE!
The pre-charge procedure must not be repeated before 15 minutes. Doing so may damage the pre-charge system due to overload.

WARNING!
If during the pre-charge any problem occurs, the inverter indicates an error related to it. The possible errors are:
F0092 – Pre-charge circuit not ready.
F0014 – Input switchgear closing failure
F0017 – Input switchgear not ready.
F0020 – Time exceeded in the pre-charge process.
Refer to these error (alarm/fault) descriptions in the Programming Manual available for download on the website: **www.weg.net**.

NOTE!
The last speed reference value set by the keys ▲ and ▼ is memorized (P0120 = 1).
If you want to change its value before enabling the inverter, change it using parameter P0121 - Switch Reference.

NOTES:

1. If the motor direction of rotation is reverse, de-energize the inverter, follow the instructions in Section 6.6 SAFE DE-ENERGIZATION INSTRUCTIONS on page 6-28 and invert the connection of any two cables from the output to the motor.
The HMI must indicate the same direction seen looking against the motor shaft end;
2. If the current is too high during the acceleration, especially at low speeds, it is necessary to reduce the acceleration ramp time (P0100 or P0102) or change P0136 - Torque boost setting.
Gradually increase and decrease the P136 content until reaching an operation with approximately constant current throughout the entire speed range. In the case above, see the description of the parameters in the Programming Manual available for download at: **www.weg.net**;
3. In case some DC link overvoltage fault occurs during the deceleration, it will be necessary to increase the deceleration time through P0101/P0103 and check P0151.

WARNING!
If the inverter receives a ”General Enable” or ”Run/Stop” command before the pre-charge procedure has been completed (the inverter is still in the undervoltage state), the command will be ignored and an alert message “inverter in undervoltage” will be displayed on the HMI.

6.4 CONTACT THE AUTHORIZED SERVICE CENTER

6

NOTE!
For technical support or servicing, it is important to have the following information at hand:

- Inverter model;
- Serial number, manufacturing date and hardware revision indicated on the nameplate of the product (see Section 2.2 MVW3000 IDENTIFICATION LABEL on page 2-1).

For explanations, training or services, please contact a WEG Authorized Service Center.

6.5 PREVENTIVE MAINTENANCE

DANGER!

- Only people properly qualified and familiar with the MVW3000 inverter and associated equipment must plan or service this equipment.
- Such people must follow all the safety instructions described in this manual and/or defined by local regulations;
- Failure to comply with the safety instructions may result in risk of death and/or damage to the equipment.

The MVW3000 inverter has been designed and tested to have a long, failure-free, service life.

The preventive maintenance helps in the early identification of possible failures, extending the equipment service life, increasing the mean time between failures and reducing the downtime.
It also helps identify whether the equipment is being used within its mechanical, electrical and environmental limits.

The periodical cleaning during preventive maintenance ensures correct operation when the inverter is used within its rated conditions.

In order to obtain the best benefits, the preventive maintenance must be performed regularly at fixed intervals by a qualified technician.
The interval depends on factors like duty cycle (operating conditions) and environmental conditions (ambient temperature, ventilation, presence of dust etc.).

It is recommended to start performing the preventive maintenance more frequently and then extend the intervals as the obtained results indicate such possibility.
A detailed record of the preventive maintenance is also recommended.

These records serve as proof the maintenance was executed and help identify the cause of possible faults and alarms.

Two types of preventive maintenance are described below:
with the inverter in operation and with its complete stop/de-energization.

6.5.1 Preventive Maintenance in operation

This type of maintenance is performed with the inverter energized and in operation. It is just necessary to access the control cabinet where only low voltage power supply ($\leq$ 480 V) is present, but which is potentially dangerous.

DANGER!

- This equipment has high voltages that may cause electric shocks. Only people properly qualified and familiar with the MVW3000 inverter and associated equipment must plan or service this equipment. In order to avoid the risk of electric shock, follow all the safety procedures required for servicing energized equipment.
- Do not touch any electrical circuit before ensuring it is de-energized.

Procedures:

1. Operation of the fans/exhausters:
Check the correct operation of the exhausters on top of the inverter panel: the fans must be spinning in the same direction and their panel air exhausting action must be checked. Check the correct operation of the fan on the control panel door: it must be spinning and blowing air into the panel.

2. Cleaning of the ventilation air inlet filters:
Remove the protection grids from the air inlets on the doors of all the cabinets by unbolting them. Remove the filters and clean, wash or replace them. The amount of accumulated dirt on the filters helps define the correct interval between preventing maintenances. Reinstall the filters and bolt the protection grids again.

3. Open the control panel door and visually inspect the components inside, checking the following points to detect faults or the need for preventive maintenance with complete stop/de-energization for cleaning or replacement:

Components	Problem
Electronic boards	Excess accumulation of dust, oil, humidity, etc. Discolored or blackened spots due to overheating
Capacitors on electronic boards	Discoloration, smell, electrolyte leakage, case deformation
Resistors in general	Discoloration or smell

Table 6.8 on page 6-26 shows the periodic preventive maintenance procedures under operation condition.

Table 6.8: *Intervals and procedure of the preventive maintenance in operation*

Interval	Items	Procedure
1 month after start-up	Monitoring parameters	Check if the inverter is operating within the project specifications: input transformer secondaries voltage (VSEC = VLINK / 1.35 in each power cell) and output current (P0003). Change the position of the main transformer taps if necessary.
Every 3 months	Cleaning (or replacement) of the air filters(1)	▪ Remove all filters from the panel and clean them with an air blower or with compressed air, or wash them with neutral detergent and dry them well, before installing them back into the panel; ▪ Replace all filters if cleaning is not efficient.
Every 3 months	Visual inspection of the ventilation	▪ Check if the flaps of the exhausters are open. Check the rotation direction of the exhausters in panels without flaps; ▪ Check the rotation direction of the control panel fan.
Every 3 months	Upload of the Log of Faults and Alarms	▪ Make a backup of the inverter complete programming. Follow the WPS© software instructions; ▪ Upload the Log of Faults and Alarms (P0067). Follow the WPS© software instructions.
Every 3 months	Date and time setting	Adjust the current date and time, if necessary. Use the parameters P0080 (Date) and P0081 (Hour) by the Graph HMI V2 or the menu Settings by the Graph HMI V3 (touchscreen).
Every 3 months	Visual inspection of the control panel	▪ **Electronic boards:** – Check for excessive dust accumulation or any accumulation of conductive particles or humidity; – Check for heating spots (discolouration or blackening of components); – Check for leakage or deformation (expansion) of the body of electrolytic capacitors. ▪ **Pre-charge resistors:** check for heating spots (discolouration or blackening); ▪ **Flat cables and internal wiring:** check for heating spots (deformation, discolouration or blackening); ▪ **Internal and signal lights:** check the operation; ▪ **Space heater cord:** check the operation. If there is a thermostat, adjust the temperature to turn it off between 5 and 10 °C above the medium temperature of the electrical room.
Every 3 months	Basic measurements on the control panel	▪ **Auxiliary power supplies:** – Measure the voltages L1, L2 and L3 of the auxiliary power supply and check if it is within the +10/-15% tolerance; – Measure the auxiliary single phase supply for space heaters, sockets and lamps (if separate) and check if it is within the +10/-15% tolerance. ▪ **PSS24 power supply:** – Measure the 220 VAC input voltages and check if they are within the +10/-15% tolerance; Measure the 24 VDC output voltage and check if it is within the ±0.2 V tolerance; – Measure the temperature on the aluminium base and check if it is below Tamb + 20 °C (36 °F).

(1) The interval may be extended, according to the electrical room cleanliness, from 3 to 6 or 12 months.

6.5.2 Preventive Maintenance with stop and de-energization

DANGER!

- This equipment has high voltages that may cause electric shocks. Only people properly qualified and familiar with the MVW3000 inverter and associated equipment must plan or service this equipment. In order to avoid the risk of shock, follow all the safety procedures required for servicing energized equipment.
- Do not touch any electrical circuit before ensuring it is de-energized.

This type of maintenance is also intended to clean and visually inspect the high voltage panels; therefore, it requires the complete de-energization of the inverter.
In order to de-energize the inverter and clean the medium voltage panels, the instructions contained in Section 6.6 SAFE DE-ENERGIZATION INSTRUCTIONS on page 6-28 must be followed.

Its frequency can be lower than the preventive maintenance in operation.

Procedures:

1. Execute procedures 1 and 3 described in Section 6.5.1 Preventive Maintenance in operation on page 6-25;
2. Follow the instructions in Section 6.6 SAFE DE-ENERGIZATION INSTRUCTIONS on page 6-28.

Table 6.9 on page 6-27 shows the periodic preventive maintenance procedures under stop and de-energization condition.

Table 6.9: *Intervals and procedure of the preventive maintenance with stop and de-energization*

Interval	Items	Procedure
Every 12 months	Internal panel cleanliness(1)	▪ **Electronic boards:** use only an antistatic brush; ▪ **Insulating materials, bars and air ducts:** use an air blower and a flannel moistened with isopropyl alcohol. Avoid using compressed air, as it could contaminate the panels with oil or humidity; ▪ **Power cables:** use a dry flannel; ▪ **Fins of the power cells heat sinks(2):** use an air blower; ▪ **Exhausters and fan:** use air blower and a flannel moistened with isopropyl alcohol.
Every 12 months	Maintenance of the input circuit breaker(1)(3)	▪ Indicators ON/OFF; ▪ Operations counter; ▪ Abnormal smell and noise.
Every 12 months	Visual inspection of the power panels(1)	▪ **Electronic boards:** – Check for excessive dust accumulation or any accumulation of conductive particles or humidity; – Check for heating spots (discolouration or blackening of components); – Check for leakage or deformation (expansion) of the body of electrolytic capacitors. ▪ **Optical fibers and internal wiring:** – Make sure the optical fibers are correctly inserted and that they do not bend with radius lower than 4 cm; – Check for heating spots (deformation, discolouration or blackening). ▪ **Space heater cord:** check the operation. If there is a thermostat, adjust the temperature to turn it off between 5 and 10 °C above the medium temperature of the electrical room.
Every 12 months	Power and control connections	Check the tightening of all connections (control and power). Use the torques recommended by the user's guide.
Every 2 years	Calibrations	Check the status of the offset calibrations. VMP-GND must be 0.0% and within the $\pm$1.0% tolerance.
Every 2 years	Test of the protection relay(4)	▪ Test of the selectivity adjustments; ▪ Trip test of the overcurrent output.
Every 3 years	Maintenance of the input circuit breaker or contactor(3)	▪ Insulation resistance; ▪ Lubrication; ▪ Cleanliness; ▪ Heating points etc.
Every 40000 h of operation(5)	Replacement of the exhausters	Replace the exhausters of the power columns and the fan of the control column.
Every 5 years	Power cells clamps	Clean the contacts and clamps with a dry flannel and apply new conductive grease(6) to all clamps.
Every 5000 energizations	Maintenance of the input circuit breaker or contactor(3)	▪ Insulation resistance; ▪ Lubrication; ▪ Cleanliness; ▪ Heating points etc.

(1) The interval may be reduced or extended, according to the electrical room cleanliness, from 6 to 12 or 24 months.
(2) Remove the cells only in case of great dirt accumulation. Use an air blower and antistatic brush. Never use compressed air, as it could contaminate the cell with oil or humidity.
(3) Recommendation from most medium voltage circuit breakers and contactors manufacturers. Refer to the manufacturer's documentation.
(4) Recommendation from most protection relay manufacturers. Refer to the manufacturer's documentation.
(5) If the inverter is in operation 24/7, 40000 h are approximately 4.5 years.
(6) Conductive grease type PENETROX A, manufacturer BURNDY.

6.6 SAFE DE-ENERGIZATION INSTRUCTIONS

DANGER!

- Although the inverter commands the opening of the input cubicle, there is no guarantee of its opening and neither that no voltages are present, because the capacitors remain charged for a long time and they can also be charged through the auxiliary supply (pre-charge);
- In order to open the medium voltage cabinets, follow all the safe de-energization procedures described next.

1. Decelerate the motor to a complete stop;

2. View the busbar voltage values of the installed power cells at HMI parameters P1000 to P1035;

3. Press the "POWER OFF" pushbutton.
The input transformer switchgear should open at this moment, which is indicated by the "INPUT ON" pilot light going off.

WARNING!
If the input transformer switchgear does not open with the "POWER OFF" command, then open it manually.

4. Observe the DC link voltage decrease through the respective parameters on the HMI.
Even with the zero volt indication, you must wait for ten minutes to ensure the full discharge of the DC link capacitors.
Observe the decrease in voltage of the DC link through HMI parameter P1000 to P1035 and the neon lamps mounted on the HVM2 board.
When the DC link voltage remains < 50 V, the neon lamps remain off, and for voltage > 50 V, they start blinking or remain on;

5. Press the emergency pushbutton located on the control panel door and remove the key.

6. For switchgear with switch-disconnectors, fuses and vacuum contactors, it is mandatory to open the switch-disconnector and ground the inverter circuit. It is necessary to confirm visually the opening of the switch-disconnector through the inspection window.
For switchgear with circuit breaker and protection relay, it is mandatory to withdraw the circuit breaker and ground the inverter circuit before any intervention on the MVW3000 control panel.
In both cases, it is necessary to lock the panel and/or add a warning tag indicating "System in maintenance";

7. Open the Q2 circuit breaker in the control panel and lock it in the open position with a padlock and/or or warning tag indicating "System in maintenance".

8. Switch off the Q1 circuit breaker in the control column. De-energize the auxiliary power supply.

Only after the sequence of procedures described above are performed, the doors of the high voltage compartment can be opened.

DANGER!
Even after the DC link voltage indication parameters display 0 V on the HMI, 250 V may still be present on the DC links of the power cells. Wait for ten minutes, and the panel doors may be opened.
In cases where it is not possible to monitor the discharge of the DC link capacitors through the HMI and the neon lamps mounted on the HVM2 board due to a malfunction or a preliminary shutdown, follow instructions 5 to 8 above and wait for 10 minutes.

9. Execute procedures 2 and 3 described in Section 6.5.1 Preventive Maintenance in operation on page 6-25;

10. Clean the dust accumulated inside the control and high voltage panels as described next:

- Ventilation system (fans/sinks of the inverter arms): remove the dust accumulated on their fins using compressed air;
- Electronic boards: remove the dust accumulated on the boards using an anti-static brush and/or low-pressure ion compressed air gun. If necessary, remove the boards from the inverter.

WARNING!
Electronic boards have components sensitive to electrostatic discharges. Do not touch the components or connectors directly. If necessary, first touch the grounded metallic frame or wear a proper grounded wrist strap.

- Panel interior and other components: remove the accumulated dust using a vacuum cleaner with a nonmetallic nozzle. Perform this cleaning especially on the insulating materials that hold energized parts to avoid leakage currents during operation.

11. Tightening of the connections: inspect all the electrical and mechanical connections and tighten them if necessary.

12. Reinstall all removed components or connections in their respective places and follow the startup procedures described in Section 6.3 POWER-UP IN OPERATION on page 6-21.

7 OPTIONAL ACCESSORIES AND BOARDS

7.1 MVC4 SIGNAL AND CONTROL CONNECTIONS

”The signal (analog inputs/outputs) and control (digital inputs/outputs and relay outputs) connections are made at the following terminal strips on the MVC4 control board (refer to the Figure 7.1 on page 7-1).”
XC1A : digital signals.
XC1B : analog signals.
XC1C : relay outputs.

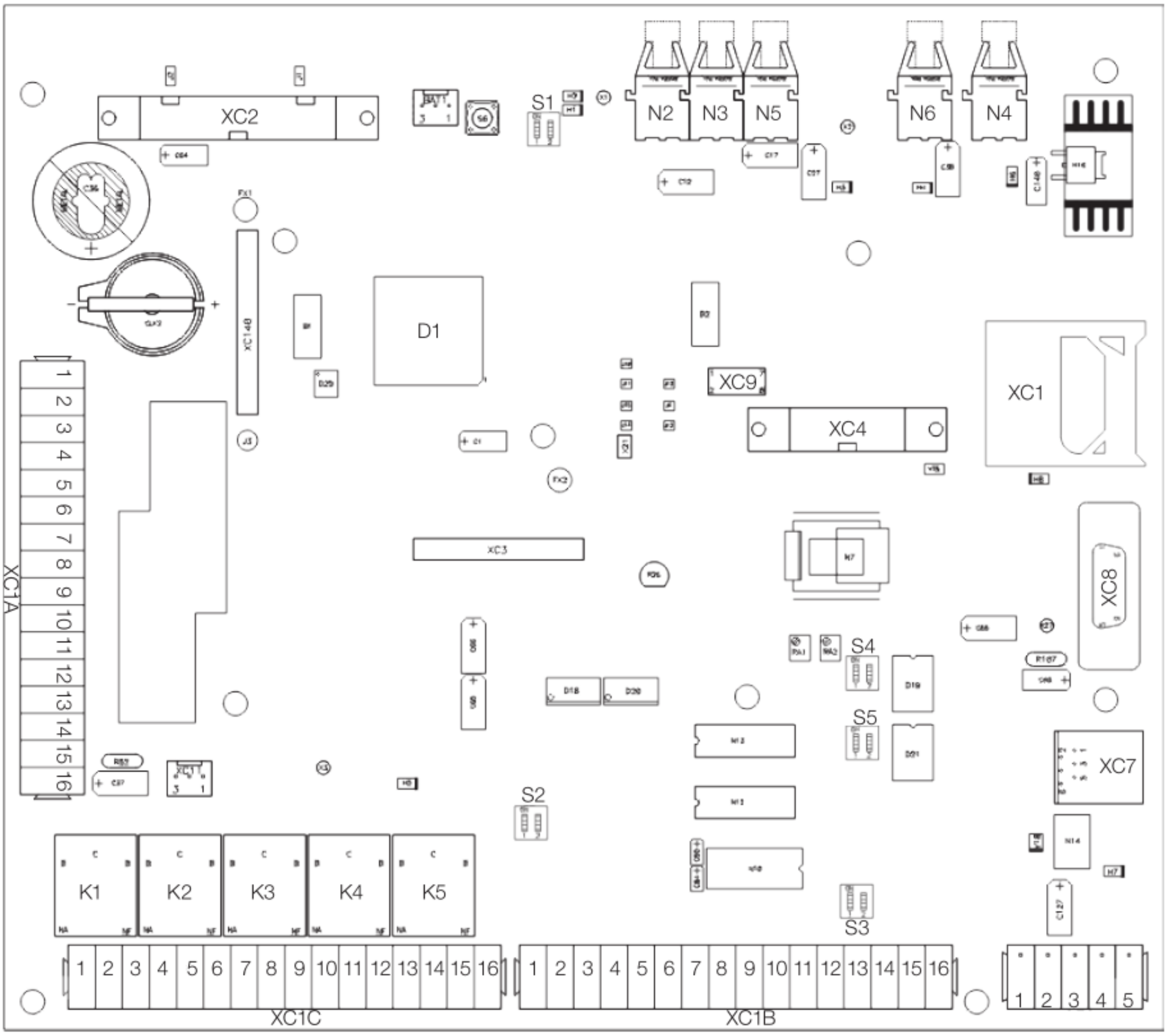


Figure 7.1: MVC4 - Customer connectors

7.1.1 Digital inputs

Table 7.1: *Description of the XC1A connector: digital inputs.*

Connector	Signal	Function (factory default)	Specification
1	24 Vdc	Power supply for digital inputs	24 Vdc ± 8%, 90 mA
2	DI1	P0263 = Start/Stop	Isolated digital input
3	DI2	P0264 = Forward/Reverse	Isolated digital input
4	DI3	P0265 = Not Used	Isolated digital input
5	DI4	P0266 = Not Used	Isolated digital input
6	DI5	P0267 = JOG	Isolated digital input
7	DI6	P0268 = Ramp 2	Isolated digital input
8	24 Vdc	Power supply for digital inputs	24 Vdc ± 8%, 90 mA
9	COM	Common point of the digital inputs	-
10	DGND*	0 V reference of the 24 Vdc power supply	Grounded
11	24 Vdc	Power supply for digital inputs	24 Vdc ± 8%, 90 mA
12	DI9	P0271 = Not Used	Isolated digital input
13	DI10	P0272 = Not Used	Isolated digital input
14	24 Vdc	Power supply for digital inputs	24 Vdc ± 8%, 90 mA
15	COM	Common point of the DI9 and DI10 digital inputs	-
16	DGND*	0 V reference of the 24 Vdc power supply	Grounded

NOTES:
- Isolated digital inputs
- Minimum high level: 18 Vdc
- Maximum low level: 3 Vdc
- Maximum voltage: 30 Vdc
- Input current: 11 mA @ 24 Vdc

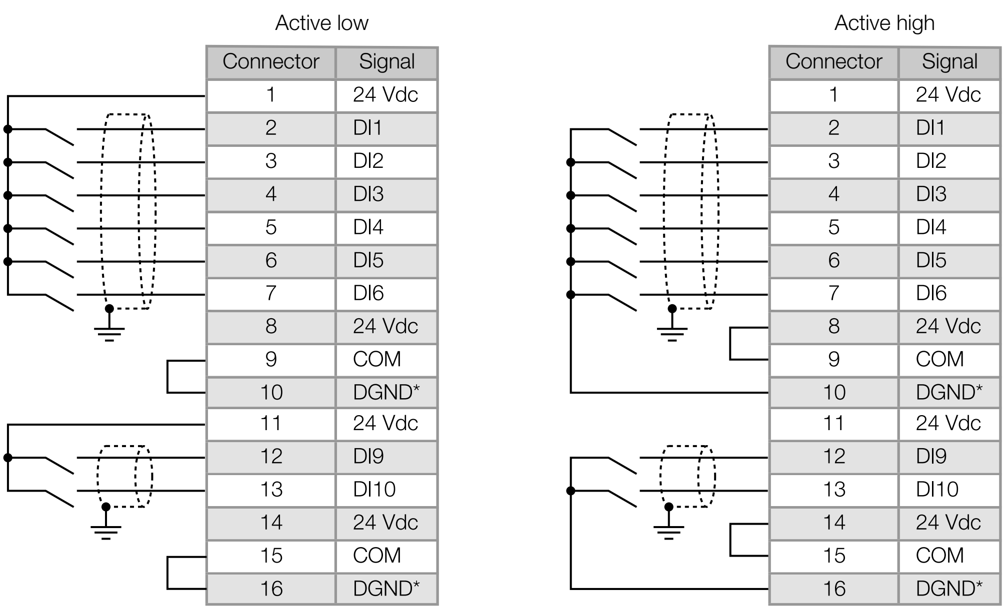
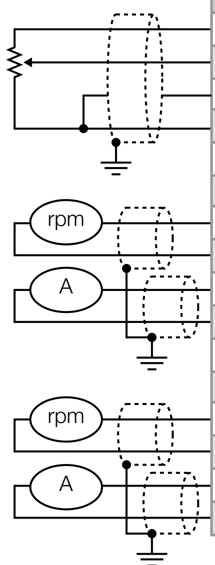


Figure 7.2: *Description of the XC1A connector: digital inputs*

7.1.2 Analog inputs and outputs

Table 7.2: *Description of connector XC1B: analog inputs and outputs.*

Connector	Signal	Function (factory default)	Specification
1	+Ref	Positive reference for potentiometer	+ 5.4 V ± 5%, 2 mA
2	AI1+	Speed reference (remote)	Resolution: 10 bits
3	AI1-		
4	-Ref	Negative reference for potentiometer	- 4.7 V ± 5%, 2 mA
5	AI2+	P0237 = P0221/P0222	Resolution: 9 bits
6	AI2-		
7	AO1	P0251 = Motor speed	Resolution: 11 bits
8	DGND	0 V reference for analog output	Grounded
9	AO2	P0253 = Motor current	Resolution: 11 bits
10	DGND	0 V reference for analog output	Grounded
11	AI5+	P0721 = P221/P222	Resolution: 10 bits
12	AI5-		
13	AO5	P0259 = Motor speed	Resolution: 11 bits
14	AO5 GND	0 V reference for analog output 5	Grounded
15	AO6	P0261 = Motor current	Resolution: 11 bits
16	AO6 GND	0 V reference for analog output 6	Grounded



Connector	Signal
1	+Ref
2	AI1+
3	AI1-
4	-Ref
5	AI2+
6	AI2-
7	AO1
8	DGND
9	AO2
10	DGND
11	AI5+
12	AI5-
13	AO5
14	AO5 GND
15	AO6
16	AO6 GND

Figure 7.3: *Description of connector XC1B: analog inputs and outputs*

Table 7.3: *Switch settings.*

Signal	Function (factory default)	Setting Element	Selection
AI1	Speed reference	S2.A	OFF - (0 to 10) V ON - (0 to 20) mA / (4 to 20) mA
AI2	P0237 = P0221/P0222	S2.B	OFF - (0 to 10) V ON - (0 to 20) mA / (4 to 20) mA
AI5	P0721 = P221/P222	S3.A	OFF - (0 to 10) V ON - (0 to 20) mA / (4 to 20) mA
AO5	P0259 = Motor speed	S4.A	OFF - (0 to 20) mA ON (4 to 20) mA
AO6	P0261 = Motor current	S5.A	OFF - (0 to 20) mA ON (4 to 20) mA

7.1.3 Relay output

Table 7.4: *XC1A terminal strip description: relay outputs.*

Connector	Relay		Function (factory default)	Specification
1	RL1	NA	P0277 = No Fault	240 Vac, 1 A
2		C		
3		NF		
4	RL2	NA	P0279 = N > Nx	240 Vac, 1 A
5		C		
6		NF		
7	RL3	NA	P0280 = N* > Nx	240 Vac, 1 A
8		C		
9		NF		
10	RL4	NA	P0281 = Not Used	240 Vac, 1 A
11		C		
12		NF		
13	RL5	NA	P0282 = Not Used	240 Vac, 1 A
14		C		
15		NF		
16	-	-	-	-

NOTES:
NF = normally closed contact.
NA = normally open contact.
C = common.

7.1.4 Wiring installation

In the installation of signal and control wiring, the following care must be taken:

1. Cable gauges 0.5 mm² to 1.5 mm².
2. Maximum torque: 0.50 N.m (4.50 lbf.in);
3. Connections to XC1A, XC1B and XC1C must be made with shielded cable and separated from the other connections (power, control at 110/220 V, etc.). If those cables have to cross, such cross must be perpendicular, keeping a minimum separation distance of at least 5 cm at the crossing point;

   Screws located on the board and on the MVC4 board support plate, connect shield according to Figure 7.4 on page 7-4:

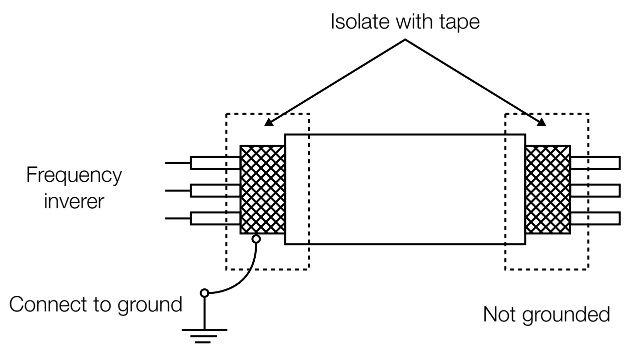


Figure 7.4: *Shield connection*

4. It is necessary to use galvanic isolators at the XC1B terminal strip signals for wiring distances longer than 50 m (150 ft);

5. Relays, contactors, solenoids or electromagnetic braking coils installed near inverters can generate interference in the control circuit; In order to eliminate this interference, connect RC suppressors in parallel with the coils of AC relays. Connect a free-wheeling diode in case of DC relays/coils;

6. When an external keypad (HMI) is used (for further information, refer to the programming manual available for download on **www.weg.net**), separate the cable that connects the keypad to the inverter from other cables of the installation, keeping a minimum distance of 10 cm (4 in) between them.

7.2 FUNCTION EXPANSION BOARDS

The function expansion boards increase the MVC4 control board functions. There are 3 expansion boards available and their selection depends on the application and the desired functions.. The three boards cannot be used simultaneously. The difference between the EBA and EBB boards is in the analog inputs/outputs. The EBC1 board serves for the encoder connection; however, it does not have its own power supply as the EBA/EBB boards do. Next, the detailed description of those boards is presented

7.2.1 EBA (Expansion Board A - I/O)

The EBA board can be supplied in different configurations, created from the combination of specific functions.

The available configurations are shown in the table below.

Table 7.5: *EBA card versions and functions available.*

Functions	EBA.01-A1	EBA.02-A2	EBA.03-A3
Differential input for incremental encoder with 12 V/200 mA, isolated internal power supply, feedback for speed regulator, digital speed measurement 14 bit resolution, (100 kHz maximum signal frequency).	Available	Not available	Not available
Buffered encoder output signals: isolated input signal repeater, differential output, available to external 5 V to 15 V power supply.	Available	Not available	Not available
1 Differential analog input (AI4): 14 bits (0.006% of the range [+-10 V]), two-pole: -10 V to +10 V, (0 to 20) mA / (4 to 20) mA, programmable.	Available	Not available	Available
2 Analog outputs (AO3/AO4): 14 bits (0.006% of the range [+-10 V]), two-pole: -10 V to +10 V, programmable.	Available	Not available	Available
Isolated RS-485 serial port.	Available	Available	Not available
Digital Input (DI7): isolated, programmable, 24 V.	Available	Available	Available
Digital input (DI8) with special function for motor thermistor (PTC): actuation 3,9 kΩ, release 1,6 kΩ.	Available	Available	Available
2 isolated Open Collector transistor outputs (DO1/DO2): 24 V, 50 mA, programmable.	Available	Available	Available

NOTE!
The use of the RS-485 serial interface does not allow the use of the standard RS-232 input of the MVC4 board.
They cannot be used simultaneously.

***Table 7.6:** Description of the XC4 connector (full EBA board)*

Connector	Signal	Function (factory default)	Specification
1	NC	-	-
2	DI8	Input 1 for the motor thermistor - PTC1 (See P0270)	Actuation: 3.9 kΩ Release:1,6 k Ω Minimum resistance: 100Ω
3	DGND (DI8)	Input 2 for motor thermistor - PTC 2 (See P0270)	Referenced to DGND (DI8) through a 249 Ω resistor
4	DGND	0 V reference of the 24 Vdc power supply	Grounded via 249 Ω resistor
5	DO1	Transistor output 1: Not used	Isolated, open collector, 24 Vdc, max: 50 mA, required load (Rc) 500 Ω
6	COM	Common point DI7 digital input and DO1 and DO2 digital outputs	-
7	DO2	Transistor output 2: Not used	Isolated, open collector, 24 Vdc, max: 50 mA, required load (Rc) 500 Ω
8	24 Vdc	Power supply for digital inputs/outputs	24 Vdc ± 8% Isolated, Capacity: 90 mA
9	DI7	Isolated digital input: Not used	Minimum high level: 18 Vdc Maximum low level: 3 Vdc Maximum voltage: 30 Vdc Input current: 11 mA @ 24 Vdc
10	SREF	Reference for RS-485	Isolated RS-485 serial
11	A-LINE	RS-485 A-LINE	
12	B-LINE	RS-485 B-LINE	
13	AI4 +	Analog input 4: Speed reference	Programmable differential (see P0243) Resolution: 14 bits (0.006% of full scale) Impedance: 40 kΩ (-10 to +10) V 500 Ω [(0 to 20) mA/(4 to 20) mA]
14	AI4 -		
15	AGND	0 V reference for analog output (internally grounded)	Resolution: 14 bits (0.006% of full scale) Required load (Rc) 2 kΩ
16	AO3	Analog output 3: Speed	
17	AGND	0 V reference for analog output (internally grounded)	
18	AO4	Analog output 4: Motor current	
19	+V	External power supply for encoder repeater output (XC8)	External power supply: 5 to 15 V Consumption: 100 mA @ 5 V, excluding the outputs
20	COM 1		

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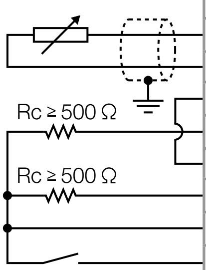
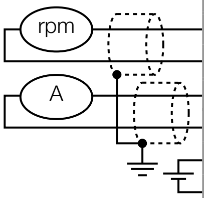


Connector	Signal
1	NC
2	DI8
3	DGND (DI8)
4	DGND
5	DO1
6	COM
7	DO2
8	24 Vdc
9	DI7
10	SREF



Connector	Signal
11	A-LINE
12	B-LINE
13	AI4+
14	AI4-
15	AGND
16	AO3
17	AGND
18	AO4
19	+V
20	COM 1

***Figure 7.5:** Description of the XC4 connector (full EBA board)*

ENCODER CONNECTION: refer to Section 7.3 INCREMENTAL ENCODER on page 7-14

INSTALLATION

The EBA board is installed directly on the MVC4 control board, secured with spacers and connected via terminal blocks XC11 (24 V) and XC3.

Mounting instructions:

1. De-energize the control rack;

2. Configure the board via S2 and S3 DIP switches (refer to the Table 7.7 on page 7-8);
3. Carefully insert XC3 connector (EBA) into the female connector XC3 on the MVC4 control board. Make sure that all pins fit in the XC3 connector;
4. Press on the EBA board (near to XC3) and on the left top edge until the complete insertion of the connector and the plastic spacer;
5. Secure the board to the 2 metallic spacers with the 2 provided bolts;
6. Plug the XC11 connector of the EBA board to the XC11 connector on the MVC4 control board.

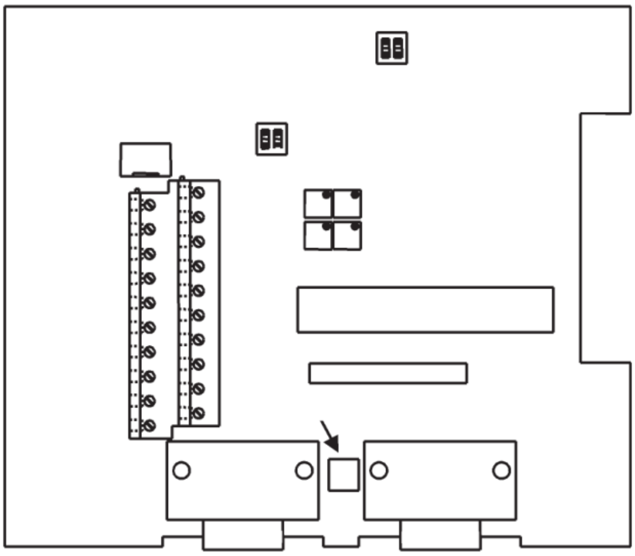


Figure 7.6: *Position of the adjustment elements - EBA board*

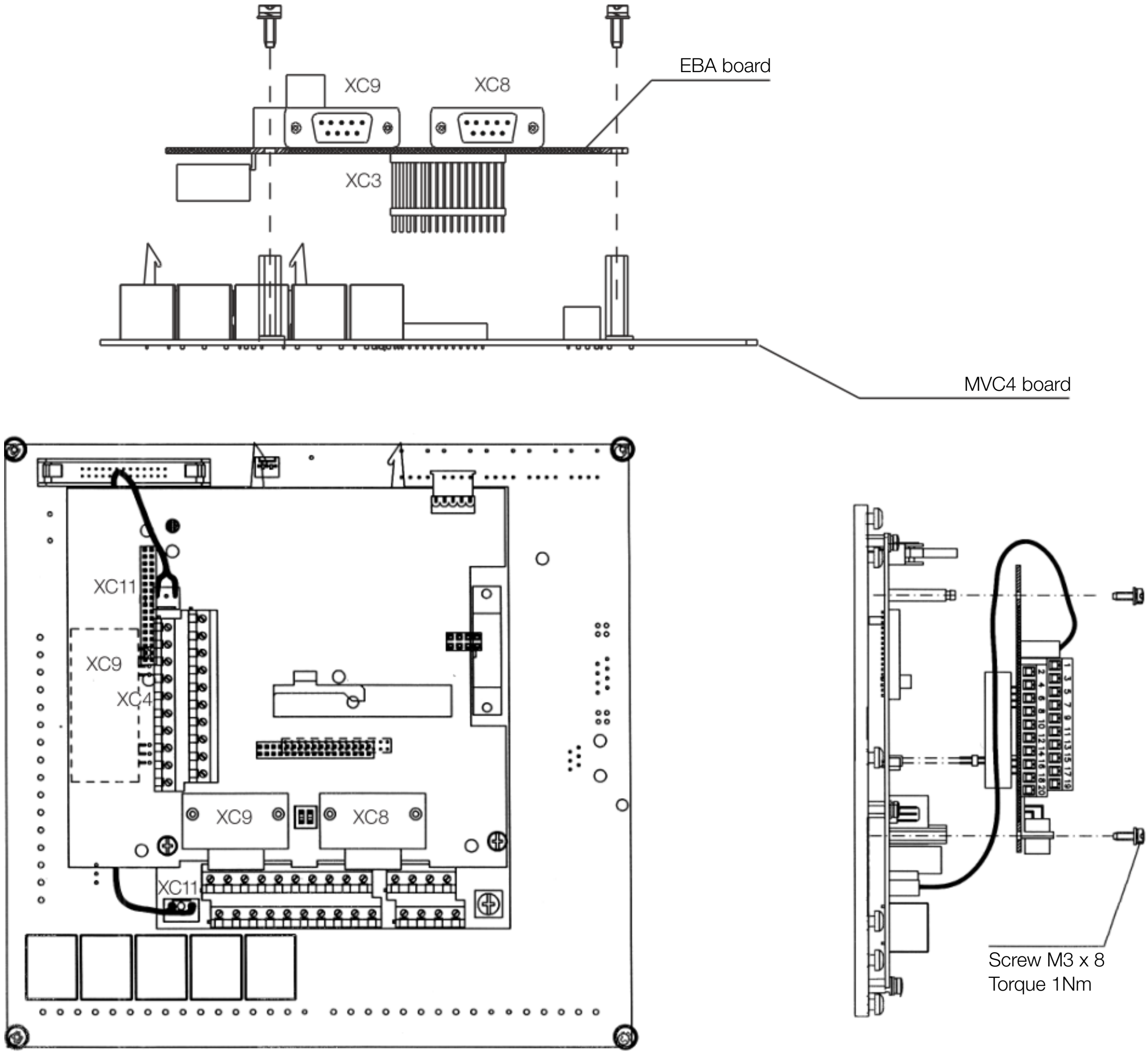


Figure 7.7: EBA board installation procedure

Table 7.7: EBA board configuration of setting elements.

Switch	Signal – Factory Default	OFF (factory default)	ON
S2.1	AI4 - Speed Reference	(0 to 10) V	(0 to 20) mA or (4 to 20) mA
S3.1	RS-485 B - LINE (+)	Without termination	With termination (120 Ω)
S3.2	RS-485 A - LINE (-)	Without termination	With termination (120 Ω)

Table 7.8: Trimpot settings - EBA card.

Trimpot	Function	OFF (factory default)
RA1	AO3 - Offset	P0255 = Motor speed
RA2	AO3 - Ganho	
RA3	AO4 - Offset	P0257 = Motor current
RA4	AO4 - Ganho	

NOTE!

The external signal and control wiring must be connected to XC4 (EBA), following the same recommendations as for the wiring of the MVC4 control board (refer to the Section 7.1 MVC4 SIGNAL AND CONTROL CONNECTIONS on page 7-1).

7.2.2 EBB (Expansion Board B - I/O)

The EBB board can be supplied in different configurations, created from the combination of specific functions.

The available functions are presented in the Table 7.9 on page 7-9.

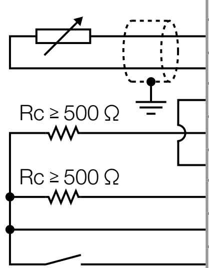
Table 7.9: *EBB board versions and available features.*

Functions	EBB.01-B1	EBB.02-B2	EBb.03-B3	EBb.04-B4*	EBb.05-B5
Differential input for incremental encoder with 12 V/200 mA, isolated internal power supply, feedback for speed regulator, digital speed measurement, 14 bits, resolution (100 kHz maximum signal frequency).	Available	Available	Not available	Available	Not available
Buffered encoder output signals: isolated input signal repeater, differential output, available to external 5 V to 15 V power supply.	Available	Not available	Not available	Available	Not available
Analog differential input (AI3): 10 bits (0 to 10) V, (0 to 20) mA / (4 to 20) mA, programmable.	Available	Not available	Available	Available	Not available
2 Analog outputs (AO1'/AO2'): 11 bits (0,05% of the full scale range), (0 to 20) mA / (4 to 20) mA, programmable.	Available	Not available	Available	Available	Available
Isolated RS-485 serial port.	Available	Not available	Not available	Available	Not available
Digital input (DI7): isolated, programmable, 24 V.	Available	Available	Available	Available	Not available
Digital input (DI8) with special function for motor thermistor (PTC): actuation 3,9 kΩ, release 1,6 kΩ.	Available	Available	Available	Available	Not available
2 isolated Open Collector transistor outputs (DO1/DO2): 24 V, 50 mA, programmable.	Available	Available	Available	Available	Not available

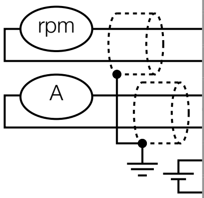
NOTE!
The use of the RS-485 serial interface does not allow the use of the standard RS-232 input of the MVC4 board. They cannot be used simultaneously.
AO1'/AO2' analog outputs are the same AO1/AO2 outputs on the MVC4 control board.

Table 7.10: Description of the XC5 connector (full EBB board)

Connector	Signal	Function (factory default)	Specification
1	NC	-	-
2	DI8	Input 1 for the motor thermistor - PTC1 (See P0270)	Actuation: 3.9 kΩ Release:1.6 kΩ Minimum resistance: 100 Ω
3	DGND (DI8)	Input 2 for motor thermistor - PTC 2 (See P0270)	Referenced to DGND (DI8) through a 249 Ω resistor
4	DGND	0 V reference of the 24 Vdc power supply	Grounded via 249 Ω resistor
5	DO1	Transistor output 1: Not used	Isolated, open collector, 24 Vdc, max: 50 mA, required load (Rc) 500 Ω
6	COM	Common point DI7 digital input and DO1 and DO2 digital outputs	-
7	DO2	Transistor output 2: Not used	Isolated, open collector, 24 Vdc, max: 50 mA, required load (Rc) 500 Ω
8	24 Vdc	Power supply for digital inputs/outputs	24 Vdc ± 8% Isolated, Capacity: 90 mA
9	DI7	Isolated digital input: Not used	Minimum high level: 18 Vdc Maximum low level: 3 Vdc Maximum voltage: 30 Vdc Input current: 11 mA @ 24 Vdc
10	SREF	Reference for RS-485	Isolated RS-485 serial
11	A-LINE	RS-485 A-LINE	
12	B-LINE	RS-485 B-LINE	
13	AI3 +	Analog Input 3: Speed reference	Programmable differential (see P0243) Resolution: 10 bits (0.1% of full scale) Impedance: 400 kΩ (0 to 10) V 500 Ω [(0 to 20) mA/(4 to 20) mA]
14	AI3 -		
15	AGND	0 V reference for analog output (internally grounded)	Resolution: 11 bits (0.5% of full scale) Required load 600 Ω
16	AO1	Analog output 1: Speed	
17	AGND	0 V reference for analog output (internally grounded)	
18	AO2	Analog output 2: Motor current	
19	+V	External power supply for encoder repeater output (XC8)	External power supply: 5 to 15 V Consumption: 100 mA @ 5 V, excluding the outputs
20	COM 1		



Connector	Signal
1	NC
2	DI8
3	DGND (DI8)
4	DGND
5	DO1
6	COM
7	DO2
8	24 Vdc
9	DI7
10	SREF



Connector	Signal
11	A-LINE
12	B-LINE
13	AI3+
14	AI3-
15	AGND
16	AO1
17	AGND
18	AO2
19	+V
20	COM 1

Figure 7.8: Description of the XC5 connector (full EBB board)

WARNING!
The analog input AI3 and the analog outputs AO1’ and AO2’ isolation has the purpose of interrupting ground loops. Do not connect them to high potentials.

ENCODER CONNECTION: refer to Section 7.3 INCREMENTAL ENCODER on page 7-14

INSTALLATION
The EBB board is installed directly on the MVC4 control board, secured with spacers and connected via terminal blocks XC11 (24 V) and XC3.

Mounting instructions:

1. De-energize the control rack;
2. Configure the board as desired (switches S4, S5, S6 and S7, referring to Table 7.7 on page 7-8);
3. Carefully insert the XC3 pin bar connector (EBB) into the XC3 female connector on the MVC4 control board. Check the exact match of all the pins of the XC3 connector;
4. Press on the EBA board (near to XC3) and on the left top edge until the complete insertion of the connector and the plastic spacer;
5. Secure the board to the 2 metallic spacers with the 2 provided bolts;
6. Fit the XC11 connector on the EBB board to the XC11 connector on the control board (MVC4).

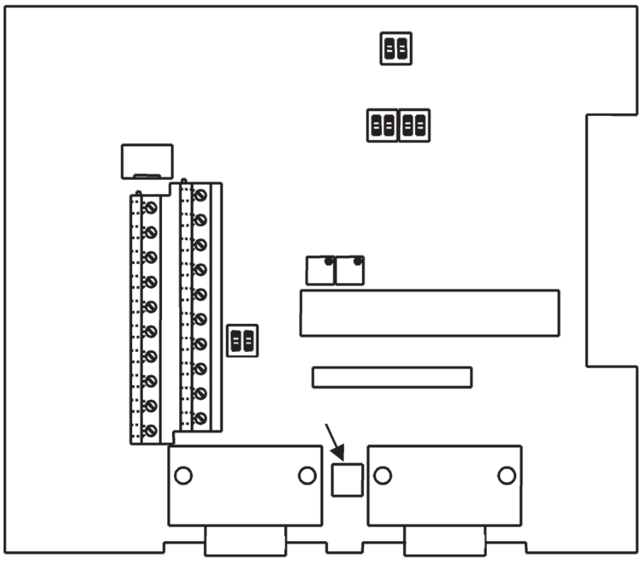


Figure 7.9: *Position of the adjustment elements - EBA board*

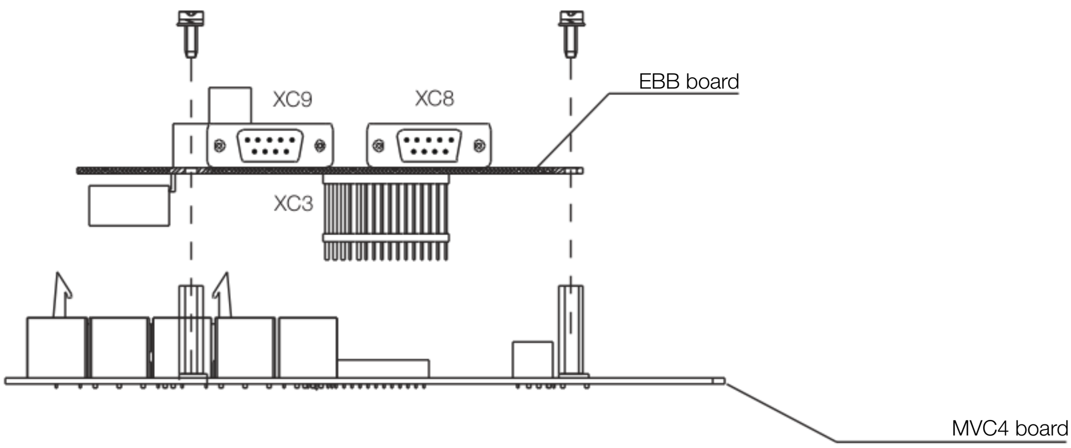


Figure 7.10: *Procedure to install the EBB board*

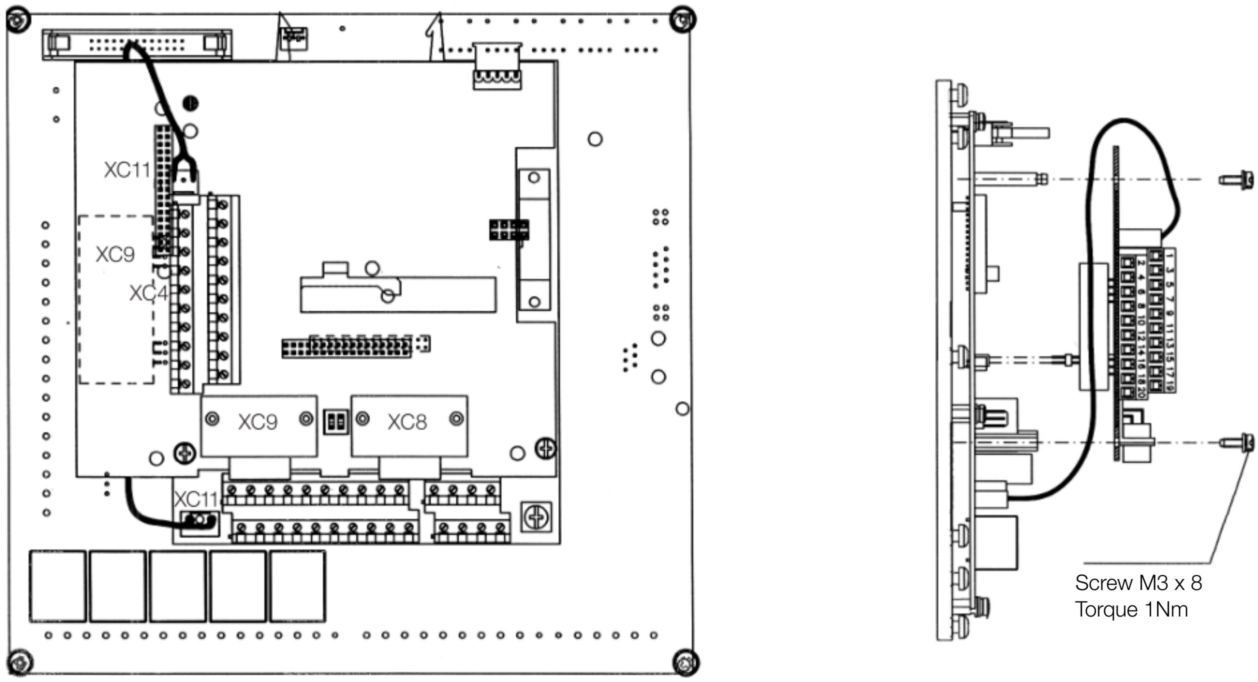


Figure 7.11: *Procedure to install the EBB board*

Table 7.11: *Configurations of the setting elements - EBB board.*

Setting	Function (factory default)	OFF	ON
S4.1	AI3 - P0241 = P0221/P0222	(0 to 10) V	(0 to 20) mA or (4 to 20) mA
S5.1 e S5.2	AO1 - P0251 = Motor speed	(0 to 20) mA	(4 to 20) mA
S6.1 e S6.2	AO2 - P0253 = Motor current		
S7.1 e S7.2	RS-485 B - LINE (+)	Without termination	With termination (120 Ω)
	RS-485 A - LINE (-)		

Table 7.12: *Configurations of the setting elements - EBB board.*

Trimpot	Function	Function (factory default)
RA5	AO1 - full scale	P0251 = Motor speed
RA6	AO2 - full scale	P0253 = Motor current

NOTE!
The external signal and control connection must be fitted to XC5 (EBB) observing the same recommendations as those for the connection of the MVC4 control board (see Section 7.1 MVC4 SIGNAL AND CONTROL CONNECTIONS on page 7-1).

7.2.3 PLC2

NOTE!
For further information, see the specific manual for the PLC2 board.

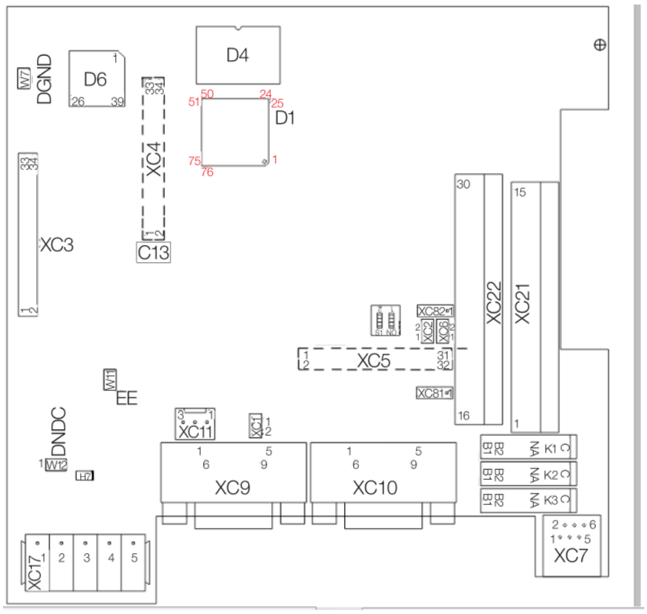


Figure 7.12: *PLC2 board connectors*

The connectors on the board and the function of their terminals are described below.

XC21 connector: Relay Outputs and Digital Inputs

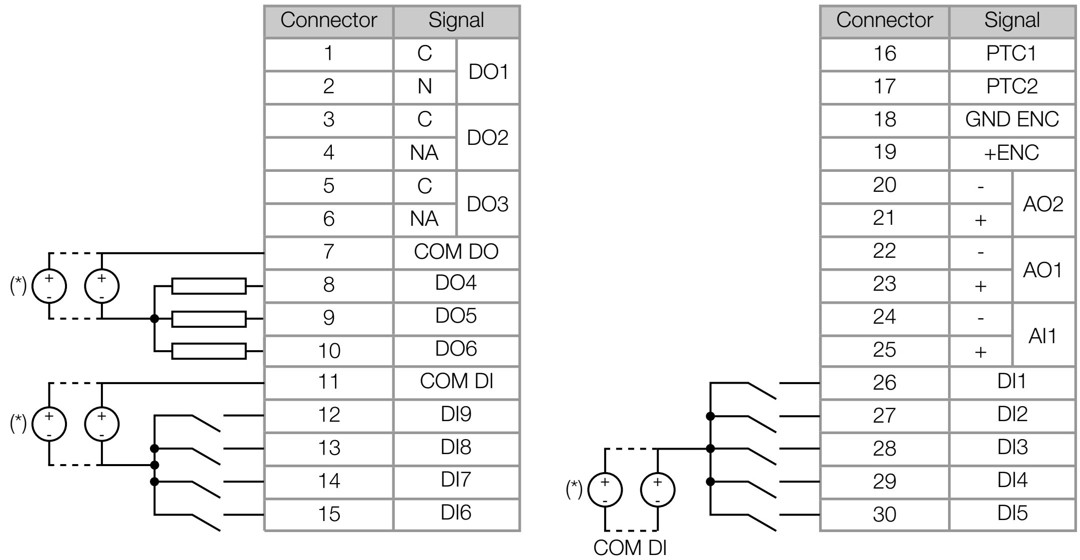
Table 7.13: *Description of the XC21 connector.*

Connector	Function		Description	Specification
1	C	DO1	Digital relay outputs	250 Vac, 3 A
2	NA			
3	C	DO2		
4	NA			
5	C	DO3		
6	NA			
7	COM DO		Common of the DO4...DO6 digital outputs	-
8	DO4		Bidirectional isolated digital inputs	48 Vdc, 500 mA
9	DO5			
10	DO6			
11	COM DI		Common of the DI1...DI9 inputs	-
12	DI9		Bidirectional isolated digital inputs	15-30 Vdc, 11 mA @ 24 Vdc
13	DI8			
14	DI7			
15	DI6			

Table 7.14: *Description of the XC22 connector.*

Connector	Function		Description	Specification
16	PTC1		Motor thermistor input	Actuation: 3900 Ω, Release: 1600 K
17	PTC2		PTC	Minimum Resistance: 100 Ω
18	GND ENC		Power supply reference for the encoder inputs	-
19	+ENC		Power supply for the encoder inputs	5 Vdc regulator or (8 to 24) Vdc, 50 mA (**)
20	-	AO2	Analog output 2, 12 bits	(-10 to +10) Vcc or (0 to 20) mA
21	+			
22	-	AO1	Analog output 1, 12 bits	
23	+			
24	-	AI1	Differential analog input 1, 12 bits	
25	+			
26	DI1		Bidirectional isolated digital inputs	15-30 Vdc, 11 mA @ 24 Vdc
27	DI2			
28	DI3			
29	DI4			
30	DI5			

NOTES:
NA = normally open contact.
C = common.



Connector	Signal	
1	C	DO1
2	N	
3	C	DO2
4	NA	
5	C	DO3
6	NA	
7	COM DO	
8	DO4	
9	DO5	
10	DO6	
11	COM DI	
12	DI9	
13	DI8	
14	DI7	
15	DI6	

Connector	Signal	
16	PTC1	
17	PTC2	
18	GND ENC	
19	+ENC	
20	-	AO2
21	+	
22	-	AO1
23	+	
24	-	AI1
25	+	
26	DI1	
27	DI2	
28	DI3	
29	DI4	
30	DI5	

Figure 7.13: *Description of the XC21 and XC22 connectors*

> **WARNING!**
> **(*)** External power supply.
> **(**)** For current, S1 switch must be ON.

7.3 INCREMENTAL ENCODER

Applications that require more speed or positioning accuracy, a speed feedback of the motor shaft by means of incremental encoder is required. The connection to the inverter is made through the XC9 connector (DB9) on the EBA function expansion board, or XC9 on EBB, or XC10 on EBC.

7.3.1 EBA/EBB Boards

When the EBA or EBB board is used, the selected encoder should have the following characteristics:

- Power supply voltage: 12 Vdc, less than 200 mA current consumption.

2 quadrature channels (90º) + zero pulse with complementary outputs (differential):

- Signals A, /A, B, /B, Z e /Z;
- Linedriver or "Push-Pull" output circuit type (12 V level);
- Electronic circuit isolated from the encoder frame;
- Recommended number of pulses per revolution: 1024 ppr.

Follow the recommendations bellow when mounting the encoder on the motor:

- Coupling the encoder directly to the motor shaft (using a flexible coupling, however without torsional flexibility);

- Both the encoder metallic housing and the shaft must be electrically isolated from the motor (minimum spacing: 3 mm);
- Use good quality flexible couplings that prevent mechanical oscillations or "backlash".

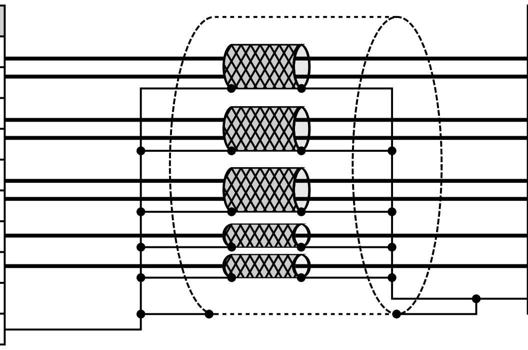
For electrical connection, use a shielded cable, keeping it as far as possible (> 25 cm) from other wiring (power, control etc.). Preferably, inside a metallic conduit.

During start-up, it is necessary to program parameter P0202 (Control Type) = 4 (Vector with Encoder) to operate with speed feedback by incremental encoder.

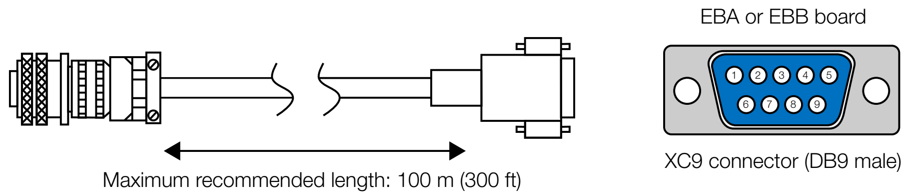
For further details on vector control, see the programming manual available for download on **www.weg.net**.

The function expansion boards EBA and EBB have an encoder signal repeater, isolated and externally powered.

Encoder[3]	Signal	Colour
A	A	Red
H	/A	Blue
B	B	Yellow
I	/B	Green
C	Z	Gray
J	/Z	Pink
D	+VE	White
F	COM	Brown
E	NC	
G	Ground	



XC9	Signal	Description
3	A	Signal encoder
2	/A	
1	B	
9	/B	
8	Z	
7	/Z	
4	+VE	Source[1]
6	COM	Reference 0 V[2]
5	Ground	Ground



(1) Encoder power supply 12 Vdc 200 mA;
(2) Referenced to ground with 1 uF parallel to 1 kOhm;
(3) Valid pinout for encoder HS35B Dynapar;
For other models of the encoder verify the correct connection to comply with the necessary sequence.

Figure 7.14: *EBA and EBB encoder input.*

> **NOTE!**
> The maximum allowed encoder signal frequency is 100 kHz.

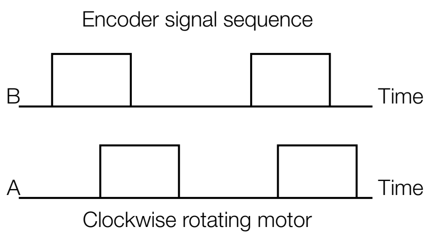


Figure 7.15: *Encoder Signals*

Table 7.15: Encoder signal repeater output.

Connector	Signal	Description
3	A	Encoder Signals
2	/A	
1	B	
9	/B	
8	Z	
7	/Z	
4	+V (*)	Power Supply
6	COM 1 (*)	Reference 0 V
5	Ground	Grounding

(*) For 5 V to 15 V external power supply, consumption 100 mA @ 5 V, excluding the outputs.

NOTE!

- Optionally, the external power supply may be connected via XC4:19 and XC4:20 (EBA) or XC5:19 and XC5:20 (EBB);
- Encoder Signals Line Driver differential (88C30). Average current value: 50 mA High level.

7.3.2 EBC1 Board

When the board EBC1 is used, the selected encoder should have the following characteristics:

- Power supply voltage: 5 V to 15 V;
- 2 quadrature channels (90 º) with complementary outputs (differential): Signals A, A, B and B;
- ”Linedriver” ou ”Push-Pull” output circuit type (with identical level as the power supply voltage);
- Electronic circuit isolated from the encoder frame;
- Recommended number of pulses per revolution: 1024 ppr.

7

INSTALLATION OF THE EBC1 BOARD

The EBC board is installed directly on the MVC4 control board, secured by means of spacers and connected through the XC3 connector.

Mounting instructions:

1. De-energize the control rack;
2. Carefully insert the XC3 pin bar connector (EBC1) into the XC3 female connector on the MVC4 control board; Check the exact match of all the pins of the XC3 connector;
3. Press the center of the board (near XC3) until the connector is completely inserted;
4. Secure the board to the 2 metallic spacers with the 2 provided bolts.

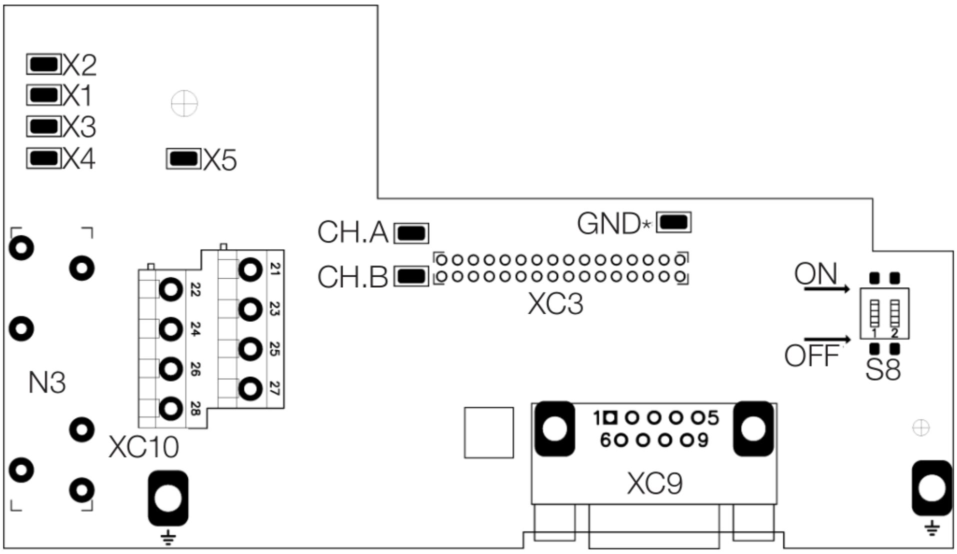


Figure 7.16: *Position of the setting elements - EBC1 board.*

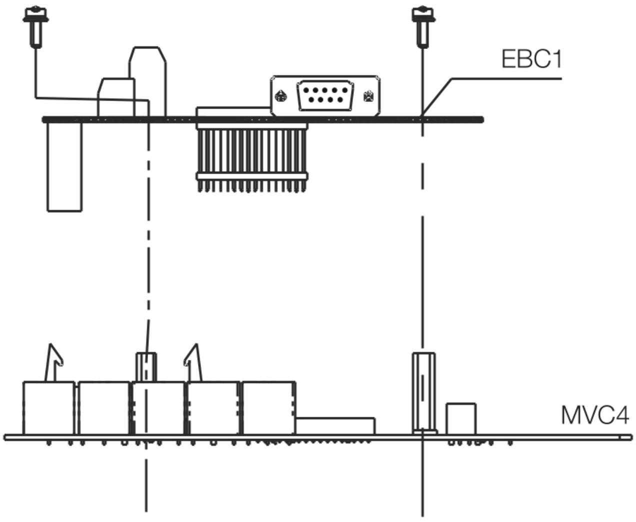


Figure 7.17: *Procedure to install the EBC1 board.*

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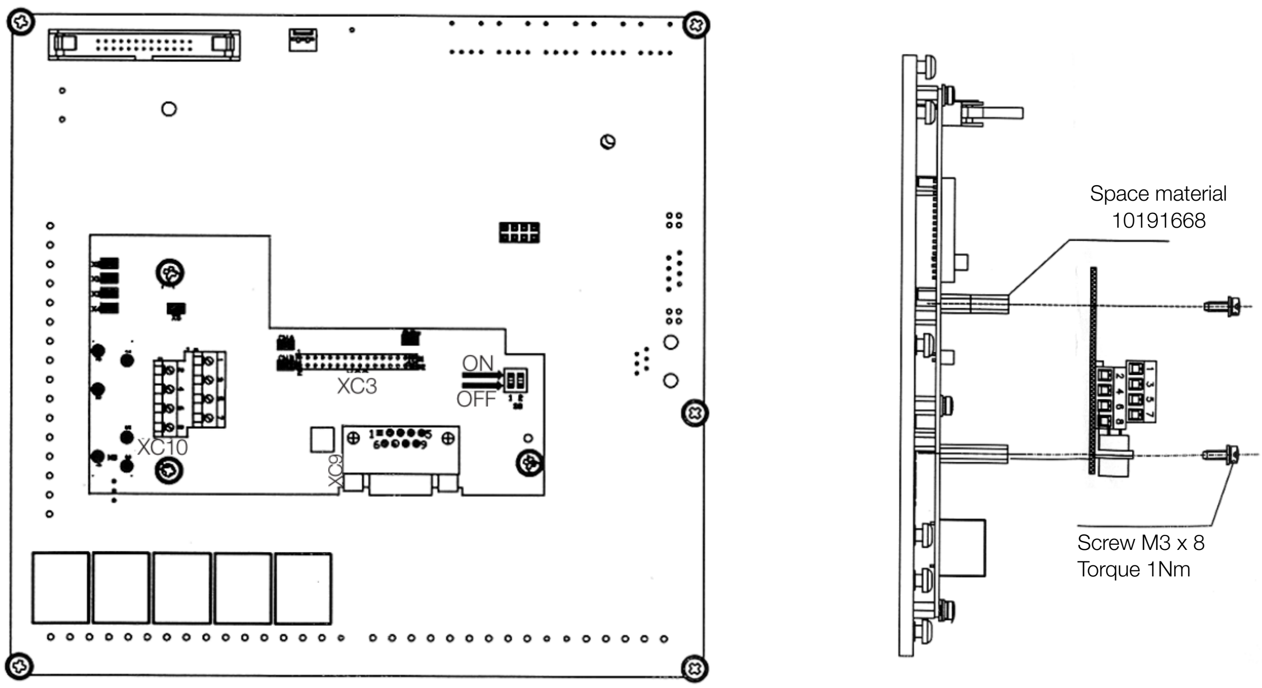


Figure 7.18: Procedure to install the EBC1 board

CONFIGURATIONS:

Table 7.16: Configurations of the setting elements - EBB board.

Expansion Board	Power supply	Encoder Voltage	Necessary Setting
EBC1.01	External 5 V	5 V	Switch S8 to ON, consult Figure 7.16 on page 7-17 for more details
	External 8 V to 15 V	8 V to 15 V	No action
EBC1.02	Internal 5 V	5 V	No action
EBC1.03	Internal 12 V	12 V	No action

NOTE!
The XC10:22 and XC10:23 terminals (see Figure 7.16 on page 7-17) should only be used to power the encoder if the connection to the DB9 connector is not used.

ENCODER MOUNTING:

Follow the recommendations bellow when mounting the encoder on the motor:

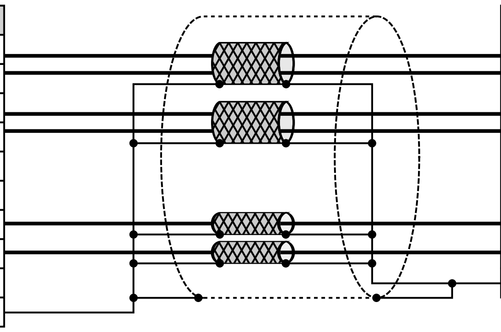
- Coupling the encoder directly to the motor shaft (using a flexible coupling, however without torsional flexibility);
- Both the shaft and the metallic frame of the encoder must be electrically isolated from the motor (minimum distance of 3 mm);
- Use good quality flexible couplings that prevent mechanical oscillations or “backlash”.

Use shielded cable for the electrical connection, keeping it as far as possible (> 25 cm) from the other wiring (power, control, etc.). Preferably, inside a metallic conduit.

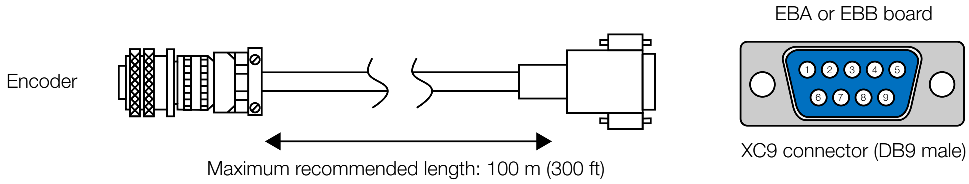
During start-up, it is necessary to program parameter P0202 (Control Type) = 4 (Vector with Encoder) to operate with speed feedback by incremental encoder.

For further details on vector control, see the programming manual available for download on **www.weg.net**.

Encoder[3]	Signal	Colour
A	A	Red
H	/A	Blue
B	B	Yellow
I	/B	Green
C	Z	
J	/Z	
D	+VE	White
F	COM	Brown
E	NC	
G	Ground	



XC9	XC10	Signal	Description
3	26	A	Signal encoder
2	25	/A	
1	28	B	
9	27	/B	
8	-	Z	
7	-	/Z	
4	21,22	+VE	Source[1]
6	23,24	COM	Reference 0 V[2]
5	-	Ground	Ground



(1) Encoder power supply 5 to 15 Vdc 40 mA;
(2) Referenced to ground with 1 uF parallel to 1 kOhm;
(3) Valid pinout for encoder HS35B Dynapar.
For other models of the encoder verify the correct connection to comply with the necessary sequence.

Figure 7.19: *EBC1 encoder input*

NOTE!
The maximum allowed encoder signal frequency is 100 kHz.

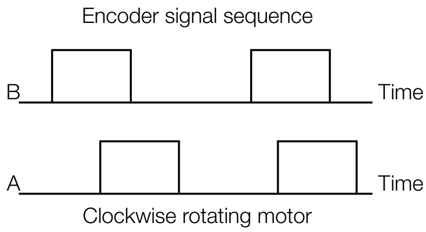


Figure 7.20: *EBC1 encoder signals*

7.4 SHORT UPS MODULE

The Short UPS module is an accessory that provides autonomy of approximately 500 ms in case of failure of the MVW3000 inverter auxiliary power supply. After the occurrence of the auxiliary power supply failure, the inverter remains operational, without faults, during 500 ms.

The module is based on a low voltage frequency inverter, CFW10 and an external capacitor bank, which ensure the energy supply to the power supplies during the specified period. A filter is added to the inverter output, necessary because of the characteristic of the fed loads.

The Short UPS feeds the following loads:

- PS1S power supply: responsible for feeding the gate drivers;
- PSS24 power supply: responsible for feeding the control;
- General command: input circuit breaker supply and its undervoltage release.

7.4.1 CFW10 Inverter Parameterization

For the correct operation of the Short UPS module, the CFW10 inverter must be parameterized as shown below:

- P100 = 1,0 (Acceleration time);
- P101 = 0,5 (Deceleration time);
- P121 = 57,4 (Output frequency);
- P206 = 3 (Auto-reset time);
- P222 = 0 (Remote speed reference);
- P263 = 0 (DI1 Digital input);
- P264 = 0 (DI2 Digital input);
- P265 = 4 (DI3 Digital input);
- P266 = 6 (DI4 Digital input);
- P297 = 10 kHz (Switching frequency).

7.5 MVC3 CONTROL BOARD CONNECTIONS

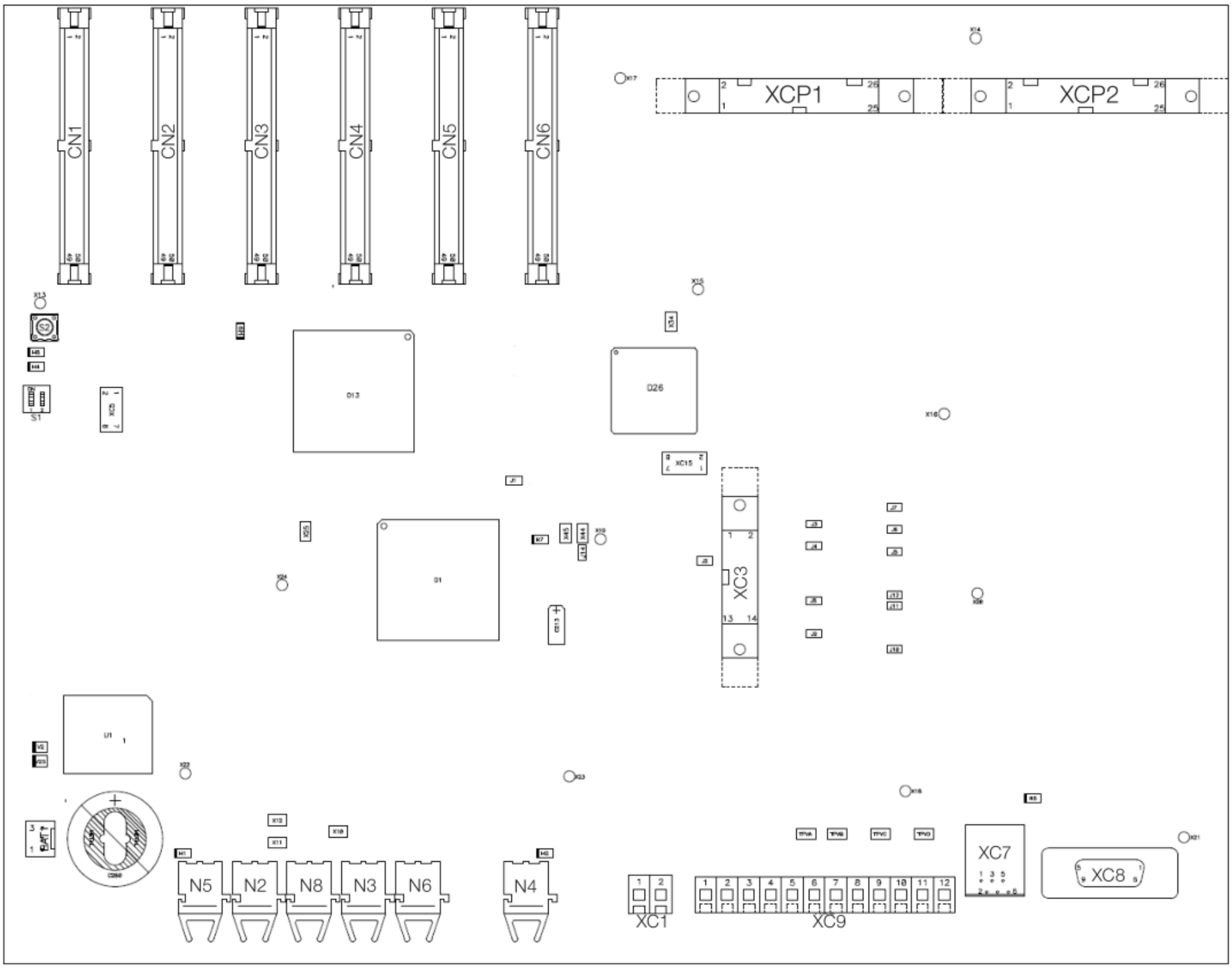


Figure 7.21: *MVC3 board connections*

Table 7.17: *XC9 terminal strip connections.*

Connector	Signal	Function (Factory default)	Specification
1	+5,4 V	Positive reference for potentiometer	+5,4 V +-5%, 2 mA
2	AI1-	P0740 (Function of analog input AI1 MVC3): 0 (Not used)	Differential, 11-bit resolution Impedance: 400 kΩ (-10 V to 10 V)
3	AI1+		
4	-4,7 V	Negative reference for potentiometer	-4,7 V +-5%, 2 mA
5	AO1+	P0652 (MVC3 AO1 Funct.): 2 (Iu rms)	Differential, 11-bit resolution -10 V to 10 V, RL ≥ 10 kΩ (Maximum load)
6	AGND		
7	AO2+	P0654 (MVC3 AO2 Funct.): 5 (g_usM)	Differential, 11-bit resolution -10 V to 10 V, RL ≥ 10 kΩ (Maximum load)
8	AGND		
9	AO3+	P0656 (MVC3 AO3 Funct.): 2 (Iu rms)	Differential, 11-bit resolution -10 V to 10 V, RL ≥ 10 kΩ (Maximum load)
10	AGND		
11	AO4+	P0658 (MVC3 AO4 Funct.): 5 (g_usM)	Differential, 11-bit resolution -10 V to 10 V, RL ≥ 10 kΩ (Maximum load)
12	AGND		

Table 7.18: *Description of the XC1 connector.*

Connector	Signal	Function (Factory default)	Specification
1	AI2-	P0744 (Function of analog input AI2 - MVC3): 0 (Not used)	Differential, 11-bit resolution Impedance: 400 kΩ (-10 V to 10 V)
2	AI2+		

WARNING!
The I/Os described above are not isolated. Their utilization must be with galvanic isolators.

7

8 SPECIAL FUNCTIONS

8.1 FUNCTION LOAD SHARING 'MAIN/ASSISTANT'

Conveyors belts and overhead cranes are classic examples of applications where the torque or position control is used to maintain the conveyor belt voltage within the limits during the operation, start and stop procedures or even in the transportation of materials in a rising or falling slope.

For motors connected to the same load, it is necessary to ensure a reliable load sharing. Such characteristic is best achieved with the use of multiple inverters operating in speed reference mode (Main) and torque limitation mode (Assistant(s)).

Implementation Modes

Three modes to implement the load sharing function will be presented. For the first two modes, it is mandatory that the inverters involved in the process are to be set to vector operating mode. For most applications, the vector operating mode with speed or position sensor is recommended.

In order to implement the load sharing, the inverter assigned as main controls the load speed using all the other inverters of the process as actuators.

In the vector mode, there are two ways to implement the load sharing function: in the first one, the main inverter sends the assistants the torque reference signal; in the second one, it sends the torque reference limitation signal. The mode to be used must be analyzed for each application.

For operation in scalar mode with load sharing, all inverters must receive the same speed reference signal. This type of load sharing is called "droop" or negative slip.

The three implementation methods and the main parameters used in each method are shown below.

Torque Reference - Operation in Vector Mode

One of the possible ways to implement the load sharing function is by parameterizing the assistant inverter(s) to follow an external torque reference, which will be sent by the main inverter. Figure 8.1 on page 8-1 shows the diagram of the torque reference control strategy.

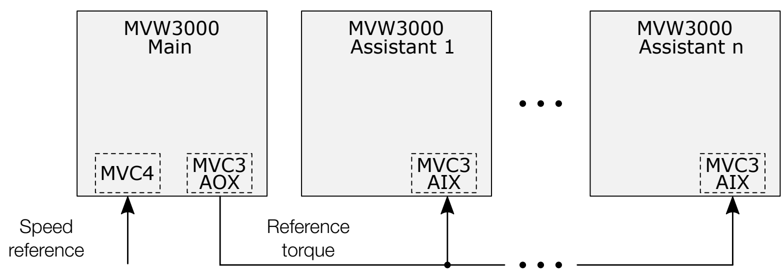


Figure 8.1: *General operating diagram of the torque reference function*

In order to do so, the inverters must be parameterized as follows:

Main:

Parameterize one of the analog outputs of the MVC3 control board to send the torque reference to the assistant inverter(s). In the example below, the analog output AO1 is parameterized.

P0652 (Analog Output 1 Function) = 188 (Inverter torque reference).

Assistant(s):

On the assistant inverter(s), it is necessary to parameterize an analog input of the MVC3 board to receive the torque reference sent by the main inverter.

P0740 (Analog Input 1 Function) = 1 (Torque reference).

NOTE!
Observe the polarity of the analog ones at the moment of the connection between the inverters.

Limitation of the Torque Current - Operation in Vector Mode

As in the previous mode, the main inverter operates in speed control mode, while the assistant inverter operates in torque current regulation mode. Besides the limit value of the torque current, the assistants inverter(s) receives the speed reference signal; therefore, in a potential situation of sudden load reduction, the speed reference is saturated, thereby avoiding a possible sudden acceleration of the motor.

The speed reference signal sent to the assistants inverter(s) must be set to a value slightly above the main inverter reference. It is recommended to apply an offset to the analog inputs of the assistant(s) greater than 5% added to the reference sent by the main inverter; the ideal value may vary according to the application. The general diagram of such control strategy is shown in Figure 8.2 on page 8-2 .

NOTE!
As the operation with negative torque reference is impossible, this method cannot be used for regenerative inverters or with dynamic braking.

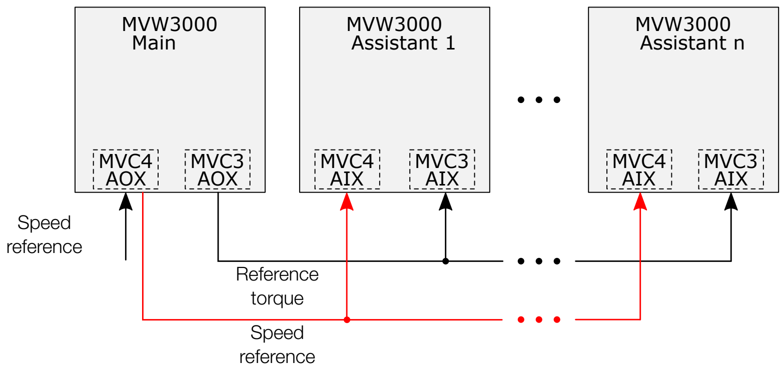


Figure 8.2: *General operating diagram of the torque current limitation function*

In order to do so, the inverters must be parameterized as follows:

Main:
Parameterize one of the analog outputs of the MVC3 board to send the torque current limit to the assistant inverter(s). The example below shows the parameterization of analog output AO1 of the MVC4 board to send the speed reference.

P0652 (Analog Output 1 Function - MVC3) = 188 (Inverter torque reference).

P0251 (Analog Output 1 Function - MVC4) = 0 (Speed reference).

Assistant(s):
The assistant inverter(s) requires the parameterization of an analog input of the MVC3 board to receive the torque current limit sent by the main inverter. For the speed reference, use the analog input AI1 of the MVC4 board, whose standard function is the speed reference signal.

P0740 (Analog Input 1 Function - MVC3) = 2 (Torque Current Limit).

P0221/P0222 (Speed Reference Selection Local/Remote Situation) = 1 (AI1 - MVC4).

P0236 (Offset Input AI1) = 5.0%.

P0133 (Minimum Speed Reference) = set according to the application.

P0134 (Maximum Speed Reference) = set according to the application; it must be 5% above the maximum limit of the main inverter.

Negative Slip – Operation in Scalar Mode

This method to implement the load sharing function is limited to applications of induction motor drive. It is based on the decrease of the frequency according to the increase of load on the motor; thus there is a natural distribution of the loads.

Regardless of the chosen speed reference source, it must be sent to all inverters. Due to the low accuracy of analog inputs, its use as speed reference source is not recommended.

This method to implement the load sharing must not be used for applications that require dynamic performance, which can only be used when the inverters drive motors with the same characteristic slip. Figure 8.3 on page 8-3 shows the general diagram of the control strategy by negative slip.

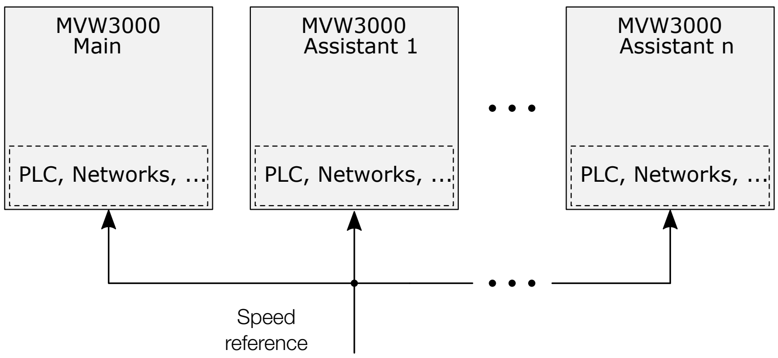


Figure 8.3: *General operating diagram of the negative slip function*

Therefore, the inverters must be parameterized as follows:

P0138 (Rated slip) = the motor slip is recommended (negative signal).

P0139 (Output current filter) = it is recommended to start with the standard value and gradually increment it if the system presents instability.

Besides the presented parameter settings, the implementation of the load sharing function requires that all inverters involved in the process be enabled simultaneously; thus, the "General Enable" and "Run/Stop" signal must be sent to all inverters at the same time. There are several ways to meet such requirement and the most appropriate method will depend on each application.

The description given of the ways to implement the load sharing function intends neither to approach all possibilities of implementation, nor to detail all the aspects involved. The definition of the best implementation mode for a certain application, as well as the optimal adjustment of each mode must be defined by WEG engineering and application teams.

8.2 SYNCHRONOUS TRANSFER FUNCTION

For applications where speed variation is not required during operation, the synchronous transfer function enables the motor to be accelerated through the inverter up to the rated operating frequency, and then the transfer to the supply line occurs. Thus, it is possible to eliminate the effects of the starting current related to a direct on-line start, and the inverter is sized only for the motor starting condition.

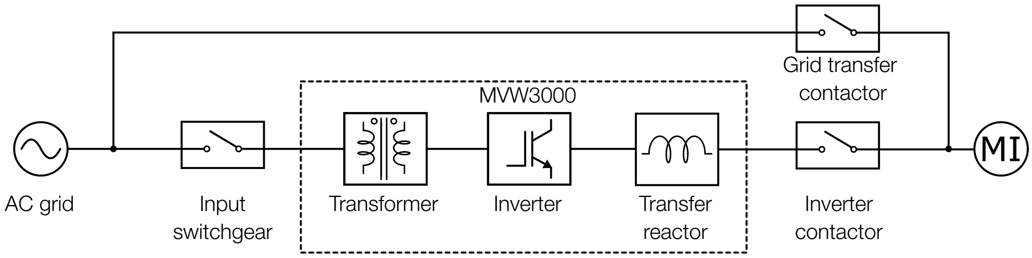


Figure 8.4: *General scheme of synchronous transfer*

Basic Settings

The synchronous transfer process involves accelerating the motor up to the rated speed, synchronizing the voltage imposed to the motor with the line voltage, and making the transfer to the line. For the transfer to occur properly and with minimal impact on the motor and on the inverter, a series of parameters must be carefully adjusted so as to ensure the phase synchronization, the minimum difference of the RMS value between the inverter and the line voltages and the timely occurrence of each step of the process.

Even with the correct setting of parameters related to the synchronous transfer process, it is necessary to use a reactor between the inverter and the motor in order to absorb differences between the inverter and the line voltage, thus protecting the inverter during the closing of the line contactor.

Therefore, after making all the start-up procedure for inverter with operation in normal mode, it is necessary to:

- Configure the motor voltage **(P0400)** to the same value as the electric grid voltage where the motor will be transfered. In the synchronous transfer operation, the inverter uses this value to calculate the RMS voltage that will be imposed to the motor when operating at rated frequency;
  E.g.: motor nameplate voltage of 4000 V and grid of 4160 V; Configure P0400 = 4160 V;
- Configure the inverter in synchronous transfer mode;
- Choose one of the DIs available on the MVC4 board (DI3 to DI10) and configure it to start the synchronous transfer (**P0265 to P0272 = 23 or 25)**;
- Configure a DO (RL1 to RL5) to indicate that the synchronism with the network is "OK" **(P0277 to P0282 = 34)**.

Parameterization Used for Most Applications

In addition to the aforementioned basic settings, other parameters must be set for the correct operation of the function below. Below is a brief description of each parameter and the setting used in most applications.

- **P0629 = 2 s -** Minimum time for which the inverter will have to keep the phase error between the input and output voltage lower than the setting in P0632 so as to signal synchronism OK.
- **P0630 = 60 s -** Synchronism with the network time out. Time counted from the activation of the MVC4 DI that starts the search until the signaling of synchronism OK. If this time is exceeded, A0008 will be indicated.
- **P0631 = set in the application -** Delay of the PIC2 board DI13 used to disable the inverter after the transfer. This time is used to compensate the transfer circuit delay, preventing the motor from remaining a period without voltage.
- **P0632 = 1966 -** Phase error between the mains and the inverter voltage used together with P0629 to indicate synchronism OK. **(P0632/65536)*360° = value in degrees.**

- **P0636 = set in the application -** Parameter used to compensate the phase error between the voltage the inverter uses as reference for synchronism and the actual voltage in the point where the motor will be connected to the mains.

Possible setting between (-180 ° and +180º). **(P0636/65536)*360º = value in degrees.**

Operation sequence

Figure 8.5 on page 8-5 describes all the operating sequence of the signals involved in the synchronous transfer process.

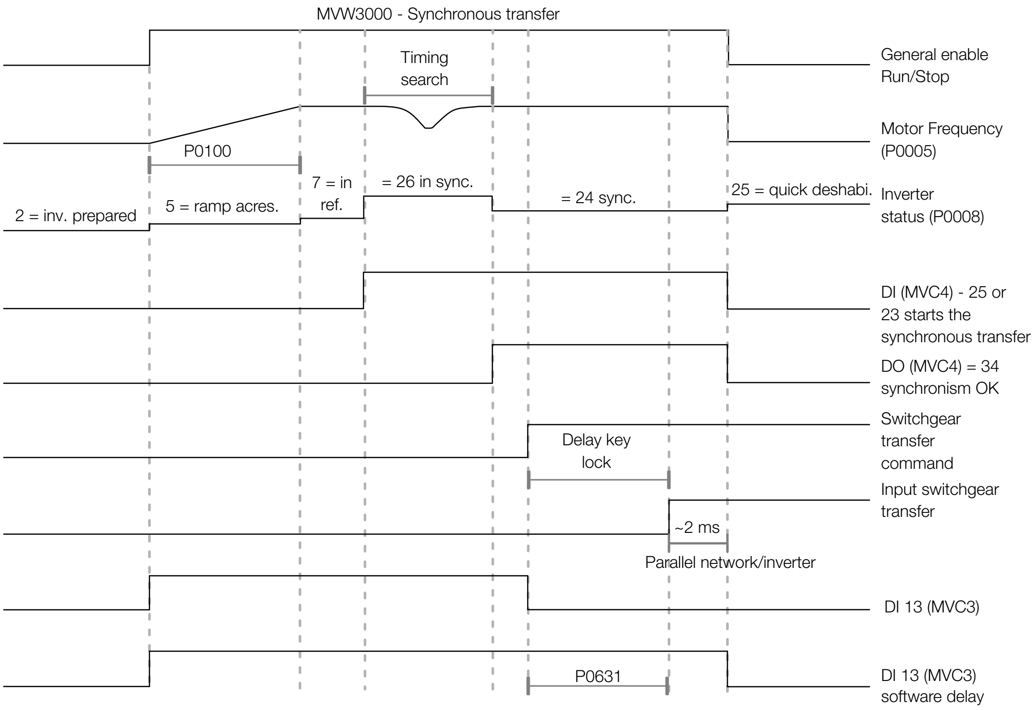


Figure 8.5: *Operating diagram of the synchronous transfer function*

8

8.3 CELL BYPASS

The MVW3000 has the cell bypass system as optional function. For this function to be available, the MVW3000 power cells must have the bypass system integrated. The bypass system goes into operation if some fault is detected inside a cell. If a fault occurs, the main control requests the local control to activate the bypass system, the main control inhibits the IGBT command pulses of the cell and starts ignoring the fault signals of this cell, informing that the cell number “X” of phase “Y” went into bypass mode.

It is important to point out that during this process, the inverter continues operating normally with a small reduction in the output voltage. Control techniques will be used for the application to continue operating normally. For applications that cannot operate with reduced voltage, it is recommended to use an MVW3000 with voltage above the motor rated voltage so as to withstand the load at full voltage even with a higher number of cells out of operation simultaneously.

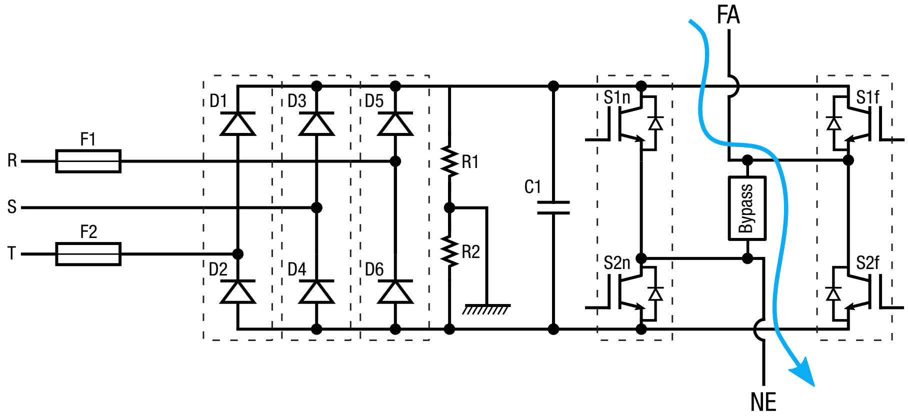


Figure 8.6: *Power cell with bypass system active*

Figure 8.6 on page 8-6 represents the operation of the power cell with the bypass system active. The current of the respective phase passes through the bypass system so as not to reduce the inverter current capacity. That is a consequence of the connection in series of the power cells.

8.4 AMPLITUDE ADJUSTMENT

During the operation of the MVW3000 in bypass mode, the inverter current capacity is preserved, because of the connection is series of the power cells. Differently, the maximum voltage available at the motor terminals will smaller, due to the connection in series. Such effect is not desired, since the motor torque is directly related to the voltage and current applied to its terminals. In addition to the smaller voltage available for the load, the inverter output also becomes unbalanced, jeopardizing the motor operation. Those problems can be circumvented by using the technique of amplitude adjustment between the converter phases.

This technique consists of changing the modulation indices of the cells to compensate for phase differences and maintain the balance between the line voltages. Thus it is possible to balance the line voltages, keep the three amplitudes equal and have a smaller impact of the cell bypass on the output voltage applied to the motor. In order to exemplify how the technique works, it is possible to represent an 18-cell MVW3000 with 9 cells (3 per phase), by 9 voltage sources (3 in series per phase, connected in Y). Under normal operation of the inverter, with all the cells operating, the phase voltages are shifted 120° between each other, and the line voltages have the same amplitude, as shown in Figure 8.7 on page 8-7 .

In bypass operation, without the amplitude adjustment technique, the line voltages become unbalanced, since the amplitude of the phase whose cell has been bypassed is reduced, as shown in Figure 8.7 on page 8-7 . In practice, this case is not compatible with the operation of the application; therefore, as soon as the cell is bypassed, the inverter applies the amplitude adjustment method to balance the line voltages.

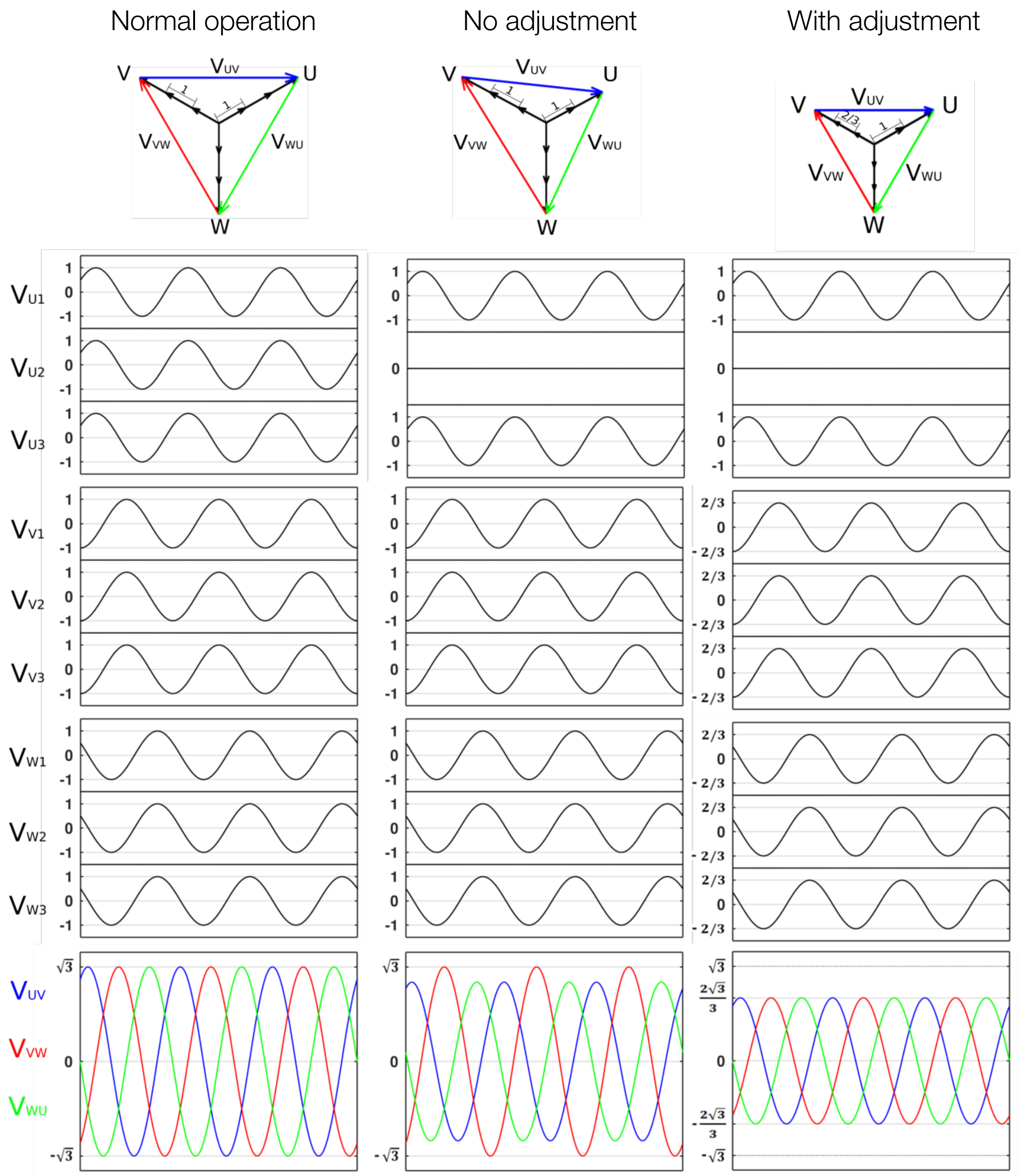


Figure 8.7: *Phase (center) and line (below) voltage diagrams during a bypass*

With the amplitude adjustment, shown in Figure 8.7 on page 8-7, it is possible to observe that the line voltages remain balanced. The phase voltage amplitudes are controlled to ensure the balance among the line voltages. The voltage available at the motor terminals for such condition is 67% (0.667 p.u.) of the inverter rated voltage.
The graph of Figure 8.8 on page 8-8 shows the line voltage obtained (in p.u) after the bypass of one cell on inverters with 2 to 12 cells per phase (range of possible values for the MVW3000).

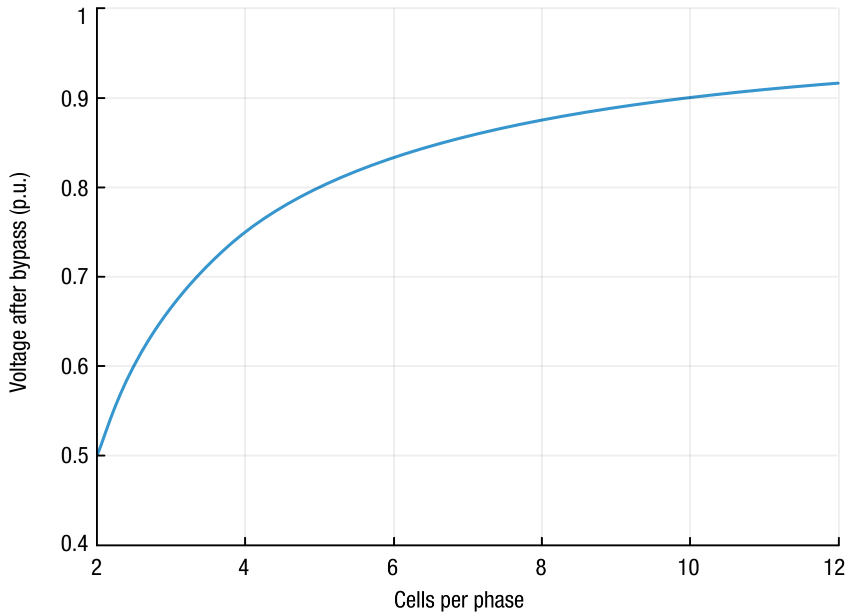


Figure 8.8: *Voltage after bypass of one cell*

NOTE!
For other possible configurations in bypass, contact WEG technical assistance.

9 COMMUNICATION NETWORKS

The MVW3000 can be connected to communication networks allowing control and parameter setting.

For the MVW3000 to communicate on the Profibus DP, DeviceNet, Ethernet/IP or PROFINET network, it is necessary to use a communication board provided via an optional kit with the desired Fieldbus standard.

9.1 FIELDBUS

Kit fieldbus Profibus DP-V0 (code 10932880)

Quantity	Description	Code
1	ABS Profibus DP communication board	10413436
1	Connection cable	10050246

Kit fieldbus Profibus DP-V1 (code 10933427)

Quantity	Description	Code
1	ABS Profibus DP-V1 communication board	10413449
1	Connection cable	10050246

Kit fieldbus DeviceNet (code 10932883)

Quantity	Description	Code
1	ABS DeviceNet communication board	10049957
1	Connection cable	10050247

Kit fieldbus DeviceNet Drive Profile (code 10933426)

Quantity	Description	Code
1	ABS DeviceNet communication board	10413437
1	Connection cable	10413374

Kit fieldbus Ethernet/IP (code 10933495)

Quantity	Description	Code
1	ABS Ethernet/IP communication board	10413441

Kit fieldbus Profinet (code 13760262)

Quantity	Description	Code
1	ABS PROFINET IO communication board	13759351

NOTE!

- For communication with Modbus-TCP/IP protocol, use the Ethernet/IP fieldbus Kit;
- The chosen Fieldbus option can be specified in the appropriate field of the the MVW3000 coding. In this case, the user receives the MVW3000 with all the necessary components already installed on the product. In the subsequent purchase of the optional Fieldbus Kit, the installation must be done by the user himself.

9.1.1 Introduction

This chapter provides the necessary description for network operation of the MVW3000, using the optional communication board for Profibus DP, DeviceNet, Ethernet/IP and PROFINET. The subjects covered in this item include:

- Description of the communication kit;
- Characteristics of the MVW3000 on fieldbus network;
- Parameter settings of the MVW3000;

- Operation of the MVW3000 via fieldbus interface;
- Errors and possible causes.

FIELDBUS NETWORK

"Fieldbus" is a generic term used to describe a digital communication system connecting various equipment in the field, such as sensors, actuators and controllers. A fieldbus network functions like a local communication network.

Currently, there are several different protocols used for communication between devices in the field, including the Profibus DP, DeviceNet, Ethernet/IP and PROFINET protocols. In this item, which deals with the use of communication board for the Profibus DP, DeviceNet, Ethernet/IP and PROFINET protocols, the term fieldbus will be used to generically designate these protocols.

ABBREVIATIONS AND DEFINITIONS

CAN	Controller Area Network
DP-V0	Decentralized Periphery Version 0
DP-V1	Decentralized Periphery Version 1
I/O	Input / Output
ODVA	Open DeviceNet Vendor Association
CLP	Programmable Logic Controller
HMI	Human Machine Interface

NUMERICAL REPRESENTATION

- Decimal numbers are represented by means of digits without suffix;
- Hexadecimal numbers are represented with the letter 'h' after the number.

9.1.2 Installation

The communication board that forms the Fieldbus kit is directly installed on the MVC4 control board, connected to the XC140 connector and fixed by spacers.

> **NOTE!**
> Follow the safety instructions in Chapter 1 SAFETY NOTICES on page 1-1 .

If a function expansion board (EBA/EBB) is already installed, it is necessary to remove it temporarily.

1. De-energize the control rack;
2. Remove the screw attached to the metal spacer near the XC140 connector (MVC4);
3. Carefully insert the pin bar connector of the Fieldbus electronic board into the XC140 female connector of the MVC4 control board. Check the exact match of all the pins of the XC140 connector according to Figure 9.1 on page 9-3 ;
4. Press the board near XC140 and on the lower right corner until the connector and plastic spacer are completely inserted;

5. Fix the board to the metal spacer using the screw;
6. Connect one end of the cable to the control rack the MVW3000, and the other end to the Fieldbus board.

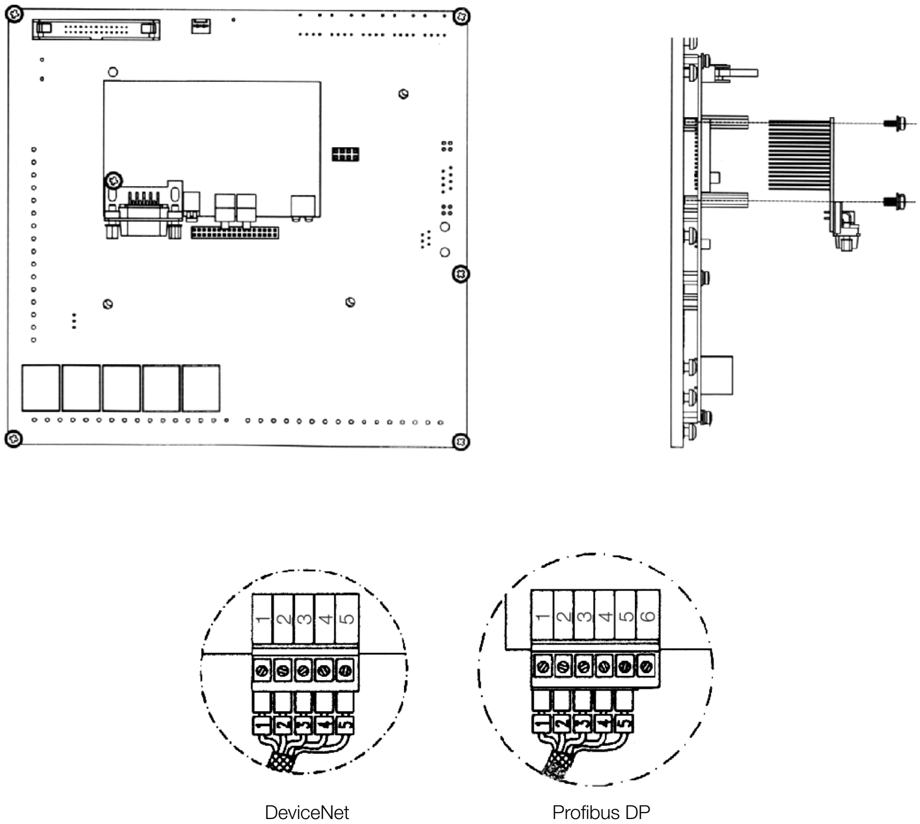


Figure 9.1: *Installing the Fieldbus electronic board*

9.1.3 Fieldbus communication parameters

The MVW3000 has a set of parameters, described below, for setting the device on the Fieldbus network. Before starting the network operation, it is necessary to configure these parameters so that the inverter operates as desired.

P0309 - Fieldbus			
Adjustable range:	0 to 13	Factory setting:	0

This parameter allows enabling the fieldbus board and setting the number of words communicated between the MVW3000 and the network master.

P0309	Function
0	Inactive
1	Profibus DP 2 I/O
2	Profibus DP 4 I/O
3	Profibus DP 6 I/O
4	DeviceNet 2 I/O
5	DeviceNet 4 I/O
6	DeviceNet 6 I/O
7	Modbus-RTU 2 I/O
8	Modbus-RTU 4 I/O
9	Modbus-RTU 6 I/O
10	DeviceNet Drive Profile
11	Ethernet 2 I/O
12	Ethernet 4 I/O
13	Ethernet 6 I/O

It is possible to select three different communication options, containing 2, 4 or 6 input/output words (2, 4 or 6 words, where 1 word = 2 bytes). The content of each word is described in the Section 9.1.9 Operation via network on page 9-24 .

NOTE!
The Ethernet settings include the Ethernet/IP, Profinet-IO and Modbus TCP/IP protocols.

P0313 - Disabling with alarm A128, A129 and A130

Adjustable range: 0 to 5 Factory setting: 0

If the drive is being controlled via network, and a problem communicating with the master occurs (cable break, power failure, master failure, etc.), it will not be possible to send a command via network to disable the device. In applications where that is an issue, it is possible to program an action in P0313 that the MVW3000 will automatically execute in case of a network failure.

Table 9.1: *Communication error action*

P0313	Function
0	Stop by ramp
1	General disable
2	No action
3	Go to LOC
4	Reserved
5	Fault

For fieldbus communication, errors 129 (Fieldbus Connec. Inactive) and error 130 (Fieldbus board inactive) are considered communication errors.

- **0 - Disable via Run/Stop**: It disables the motor by deceleration ramp in case of a communication error.
- **1 - Disable via General Enable**: In this option, the MVW3000 cuts off the power to the motor, which should coast to a stop.
- **2 - Inactive**: if one of the errors previously mentioned occurs, the drive remains in its current state and only indicates the error.
- **3 - Go to LOCAL**: If you are operating in REMOTE mode, and a communication error occurs, it will automatically go to LOCAL mode.
- **5 - Fault**: Upon detecting a communication fault, it will go to the error state, the motor will be disabled, and the error indication will only be removed after resetting the device errors.

NOTE!
The Disable via Run/Stop and Go to LOCAL commands can only be executed if they are being controlled via fieldbus. This setting is done through parameters P0220 (LOCAL/REMOTE selection source), P0224 (Start/Stop Selection LOCAL Situation) and P0227 (Start/Stop Selection REMOTE Situation).

LOCAL setting:

P0220 - LOCAL/REMOTE selection source

P0221 - Speed reference selection LOCAL situation

P0223 - Forward/Reverse Selection LOCAL Situation

P0224 - Start/Stop Selection LOCAL Situation

P0225 - Selection of JOG Source LOCAL Situation

REMOTE setting:

P0220 - LOCAL/REMOTE selection source

P0222 - Speed reference selection REMOTE situation

P0226 - Selection of Direction of ROTATION REMOTE Situation

P0227 - Start/Stop Selection REMOTE Situation

P0228 - JOG Selection - REMOTE Situation

These parameters define the source of commands and references for the inverter in the LOCAL and REMOTE modes. For the commands that will be controlled via network, set it in the "Fieldbus" option.

P0275 - DO1 Function

P0276 - DO2 Function

P0277 - RL1 Function

P0279 - RL2 Function

P0280 - RL3 Function

P0281 - RL4 Function

P0282 - RL5 Function

These parameters define the function of the inverter digital outputs.
For the digital outputs that will be controlled via network, set it in the "Fieldbus" option.

9.1.4 Profibus DP

The term Profibus is used to describe a digital communication system that can be used in several application fields. It is an open and standardized system, defined by IEC 61158 and IEC 61784 standards, which covers from the physical medium used to data profiles for certain device sets.
In this system, the DP communication protocol was developed to allow fast, cyclical and deterministic communication between masters and slaves.

Among the various communication technologies that can be used in this system, Profibus DP technology means a solution that is typically composed of the DP protocol, RS-485 transmission medium and application profiles, used mainly in applications and devices focused on manufacturing automation.

Currently, there is an organization called Profibus International, responsible for maintaining, updating and disseminating Profibus technology among users and members. Further information regarding the technology, as well as the complete protocol specification, can be obtained from this organization or from one of the regional associations or centers of competence linked to the Profibus International.

9.1.4.1 Baud rates

The Profibus DP protocol defines a series of baud rates that can be used, from 9.6 Kbit/s to 12 Mbit/s. The maximum length of the transmission line depends on the baud rate used, and this relationship is shown in Table 9.2 on page 9-6.

Table 9.2: *Baud rate and cable length*

Baud rate [kbps]	Maximum cable length [m]
9.6	1200
19.2	1200
45.45	1200
93.75	1200
187.5	1000
500	400
1500	200
3000	100
60000	100
12000	100

The of the MVW3000 communication board has automatic baud rate detection, according to the settings of the network master, and setting this option is not required.

9.1.4.2 Addressing

The Profibus DP protocol allows connecting up to 126 devices to the network, among masters and slaves, with addresses from 0 (zero) to 125 (addresses 126 and 127 are reserved). Each device on the network must have a different address.

The MVW3000 has two rotating switches that allow selecting the address on the Profibus DP network from 0 (zero) to 99. The drive address is formed by the values of those switches, where the left rotating switch (next to the Profibus connector) provides the tens digit, while the right rotating switch (next to the LED indicators) provides the units digit.

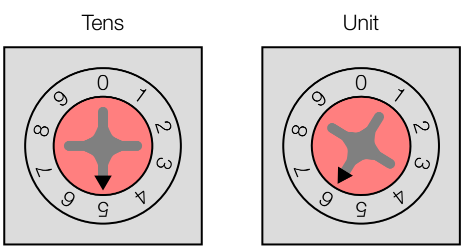


Figure 9.2: *Example showing how to set address 56 on the Profibus DP board*

9.1.4.3 LED indicators

The Profibus DP communication board has four LEDs for the device diagnostics.

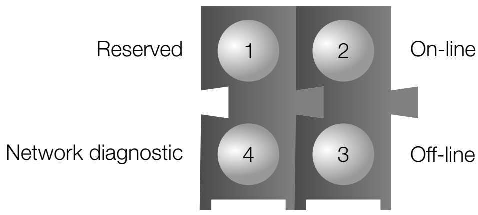


Figure 9.3: *Profibus DP network status LEDs*

Table 9.3: *Network status LED indicators*

LED	Color	Function
On-line	Green	**Off:** drive is not online **On:** drive is online
Off-line	Red	**Off:** drive is not offline **On:** drive is offline
Network diagnostics	Red	**Off:** without diagnostics **Flashing 1 Hz:** error in the setting of the number of input and/or output words communicated with the master **Flashing 2 Hz:** error in parameter data communicated via network (not used) **Flashing 4 Hz:** error in the initialization of the component responsible for processing the Profibus communication (ASIC)

9.1.4.4 Connector

For connection to the network, the fieldbus kit for Profibus DP of the MVW3000 has a connecting cable with a 6-way plug-in connector at one end that must be connected to the communication board and a female DB9 connector at the other end used for connection to the Profibus DP busbar. The pinout of these connectors follows the description in Table 9.4 on page 9-7 .

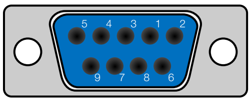


Table 9.4: *Connection of (DB9) pins for Profibus DP*

Pin	Description	Function
1	Not connected	-
2	Not connected	-
3	B-Line	Positive RxD/TxD, according to RS-485 specification
4	Not connected	-
5	GND	0 V isolated from the RS-485 circuit
6	+5 V	+5 V isolated from the RS-485 circuit
7	Not connected	-
8	A-Line	Negative RxD/TxD, according to RS-485 specification
9	Not connected	-
Frame	Shield	Connected to the protective earth (PE)

9.1.4.5 Profibus DP cable

In the installation, it is recommended to use type A cable, whose characteristics are described in Table 9.5 on page 9-7 . The cable has a pair of wires that must be shielded and twisted to ensure greater immunity to electro-magnetic interference.

Table 9.5: *Properties of type A cable*

Impedance	135 to 165 Function
Capacitance	30 pF / m
Resistance and loop	110 Ω / km
Cable diameter	> 0.64 mm
Wire cross section	> 0.34 mm^2

9.1.4.6 Connection of the drive to the network

The Profibus DP protocol, using RS485 physical medium, allows connecting up to 32 devices per segment without repeaters. With repeaters, up to 126 addressable devices can be connected to the network. Each repeater must also be included as a device connected to the segment, although it will not take an address in the network.

It is recommended that all the devices present on the Profibus DP network be connected from the main bus. In general, the connector of the Profibus network itself has one input and one output for the cable, allowing the connection to be taken to the other points of the network. Shunts from the main line are not recommended, especially for baud rates greater than or equal to 1.5 Mbit/s.

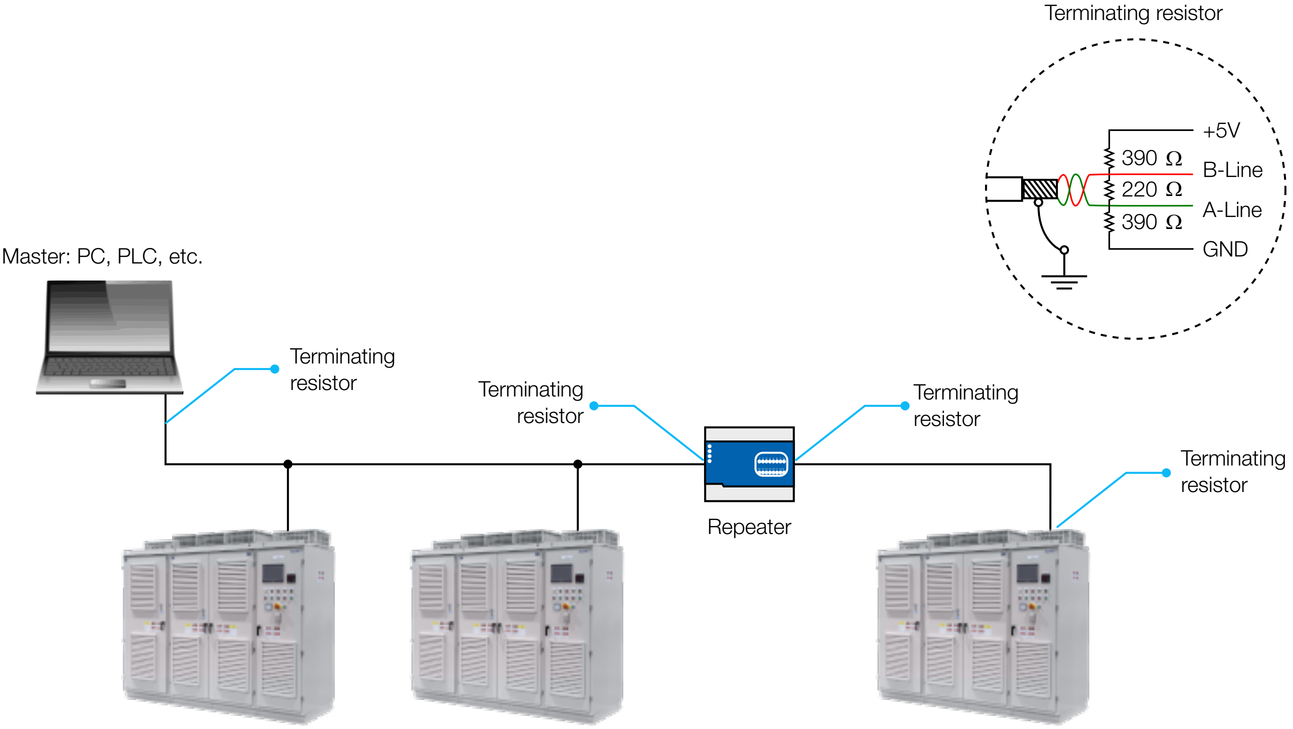


Figure 9.4: *MVW3000 on Profibus DP network*

The Profibus DP network cable must be routed separately (and if possible distant) from the power supply cables. All drives must be properly grounded, preferably on the same connection with the ground. The Profibus cable shield must also be grounded. The DB9 connector of the Profibus board of the MVW3000 already has a connection to the protective earth and, thus, connects the shield to the ground when the Profibus connector is connected to the drive. However, a better connection, by means of fixing clamps between the shield and a grounding point, is also recommended.

9.1.4.7 Termination resistor

9

For each segment of the Profibus DP network, it is necessary to enable a termination resistor at the ends of the main bus. The communication board of the MVW3000 itself has a switch for enabling the resistor, which should only be enabled (ON position) if the drive is the first or the last element in the segment.

That switch must also remain disabled if the Profibus DP network connector already has the termination resistor enabled.

It is worth to mention that, to allow disconnecting the element from the network without damaging the bus, it is recommended to place active terminations, which are elements that just play the role of the termination. Thus, any drive on the network can be disconnected from the bus without damaging the termination.

9.1.4.8 Configuration file (GSD file)

Every element of the Profibus DP network has an associated configuration file with GSD extension. This file describes the features of each device, and it is used by the configuration tool of the Profibus DP network master. During the master configuration, the GSD configuration file, supplied with the equipment, must be used. The communication board used by the MVW3000 was developed by the company HMS Industrial Networks AB. Therefore, in the network configuration software, the product will not be recognized as MVW3000 but as “AnyBus-S PDP” or “AnyBus-S Profibus DPV1” in the “General” category.

9.1.4.9 Profibus DP-V1 – Access to parameters

The DP-V1 communication kit supports class 1 and 2 DP-V1 services. By using these services, in addition to the exchange of cyclic data, it is possible to read/write on parameters through DP-V1 acyclic functions, via both the network master and a commissioning tool. Parameters are mapped based on the index and slot addressing, as shown in the equation below:

- Slot: (parameter number - 1) / 255.
- Index: (parameter number -1) MOD 255.

Example: Parameter P0100 will be identified through acyclic messages as located in slot 0, index 99.
Parameter P0312 will be identified through acyclic messages as located in slot 1, index 57.

The value for the parameters is always communicated with a size of 2 bytes (1 word). The value is also transmitted as an integer, without a decimal point, and its representation depends on the resolution used.

Example: P0003 = 3.6 A → The value read via network is 36.

9.1.5 DeviceNet

Initially developed by Allen-Bradley in 1994, the DeviceNet communication protocol is used to interconnect controllers and industrial devices, such as sensors, valves, starters, barcode readers, frequency inverters, panels and operating interfaces. Currently, there are several suppliers of PLCs, processors and devices for communication.

One of the main characteristics of the DeviceNet network is that it uses the so-called CAN - Controller Area Network to transmit and receive telegrams. The CAN bus is composed of a pair of wires that transmit a differential electrical signal, responsible for sending the communication signal to all devices connected to the bus.

The DeviceNet protocol is an open protocol, and it is possible to obtain any information about this technology to develop devices for communication. Currently, ODVA (Open DeviceNet Vendor Association) is the organization that manages the specifications of the DeviceNet network for its development.

9.1.5.1 Baud rates and address

To set the baud rate and the address of the MVW3000 on the network, the DeviceNet communication board has a set of eight switches, which have the following function:

Baudrate [kbits/s]	DIPs 1...2
125	00
250	01
500	10
Reserved	11

Address	DIPs 3...8
0	000000
1	000001
...	...
62	111110
63	111111

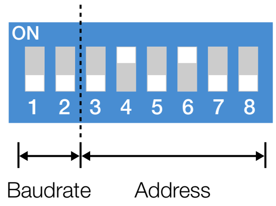


Figure 9.5: *Configuration of baud rate and address for DeviceNet*

The DeviceNet protocol defines three baud rates that can be used: 125, 250 and 500 kbit/s. All devices connected to the network must be set to operate at the same baud rate. For the MVW3000, this setting is done using switches 1 and 2 located on the communication board.

A device on the DeviceNet network can take the addresses from 0 (zero) to 63. For the MVW3000, this setting is done using switches 3 to 8 located on the communication board. Each device on the network must have a different address from the others.

NOTE!
The baud rate and the address of the MVW3000 on the network are only updated when the device is powered up. Therefore, if changes are made to those settings, the device must be turned off and back on.

9.1.5.2 LED indicators

The DeviceNet communication board has a set of four LEDs for device diagnostics. The description of each LED function is shown in Table 9.6 on page 9-10.

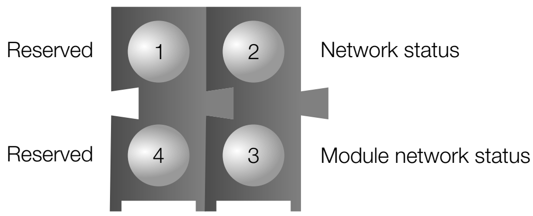


Figure 9.6: *LEDs for indicating the DeviceNet network status*

Table 9.6: *Network status LED indicators*

LED	Color	Function
Network Status	Green or red	**Off:** No power/offline **Green:** Online, connected **Red:** Fault **Flashing green:** Online, not connected **Flashing red:** Connection timeout
Network Status Module	Green or red	**Off:** No power/offline **Green:** Operating board **Red:** Fault **Flashing red:** Manageable fault

LED 3 provides information about the communication board only, and its normal state should be solid green. LED 2 provides information about the connection to the network, and whether the device is communicating with the master or not. Its normal state should be solid green. Variations in this LED may indicate problems in the connection with the bus or in the settings of the network master.

9.1.5.3 Connector and cables

The fieldbus kit for DeviceNet of the MVW3000 has a female 5-way plug-in connector that must be used to connect to the bus. The pinout of this connector, as well as the standard color used in DeviceNet cables, follows the description of the following table.

Pin	Description	Color
1	V-	Black
2	CAN_L	Blue
3	Shield	
4	CAN_H	White
5	V+	Red

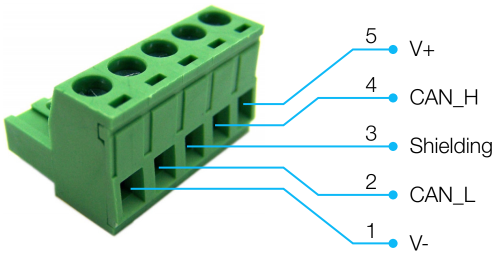


Figure 9.7: *Connector for the DeviceNet network*

To connect the various devices to the network, it is recommended to use a shielded cable with two twisted pairs: one pair of wires to transmit communication signals (CAN_L and CAN_H) and another for the power supply signal (V- and V+). Note that the maximum cable size allowed depends on the baud rate and the type of cable used. The following table shows the relationship between the baud rate used and the maximum cable length.

Table 9.7: *Maximum DeviceNet cable length*

Cable type	Baud rate		
	125 Kbps	250 Kbps	500 Kbps
Thick cable	500 m	250 m	100 m
Thin cable	100 m	100 m	100 m
Maximum length per shunt	6 m	6 m	6 m
Maximum cumulative shunt length	156 m	78 m	39 m

9.1.5.4 Bus power supply

As previously mentioned, one of the characteristics of the DeviceNet network is that the network cable itself must have a pair of wires to send a supply voltage to all devices connected to the bus. This voltage is used to feed the network interface circuit. For the communication board of the MVW3000, the current and voltage data used to size the source are provided in the following table.

Supply voltage (Vdc)			Current consumption (mA)		
Minimum	Maximum	Recommended	Minimum	Maximum	Typical
11	25	24	-	30	25

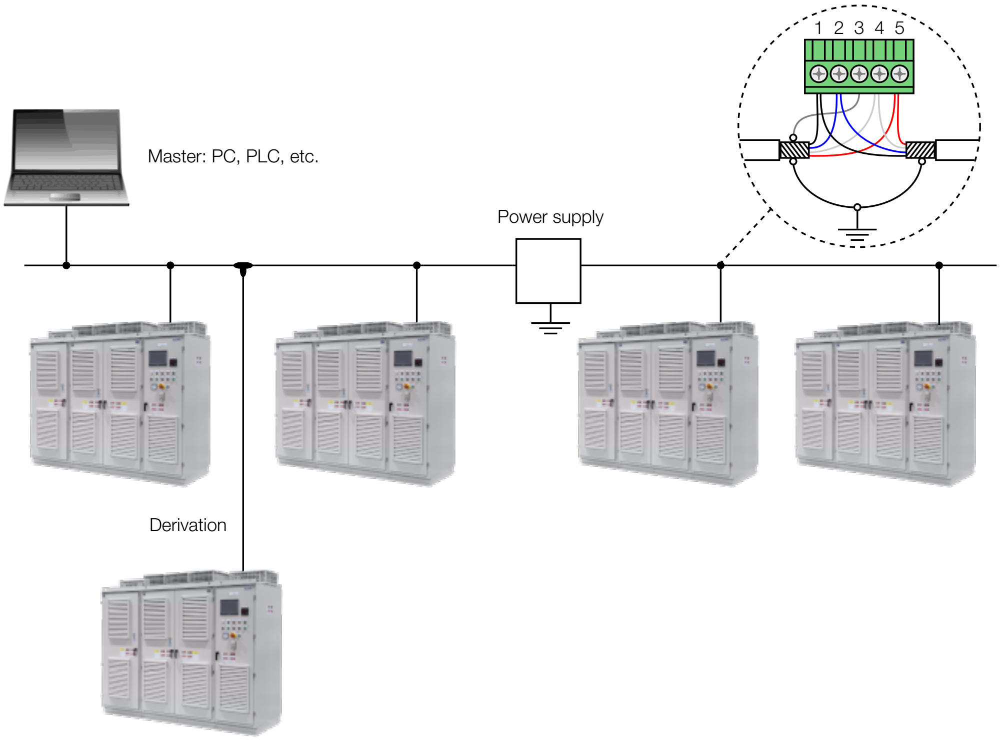


Figure 9.8: *MVW3000 on DeviceNet network*

The DeviceNet network cable must be routed separately (and if possible distant) from the power supply cables. All drives must be properly grounded, preferably on the same connection with the ground. The shield of the DeviceNet cable must be grounded at a single point near the source that supplies power to the bus.

9.1.5.5 Termination resistors

For the DeviceNet network, it is necessary to install termination resistors at the ends of the main busbar, at the value of 121Ω / 0.25W Each resistor must connect the CAN_H and CAN_L signals (pins 2 and 4 of the connector), and they may be placed on the connector that connects the device to the network.

9.1.5.6 Data types

9

The DeviceNet network allows different connections types to exchange data between the network master and other devices. For the MVW3000, the connection types available to transmit I/O data depend on the communication kit used:

- DeviceNet fieldbus kit: only Polled messages can be communicated.
- DeviceNet Drive Profile fieldbus kit: Polled or Change of State & Cyclic messages can be communicated.

Those connection types are set using a configuration tool of the DeviceNet network master, so that the MVW3000 can communicate correctly with the master. The amount of data that must be set depends on the value set at parameter P0309 (Fieldbus).

9.1.5.7 Configuration file (EDS file)

Every element of the Profibus DP network has an associated configuration file with EDS extension. This file describes the features of each device, and it is used by the configuration tool of the Profibus DP network master. When setting the master, the EDS configuration file, supplied with the device, must be used.

The EDS file to be used also depends on the communication kit used:

- DeviceNet fieldbus kit: you must use the EDS file provided in the ”DeviceNet” directory, on the CD-ROM that comes with the product. For this kit, the product will not be recognized as MVW3000 but as “AnyBus-S DeviceNet” in the “Communications Adapter” category.
- DeviceNet Drive Profile fieldbus kit: you must use the EDS file provided in the “DeviceNet Drive Profile” directory on the CD-ROM that comes with the product. It is important to check the software version of the MVW3000, which must match the version indicated in the EDS file name.

9.1.5.8 Parameter setting via Acyclic Data

The DeviceNet Drive Profile fieldbus kit, in addition to the I/O data communicated cyclically with the master, also allows setting the parameters of the MVW3000 through acyclic data. The EDS file for this communication kit provides information about the parameters of the device and can be used by a commissioning tool to view or edit the value of the parameters. To that end, it is important to check the software version of the MVW3000, which must match the version indicated in the EDS file name.

9.1.6 Ethernet

Ethernet/IP (Industrial Ethernet Protocol) is a communication system suitable for industrial environments. This system allows exchanging critical or time-restricted application data between industrial devices. Ethernet/IP is available for both simple devices such as sensors/actuators and complex devices such as robots, welders, PLCs, HMIs and drives.

EtherNet/IP uses CIP (Common Industrial Protocol) at the application layer. This is the same protocol used by DeviceNet™ and ControlNet™, which structures the devices as a collection of objects and defines methods and procedures for accessing the data. In addition, it uses the standard IEEE 802.3 Ethernet at the lower layers and the TCP/IP and UDP/IP protocols at the intermediate layers to carry CIP packets.

Therefore, the infrastructure used by Ethernet/IP is the same as the one used by corporate Ethernet computer networks. This fact considerably expands the control and monitoring methods of devices connected to the network, such as:

- Availability of application protocols (HTTP, FTP etc.);
- Integration of the industrial network from the production line to the office network;
- It is based on a widely spread and accepted standard;
- Greater data flow than the protocols normally used in industrial automation.

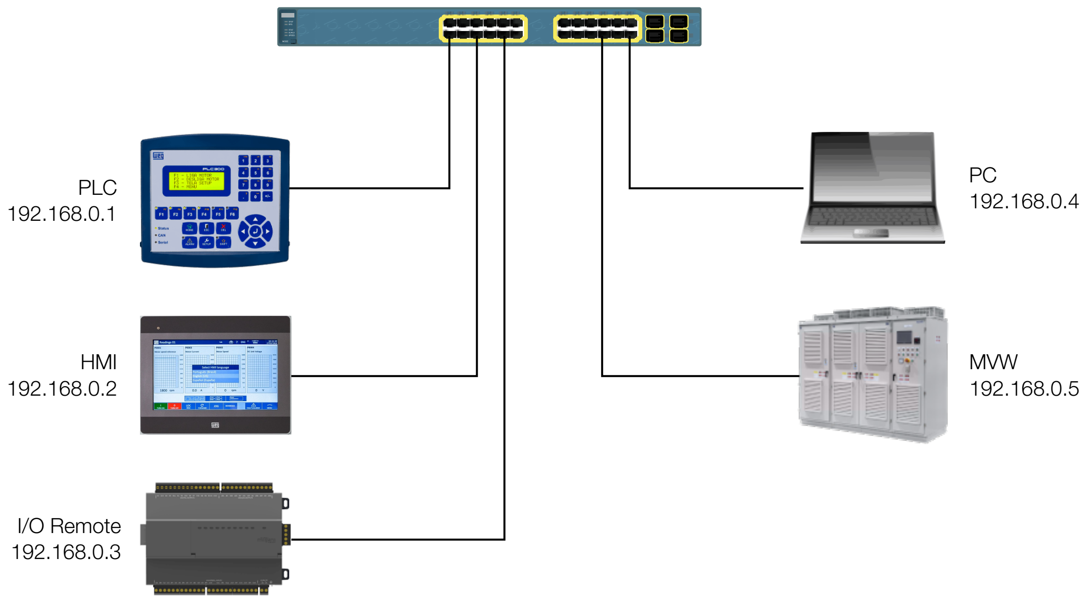


Figure 9.9: *Example of an Ethernet network*

9.1.6.1 Connector

Connector: socket for 8-way RJ-45 plug.

Pinout: there are two patterns for straight-through Ethernet cables: T-568A and T-568B. The cable to be used must follow one of these two standards. In addition, a single standard should be used to make the cable. That is, the plugs at the ends of a cable must be crimped according to standard T-568A or T-568B.

RJ-45 plug with T-568A standard

Pin	Wire color	Signal
1	White/Green	TX+
2	Green	TX-
3	White/Orange	RX+
4	Blue	-
5	White/Blue	-
6	Orange	RX-
7	White/Brown	-
8	Brown	-

RJ-45 plug with T-568B standard

Pin	Wire color	Signal
1	White/Orange	TX+
2	Orange	TX-
3	White/Green	RX+
4	Blue	-
5	White/Blue	-
6	Green	RX-
7	White/Brown	-
8	Brown	-

Figure 9.10: *Standards for Ethernet straight-though cables (Straight-Through)*

9.1.6.2 Line termination

On Ethernet 10BASE-T (10 Mbps) or 100BASE-TX (100 Mbps), the termination is already done in the communication board and also in any other device that uses peer-to-peer twisted pair. Therefore, no additional settings to the MVW3000 are necessary.

9.1.6.3 Baud rate

The MVW3000 can operate on Ethernet networks at rates of 10 Mbps or 100 Mbps and in half-duplex or full-duplex mode. When it operates at 100 Mbps full-duplex, the effective rate doubles to 200 Mbps. Those settings are made in the network configuration and programming software. No setting is required on the board.
It is recommended to use the autosensing function of those parameters.

9.1.6.4 Configuration file (EDS file)

Each device on an Ethernet/IP network is associated with an EDS file that contains information about its operation. This file provided with the product is used by the network configuration program.

9.1.6.5 Data settings

When setting the master, besides the IP address used by the EtherNet/IP board, it is necessary to indicate the number of I/O instances and the quantity of data exchanged with the master in each instance. For the MVW3000 with Anybus-S Ethernet/IP board, the following values must be set:

- Input instance (input): 100
- Output instance (output): 150
- Quantity of data: programmable via P0309, which can be 2, 4 or 6 words of 16 bits (4, 8 or 12 bytes).
- The EtherNet/IP board is described on the network as Generic Ethernet Module. Using those settings, it is possible to set the master of the network to communicate with the MVW3000.

9.1.6.6 LED indicators

The communication board has four bicolor LEDs grouped on the lower right corner that indicate the status of the module and Ethernet/IP network.

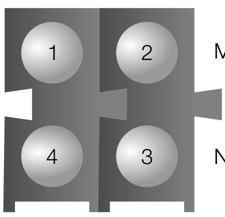


Figure 9.11: *LEDs for indicating the status of the Ethernet/IP network*

Table 9.8: Network status LED indicators

LED	Color	Function
Link	Green	**Off:** Not connected **On:** Connected
Module status	Green or red	**Off:** No power **Green:** Operating correctly **Red:** Fault **Flashing green:** Module not set, or network master in IDLE **Flashing red:** Manageable fault **Flashing green/red:** running self-diagnosis
Network status	Green or red	**Off:** No power/IP address not set **Green:** Ethernet/IP connection established **Red:** Duplicate IP address **Flashing green:** No connections allocated **Flashing red:** Timeout **Flashing green/red:** running self-diagnosis
Activity	Green	**Flashing green:** Receiving and/or transmitting

NOTE!
The communication board that comes with the product was developed by the company HMS Industrial Networks AB. Therefore, in the network configuration software, the product will not be recognized as MVW3000, but as “Anybus-S Ethernet/IP” in the category ”Communication Adapter”.
The distinction will be based on the device address on the network.

9.1.6.7 WEB control and monitoring

The Ethernet/IP communication board has an internal HTTP server. This means that it is capable of serving HTML pages. Thus, you can set network parameters, control and monitor the MVW3000 through a WEB browser installed on a computer on the same network as the drive. This operation is done using the same reading/writing variables of the MVW3000; (see Section 9.1.9 Operation via network on page 9-24).

NOTE!
For the first access via WEB, use the factory default username and password.
Username: web
Password: web.

Figure 9.12: *WEB input screen*

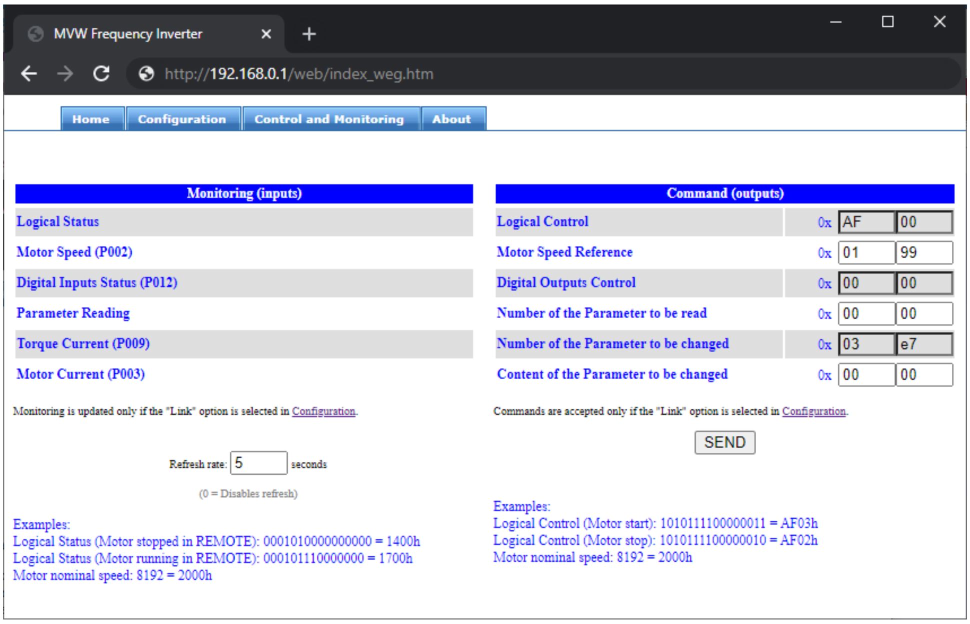


Figure 9.13: *WEB input screen*

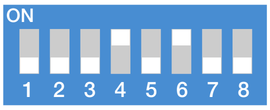
NOTE!
A PC with an Ethernet board connected to the same network as the MVW3000 and an Internet browser (MS Internet Explorer or Mozilla/Firefox) are required.
For better compatibility, it is recommended to use the Internet Explorer browser version 8 or earlier.

9.1.6.8 Settings

To operate the MVW3000 on an Ethernet/IP network, follow the steps below:

1. Install the KFB-ENIP kit on the MVW3000;
2. Using parameter P0309, select the Ethernet protocol and the number of input/output words;

3. Connect the RJ-45 plug of the Ethernet network cable to the MVW3000 and make sure the Link indicator LED is lit (LED 1);
4. Open your browser and enter the address of the MVW3000 on the network; the factory default is 'http://192.168.0.1'. Make sure that your browser supports JavaScript and that cookies are enabled;
5. On the 'configuration' tab of the displayed web page, set the network parameters in 'Network Parameters' if necessary.
    a) If the address of the MVW3000 on the network belongs to the reserved range '192.168.0.X', you can use the board dip-switch for addressing. In this case, the switch represents the binary value of the last byte of the address.
    Example:

    The dip-switch above is set to 0001 0100 (20 in decimal).
    Therefore, the address of the MVW3000 on the network is 192.168.0.20;
    b) If the MVW3000 has an IP address different from the default range (192.168.0.X), disable the hardware addressing via dip-switch by placing it in the zero position (00000000).
    c) If the network addressing is done through a DHCP server, check the 'DHCP enabled' box and set the dip-switch position to zero (00000000).
    d) Click on the 'STORECONFIGURATION' button to save the settings.
6. Also set the content of parameter P0309 (Fieldbus).
    a) For the Online/Offline status modification to be effected when the Link status changes, select the 'Link' option;
    b) For the Online/Offline status modification to be effected when there are no telegrams being exchanged with the Ethernet/IP master, select the 'EtherNet/IP' option;
    c) For the Online/Offline status modification to be effected when there are no telegrams in the MVW3000 being exchanged with the Modbus master for a certain time, select the 'Modbus' option and set the Timeout according to the application;
    d) Click on the 'STORECONFIGURATION' button to save the settings.

Restart the MVW3000.

9.1.6.9 Communication board access

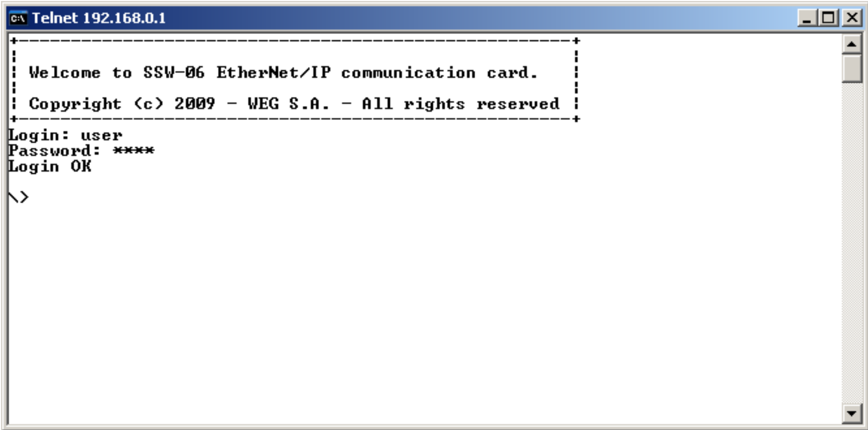
The communication board allows access via FTP and Telnet. Thus, you can transfer files to/from the board and also access the file system in an interactive way.

To use such services, proceed as follows:

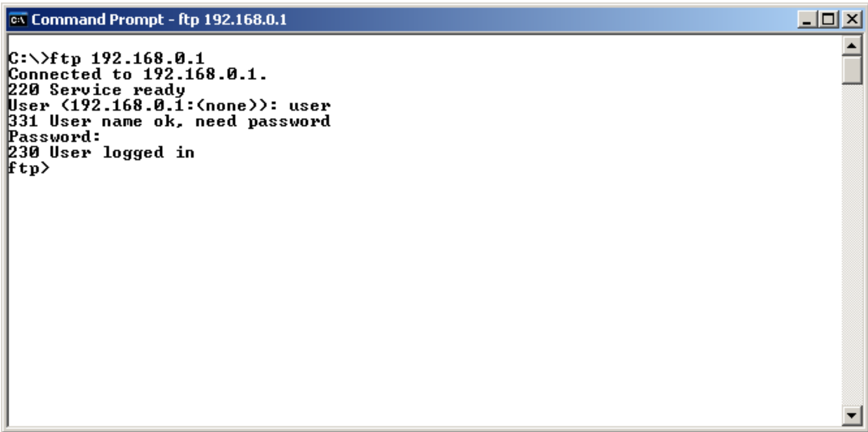
- Open an MS-DOS command window;
- Enter the desired service (FTP or Telnet) followed by the IP or hostname of the MVW3000 on the network.
- Enter: Username: user Password: user

Examples:

Telnet session to the MVW3000 whose IP address is 192.168.0.1



FTP session for the MVW3000 whose IP address is 192.168.0.1



9.1.6.10 Security and access passwords

The communication board file system has two security levels for the users; **admin** and **normal**.

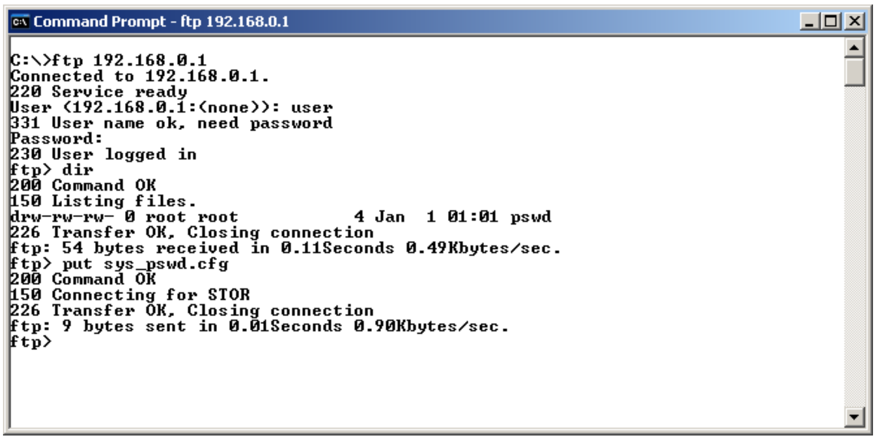
It is allowed to connect in normal mode only. In this case, users are restricted to the 'user\' directory, being allowed to create or delete files and/or directories. User accounts at this level are registered in the 'sys_pswd.cfg' file located in the 'user\pswd\' directory. Each line in this file contains a 'login: password' pair that corresponds to a user account.

To change it, create, with a simple text editor (Windows Notepad, for example), a file that contains a 'login: password' pair in each line The two words must be separated by a colon.

Note that there is no password encryption mechanism, that is, both the login and the password are in plain text.

After creating/modifying the user accounts, transfer the file 'sys_pswd.cfg' via FTP to the directory 'user\pswd\'.

Example of file transfer via FTP:



NOTE!
The MVW3000 leaves the factory set with a normal user account:
Username: user Password: user
Users of security level **normal** are restricted to the **'\user'** directory.

In addition to the control for accessing the file system, there is also a password for accessing the HTML pages of the communication board. The access password file is located in the 'user\pswd' directory, and it is called 'web_accs.cfg'. As with other passwords, each line in the file represents an account for access. To change it, create a text file with the same name containing a 'login: password' pair in each line. Then transfer this new file via FTP to the communication board, exactly as in the previous case.

NOTE!
After the equipment start-up period, it is recommended to change all passwords on the Ethernet/IP communication board. The new passwords will only take effect after the MVW3000 is powered up again. When the MVW3000 returns from the offline state, the output values are reset to zero.

9.1.7 Modbus/TCP

Modbus is a data communication protocol used in industrial automation systems. Created in the 1970s by Modicon, it is one of the oldest protocols used in networks for supervision and control of automation equipment.

The Modbus/TCP protocol is an implementation of the Modbus standard over TCP/IP enabling the use of the ModBus message system on an 'Intranet' or 'Internet' network. Modbus/TCP basically encapsulates a Modbus frame in a TCP frame in a simple way.

Modbus/TCP uses the physical medium Ethernet (IEEE 802.3) and the client-server model. The infrastructure used is the same as that used by corporate Ethernet computer networks. This fact considerably expands the control and monitoring methods of devices connected to the network.

The Ethernet/IP board for the MVW3000 has a Modbus/TCP server that provides access to the Input and Output areas through a set of functions defined in the Modbus/TCP specification. All messages use TCP port 502 and the Modbus/TCP server can manage a maximum of 8 simultaneous connections.

The following items for the Modbus/TCP protocol are similar to that described for the Ethernet/IP protocol:

Description	See item
Connector	Section 9.1.6.1 Connector on page 9-14
Line termination	Section 9.1.6.2 Line termination on page 9-15
Baud rate	Section 9.1.6.3 Baud rate on page 9-15
LED indicators	Section 9.1.6.6 LED indicators on page 9-15
WEB control and monitoring	Section 9.1.6.7 WEB control and monitoring on page 9-16
Settings	Section 9.1.6.8 Settings on page 9-17
Communication board access	Section 9.1.6.9 Communication board access on page 9-18

9.1.7.1 Data Settings for the Network Master

To use the Modbus/TCP protocol of the Ethernet/IP communication board, it is necessary to set the amount of data exchanged with the master.

For the MVW3000 with Anybus-S Ethernet/IP board, the quantity of data is programmable through P0309, which can be 2, 4 or 6 16-bit words (4, 8 or 12 bytes).

The mapping of the I/O words in the Modbus protocol is shown in the table below:

Table 9.9: *Addressing map*

Area	Register	I/O word
Input data	1	1ª WORD
	2	2ª WORD
	3	3ª WORD
	4	4ª WORD
	5	5ª WORD
	6	6ª WORD
Output data	1025	1ª WORD
	1026	2ª WORD
	1027	3ª WORD
	1028	4ª WORD
	1029	5ª WORD
	1030	6ª WORD

NOTE!

- The table above applies to all function codes;
- Coils are mapped with MSB first, e.g.: coil#1 corresponds to bit 15 of register #1.
- I/O words are represented in registers with the least significant byte first.

Thus, it may be necessary to replace the most significant byte with the least significant byte so that the words are interpreted correctly by the network master.

- Some Clients employ offset in the register address.

Several Modbus functions may be used to access the same data area on the module. Below are the functions available for the Ethernet/IP module:

Table 9.10: Supported function codes

Modbus function	Function Code	Associated with...
Read Coil	1	Input and Output data
Read Input Discrete	2	
Read Multiple Registers	3	
Read Input Registers	4	
Write Coil	5	Output data
Write Single Register	6	
Force Multiple Coils	15	
Force Multiple Registers	16	
Mask Write Register	22	
Read/Write Registers	23	Input and Output data

Table 9.11: Supported error codes

Code	Name	Description
0x01	Illegal function	Function code is not supported
0x02	Illegal data address	Address outside the initialized memory area
0x03	Illegal data value	Illegal value

9.1.8 Profinet

9.1.8.1 Connector

Connector: socket for 8-way RJ-45 plug.

Pinout: there are two patterns for straight-through Ethernet cables: T-568A and T-568B. The cable to be used must follow one of these two standards. In addition, a single standard should be used to make the cable. That is, the plugs at the ends of a cable must be crimped according to standard T-568A or T-568B.

RJ-45 plug with T-568A standard

Pin	Wire color	Signal
1	White/Green	TX+
2	Green	TX-
3	White/Orange	RX+
4	Blue	-
5	White/Blue	-
6	Orange	RX-
7	White/Brown	-
8	Brown	-

RJ-45 plug with T-568B standard

Pin	Wire color	Signal
1	White/Orange	TX+
2	Orange	TX-
3	White/Green	RX+
4	Blue	-
5	White/Blue	-
6	Green	RX-
7	White/Brown	-
8	Brown	-

Figure 9.14: *Standards for Ethernet straight-though cables (Straight-Through)*

9.1.8.2 Baud rate

The Ethernet interface of the MVW3000 for the PROFINET IO protocol can communicate using the 100 Mbps rate in full duplex mode, as required by the protocol.

9.1.8.3 Configuration file (GSDML file)

Each device on a PROFINET network is associated with a GSDML file that contains information about its operation. This file provided with the product is used by the network configuration program.

9.1.8.4 Station name

A name must be assigned to each device on the PROFINET IO network. Such name, which is stored in the communication accessory itself, is used to identify and address the device on the network. For the MVW3000, this name must be assigned via the PROFINET network master configuration tool.

9.1.8.5 Data settings

To set the master, in addition to the Station Name used by the PROFINET board, it is necessary to indicate the amount of data exchanged with the master. For the MVW3000 with Anybus-S PROFINET board, the following values must be set:

- Number of data: programmable via P0309, which can be 2, 4 or 6 words of 16 bits (4, 8 or 12 bytes). This number of words must also be set in the network configuration tool, using the GSDML configuration file, and selecting the input and output modules necessary to compose the number of words as set in P0309.
- The PROFINET board for the MVW3000 is identified on the network as Anybus-S PRT. Using those settings, it is possible to set the master of the network to communicate with the MVW3000.

9.1.8.6 LED indicators

The communication board has four bicolor LEDs grouped on the lower right corner indicating the status of the module and of the Ethernet/IP network

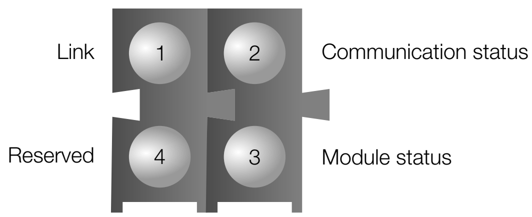


Figure 9.15: *PROFINET network status LED indicators*

Table 9.12: Supported function codes

LED	Color	Function
Link	Green	**On:** Link established **Flashing:** Receiving/transmitting data **Off:** No link or not powered
Communication status	Green	**On:** On line, RUN. Connection to controller established **Flashing:** On line, STOP. Connection to controller established **Off:** Off line. No connection to the controller
Module status	Green or red	**Off:** Module not powered or not initialized **On green:** Initialized, no error **Flashing Green, 1 flash:** With diagnostic data **Flashing green, 2 flashes:** Blink function, used to identify slave on the network **Flashing Red, 1 flash:** Configuration error. Incorrect module or incorrect number of configured I/O words **Flashing Red, 3 flashes:** Station Name or IP Address has not been configured **Flashing Red, 4 flashes:** Internal error

9.1.9 Operation via network

Parameter P0309 allows setting the number of I/O words that will be exchanged with the network master. This item will present the data format for each of the existing options.

Depending on the value selected in parameter P0309, the drive will communicate with the network master 2, 4 or 6 I/O words. The greater the number of words communicated via network, the more functions are available for operation of the MVW3000, but both the amount of memory reserved in the master and the time required for communication will also be greater.

Input (drive → master):

Input	Description
1st word	Inverter logical status
2nd word	Motor speed
3rd word	Digital inputs DI1 to DI10 status
4th word	Content of the read parameter
5th word	Motor torque
6th word	Motor current

Output (master → drive):

9

Output	Description
1st word	Logical command
2nd word	Motor speed reference
3rd word	Digital outputs DO1 to RL5 status
4th word	Number of the parameter to be read
5th word	Number of the parameter to be changed
6th word	Content of the parameter to be changed

9.1.9.1 Input - 1st word: Inverter Logical Status

The word that defines the Logical Status consists of 16 bits, with 8 upper bits and 8 lower bits (reserved), having the following construction:

Table 9.13: Logical Status: Upper bits

Bit	Function	Description
15	Active fault	0 = No 1 = Yes
14	PID controller	0 = Manual 1 = Automatic
13	Undervoltage in the sources of the electronics	0 = Without undervoltage 1 = With undervoltage
12	Local/Remote Command	0 = Local 1 = Remote
11	Jog Command	0 = Inactive 1 = Active
10	Direction of Rotation	0 = Reverse 1 = Forward
09	General Enable	0 = Disabled 1 = Enabled
08(*)	Run/Stop	0 = Stop 1 = Run

To obtain the fault code, see parameter P0068.

(*) Bit 08 = 1. It means the inverter received the run/stop command via networks. This EL is not intended to signal that the motor is effectively spinning.

9.1.9.2 Input - 2nd word: Motor speed

This variable is shown using 13-bit resolution plus signal. Therefore, the rated value will be equal to 8191 (1FFFh) (forward run) or -8191 (E001h) (reverse run) when the motor is spinning at synchronous speed (or base speed, for example 1800 rpm for a 4-pole, 60 Hz).

9.1.9.3 Input - 3rd word: Status of digital inputs

Indicates the content of parameter P0012 (Digital inputs DI1 to DI10 status).

The digital inputs of this WORD are distributed as follows:

Table 9.14: Status of digital inputs

Bit	Function	Description
9	DI10	0 = Inactive 1 = Active
8	DI09	0 = Inactive 1 = Active
7	DI01	0 = Inactive 1 = Active
6	DI02	0 = Inactive 1 = Active
5	DI03	0 = Inactive 1 = Active
4	DI04	0 = Inactive 1 = Active
3	DI05	0 = Inactive 1 = Active
2	DI06	0 = Inactive 1 = Active
1	DI07	0 = Inactive 1 = Active
0	DI08	0 = Inactive 1 = Active

9.1.9.4 Input - 4th word: Content of the parameter to be read

This position allows reading the content of the inverter parameters, which are selected in position 4. Number of the parameter to be read, of the "Variables Written on the Inverter". The values read will have the same order of magnitude as those described in the product manual or shown on the HMI.
Values are read without the decimal point, when applicable.

Examples:
a) HMI indicates 12.3, and the reading via Fieldbus will be 123.
b) HMI indicates 0.246 and the reading via Fieldbus will be 246.

9.1.9.5 Input - 5th word: Torque on the motor

Indicates the content of parameter P0009, disregarding the decimal point. This variable is filtered by a low-pass filter with a time constant of 0.5 s.

9.1.9.6 Input - 6th word: Motor current

Indicates the content of parameter P0003, disregarding the decimal point. This variable is filtered by a low-pass filter with a time constant of 0.3 s.

9.1.9.7 Output - 1st word: Logical Command

This word is transmitted from the network master to the MVW3000, in the first position of the output data, allowing the control of the main functions of the device. It has 16 bits, which can be divided into two bytes for a better understanding of the command:

Most significant byte: acts as the command mask. Each bit enables the execution of a command, and the effective value of the command is transmitted in the corresponding least significant bit.

Table 9.15: *Logical Command - Upper bits*

Bit	Function
15	Inverter fault reset
14	Not used
13	Save changes of parameter P169/P170 to the EEPROM
12	Local/Remote Command
11	Jog Command
10	Direction of Rotation
09	General Enable
08	Run/Stop

9

Least significant byte: has the effective value for each command you want to execute. Each bit is responsible for executing a command, but the command will only be executed if the corresponding upper bit is set to 1. If the mask bit is not set to 1, the value received in the corresponding lower bit is disregarded.

Table 9.16: *Logical Command - Lower bits*

Bit	Function	Description
7	Inverter fault reset(*)	0 = No
		0 → 1 = Reset
6	Not used	-
		-
5	Save changes of parameter P169/P170 to the EEPROM	0 = Save
		1 = Not save
4	Local/Remote Command	0 = Local
		1 = Remote
3	Jog Command	0 = Inactive
		1 = Active
2	Direction of Rotation	0 = Reverse
		1 = Forward
1	General Enable	0 = Disabled
		1 = Enabled
0	Run/Stop	0 = Stop
		1 = Run

NOTE!
Logic command Bit 13:
The function to save changes in the content of the parameters to the EEPROM occurs normally when using the HMI. The EEPROM supports a limited number of writings (100,000). In applications where the speed regulator is saturated and you want to control the torque, you must act on the current limitation value P0169/P0170 (valid for P0202 > 2).
When the Network Master writes on P0169/P0170 continuously, you must prevent the changes from being saved on the EEPROM, doing the following: Bit 13 = 1 and Bit 5 = 1.

9.1.9.8 Output - 2nd word: Motor speed reference

This variable is displayed using a 13-bit resolution. Therefore, the speed reference value for the motor synchronous speed will be equal to 8191 (1FFFh).

NOTE!
Values above 8191 (1FFFh) are allowed when it is desired to obtain values above the motor synchronous speed, as long as they respect the value set for the inverter maximum speed reference.

9.1.9.9 Output - 3rd word: Command for digital outputs

It allows changing the status of the digital outputs set for Fieldbus in parameters P0275 to P0282. The word that defines the state of the digital outputs is formed by 16 bits, with the following construction:

Table 9.17: *Command of the digital outputs - Upper bits*

Bit	Function
8	DO1 output control
9	DO2 output control
10	RL1 output control
11	RL2 output control
12	RL3 output control
13	RL4 output control
14	RL5 output control

Table 9.18: Command of the digital outputs - Lower bits

Bit	Function	Description
0	DO1 output command	0 = Inactive output 1 = Active output
1	DO2 output command	0 = Inactive output 1 = Active output
2	RL1 output command	0 = Inactive output 1 = Active output
3	RL2 output command	0 = Inactive output 1 = Active output
4	RL3 output command	0 = Inactive output 1 = Active output
5	RL4 output command	0 = Inactive output 1 = Active output
6	RL5 output command	0 = Inactive output 1 = Active output

9.1.9.10 Output - 4th word: Number of the parameter to be read

Through this position it is possible to read any parameter of the inverter. The number corresponding to the desired parameter must be provided, and its content will be shown in position 4 of the "Inverter variables read".

9.1.9.11 Output - 5th word: Number of the parameter to be changed

This position works together with the Output - 6th word.
If you do not want to change any parameters, the 999 code must be placed in this position.

During the modification process, you must:

- Keep code 999 in position 5.
- Replace code 999 with the number of the parameter to be changed.
- If no error code (124 to 127) is signaled in the Logical Status, replace the parameter number with code 999 to end the modification.

The modification can be checked via HMI or by reading the parameter content.

NOTE!

- The command to switch from scalar to vector control will not be accepted if any of parameters P0409 to P0413 are set to zero. This must be done via HMI.
- Do not set P0204 = 5 since in the factory settings P0309 = Inactive.
- P0204 and P0408 do not accept command modifications via networks.
- The desired content must be maintained by the master for 15.0 ms.
  Only after this time has elapsed can a new value be sent or written to another parameter.

9.1.9.12 Output - 6th word: Content of the parameter to be changed

Value for the parameter selected in Output - 5th word: (write the value without the decimal point).

NOTE!
When parameters P0409 to P0413 are changed, slight differences in content may arise due to truncation (rounding) during the reading process.

9.2 SERIAL

This chapter provides the necessary information for the operation of the MVW3000 via serial communication.

CAUTION

- Carefully follow the cautions and safety warnings contained therein.
- When there is a possibility of damage to people or equipment related to motors driven by the inverter, provide electromechanical safety devices.

ATTENTION

- Carefully follow the precautions defined in this manual regarding the interconnection cables of the two interfaces for serial communication.
- Equipment with components sensitive to static electricity. Electronic boards must be handled with the following care:
  - Do not directly touch with the hands the component parts or connectors. When necessary, first touch a grounded metallic object.
  - Use weld iron with a grounded tip.

TERMS USED

- **Parameters:** Are those existing on the drive and which can be viewed and changed via human-machine interface (HMI).
- **Basic variables:** Internal values of the MVW3000 that can only be accessed through the serial, used to monitor the device status, commands and identification.
- **Registers:** These are internal memory addresses of the MVW3000. Can be used to represent both basic variables and parameters.
- **EEPROM:** It is the non-volatile memory that allows the MVW3000 to maintain parameter values even after the device is turned off.

NUMERICAL REPRESENTATION:

- Decimal numbers are represented by means of digits without suffix.
- Hexadecimal numbers are represented with the letter “h” after the number.

9.2.1 Introduction

The basic purpose of serial communication is the physical connection between two or more devices in a network configured as follows:

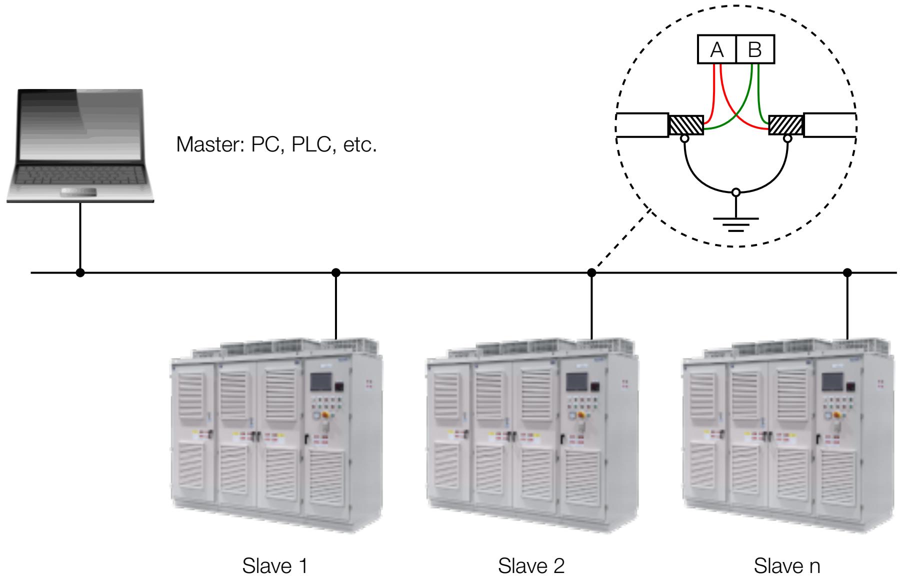


Figure 9.16: *Connection Diagram*

Using this interface, the network master can request several services from each slave connected to the network, such as:

- IDENTIFICATION:
  - Type of device (frequency inverter, servo drive, soft-starter)
  - Status monitoring
  - Reading of errors
- PARAMETER SETTING:
  - Reading of parameters (current, voltage, etc.)
  - Writing of parameters for the device configuration
- COMMANDS:
  - Enabling
  - Direction of rotation
  - Error reset

The MVW3000 uses the Modbus-RTU protocol for communication via its serial interface. This protocol allows the integration of of the MVW3000 into different systems, since it allows its connection to various devices, such as:

- PC (master) to set the parameters of one or several drives simultaneously.
- SDCD monitoring variables and parameters of the MVW3000.
- PLC controlling the operation of the device in an industrial process.

9.2.2 Serial communication parameters

The parameters related to serial communication and operation via the Modbus-RTU protocol of the of the MVW3000will be described next.

P0308 - Address			
Adjustable range:	1 to 30	Factory setting:	1

Each slave on the network must have an address different from the others, so that the master can send the desired telegram to a specific slave on the network. This parameter allows setting address of the MVW3000 on the network.

It is necessary to install a repeater for more than 30 devices on the same communication network.

P0312 - Protocol			
Adjustable range:	0 to 11	Factory setting:	7

The MVW3000 has one of the following options for communication via the product serial interface:

P0312	Function
0	Not used
1	Modbus-RTU, 9600 bps, no parity
2	Modbus-RTU, 9600 bps, odd parity
3	Modbus-RTU, 9600 bps, even parity
4	Modbus-RTU, 19200 bps, no parity
5	Modbus-RTU, 19200 bps, odd parity
6	Modbus-RTU, 19200 bps, even parity
7	Modbus-RTU, 38400 bps, no parity
8	Modbus-RTU, 38400 bps, odd parity
9	Modbus-RTU, 38400 bps, even parity

It is necessary that all devices operating on the same network have the same communication settings.

P0313 - Disabling with alarm A128, A129 and A130			
Adjustable range:	0 to 5	Factory setting:	0

Table 9.19: *Communication error action*

P0313	Function
0	Stop by ramp
1	General disable
2	No action
3	Go to LOC
4	Reserved
5	Fault

- **0 - Disable via Run/Stop**: It disables the motor by deceleration ramp in case of a communication error.
- **1 - Disable via General Enable**: In this option, the MVW3000 cuts off the power to the motor, which should coast to a stop.
- **2 - Inactive**: if one of the errors previously mentioned occurs, the drive remains in its current state and only indicates the error.
- **3 - Go to LOCAL**: If you are operating in REMOTE mode, and a communication error occurs, it will automatically go to LOCAL mode.
- **5 - Fault**: Upon detecting a communication fault, it will go to the error state, the motor will be disabled, and the error indication will only be removed after resetting the device errors.

Only the timeout receiving telegrams error is considered a communication error. The timeout receiving telegrams is set through parameter P0314.

NOTE!
The Disable via Run/Stop and Go to LOCAL commands can only be executed if they are being controlled via fieldbus. This setting is done through parameters P0220 (LOCAL/REMOTE selection source), P0224 (Start/Stop Selection LOCAL Situation) and P0227 (Start/Stop Selection REMOTE Situation).

P0314 - Watchdog			
Adjustable range:	0.0 to 999.0 s	Factory setting:	0.0 s

It allows setting the time for detecting timeout when receiving telegrams. Value 0 (zero) disables this function.

If the drive is controlled via serial, and a problem communicating with the master occurs (cable break, power failure, etc.), it will not be possible to send a command via serial to disable the device. In applications where that is a problem, it is possible to set a maximum interval in P0314 within which the MVW3000 must receive a valid serial telegram; otherwise, it will consider that the serial communication has failed.

Once that time has been set, if it does not receive valid serial telegrams within the time set, it will display E28 and take the action set in P0313. If the communication is reestablished, the timeout receiving telegrams indication will be removed.

P0220 - LOCAL/REMOTE selection source

P0221 - Speed reference selection LOCAL situation

P0222 - Speed reference selection REMOTE situation

P0223 - Forward/Reverse Selection LOCAL Situation

P0224 - Start/Stop Selection LOCAL Situation

P0225 - Selection of JOG Source LOCAL Situation

P0226 - Selection of Direction of ROTATION REMOTE Situation

P0227 - Start/Stop Selection REMOTE Situation

P0228 - JOG Selection - REMOTE Situation

These parameters define the source of commands and references for the inverter in the LOCAL and REMOTE modes.
For the commands that will be controlled via network, set it in the “Serial” option.

P0275 - DO1 Function

P0276 - DO2 Function

P0277 - RL1 Function

P0279 - RL2 Function

P0280 - RL3 Function

P0281 - RL4 Function

P0282 - RL5 Function

These parameters define the function of the inverter digital outputs.
For the digital outputs that will be controlled via network, set it in the “Serial” option.

9.2.3 Interface

The MVW3000 frequency inverters operate as slaves to the Modbus-RTU network, and every communication starts with the master of the Modbus-RTU network requesting some service from an address on the network.

If the inverter is configured for the corresponding address, it processes the request and responds what was requested to the master.

NOTE!

- Power and control cables with a 110 V / 220 V voltage must be separated from the Serial RS-232 wiring.
- It is not possible to use RS-232 and RS-485 simultaneously.

9.2.3.1 RS-232

The MVW3000 has an RS-232 serial port (X7 connector on the MVC4 board) available.

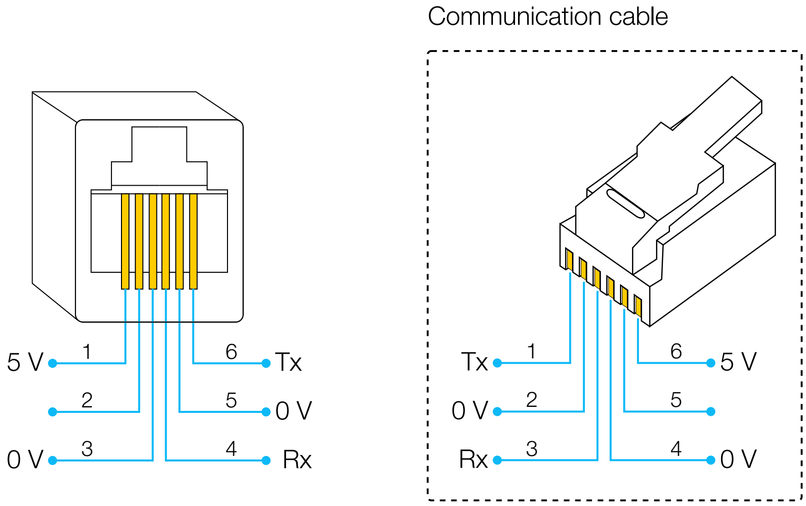


Figure 9.17: *Description of the XC7 connector signals (RJ11)*

This interface allows connecting a master to a MVW3000 (peer-to-peer) up to 10 m away. For communication with the master, one wire for transmission (TX), one for reception (RX) and a reference (0 V) must be used, signals which are present on pins 4, 5 and 6. The signals present on pins 1, 2 and 3 are on this connector for external power supply, used as one of the options for RS-485 communication.

9.2.3.2 RS-485

In addition to the EBB board (see Section 7.2 FUNCTION EXPANSION BOARDS on page 7-5), the CSI2 board (item 15423438) on the XC9 connector of the MVC4 board can be used as an RS-485 interface on the MVW3000:

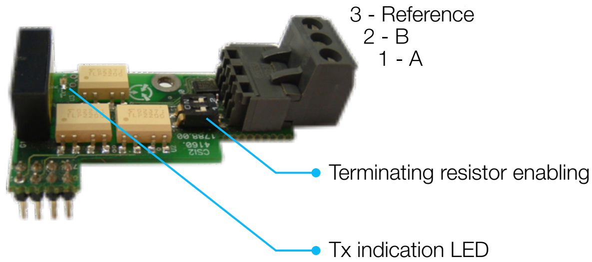


Figure 9.18: *CSI2 Board*

Using the RS-485 interface, the master can control several drives connected to the same bus.
The Modbus-RTU protocol allows the connection of up to 247 slaves (1 per address), provided that signal repeaters are also used along the bus. This interface has good noise immunity, and the maximum cable length allowed is 1000 meters.

The following recommendations must be observed when installing the network using this interface:

- Generally, a shielded twisted pair is used to transmit signals B and A. Those signals must be connected to terminals 1 and 2 of the board;
- Terminal 3 is used to connect the reference signal to the RS-485 circuit. If this signal is not used, this connection can be disregarded;

- It is very important to correctly ground all devices connected to the RS-485 network, preferably at the same grounding point. The cable shield must also be grounded, and for that purpose, the shield can be connected somewhere to the frame of the MVW3000;
- The cable must be routed separately and, if possible, distant from the power supply cables;
- Termination resistors must be provided on the first and last devices connected to the main bus. The interface board for RS-485 CSI2 has switches for enabling this resistor. Just put both S1 switches to the “ON” position.

9.2.4 Accessible data

Various data can be accessed via the serial interface to enable their setting, command and monitoring. Basically, those data can be divided into two groups: basic parameters and variables.

9.2.4.1 Parameters

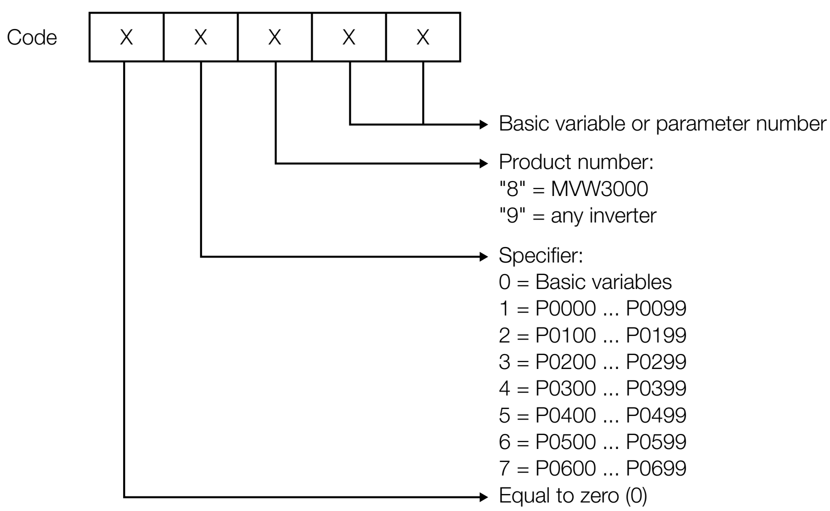
The parameters are those available through the MVW3000 HMI. Virtually all drive parameters can be accessed via serial, and through those parameters it is possible to configure the way the device will operate and monitor information relevant to the application, such as current, voltage, errors etc..

9.2.4.2 Basic variables

The basic variables are internal values of the MVW3000 accessible only through the serial interface of the product. Using these variables, it is possible to monitor the states of the drive and send commands such as enable and reset.

Each basic variable represents a register (16 bits). For the MVW3000, the following basic variables were provided:

V00 (address: 5000):
Inverter model indication (reading variable).
The reading of this variable allows identifying the inverter type. For the MVW3000 this value is 8, as shown below:



V02 (address: 5002):
Inverter status indication (reading variable).
Logical status (byte-high). Error code (byte-low).

Where:
Logical Status:

	MSB							
logic state	15	14	13	12	11	10	9	8

- Bit 8: 0 = Enable by ramp (run/stop) inactive / 1 = Enable by ramp active;
- Bit 9: 0 = General enable inactive / 1 = General enable active;
- Bit 10: 0 = Reverse / 1 = Forward;
- Bit 11: 0 = JOG inactive / 1 = JOG active;
- Bit 12: 0 = Local / 1 = Remote;
- Bit 13: 0 = Without undervoltage / 1 = With undervoltage;
- Bit 14: 0 = Manual (PID) / 1 = Automatic (PID);
- Bit 15: 0 = Without fault / 1 = With fault.

V03 (address: 5003):
Selection of the logical command.
Writing variable, whose bits have the following meaning:

Upper bits: mask of the desired action. The corresponding bit must be set to 1 for the action to occur.

	MSB							
Logic command	15	14	13	12	11	10	9	8

- Bit 8: 1 = Enable ramp (run/stop);
- Bit 9: 1 = General Enable;
- Bit 10: 1 = Direction of rotation;
- Bit 11: 1 = JOG;
- Bit 12: 1 = Local/Remote Selection;
- Bit 13: Not used;
- Bit 14: Not used;
- Bit 15: 1 = Fault reset.

Lower bits: logical level of the desired action.

								LSB
Logic command	7	6	5	4	3	2	1	0

- Bit 0: 0 = Disable (stop) / 1 = Enable (run);
- Bit 1: 0 = General disable / 1 = General enable;
- Bit 2: 0 = Reverse / 1 = Forward;
- Bit 3: 0 = JOG inactive / 1 = JOG active;
- Bit 4: 0 = Local / 1 = Remote;
- Bit 5: Not used;
- Bit 6: Not used;
- Bit 7: 0 = Reset inactive. / 1 = Reset active.

NOTE!

- Disable via DIx has priority over these disable functions;
- To enable the inverter via serial, it is necessary that CL0 = CL1 = 1 and that the external disable be inactive;
- If CL0 = CL1 = 0 simultaneously, general disable will occur.

V04 (address: 5004):
Speed reference given by the Serial (reading/writing variable).
It allows sending the reference to the inverter provided that P0221 = 9 for Local or P0222 = 9 for Remote; this variable has a 13-bit resolution.

V06 (address: 5006):
Status of the operating modes (reading variable).

								LSB
Operating modes	7	6	5	4	3	2	1	0

- Bit 0: 1 = Setting mode after reset to factory settings/first power-up;
- The inverter will go into this operating mode when it is powered up for the first time or when the factory settings of the parameters is loaded (P0204 = 5 or 6). In this mode, only parameters P0023, P0201, P0295, P0296, P0400, P0401, P0402, P0403, P0404 and P0406 will be accessible. If another parameter is accessed, the inverter will return A0125;
- Bit 1: 1 = Setting mode after changing from Scalar to Vector control;
- The inverter will go into this operating mode when the control mode is changed from Scalar (P0202 = 0, 1 or 2) to Vector (P0202 = 3 or 4). In this mode, only parameters P0023, P0201, P0295, P0296, P0400, P0401, P0402, P0403, P0404 and P0406 will be accessible. If another parameter is accessed, the inverter will return A0125;
- Bit 2: 1 = Performing Self-tuning;
- Bit 3: Not used;
- Bit 4: Not used;
- Bit 5: Not used;
- Bit 6: Not used;
- Bit 7: Not used.

V07 (address: 5007):
Status of the operating modes (reading/writing variable).

								LSB
Operating modes	7	6	5	4	3	2	1	0

- Bit 0: 1 = Exit the setting mode after Reset to factory settings;
- Bit 1: 1 = It exits the setting mode after changing from Scalar to Vector control.;
- Bit 2: 1 = Abort Self-tuning.;
- Bit 3: Not used;
- Bit 4: Not used;
- Bit 5: Not used;
- Bit 6: Not used;
- Bit 7: Not used.

V08 (address: 5008):
Motor speed in 13 bits (reading variable).

V09 (address: 5009). Reading:

- Bit 0: 1 = Inverting DOR (Direction of Rotation);
- Bit 1: 1 = Alarm active.

VB 12 (address: 5012). Digital Output State:

It allows changing the state of the Digital Outputs set to Serial in parameters P0275...P0280.

The word that defines the state of the digital outputs is formed by 16 bits, with the following construction:

Upper bits: define the output you want to control when set to 1.

- Bit 8: 1 - DO1 output control;
- Bit 9: 1 - DO2 output control;
- Bit 10: 1 - RL1 output control;
- Bit 11: 1 - RL2 output control;
- Bit 12: 1 - RL3 output control;
- Bit 13: 1 - RL4 output control;
- Bit 14: 1 - RL5 output control.

Lower bits: define the desired state for each output.

- Bit 0: - DO1 output state: 0 = output disabled, 1 = output enabled;
- Bit 1: - DO2 output state: 0 = output disabled, 1 = output enabled;
- Bit 2: - RL1 output state: 0 = output disabled, 1 = output enabled;
- Bit 3: - RL2 output state: 0 = output disabled, 1 = output enabled;
- Bit 4: - RL3 output state: 0 = output disabled, 1 = output enabled;
- Bit 5: - RL4 output state: 0 = output disabled, 1 = output enabled;
- Bit 6: - RL5 output state: 0 = output disabled, 1 = output enabled.

9.2.5 Modbus-RTU

The Modbus protocol was initially developed in 1979. Currently, it is an open protocol widely used by several manufacturers in different kinds of equipment. The Modbus-RTU communication of the MVW3000 was developed based on two documents:

1. MODBUS Protocol Reference Guide Rev. J, MODICON, June 1996.
2. MODBUS Application Protocol Specification, MODBUS.ORG, may 8th 2002.

These documents define the format of messages used by the elements that are part of the Modbus network, the services (or functions) that can be provided via network and how these elements exchange data on the network.

9.2.5.1 Transmission Modes

The protocol specification defines two transmission modes: ASCII and RTU. The modes define the way the message bytes are transmitted. It is not possible to use two transmission modes on the same network.

In the RTU mode, each word transmitted has 1 start bit, eight data bits, 1 parity bit (optional) and 1 stop bit (2 stop bits if no parity bit is used). Thus, the sequence of bits for transmission of a byte is as follows:

START	B0	B1	B2	B3	B4	B5	B6	B7	Parity or STOP	STOP

In the RTU mode, each data byte is transmitted as a single word with its value directly in hexadecimal. The MVW3000 uses only this transmission mode for communication; therefore, it does not have communication in ASCII mode.

9.2.5.2 Message structure in the RTU Mode

The Modbus-RTU network operates in the Master-Slave system, which may contain up to 247 slaves, but only one master. Every communication begins with the master making a request to a slave, and the slave responds to the master what was requested. In both telegrams (request and response), the structure used is the same: Address, Function Code, Data and CRC. Only the data field can have variable length, depending on what is being requested.

Table 9.20: *Telegram structure*

Master	Slave
Slave address (1 byte)	Slave address (1 byte)
Function (1 byte)	Function (1 byte)
Data (n bytes)	Data (n bytes)
CRC (2 bytes)	CRC (2 bytes)

Address:
The master starts the communication by sending a byte with the address of the slave destination of the message.

When sending the response, the slave also starts the telegram with its own address. The master can also send a message to address 0 (zero), which means that the message is sent to all the slaves on the network (broadcast). In this case, no slave will respond to the master.

Function Code:
This field also contains a single byte, where the master specifies the type of service or function requested from the slave (reading, writing, etc.). According to the protocol, each function is used to access a specific type of data.

In the MVW3000, data related to basic parameters and variables are available as holding type registers (referenced from address 40000 or '4x'. In addition to those registers, the inverter status (enabled/disabled, with error/without error, etc.) and the command for the inverter (run/stop, forward run/reverse run, etc.) can also be accessed through functions for reading/writing "coils" or internal bits (referenced from address 00000 or '0x').

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Data Field:
Field with variable size. The format and content of this field depend on the function used and the values transmitted. This field is described together with the functions (see Section 9.2.7 Detailed description of the functions on page 9-42).

CRC:
The last part of the telegram is the field for checking transmission errors. The method used is the CRC-16 (Cycling Redundancy Check). This field consists of two bytes, where the least significant byte (CRC-) is transmitted first, and then the most significant byte (CRC+).

The CRC calculation starts first by loading a 16-bit variable (from now on referred to as CRC variable) with the FFFFh value. Then perform the steps according to the following routine:

1. The first byte of the message (only the data bits - start bit, parity and stop bit are not used) is submitted to an XOR (exclusive OR) logic with the eight least significant bits of the CRC variable, returning the result in the CRC variable itself;

2. Then, the CRC variable is shifted one position to the right, towards the least significant bit, and the position of the most significant bit is filled in with 0 (zero).
3. After this shift, the flag bit (bit that was shifted out of the CRC variable) is analyzed, with the following occurring:
   - If the bit value is 0 (zero), nothing is done;
   - If the bit value is 1, the content of the CRC variable is submitted to an XOR logic with a constant value of A001h, and the result is returned to the CRC variable.
4. Steps 2 and 3 are repeated until eight shifts;
5. Steps 1 through 4 are repeated, using the next byte of the message, until the entire message has been processed.

The final content of the CRC variable is the value of the CRC field that is transmitted at the end of the telegram. The least significant part is transmitted first (CRC-) and then the most significant part (CRC+).

Time between Messages:
The RTU mode does not have a specific character that indicates the beginning or the end of a telegram. Thus, what indicates when a new message starts or when it finishes is the absence of data transmission on the network for a minimum period of 3.5 times the transmission time of a data word (11 bits). Thus, if a telegram is started after this minimum no transmission period has elapsed, the network elements will assume that the character received represents the beginning of a new telegram. And, likewise, the network elements will assume that the telegram reached the end after this period has elapsed again.

If during the transmission of a telegram, the time between the bytes is longer than this minimum period, the telegram will be considered invalid, because the inverter will discard the bytes already received and build a new telegram with the bytes that are being transmitted.

The table below shows the times for three different baud rates.

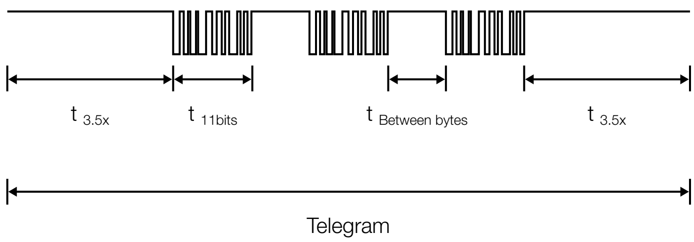


Figure 9.19: *Times involved during the communication of a telegram*

Table 9.21: *Telegram transmission time*

Baud rate [Kbps]	$t_{11\ bits}$ [μs]	$t_{3.5x}$ [ms]
9600	1146	4.010
19200	573	2.005
38400	285	1.003

$t_{11\ bits}$ = time to transmit a word of the telegram.
time between bytes = time between bytes (cannot be longer than 3.5x time).
$t_{3.5x}$ = minimum interval to indicate the beginning and end of the telegram (3.5 times the 11-bit time).

9.2.6 Operation

The MVW3000 frequency inverters operate as slaves to the Modbus-RTU network, and every communication starts with the master of the Modbus-RTU network requesting some service from an address on the network.

If the inverter is configured for the corresponding address, it processes the request and responds what was requested to the master.

Available Functions and Response Times:
In the specification of the Modbus-RTU protocol, you define the functions used to access the register types described in the specification. In MVW3000, both parameters and basic variables were defined as holding registers (referred to as 4x). In addition to these registers, it is also possible to directly access internal command and monitoring bits (referred to as 0x). To access these bits and registers, the following services (or functions) were provided for MVW3000frequency inverters:

Read Coils
Description: Reading of block of internal bits or coils.
Function code: 01.
Broadcast: not supported.
Response time: 5 to 10 ms.

Read Holding Registers
Description: Reading of block of holding registers.
Function code: 03.
Broadcast: not supported.
Response time: 5 to 10 ms.

Write Single Coil
Description: Writing on a single internal bit or coil.
Function code: 05.
Broadcast: supported.
Response time: 5 to 10 ms.

Write Single Register
Description: Writing on a single holding register.
Function code: 06.
Broadcast: supported.
Response time: 5 to 10 ms.

Write Multiple Coils
Description: Writing on block of internal bits or coils.
Function code: 15.
Broadcast: supported.
Response time: 5 to 10 ms.

Write Multiple Registers
Description: Writing on block of holding registers.
Function code: 16.
Broadcast: supported.
Response time: 10 to 20 ms for each written register.

Read Device Identification
Description: Identification of the inverter model.
Function code: 43.
Broadcast: not supported.
Response time: 5 to 10 ms.

Note: slaves on the Modbus-RTU network are addressed from 1 to 247. Address 0 (zero) is used by the master to send a common message to all slaves (broadcast).

Data Addressing and Offset:
The data addressing in the MVW3000 is done with an offset equal to zero, which means that the address number is equivalent to the given number. The parameters are available starting from address 0 (zero), while the basic variables are available starting from address 5000. Likewise, the status bits are provided starting from address 0

(zero) and the command bits are provided starting from address 100.

The following table illustrates the addressing of bits, parameters and basic variables:

Table 9.22: *Addressing of bits, parameters and basic variables*

Parameter	Modbus address
P0000	0
P0001	1
...	...
P0100	100
...	...

Basic variable	Modbus address
V00	5000
V01	5001
...	...
V08	5008

Status bits	Modbus address
Bit 0	00
Bit 1	01
...	...
Bit 7	07

Command bits	Modbus address
Bit 100	100
Bit 101	101
...	...
Bit 107	107

Note:
all registers (parameters and basic variables) are treated as holding registers, referenced from 40000 or 4x, while the bits are referenced from 0000 or 0x.

The status bits have the same functions as bits 8 to 15 of the logical status (basic variable 2). These bits are available as read only, and any writing command returns an error to the master.

Table 9.23: *Status bits*

Bit number	Function
0	0 = Enable by ramp inactive 1 = Enable by ramp active
1	0 = General enable inactive 1 = General enable active
2	0 = Reverse run 1 = Forward run
3	0 = JOG inactive 1 = JOG active
4	0 = Local mode 1 = Remote mode
5	0 = Without undervoltage 1 = With undervoltage
6	Not used
7	0 = Without fault 1 = With fault

The command bits are available for reading and writing and have the same function as bits 0 to 7 of the logical command (basic variable 3), without requiring mask though. The writing on basic variable 3 has an influence on the status of these bits.

Table 9.24: *Command bits*

Bit number	Function
100	0 = Disable ramp (Stop) 1 = Enables ramp (Run)
101	0 = General Disable 1 = General Enable
102	0 = Reverse run 1 = Forward run
103	0 = Disable JOG 1 = Enable JOG
104	0 = Go to Local mode 1 = Go to Remote mode
105	Not used
106	Not used
107	0 = Do not reset inverter 1 = Reset inverter

9.2.7 Detailed description of the functions

This item describes in details the functions available in the MVW3000 for Modbus-RTU communication. For the preparation of telegrams, it is important to note the following:

- Values are always transmitted in hexadecimal.
- The address of a data, the number of data and the value of registers are always represented in 16 bits. Therefore, it is necessary to transmit those fields using two bytes (high and low). To access bits, the way to represent a bit depends on the function used.
- Telegrams for both request and response cannot exceed 128 bytes.

9.2.7.1 Function 01 - Read Coils

Reads the contents of a group of internal bits that must be in numerical sequence. This function has the following structure for the reading and response telegrams (the values are always hexadecimal, and each field represents a byte):

Table 9.25: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Start bit address (byte high)	Number of data bytes
Start bit address (byte low)	Byte 1
Number of bits (byte high)	Byte 2
Number of bits (byte low)	Byte 3
CRC-	Byte n
CRC+	CRC-
-	CRC+

Each response bit is placed in a position of the data bytes sent by the slave. The first byte, in bits 0 to 7, receives the first 8 bits from the starting address indicated by the master. The other bytes (if the number of reading bits is greater than 8), continue the sequence. If the number of bits read is not a multiple of 8, the remaining bits of the last byte must be filled in with 0 (zero).

Example: reading of the status bits for general enable (bit 1) and direction of rotation (bit 2) of the of the MVW3000 at address 1:

Table 9.26: *Telegram structure example*

Request from the master	
Field	**Value**
Address	0x01
Function	0x01
Starting bit (high)	0x00
Starting bit (low)	0x01
Number of bits (high)	0x00
Number of bits (low)	0x02
CRC-	0xEC
CRC+	0x0B

Slave response	
Field	**Value**
Address	0x01
Function	0x01
Byte Count	0x01
Status of bits 1 and 2	0x02
CRC-	0xD0
CRC+	0x49

In the example, since the number of bits read is less than 8, the slave needed only 1 byte for the response. The value of the byte was 02h, which in binary has the form 0000 0010. Since the number of bits read is equal to 2, we are only interested in the two least significant bits, which have the values 0 = general disabled and 1 = forward run. As the remaining bits were not requested, they are filled with 0 (zero).

9.2.7.2 Function 03 - Read Holding Register

Reads the contents of a group of registers that must be in numerical sequence. This function has the following structure for the reading and response telegrams (the values are always hexadecimal, and each field represents a byte):

Table 9.27: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Starting register address (byte high)	Number of data bytes
Starting register address (byte low)	Data 1 (High)
Number of registers (byte high)	Data 1 (Low)
Number of registers (byte low)	Data 2 (High)
CRC-	Data 2 (Low)
CRC+	Data n (High)
-	Data n (Low)
-	CRC+
-	CRC+

Example: reading of the values with proportional value to Motor speed (P0002) and Motor current (P0003) of the MVW3000 at address 1:

Table 9.28: *Telegram structure example*

Request from the master	
Field	**Value**
Address	0x01
Function	0x03
Starting register (high)	0x00
Starting register (low)	0x02
Number of registers (high)	0x00
Number of registers (low)	0x02
CRC-	0x65
CRC+	0xCB

Slave response	
Field	**Value**
Address	0x01
Function	0x03
Byte Count	0x04
P0002 (high)	0x03
P0002 (low)	0x84
P0003 (high)	0x00
P0003 (low)	0x35
CRC-	0x7A
CRC+	0x49

Each register always consists of two bytes (high and low). For the example, we have that P0002 = 0384h, which in decimal is equal to 900. As this parameter has no decimal place for indication, the actual value read is 900 rpm.

Likewise, we have the current value P0003 = 0035h, which is equal to 53 decimal. As the current has a resolution of one decimal place, the actual value read is 5.3 A.

9.2.7.3 Function 05 - Write Single Coil

This function is used to write a value for a single bit. The value for the bit is represented using two bytes, where the value FF00h represents the bit equal to 1, and the value 0000h represents the bit equal to 0 (zero). It has the following structure (values are always hexadecimal, and each field represents one byte):

Table 9.29: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Bit address (byte high)	Bit address (byte high)
Bit address (byte low)	Bit address (byte low)
Bit value (byte high)	Bit value (bye high)
Bit value (byte low)	Bit value (bye low)
CRC-	CRC-
CRC+	CRC+

Example: activating the command enables ramp (bit 100 = 1) of a MVW3000 at address 1:

Table 9.30: *Telegram structure example*

Request from the master		Slave response	
Field	**Value**	**Field**	**Value**
Address	0x01	Address	0x01
Function	0x05	Function	0x01
Bit number (high)	0x00	Bit number (high)	0x01
Bit number (low)	0x64	Bit number (low)	0x02
Bit value (high)	0xFF	Bit value (high)	0xD0
Bit value (low)	0x00	Bit value (high)	0x49
CRC-	0xCD	CRC-	0xCD
CRC+	0xE5	CRC+	0xE5

For this function, the slave response is an identical copy of the request made by the master.

9.2.7.4 Function 06 - Write Single Register

This function is used to write a value for a single register. It has the following structure (values are always hexadecimal, and each field represents one byte):

Table 9.31: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Starting register address (byte high)	Register address (byte high)
Starting register address (byte low)	Register address (byte low)
Value for the register (byte high)	Value for the register (byte high)
Value for the register (byte low)	Value for the register (byte low)
CRC-	CRC-
CRC+	CRC+

Example: speed reference write (basic variable 4) equal to 900 rpm of a MVW3000 at address 1.

It is worth of notice that the value for basic variable 4 depends on the type of motor used, and that value 8191 is equivalent to the rated motor speed. In this case, let us assume the motor has an 1800 rpm rated speed; so, the value that will be written in basic variable 4 for a 900 rpm speed is half 8191, that is, 4096 (1000h).

Table 9.32: *Telegram structure example*

Request from the master	
Field	**Value**
Address	0x01
Function	0x06
Register (high)	0x13
Register (low)	0x8C
Value (high)	0x10
Value (low)	0x00
CRC-	0x41
CRC+	0x65

Slave response	
Field	**Value**
Address	0x01
Function	0x06
Register (high)	0x13
Register (low)	0x8C
Value (high)	0x10
Value (low)	0x00
CRC-	0x41
CRC+	0x65

For this function, again, the slave response is an identical copy of the request made by the master.
As stated earlier, the basic variables are addressed from 5000, so the basic variable 4 is addressed at 5004 (138Ch).

9.2.7.5 Function 15 - Write Multiple Coils

This function allows you to write values for a group of bits, which must be in numerical sequence. It can also be used to write a single bit (values are always hexadecimal, and each field represents a byte).

Table 9.33: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Start bit address (byte high)	Starting bit address (byte high)
Start bit address (byte low)	Starting bit address (byte low)
Number of bits (byte high)	Number of bits (byte high)
Number of bits (byte low)	Number of bits (byte low)
Byte Count	CRC-
Byte 1	CRC+
Byte 2	-
Byte n	-
CRC-	-
CRC+	-

The value of each bit being written is placed in a position of the data bytes sent by the master.

The first byte, in bits 0 to 7, receives the first 8 bits from the starting address indicated by the master.

The other bytes (if the number of written bits is greater than eight) continues the sequence. If the number of bits written is not a multiple of 8, the remaining bits of the last byte must be filled with 0 (zero).

Example: writing of the commands to enable ramp (bit 100 = 1), general enable (bit 101 = 1) and reverse run (bit 102 = 0), for a MVW3000 at address 1:

Table 9.34: *Telegram structure example*

Request from the master	
Field	**Value**
Address	0x01
Function	0x0F
Starting bit (byte high)	0x00
Starting bit (byte low)	0x64
Number of bits (byte high)	0x00
Number of bits (byte low)	0x03
Byte Count	0x01
Value for the bits	0x03
CRC-	0xBE
CRC+	0x9E

Slave response	
Field	**Value**
Address	0x01
Function	0x0F
Starting bit (byte high)	0x00
Starting bit (byte low)	0x64
Number of bits (byte high)	0x00
Number of bits (byte low)	0x03
CRC-	0x54
CRC+	0x15

As only three bits are being written, the master needed only one byte to transmit the data. The transmitted values are in the three least significant bits of the byte that contains the value for the bits. The remaining bits of this byte were left with value 0 (zero).

9.2.7.6 Function 16 - Write Multiple Registers

This function allows writing values for a group of registers, which must be in numerical sequence.
It can also be used to write a single register (values are always hexadecimal, and each field represents a byte).

Table 9.35: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Starting register address (byte high)	Starting register address (byte high)
Starting register address (byte low)	Starting register address (byte low)
Number of registers (byte high)	Number of registers (byte high)
Number of registers (byte low)	Number of registers (byte low)
Byte Count	CRC-
Data 1 (high)	CRC+
Data 1 (low)	-
Data 2 (high)	-
Data 2 (low)	-
Byte n (high)	-
Byte n (low)	-
CRC-	-
CRC+	-

Example: writing of Acceleration time (P0100) = 1.0 if Deceleration time (P0101) = 2.0 s, of a MVW3000 at address 20:

Table 9.36: *Telegram structure example*

Request from the master	
Field	**Value**
Address	0x14
Function	0x10
Starting register (byte high)	0x00
Starting register (byte low)	0x64
Number of registers (byte high)	0x00
Number of registers (byte low)	0x02
Byte Count	0x04
P0100 (high)	0x00
P0100 (low)	0x0A
P0100 (high)	0x00
P0100 (low)	0x14
CRC-	0x91
CRC+	0x75

Slave response	
Field	**Value**
Address	0x14
Function	0x10
Starting register (high)	0x00
Starting register (low)	0x64
Number of registers (high)	0x00
Number of registers (low)	0x02
CRC-	0x02
CRC+	0xD2

As both parameters have a resolution of one decimal place, for writing 1.0 s and 2.0 s, the values 10 (000Ah) and 20 (0014h) must be transmitted respectively.

9.2.7.7 Function 43 - Read Device Identification

Auxiliary function that allows reading the product manufacturer, model and firmware version. It has the following structure:

Table 9.37: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
MEI type	MEI type
Reading code	Conformity Level
Object number	More Follows
CRC-	Next Object
CRC+	Number of objects
-	Object Code
-	Object Size
-	Object Value
-	CRC-
-	CRC+

9

Fields are repeated according to the number of objects.
This function allows reading three categories of information: Basic, Regular and Extended, and each category is formed by a group of objects. Each object consists of a sequence of ASCII characters. For the MVW3000, only basic information is available, consisting of three objects:

- Object 00 - VendorName: 'WEG'.
- Object 01 - ProductCode: Formed by the product code plus the inverter rated current.
- Object 02 - MajorMinorRevision: indicates the inverter firmware version, in the format 'VX.XX'.

The reading code indicates which information categories are being read and whether the objects are being accessed in sequence or individually. In this case, the inverter supports codes 01 (basic information in sequence) and 04 (individual access to objects).

The remaining fields for the MVW3000 have fixed values.

Example: reading of basic information in sequence, from object 00, of a MVW3000 at address 1:

Table 9.38: Telegram structure example

Request from the master	
Field	**Value**
Address	0x01
Function	0x2B
MEI type	0x0E
Reading code	0x01
Object number	0x00
CRC-	0x70
CRC+	0x77

Slave response	
Field	**Value**
Address	0x01
Function	0x2B
MEI type	0x0E
Reading code	0x01
Conformity Level	0x51
More Follows	0x00
Next Object	0x00
Number of objects	0x03
Object Code	0x00
Object Size	0x03
Object Value	'WEG'
Object Code	0x01
Object Size	0x0E
Object Value	'MVW3000 7.0A'
Object Code	0x02
Object Size	0x05
Object Value	'V2.09'
CRC-	0xB8
CRC+	0x39

In this example, the value of the objects was not represented in hexadecimal but using the corresponding ASCII characters. For example, for object 00, the 'WEG' value was transmitted as three ASCII characters, which in hexadecimal have the values 57h (W), 45h (E) and 47h (G).

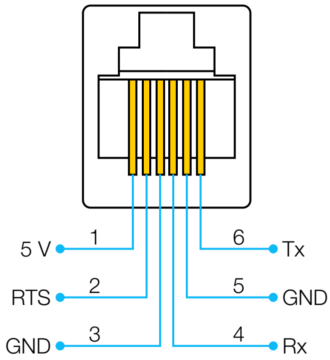
9.3 PLC2 BOARD

The PLC2 board adds to the MVW3000 inverter, important PLC functions, enabling the execution of Ladder programs. It also offers CANopen, DeviceNet and Modbus-RTU communication, in addition to increasing the number of I/Os of Fieldbus communications with Anybus-S board.

NOTE!
The PLC2 board has its own manual, which can be consulted for detailed information.

9.3.1 Modbus-RTU

9.3.1.1 Connector



Pin	Signal	Function
1	+5V	Power supply
2	RTS	Ready to send
3	GND	Power supply reference
4	Rx	RS-232, data reception
5	GND	Power supply reference
6	Tx	RS-232, data transmission

Figure 9.20: *XC7 connector: Modbus-RTU*

9.3.1.2 Parameter setting

P0764 - PLC address

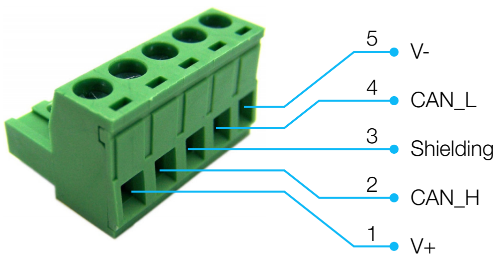
Defines the serial address of the PLC2 board.

P0765 - RS232 Baud rate

Defines the serial communication baud rate.

9.3.2 CANopen

9.3.2.1 Connector



Pin	Signal	Function
1	V-	Power supply reference
2	CAN_L	CAN_L
3	Shield	Cable shield
4	CAN_H	CAN_H
5	V+	Power supply: 11...25 Vcc

Figure 9.21: *XC17 connector: CANopen*

9.3.2.2 Termination

The starting and ending points of the network must be terminated at the characteristic impedance to avoid reflections. To that end, a 120 Ω/0.5 W resistor must be connected between pins 2 and 4 of the connector.

9.3.2.3 Inverter parameter setting

P0770 - CAN protocol

It allows selecting which protocol is desired for communication through the CAN interface.

9.3.2.4 Node address

P0771 - CAN address

It allows selecting the PLC2 address on the CAN network; the node address can be set from 1 to 127.

9.3.2.5 Baud rate

P0772 - CAN baud rate

It sets the CAN baud rate.

Table 9.39: *Baud rates of the CANopen network*

P0772	Description
0	1 Mbps
1	Reserved
2	500 Kbps
3	250 Kbps
4	125 Kbps
5	100 Kbps
6	50 Kbps
7	20 Kbps
8	10 Kbps

9.3.3 DeviceNet

9.3.3.1 Inverter parameter setting

P0770 - CAN protocol

It allows selecting which protocol is desired for communication through the CAN interface.

9.3.3.2 Node address

P0771 - CAN address

It allows selecting the PLC2 address on the CAN network; the node address can be set from 0 to 63.

9.3.3.3 Baud rate

P0772 - CAN baud rate

It sets the CAN baud rate.

Table 9.40: *Baud rates of the DeviceNet network*

P0772	Description
0	auto-baud
1	auto-baud
2	500 Kbps
3	250 Kbps
4	125 Kbps
5	auto-baud
6	auto-baud
7	auto-baud
8	auto-baud

9.3.4 Fieldbus

It allows the user to define more than six input and output variables that will be used by the Fieldbus network.

The following items are the same as described for Fieldbus networks without a PLC2 board:

- Connector
- Termination resistor
- Baud rate
- LED indicators

See Chapter 9.1 FIELDBUS on page 9-1 for more information.

9.3.4.1 Inverter parameter setting

There is a set of parameters that enable and configure the operation of the inverter in the Fieldbus network with PLC2 board. Before starting the network operation, it is necessary to configure these parameters so that the inverter operates as desired.

P0774 - Communication failure

Selects between alarm indication or fault occurrence, if the inverter is being controlled by the network and a communication failure occurs.

P0275 - DO1 Function

P0276 - DO2 Function

P0277 - RL1 Function

P0279 - RL2 Function

P0280 - RL3 Function

P0281 - RL4 Function

P0282 - RL5 Function

These parameters define the function of the inverter digital outputs. For the digital outputs that you wish to operate via Fieldbus with PLC2 board, it is necessary to set these parameters for the “PLC” option.

LOCAL setting:

P0220 - LOCAL/REMOTE selection source

P0221 - Speed reference selection LOCAL situation

P0223 - Forward/Reverse Selection LOCAL Situation

P0224 - Start/Stop Selection LOCAL Situation

P0225 - Selection of JOG Source LOCAL Situation

REMOTE setting:

P0220 - LOCAL/REMOTE selection source

P0222 - Speed reference selection REMOTE situation

P0226 - Selection of Direction of ROTATION REMOTE Situation

P0227 - Start/Stop Selection REMOTE Situation

P0228 - JOG Selection - REMOTE Situation

These parameters define the source of commands and references for the inverter in the LOCAL and REMOTE modes.
For the commands that you wish to operate via Fieldbus with PLC2 board, it is necessary to set these parameters for the “PLC” option.

9.3.4.2 Read/written variables

The following data can be configured in the WLP software, via Menu → Ferramentas → Anybus:

Inputs: allows programming the data sent from the PLC2 board to the network master
Outputs: allows programming the data sent by the network master and received by the PLC2 board.

In the list of inputs and outputs, different data can be added:

- User parameters
- Word markers
- Bit markers (always multiples of 16, as for each line added with bit marker, groups of 16 markers are considered to form a word).

Each data added to this list is 1 word (16 bits) long. The order in which the data is programmed in these lists is the same order in which this data is received and sent by the master of the network.
The maximum number of words that can be configured increases from 6 to 32.

NOTE! For use of the PLC2 board and anybus board, the parameter P0309 must be set to “inactive” so that the quantity of anybus IO’s configured on the PLC2 works correctly.

9.3.4.3 Application example

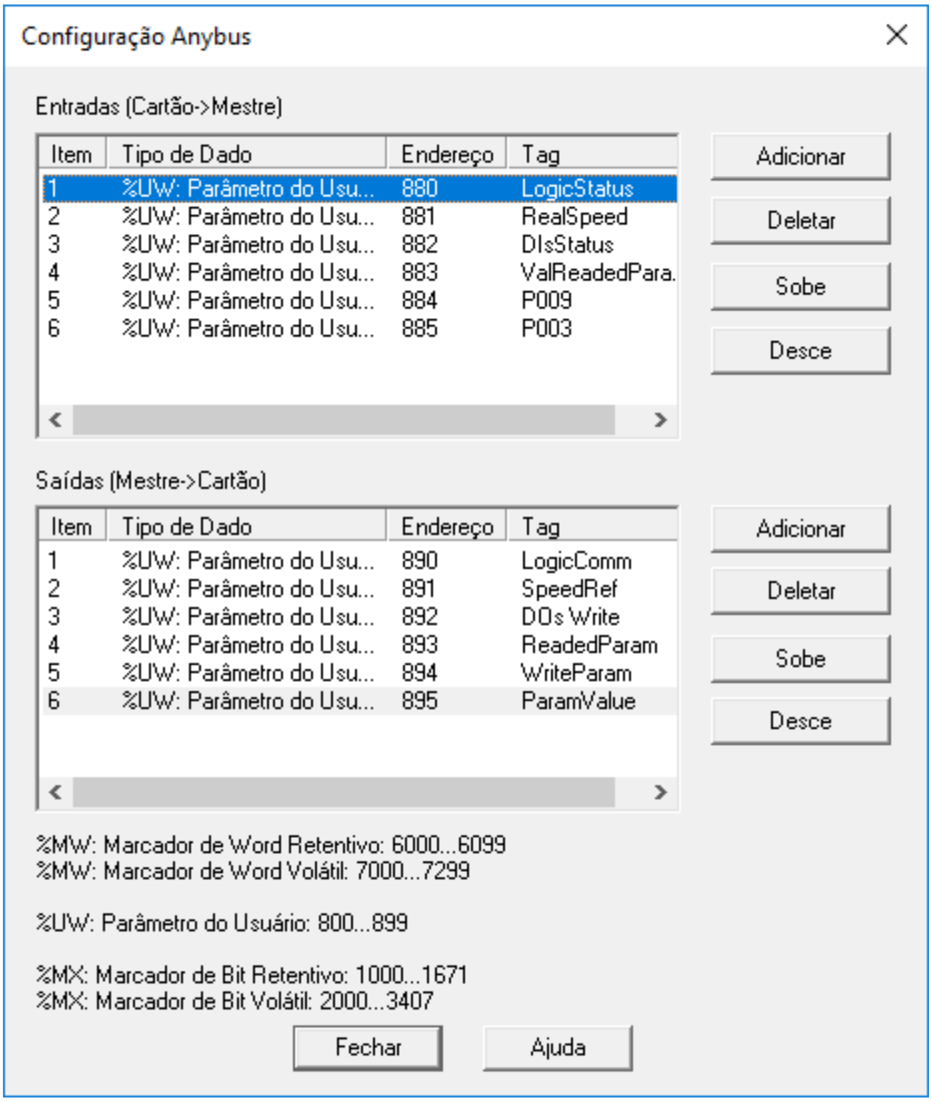


Figure 9.22: *Anybus-S word mapping*

10 PERFORMANCE

NOTE!
The values presented in tables Table 10.1 on page 10-1 to Table 10.16 on page 10-9 are typical values; however, they may change due to the special characteristics of the product:

- Acoustic noise from the MVW3000 may vary according to the number of fans used;
- Final dimensions of MVW3000;
- Final mass of MVW3000;
- Voltage and current THD values may vary according to the electrical installations of the source and motor used.

Table 10.1: *General information about the models MVW3000*

Technical data		Unit
Power supply		
Input voltage tolerance	Table 2.2 on page 2-4	%
Rated frequency		Hz
Cos φ (typical values for operation at rated condition)	> 0,95	-
Basic impulse level (BIL)	According to the voltage level of the MVW3000	kV
Short-circuit capacity	According to design	kA
Rated voltage	Table 10.2 on page 10-3 to Table 10.16 on page 10-9	
Total harmonic distortion of the input current - THDi		
Rated voltage		
Low voltage power supply	Table 2.2 on page 2-4	
Environment conditions		
Operating temperature	0 ~ 40 °C (max. 50 °C, with derating of 2.5% in the current every 1 °C above 40 °C)	°C
Storage temperature	-20 ~ +50	°C
Humidity	5 ~ 90 non-condensing	%
Altitude	0 ~ 1000 (max. 4000 m, with 1% current derating for each 100 m above 1000 m)	m
Installation	Interior	-
Rating	Non-hazardous	-
Pollution degree	2 - non-conductive	-
Electrical details		
Converter type	Voltage Source Inverter (VSI)	-
Topology	Cascaded H-Bridge (CHB)	-
Motor Type	Induction motor Synchronous motor with brush Brushless synchronous motor Synchronous motor with permanent magnets	-
Rectifier section	Low voltage diodes	-
Number of pulses: standard - redundant N+1	Table 3.2 on page 3-2	-
Control method	Sinusoidal PWM	-
Control mode	Speed control	-
Control type	V/f (scalar) Vector with/without speed sensor	-
Output frequency range	0 ~ 120	Hz
Low voltage IGBT switching frequency	500	Hz

Power cell switching frequency (Full bridge)	1000	Hz
Output voltage range	0 ~ rated	kV
Overload capacity (normal operation)	115% for 60 s every 10 minutes	-
Efficiency (typical values for operation at rated condition)	> 96.50 (al transformer) > 96.25 (al transformer) + filter > 97.00 (cu transformer) > 96.75 (cu transformer) + filter	%
Output filter	Table 4.18 on page 4-12	-
dV/dt without output filter	< 2000	V/µs
dV/dt with type 1 output filter	< 200	V/µs
Control voltage	Check out: 'Auxiliary power supply' in Table 2.2 on page 2-4	Vac
Motor temperature controller	8x Pt100	-
Communication	Modbus RTU PROFIBUS DP DeviceNet EtherNet Modbus TCP PROFINET	-
Operation quadrants	2Q	-
Electronic board coating	default (ISO 60721-3-3:2002)	-
Number of starts per hour	6	starts/hour
Total losses for Al transformers	Table 2.3 on page 2-6 to Table 2.17 on page 2-13	
Total losses for Al transformers + output filter		
Total losses for Cu transformers		
Total losses for Cu transformers + output filter		
Voltage peak (phase-ground)	Table 10.2 on page 10-3 to Table 10.16 on page 10-9	
Voltage peak (phase-phase)		
Number of pulses (default)		
Number of transformers shifted per input phase		
Number of power cells per phase		
Output switching frequency (applied to the motor)		
Drive details		
MTTR (Mean Time To Repair)	15	minutes
Speed regulation	1 (V/f) 0.5 (Vector without sensor) 0.01 (Vector with encoder)	%
Maximum sag during ride-through	30	%
Maximum ride-through time	Depends on the load inertia	-

Mechanical details		
Protection Degree	NEMA 1, IP21 (IP41 and IP42 optional)	-
Line cable entry	top / bottom	-
Motor cable entry	bottom other options on request	-
Cooling method	forced air	-
Mechanical interlock between low and medium voltage	yes)	-
Redundant fans	optional	-
Mechanical dimensions	Table 10.2 on page 10-3 to Table 10.16 on page 10-9	
Mass	Table 6.1 on page 6-2	
Material thickness		
Frame	1.984	mm
Doors/Covers	1.984	mm
Base	3.038	mm
Mounting plates	1.984	mm

Table 10.2: *1150 V and 40-600 A model*

Technical data: 1150 V model		
Rated voltage	1150	V
Output rated voltage	3.6	kV
Number of phase-shifting transformers	1	-
Number of power cells per phase: default - redundant (N+1)	1 - 2	-
Default output switching frequency - redundant N+1	1000 - 2000	Hz
Voltage peak (phase-ground)	1553	V
Voltage peak (phase-phase)	1863	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.3: *2300 V and 40-600 A model*

Technical data: 2300 V model		
Rated voltage	2300	V
Output rated voltage	3.6	kV
Number of phase-shifting transformers	1	-
Number of power cells per phase: default - redundant (N+1)	2 - 3	-
Default output switching frequency - redundant N+1	2000 - 3000	Hz
Voltage peak (phase-ground)	2484	V
Voltage peak (phase-phase)	3726	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.4: *3300 V and 40-600 A model*

Technical data: 1150 V model		
Rated voltage	3300	V
Output rated voltage	7.2	kV
Number of phase-shifting transformers	1	-
Number of power cells per phase: default - redundant (N+1)	3 - 4	-
Output switching frequency: default - redundant N+1	3000 - 4000	Hz
Voltage peak (phase-ground)	3416	V
Voltage peak (phase-phase)	5589	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.5: *4160 V and 40-600 A model*

Technical data: 4160 V model		
Rated voltage	4160	V
Output rated voltage	7.2	kV
Number of phase-shifting transformers	1	-
Number of power cells per phase: default - redundant (N+1)	4 - 5	-
Output switching frequency: default - redundant N+1	4000 - 5000	Hz
Voltage peak (phase-ground)	4347	V
Voltage peak (phase-phase)	7452	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.6: *5500 V and 40-600 A model*

Technical data: 5500 V model		
Rated voltage	5500	V
Output rated voltage	7.2	kV
Number of phase-shifting transformers	1	-
Number of power cells per phase: default - redundant (N+1)	5 - 6	-
Output switching frequency: default - redundant N+1	5000 - 6000	Hz
Voltage peak (phase-ground)	5279	V
Voltage peak (phase-phase)	9315	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.7: *6000-6300 V and 40-600 A model*

Technical data: 6300 V model		
Rated voltage	6300	V
Output rated voltage	7.2	kV
Number of phase-shifting transformers	1	-
Number of power cells per phase: default - redundant (N+1)	6 - 7	-
Output switching frequency: default - redundant N+1	6000 - 7000	Hz
Voltage peak (phase-ground)	6210	V
Voltage peak (phase-phase)	11178	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.8: *6600-6900 V and 40-600 A model*

Technical data: 6900 V model		
Rated voltage	6900	V
Output rated voltage	7.2	kV
Number of phase-shifting transformers	1	-
Number of power cells per phase: default - redundant (N+1)	6 - 7	-
Output switching frequency: default - redundant N+1	6000 - 7000	Hz
Voltage peak (phase-ground)	6210	V
Voltage peak (phase-phase)	11178	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.9: *7200 V and 40-600 A model*

Technical data: 7200 V model		
Rated voltage	7200	V
Output rated voltage	12	kV
Number of phase-shifting transformers	< 500 A: 1 ≥ 500 A: 2	-
Number of power cells per phase: default - redundant (N+1)	7 - 8	-
Output switching frequency: default - redundant N+1	7000 - 8000	Hz
Voltage peak (phase-ground)	7142	V
Voltage peak (phase-phase)	13041	V
Total harmonic distortion of the input current - THDi	≤ 5 (according to IEEE 519 or better) (for mains voltage with THDv ≤ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	≤ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: ≤ 5	%
Acoustic noise	On request	dB

Table 10.10: *8000 V and 40-600 A model*

Technical data: 8000 V model		
Rated voltage	8000	V
Output rated voltage	12	kV
Number of phase-shifting transformers	< 500 A: 1 ≥ 500 A: 2	-
Number of power cells per phase: default - redundant (N+1)	7 - 8	-
Output switching frequency: default - redundant N+1	7000 - 8000	Hz
Voltage peak (phase-ground)	7142	V
Voltage peak (phase-phase)	13041	V
Total harmonic distortion of the input current - THDi	≤ 5 (according to IEEE 519 or better) (for mains voltage with THDv ≤ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	≤ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: ≤ 5	%
Acoustic noise	On request	dB

Table 10.11: *9000 V and 40-600 A model*

Technical data: 9000 V model		
Rated voltage	9000	V
Output rated voltage	12	kV
Number of phase-shifting transformers	< 400 A: 1 ≥ 400 A: 2	-
Number of power cells per phase: default - redundant (N+1)	8 - 9	-
Output switching frequency: default - redundant N+1	8000 - 9000	Hz
Voltage peak (phase-ground)	8073	V
Voltage peak (phase-phase)	14904	V
Total harmonic distortion of the input current - THDi	≤ 5 (according to IEEE 519 or better) (for mains voltage with THDv ≤ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	≤ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: ≤ 5	%
Acoustic noise	On request	dB

Table 10.12: *10000 V and 40-600 A model*

Technical data: 10000 V model		
Rated voltage	10000	V
Output rated voltage	12	kV
Number of phase-shifting transformers	< 225 A: 1 ≥ 225 A: 2	-
Number of power cells per phase: default - redundant (N+1)	9 - 10	-
Output switching frequency: default - redundant N+1	9000 - 10000	Hz
Voltage peak (phase-ground)	9005	V
Voltage peak (phase-phase)	16767	V
Total harmonic distortion of the input current - THDi	≤ 5 (according to IEEE 519 or better) (for mains voltage with THDv ≤ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	≤ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: ≤ 5	%
Acoustic noise	On request	dB

Table 10.13: *11000 V and 40-600 A model*

Technical data: 11000 V model		
Rated voltage	11000	V
Output rated voltage	12	kV
Number of phase-shifting transformers	$<$ 225 A: 1 $\geq$ 225 A: 2	-
Number of power cells per phase: default - redundant (N+1)	10 - 10	-
Output switching frequency: default - redundant N+1	10000 - 10000	Hz
Peak voltage (phase-ground): default - redundant	9936 - 9265	V
Peak voltage (phase-phase): default - redundant	18630 - 17253	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.14: *12000 V and 40-600 A model*

Technical data: 12000 V model		
Rated voltage	12000	V
Output rated voltage	17.5	kV
Number of phase-shifting transformers	$<$ 225 A: 1 $\geq$ 225 A: 2	-
Number of power cells per phase: default - redundant (N+1)	11 - 12	-
Output switching frequency: default - redundant N+1	11000 - 12000	Hz
Voltage peak (phase-ground)	10868	V
Voltage peak (phase-phase)	20493	V
Total harmonic distortion of the input current - THDi	$\leq$ 5 (according to IEEE 519 or better) (for mains voltage with THDv $\leq$ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	$\leq$ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: $\leq$ 5	%
Acoustic noise	On request	dB

Table 10.15: 13200 V and 40-600 A model

Technical data: 13200 V model		
Rated voltage	13200	V
Output rated voltage	17.5	kV
Number of phase-shifting transformers	< 225 A: 1 ≥ 225 A: 2	-
Number of power cells per phase: default - redundant (N+1)	12 - 12	-
Output switching frequency: default - redundant N+1	12000 - 12000	Hz
Peak voltage (phase-ground): default - redundant	11799 - 11183	V
Peak voltage (phase-phase): default - redundant	22356 - 21087	V
Total harmonic distortion of the input current - THDi	≤ 5 (according to IEEE 519 or better) (for mains voltage with THDv ≤ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	≤ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: ≤ 5	%
Acoustic noise	On request	dB

Table 10.16: 13800 V and 40-600 A model

Technical data: 13800 V model		
Rated voltage	13800	V
Output rated voltage	17.5	kV
Number of phase-shifting transformers	< 225 A: 1 ≥ 225 A: 2	-
Default number of power cells per phase	12	-
Output switching frequency: default - redundant N+1	12000 - 12000	Hz
Voltage peak (phase-ground)	11799	V
Voltage peak (phase-phase)	22356	V
Total harmonic distortion of the input current - THDi	≤ 5 (according to IEEE 519 or better) (for mains voltage with THDv ≤ 2)	%
Total harmonic distortion of the output current - THDi	According to the motor characteristics	%
Total harmonic distortion of the input voltage - THDv	≤ 5 (according to IEEE 519 or better)	%
Total harmonic distortion of the output voltage - THDv	Without filter & type 1 filter: On request Type 2 filter: ≤ 5	%
Acoustic noise	On request	dB

WEG Drives & Controls - Automação LTDA.
Jaraguá do Sul – SC – Brazil
Phone 55 (47) 3276-4000 – Fax 55 (47) 3276-4020
São Paulo – SP – Brazil
Phone 55 (11) 5053-2300 – Fax 55 (11) 5052-4212
automacao@weg.net
www.weg.net

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