Motors | Automation | Energy | Transmission & Distribution | Coatings

Medium Voltage Frequency Inverter

MVW3000

User's Manual

User's Manual

Series: MVW3000

Language: English

Document: 10004823674 / 01

Publication Date: 09/2019

Version	Review	Description
-	R00	First edition
-	R01	General revision

1 SAFETY NOTICES

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

It has been written for qualified personnel with suitable training or technical qualifications to operate this type of equipment.

This manual presents all the functions and parameters of the MVW3000. However, it is not intended to present all the possible applications of the MVW3000. WEG will not take any liabilities for applications not described in this manual.

1.1 SAFETY NOTICES IN THE MANUAL

Throughout this manual the following safety notes are used:

DANGER!
The procedures recommended in this warning have the purpose of protecting the user against dead, serious injuries and considerable material damage.

DANGER!
Les procédures concernées par cet avertissement sont destinées à protéger l'utilisateur contre des dangers mortels, des blessures et des détériorations matérielles importantes.

ATTENTION!
The procedures recommended in this warning have the purpose of avoiding material damage.

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 ground (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.

DANGER!
Seul le personnel qualifié et familier avec l'onduleur de fréquence MVW3000 et ses équipements associés doit préparer et mettre en oeuvre l'installation, démarrer et ensuite entretenir cet équipement. Ce personnel doit suivre toutes les instructions de sécurité comprises dans ce mode d'emploi et/ou définies par la règlementation locale.
Le non respect de ces instructions peut causer la mort, des blessures graves ou d'importants dégâts matériels.

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.

DANGER!
Débranchez toujours l'alimentation générale avant de toucher un composant électrique associé au convertisseur. Nombreux composants peuvent rester chargés avec haute tension et/ou en mouvement (ventilateurs), même après que l'entrée d'alimentation CA a été débranchée ou coupée.
Attendez au moins 10 minutes pour s'assurer de la décharge totale des condensateurs.
Connectez toujours le boîtier de l'équipement à terre de protection (PE) au point adéquat pourça.

ATTENTION!
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 perform any high pot tests with 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 user's manual completely before installing or operating the inverter.

DANGER!
This product was not designed to be used as a safety element. Additional measures must be taken so as to avoid material and personal damages.
The product was manufactured under strict quality control, however, if installed in systems where its failure causes risks of material or personal damages, additional external safety devices must ensure a safety condition in case of a product failure, preventing accidents.

DANGER!
Ce produit n'est pas conçu pour être utilisé comme un élément de sécurité. Des précautions supplémentaires doivent être prises afin d'éviter des dommages matériels ou corporels.
Ce produit a été fabriqué sous un contrôle de qualité conséquent, mais s'il est installé sur des systèmes où son dysfonctionnement entraîne des risques de dommages matériels ou corporels, alors des dispositifs de sécurité externes supplémentaires doivent assurer des conditions de sécurité en cas de défaillance du produit, afin d'éviter des accidents.

ATTENTION!
When in operation, electric energy systems – such as transformers, converters, motors and cables – generate electromagnetic fields (EMF), posing a risk to people with pacemakers or implants who stay in close proximity to them. Therefore, those people must stay at least 2 meters away from such equipment.

2 GENERAL INFORMATION

This chapter defines the contents of this manual and describes the main characteristics of the MVW3000 frequency inverter and how to identify its components. It provides also additional information on the receiving and storage of the product.

2.1 ABOUT THIS MANUAL

This manual presents 9 chapters, which have a logical sequence so that the user receives, installs, programs and operates the MVW3000.

Chapter 1 SAFETY NOTICES on page 1-1.
Chapter 2 GENERAL INFORMATION on page 2-1.
Chapter 3 PRODUCT CHARACTERISTICS on page 3-1.
Chapter 4 TECHNICAL DATA on page 4-1.
Chapter 5 SYNCHRONOUS MOTOR LINE on page 5-1.
Chapter 6 INSTALLATION, CONNECTION AND ENERGIZATION on page 6-1.
Chapter 7 OPTIONAL ACCESSORIES AND BOARDS on page 7-1.
Chapter 8 SPECIAL FUNCTIONS on page 8-1.
Chapter 9 COMMUNICATION NETWORKS on page 9-1.

This user's manual contains information about WEG 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 the customers' needs and specific applications.

The MVW3000 product can be customized (engineered) to meet the needs and technical specifications of our customers. Variations is sizes, technical recommendations, performance data and optional items can be changed in relation to the information contained in this document.

The customer will receive the user's manual, the programming manual and a detailed project of his product. This project contains all the electrical and mechanical information, as well as instructions for the interface/installation with other equipment regarding the MVW3000 supplied.

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 MVW3000 identification label is positioned in the inner part of the Control Panel of the product. This label describes important information about the inverter.

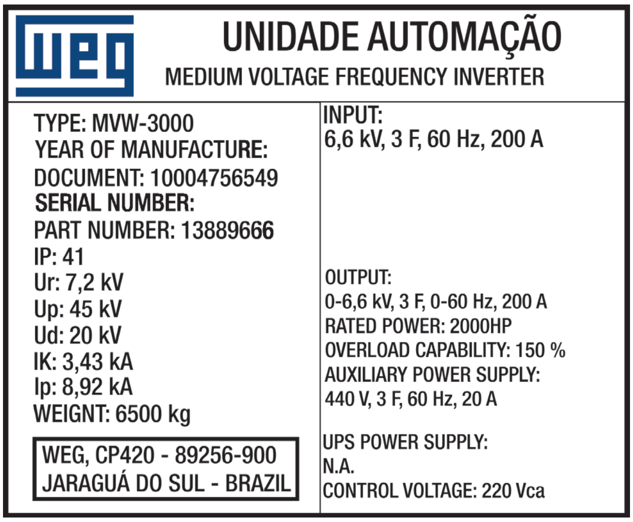


Figure 2.1: *MVW3000 identification label (example)*

2.3 RECEIVING AND STORAGE

The MVW3000 is supplied with the power cells separate from the panel and packed in sets of three cells per package. The package is composed of OSB 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. Compare the content of this label to the purchase order.

In order to open the cells, see the procedures described in Item 6.1.5 Unpacking on page 6-3. If the MVW3000 cells are not install on the cabinet soon, store them in a clean and dry place (temperature between -25 °C (-13 °F) and 50 °C (122 °F) and humidity below 80 %), covered so as protect from dust accumulation and water splashes. It is recommended to replace the silica gel every three months.

The MVW3000 cabinet has a dehumidifier module, which must remain turned on in case of storage for over thirty days.

The MVW3000 cabinet is supplied in a cardboard and wood package. The directions for handling, transportation, mechanical and electrical installations of the product are described in Chapter 6 INSTALLATION, CONNECTION AND ENERGIZATION on page 6-1, in Item 6.1.5 Unpacking on page 6-3.

2.4 HOW TO SPECIFY THE MVW3000 MODEL

***Table 2.1:** MVW3000 Code*

Lettering	Line	1	2	3	4	5	6	7	8	9	10
Code Example [(1)]	MVW3000	A0140	V063	T5A	066	P	A	S	F	R	D

1		2		3		4		5		6		7		8		9		10	
Rated Output Current		**Rated Output Voltage**		**Input Transformer**		**Input Rated Voltage**		**Manual Language**		**Cooling System**		**Input Cubicle**		**Capacitor Type**		**Cell Type**		**Rectifier Type**	
40 A	A0040	2300 V	V023	Al - 50 Hz	T5A	2300 V	023	English	E	Air	A	Not included	N	Film	F	Standard	S	Diode	D
50 A	A0050	3300 V	V033	Al - 60 Hz	T6A	3300 V	033	Spanish	S	-	-	Included	S	-	-	Bypass	B	-	-
60 A	A0060	4160 V	V041	Cu - 50 Hz	T5C	4160 V	041	Portuguese	P	-	-	-	-	-	-	Redundant	R	-	-
70 A	A0070	5500 V	V055	Cu - 60 Hz	T6C	5500 V	055	-	-	-	-	-	-	-	-	-	-	-	-
80 A	A0080	6300 V	V063	-	-	6000 V	060	-	-	-	-	-	-	-	-	-	-	-	-
90 A	A0090	6900 V	V069	-	-	6300 V	063	-	-	-	-	-	-	-	-	-	-	-	-
100 A	A0100	7200 V	V072	-	-	6600 V	066	-	-	-	-	-	-	-	-	-	-	-	-
110 A	A0110	8000 V	V080	-	-	6900 V	069	-	-	-	-	-	-	-	-	-	-	-	-
125 A	A0125	10000 V	V100	-	-	7200 V	072	-	-	-	-	-	-	-	-	-	-	-	-
140 A	A0140	11000 V	V110	-	-	8000 V	080	-	-	-	-	-	-	-	-	-	-	-	-
160 A	A0160	13200 V	V132	-	-	10000 V	100	-	-	-	-	-	-	-	-	-	-	-	-
180 A	A0180	13800 V	V138	-	-	11000 V	110	-	-	-	-	-	-	-	-	-	-	-	-
200 A	A0200	-	-	-	-	13200 V	132	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	13800 V	138	-	-	-	-	-	-	-	-	-	-	-	-

(1) For available models, see Table 2.3 on page 2-5 to Table 2.10 on page 2-8.

Table 2.2: General specification

POWER SUPPLY	Voltage	2300 V, 3300 V, 4160 V, 5500 V, 6000 V, 6300 V, 6600 V, 6900 V, 7200 V, 8000 V (± 10 %, -20 % with output power reduction)	
	Frequency	50 or 60 Hz (specify as necessary) ±3 %	
	Voltage imbalance between phases	<3 %	
	Cos φ	>0.95	
	Overvoltage category	Category III	
AUXILIARY SUPPLY	Voltage	220, 380, 400, 415, 440, 460 or 480 V	
	Frequency	50 or 60 Hz (±3 %)	
	Voltage imbalance between phase	<3 %	
PROTECTION DEGREE	Standard	IP41	
DIMENSION	Width / Height / Depth (mm)	16 distinct frames. For all available frames, see Figure 4.3 on page 4-3 and Table 4.2 on page 4-3 to Table 4.8 on page 4-4	
ENVIRONMENTAL CONDITIONS	Temperature	0 to 40 °C (32 °F to 104 °F) (up to 50 °C (122 °F) with 2.5 % reduction in the output current/ °C)	
	Humidity	5 to 90 % without condensation	
	Altitude	0 to 1000 m (up to 4000 m with derating of 10% / 1000 m)	
	Pollution degree	2	
FINISHING	Color	Gray ultra dull (Doors)	
		Blue ultra dull (Base, Roof, Shutters)	
CONTROL	Microprocessor	32 bits	
	Control method	Sinusoidal PWM	
	Control types	Scalar (Imposed Voltage - V/F), Vector (encoder and sensorless)	
	Switching frequency	500 Hz	
	Frequency range	0 to 120 Hz	
	Allowed overload	115 % during 60 seconds, every 10 minutes	
PERFORMANCE	Efficiency	Higher 96.5 % (with aluminum transformer) Higher 97.0 % (with copper transformer)	
	Speed control	V/F	Regulation: 1 % of the nominal speed with slip compensation Regulation: 1 rpm (keypad reference)
		Sensorless	Regulation: 0.5 % of the nominal speed Speed variation range: 1:100
		With Encoder (using EBA, EBB or EBC board))	Regulation: ±0.01 % of the nominal speed with a 14-bit analog input (EBA) ±0.01 % of the nominal speed with digital reference (keypad, Serial, Fieldbus, Electronic Potentiometer, Multispeed) ±0.1 % of nominal speed with 10-bit analog input
INPUTS OUTPUTS	Analogical	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 NO/NC: 240 Vac, 1 A 2 programmable isolated open collector outputs: 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 kits	
		Ethernet and Profinet	
SAFETY	Protections (memory of the last 100 faults/ alarms with date and time)	See fault in the programming manual available for download on: **www.weg. net**	

APPLICABLE STANDARDS	Electromagnetic compatibility	EMC directive 89 / 336 / EEC - industrial environment
		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 (LCD DISPLAY)	Command	Start/Stop, Parameterization (Programming of general functions)
		Increase/decrease the speed
		JOG, Forward/Reverse selection, Local/Remote selection
	Supervision (Reading)	Speed reference (rpm)
		Motor speed (rpm)
		Value proportional to the speed (e.g.: m/min)
		Motor output frequency (Hz)
		Voltage on the intermediate circuits (V)
		Motor torque (%)
		Output power (kW)
		Energized time (h)
		Operation time (h)
		Motor current (A)
		Motor voltage (V)
		Inverter status
		Digital input status
		Digital output (transistor) status
		Relay output status
		Analog input values
		100 last erros in the memory with date and time
		Fault/alarm messages
AVAILABLE RESOURCES/ FUNCTIONS	Options	Fieldbus network communication kits (installation inside the inverter)
		SUPERDRIVE kit with RS-232 serial communication interface (Inverter - PC)
		Kit Ethernet
		Kit Expansão de I/Os / Profibus DP

2.4.1 Available Models

The MVW3000 line of medium voltage inverters offers different models, classified according to their rated voltage and current levels. Different models of the MVW3000 may have distinct frames, which are presented in Table 2.3 on page 2-5 with their respective codes. For the constructive aspects of the available frames, see Chapter 4 TECHNICAL DATA on page 4-1, Figure 4.3 on page 4-3 and Table 4.2 on page 4-3 to Table 4.8 on page 4-4. For models with rated voltage above 8000 V, contact WEG.

Table 2.3: *MVW3000 2300 V models*

Models	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V023	2300	40	170	130	5.03	4.29	7062 CFM or 12000 m³/h	B2
MVW3000 A0050 V023		50	220	165	6.29	5.36		
MVW3000 A0060 V023		60	265	200	7.54	6.43		
MVW3000 A0070 V023		70	315	235	8.80	7.50		
MVW3000 A0080 V023		80	355	265	10.06	8.58		
MVW3000 A0090 V023		90	400	300	11.31	9.65		
MVW3000 A0100 V023		100	445	335	12.57	10.72		
MVW3000 A0110 V023		110	485	365	13.83	11.79		
MVW3000 A0125 V023		125	560	420	15.71	13.40		
MVW3000 A0140 V023		140	630	470	17.60	15.01		
MVW3000 A0160 V023		160	715	535	20.11	17.15	8828 CFM or 15000 m³/h	C2
MVW3000 A0180 V023		180	810	605	22.63	19.29		
MVW3000 A0200 V023		200	895	670	25.14	21.44		

2

Table 2.4: MVW3000 3300 V models

Models	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V033	3300	40	250	190	7.21	6.15	7062 CFM or 12000 m³/h	B3
MVW3000 A0050 V033		50	320	240	9.02	7.69		
MVW3000 A0060 V033		60	380	285	10.82	9.23		
MVW3000 A0070 V033		70	445	335	12.63	10.77		
MVW3000 A0080 V033		80	515	385	14.43	12.30		
MVW3000 A0090 V033		90	575	430	16.23	13.84		
MVW3000 A0100 V033		100	640	480	18.04	15.38		
MVW3000 A0110 V033		110	710	530	19.84	16.92		
MVW3000 A0125 V033		125	800	600	22.54	19.22		
MVW3000 A0140 V033		140	900	675	25.25	21.53		
MVW3000 A0160 V033		160	1030	770	28.86	24.61	8828 CFM or 15000 m³/h	C3
MVW3000 A0180 V033		180	1155	865	32.46	27.68		
MVW3000 A0200 V033		200	1285	960	36.07	30.76		

Table 2.5: MVW3000 4160 V models

Models	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V041	4160	40	320	240	9.09	7.76	77062 CFM or 12000 m³/h	B4
MVW3000 A0050 V041		50	400	300	11.37	9.69		
MVW3000 A0060 V041		60	480	360	13.64	11.63		
MVW3000 A0070 V041		70	565	425	15.92	13.57		
MVW3000 A0080 V041		80	650	485	18.19	15.51		
MVW3000 A0090 V041		90	730	545	20.46	17.45		
MVW3000 A0100 V041		100	810	605	22.74	19.39		
MVW3000 A0110 V041		110	890	665	25.01	21.33		
MVW3000 A0125 V041		125	1015	760	28.42	24.23		
MVW3000 A0140 V041		140	1135	850	31.83	27.14		
MVW3000 A0160 V041		160	1300	970	36.38	31.02	8828 CFM or 15000 m³/h	C4
MVW3000 A0180 V041		180	1460	1090	40.92	34.90		
MVW3000 A0200 V041		200	1625	1215	45.47	38.78		

Table 2.6: MVW3000 5500 V models

Modelos	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V055	5500	40	425	320	12.02	10.25	7062 CFM or 12000 m³/h	B5
MVW3000 A0050 V055		50	535	400	15.03	12.82		
MVW3000 A0060 V055		60	640	480	18.04	15.38		
MVW3000 A0070 V055		70	750	560	21.04	17.94		
MVW3000 A0080 V055		80	855	640	24.05	20.51		
MVW3000 A0090 V055		90	965	720	27.05	23.07		
MVW3000 A0100 V055		100	1070	800	30.06	25.63		
MVW3000 A0110 V055		110	1175	880	33.07	28.20		
MVW3000 A0125 V055		125	1340	1000	37.57	32.04		
MVW3000 A0140 V055		140	1505	1125	42.08	35.89		
MVW3000 A0160 V055		160	1720	1285	48.10	41.01	8828 CFM or 15000 m³/h	C5
MVW3000 A0180 V055		180	1935	1445	54.11	46.14		
MVW3000 A0200 V055		200	2150	1605	60.12	51.27		

2

Table 2.7: MVW3000 6300 V models

Models	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V063	6300	40	485	485	13.77	11.74	7062 CFM or 12000 m³/h	B6
MVW3000 A0050 V063		50	615	615	17.22	14.68		
MVW3000 A0060 V063		60	735	735	20.66	17.62		
MVW3000 A0070 V063		70	855	855	24.10	20.55		
MVW3000 A0080 V063		80	985	985	27.55	23.49		
MVW3000 A0090 V063		90	1105	1105	30.99	26.42		
MVW3000 A0100 V063		100	1230	1230	34.43	29.36		
MVW3000 A0110 V063		110	1350	1350	37.88	32.30		
MVW3000 A0125 V063		125	1540	1540	43.04	36.70		
MVW3000 A0140 V063		140	1720	1720	48.20	41.11		
MVW3000 A0160 V063		160	1970	1970	55.09	46.98	8828 CFM or 15000 m³/h	C6
MVW3000 A0180 V063		180	2215	2215	61.98	52.85		
MVW3000 A0200 V063		200	2465	2465	68.86	58.72		

Table 2.8: MVW3000 6900 V models

Models	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V069	6900	40	535	400	15.08	12.86	7062 CFM or 12000 m³/h	B6
MVW3000 A0050 V069		50	670	500	18.86	16.08		
MVW3000 A0060 V069		60	810	605	22.63	19.29		
MVW3000 A0070 V069		70	945	705	26.40	22.51		
MVW3000 A0080 V069		80	1075	805	30.17	25.73		
MVW3000 A0090 V069		90	1210	905	33.94	28.94		
MVW3000 A0100 V069		100	1345	1005	37.71	32.16		
MVW3000 A0110 V069		110	1480	1105	41.48	35.37		
MVW3000 A0125 V069		125	1685	1260	47.14	40.20		
MVW3000 A0140 V069		140	1890	1410	52.80	45.02		
MVW3000 A0160 V069		160	2155	1610	60.34	51.45	8828 CFM or 15000 m³/h	C6
MVW3000 A0180 V069		180	2430	1815	67.88	57.88		
MVW3000 A0200 V069		200	2700	2015	75.42	64.31		

Table 2.9: MVW3000 7200 V models

Models	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V072	7200	40	560	420	15.74	13.42	10595 CFM or 18000 m³/h	B7
MVW3000 A0050 V072		50	700	525	19.68	16.78		
MVW3000 A0060 V072		60	840	630	23.61	20.13		
MVW3000 A0070 V072		70	985	735	27.55	23.49		
MVW3000 A0080 V072		80	1125	840	31.48	26.84		
MVW3000 A0090 V072		90	1265	945	35.42	30.20		
MVW3000 A0100 V072		100	1405	1050	39.35	33.56		
MVW3000 A0110 V072		110	1545	1155	43.29	36.91		
MVW3000 A0125 V072		125	1760	1315	49.19	41.94		
MVW3000 A0140 V072		140	1970	1470	55.09	46.98		
MVW3000 A0160 V072		160	2250	1680	62.96	53.69	13243 CFM or 22500 m³/h	C7
MVW3000 A0180 V072		180	2530	1890	70.83	60.40		
MVW3000 A0200 V072		200	2815	2100	78.70	67.11		

2

Table 2.10: MVW3000 8000 V models

Models	Nominal Voltage [V]	Rated Current [A]	Motor Rated Power (1)		Dissipated Power (2) [kW]	Dissipated Power (3) [kW]	Flow	Frame Size
			[HP]	[kW]				
MVW3000 A0040 V080	8000	40	620	465	17.49	14.91	10595 CFM or 18000 m³/h	B8
MVW3000 A0050 V080		50	775	580	21.86	18.64		
MVW3000 A0060 V080		60	935	700	26.23	22.37		
MVW3000 A0070 V080		70	1090	815	30.61	26.10		
MVW3000 A0080 V080		80	1250	935	34.98	29.83		
MVW3000 A0090 V080		90	1405	1050	39.35	33.56		
MVW3000 A0100 V080		100	1560	1165	43.72	37.28		
MVW3000 A0110 V080		110	1720	1285	48.10	41.01		
MVW3000 A0125 V080		125	1955	1460	54.65	46.60		
MVW3000 A0140 V080		140	2190	1635	61.21	52.20		
MVW3000 A0160 V080		160	2505	1870	69.96	59.65	13243 CFM or 22500 m³/h	C8
MVW3000 A0180 V080		180	2815	2100	78.70	67.11		
MVW3000 A0200 V080		200	3130	2335	87.45	74.57		

(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. The motor rated output takes into account the operation with power factor 0.87 and 97 % of efficiency at full load.
(2) Dissipated power considering transformer with aluminum winding and operation under the conditions of Note (1).
(3) Dissipated power considering transformer with copper winding and operation under the conditions of Note (1).

Notes:
1 hp = 0.746 kW
1kW = 3412.14 BTU/hour for the dissipated power.
1 m³/h = 0.5885 CFM

***Figure 2.2:** MVW3000 panel general view (Frame size B6)*

3 PRODUCT CHARACTERISTICS

A brief theoretical explanation about the operation and a simplified electrical scheme of the power cells and their connections are presented below. The basic operation of the control system is presented at the end of this chapter.

The MVW3000 is a frequency inverter designed to control medium voltage motors at the rated values of 2.3 kV to 13.8 kV and for a power range of 150 HP to 5400 HP. Based on a topology where the low voltage cells (< 1000 V) are connected in series to form each inverter phase, its assembly is modular, enabling different configurations if necessary to drive high power motors.

NOTE!
The characteristics contained in this manual were based on models of the standard MVW3000 intended for applications 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.

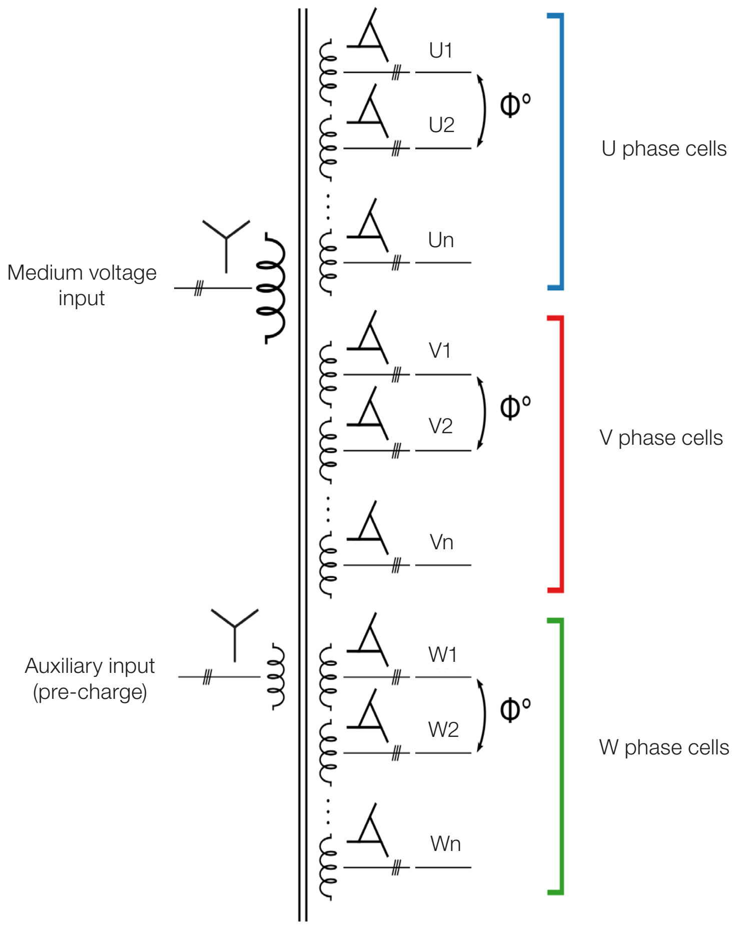


Figure 3.1: *Input phase-shifting transformer diagram*

The transformer configuration is made in star – extended delta, with phase-shifting angles φ° between the secondary windings of one 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.

Motor Voltage [kV]	2.3	3.3	4.16	5.5	6-69	7.2	8
Secondary Windings	3x2=6	3x3=9	3x4=12	3x5=15	3x6=18	3x7=21	3x8=24

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 help cancel the harmonic components coming from the non-controlled semiconductors 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 pulses 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 Figure 3.2 on page 3-3 is used, which offers good cost effectiveness with great performance regarding harmonic component cancellation and reduced cost, in comparison to transformers with more pulses.

Table 3.1 on page 3-2 contains the possible input transformer configurations for different numbers of cells installed on the MVW3000 panel.

Table 3.1: *Possible number of pulses to obtain in relation to the number of cells*

Cells per Phase	Total Cells	Number of Pulses
2	6	36, 18, 12[(1)], 6
3	9	54, 18[(1)], 6
4	12	72, 36, 24[(1)], 18, 12, 6
5	15	90, 30[(1)], 18, 6
6	18	108, 54, 36[(1)], 18, 12, 6
7	21	126, 126, 42[(1)], 18, 6
8	24	144, 72, 48, 36[(1)], 24, 18, 12, 6

(1) Standard option.

Figure 3.2 on page 3-3 indicates the connection points for the power cell inputs, in this case, the phases R, S and T. The windings with 690 V_{rms} of rated voltage process 1/18 of the converter rated power, in the case of the 18-cell MVW3000.

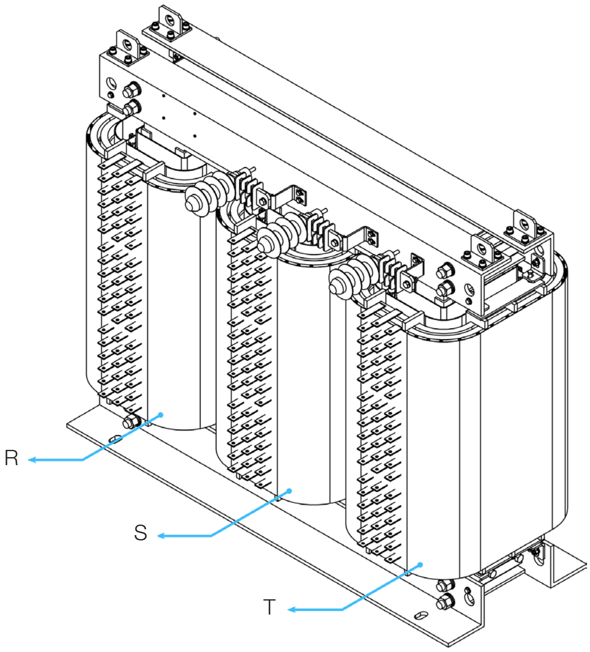


Figure 3.2: Input transformer of the 18-cell MVW3000 (Frame B6)

Physically, the cells that form phases U, V and W are connected to the main transformer according to Figure 3.3 on page 3-3.

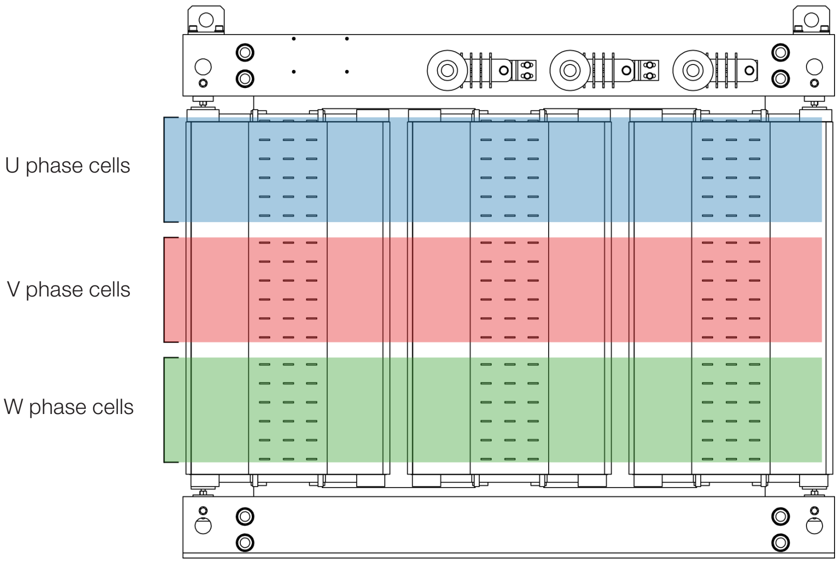


Figure 3.3: Cell connection area of each phase

The transformer has its own panel, being thus totally integrated to the MVW3000. For more details on the panels, refer to Chapter 4 TECHNICAL DATA on page 4-1, Figure 4.3 on page 4-3, Table 4.2 on page 4-3 to Table 4.8 on page 4-4.

3.2 POWER CELLS

The power cells used on the arms of the MVW3000 are single-phase low voltage inverters (output voltage of 690 V_{rms}), in a topology known as H bridge or full bridge. A basic diagram of the rms power cell circuit can be seen in Figure 3.4 on page 3-4. Each cell has the feeding of one own secondary winding (three-phase) of the main transformer, which ensures the converter medium voltage insulation.

The three-phase voltages of the input of the modules are then rectified by a Graetz bridge using non-controlled semiconductor devices (diodes), forming one own DC link (direct current) with the addition of the capacitors to the cell (represented by symbol C1). They can be electrolytic or plastic film capacitors, depending on the model of the used cell.

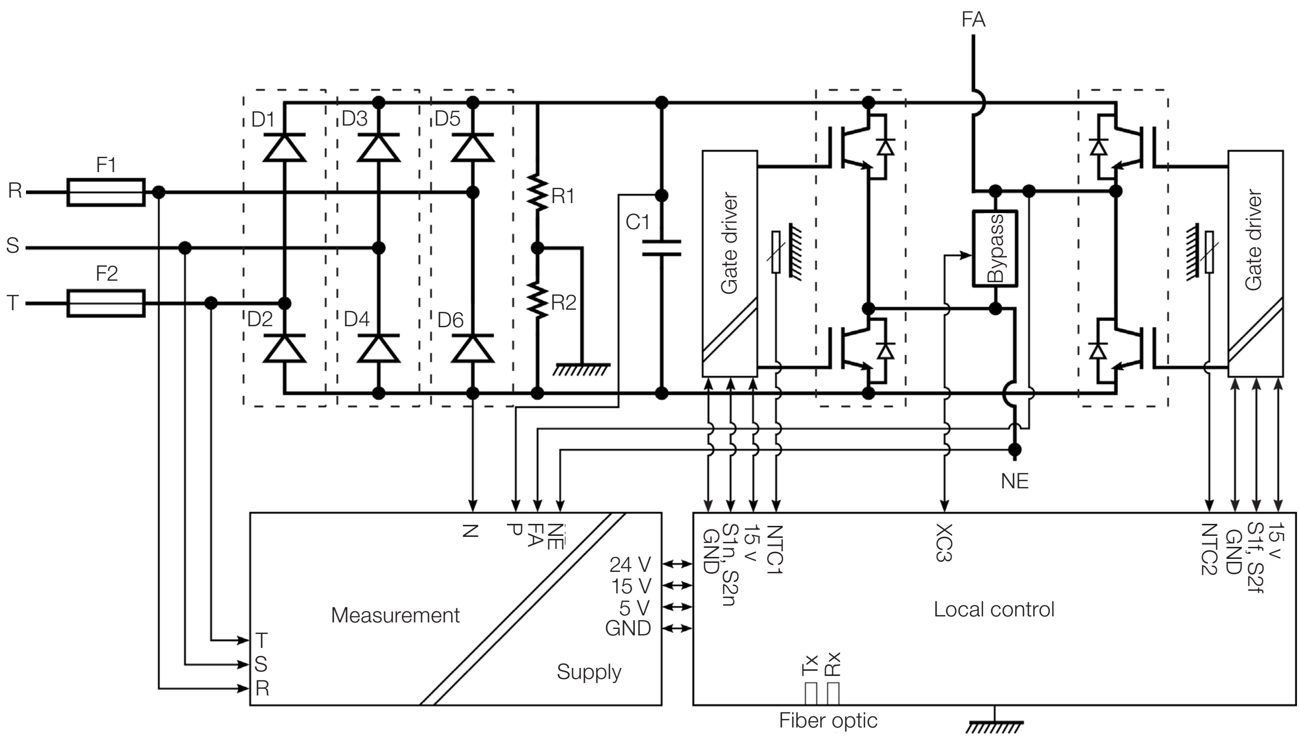


Figure 3.4: *Basic diagram of a power cell*

IGBT (Insulated Bipolar Gate Transistor) controlled semiconductor devices are used to implant the inverter bridge in H; 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), 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 the zero.

To protect the modules, two fuses F1 and F2 are connected to the input phases R and T, as shown in Figure 3.1 on page 3-1. 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 enabling the operation to continue.

When that occurs, control strategies will be applied so that the load remains operating. Further information can be found in 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 optical-fiber interface, necessary to obtain, in addition to the insulation degree required for the communication, noise immunity, greater robustness and reliability, characteristics necessary for the application. The local control makes acquisitions and monitors relevant magnitudes for the cell operation.

Some of the monitored magnitudes are the 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 activations, such as the switching of the IGBTs and the trigger 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 predicted by the control, the bypass system may be activated for protection against a possible cell failure or for removing an already damaged cell from operation.

3.3 CONNECTION OF THE CELLS

To form a three-phase output, a number "n" of power cells that operate with 690 "V_{rms}" of output are rms grouped in series per phase. The cell sets that represent phases U, V and W are connected in star configuration, with a floating neutral in common with the phases, as indicated in Figure 3.5 on page 3-5.

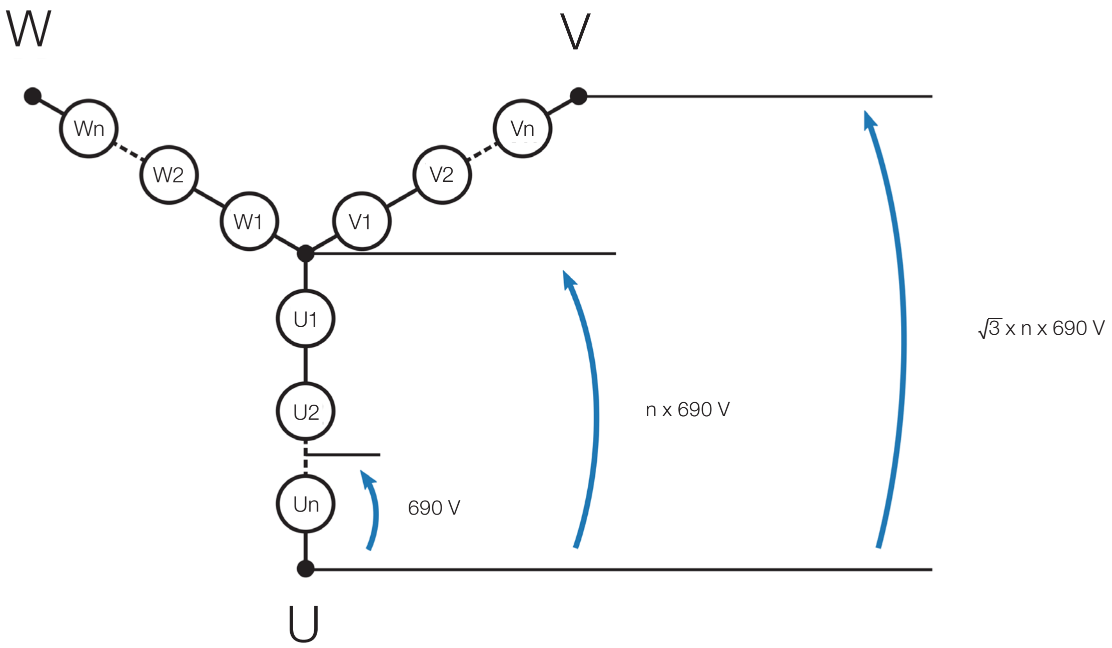


Figure 3.5: *Cell-to-phase connection diagram*

Figure 3.6 on page 3-6 shows the transformer, input switchgear and secondary winding connected to each cell. This association in series enables more voltage levels at the inverter output. Locally, each cell produces three voltage levels; however, at the converter three-phase output, it is possible to obtain 2n + 1 levels on the phase voltage and 4n+1 levels on the line voltage.

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 3-7 shows the sum of the voltages of each cell to form the phase voltage in a 9-cell MVW3000 (3 per phase).

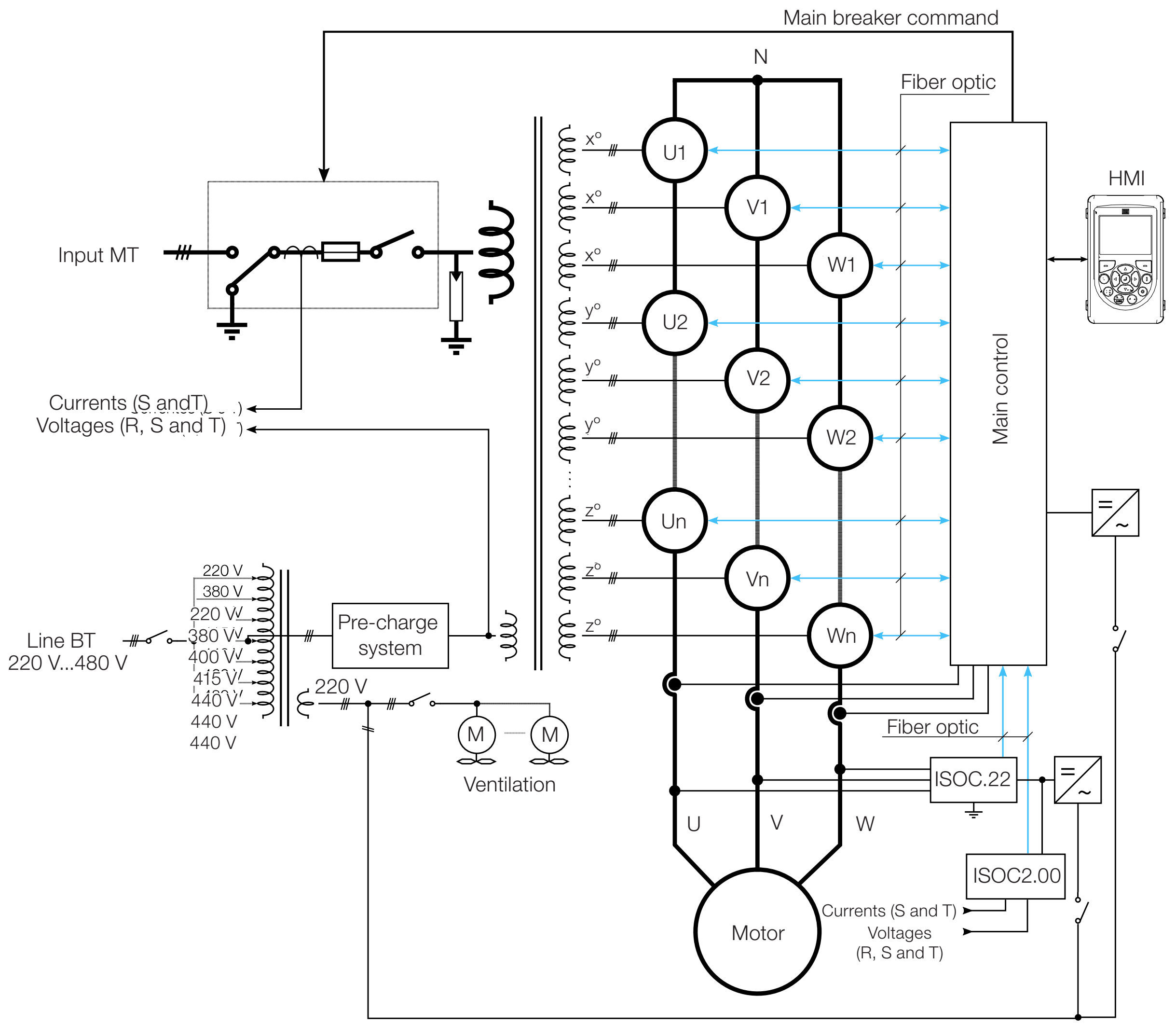


Figure 3.6: *MVW3000 simplified diagram for n power cells*

Therefore, increasing the number of cells per phase, in addition to enabling the drive of motors with higher voltages and powers, a better sinusoidal shaped wave is obtained. Thus, the converter provides a smaller THD (total harmonic distortion), reduction of noises and vibration on the motor, operating with high efficiency.

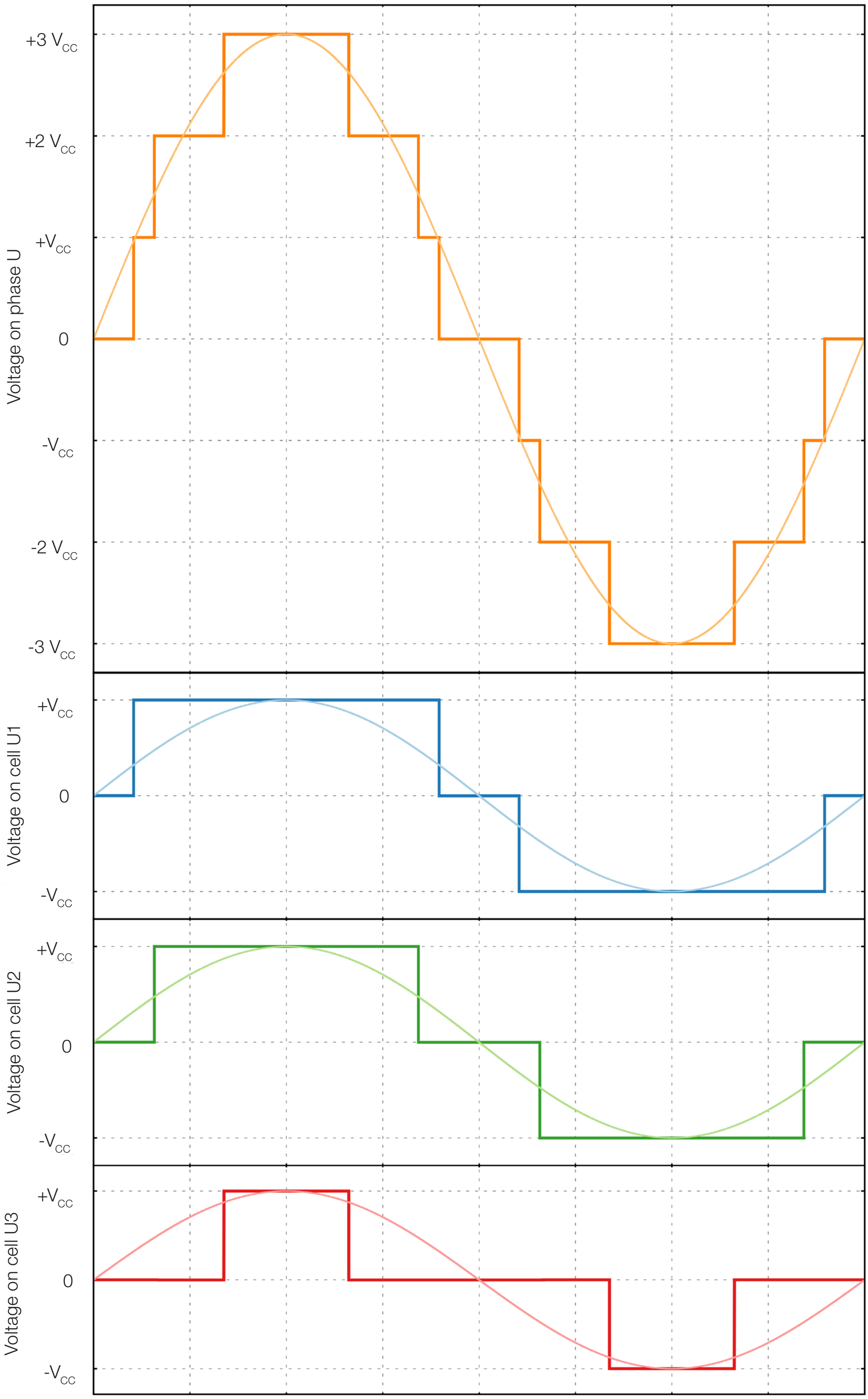


Figure 3.7: *Wave form of the phase voltage for a CHB of 3 cells per phase*

The diagram also shows the medium voltage input switchgear, the low voltage auxiliary winding to perform the pre-charge of the cell capacitors, as well as the fiber optic interface between the main control and the local control of the power cells.

3.4 CONTROL

The MVW3000 has protections against overload, short circuit, current limit, 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 converter output terminals from the association of “n” low voltage cells in series. For further information on the central control, refer to Section 4.3 CONTROL RACK on page 4-6.

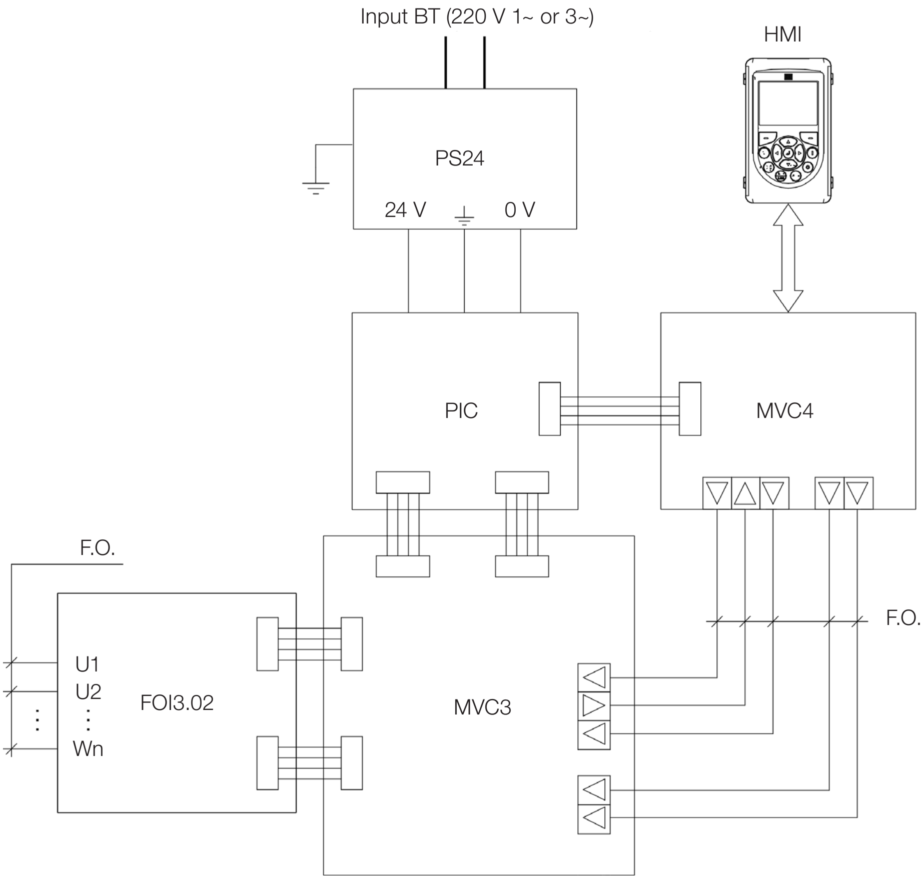


Figure 3.8: *Central control simplified diagram*

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 for indication on the HMI and for implanting the converter control and protection functions.

The pre-charge is done by means of an auxiliary winding of the input transformer, which is driven by the inverter auxiliary supply circuit via current limiter elements. In order to prevent high starting current levels on the inverter, activation of protection systems or even damages to its own components, the cell capacitor pre-charge must be done through and auxiliary winding of the input transformer. The auxiliary supply is also responsible for feeding the control circuit and fans for the panel cooling.

4 TECHNICAL DATA

This chapter contains technical information on the MVW3000, cabinet details, input transformer, power cell and control rack. It also provides information about the available output filters for the MVW3000.

4.1 MVW3000 PANEL

The MVW3000 is assembled as coupled panels forming four distinct compartments. In the first column of the panel, to the left, are the input safety devices, such as fuses and the input circuit breaker/contactor (if installed). This part also shows the input transformer temperature on the temperature display. Below the safety devices, in a separate section, is the main medium voltage input transformer. In the central section, the inverter power cells are installed; each of the three columns shown in Figure 4.2 on page 4-2 represents each of the three inverter phases: U, V and W.

Figure 4.1: *Closed panel of the 18-cell MVW3000 (Frame B6)*

The handles of average tension that feed the cells of the invertor come from the secondary ones of the transforming one of entrance. 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 and independent secondary winding insulated from the main transformer. In the right panel, in the upper compartment, is the control compartment, containing the main control, user interface, HMI, command and signalling, which are exclusively supplied by low voltage circuits.

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

The standard panels of the models equipped with drive system and input protection feature medium voltage fuses in order 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 presents the fuse models recommended for the standard inverters where the input and output voltage are the same; for applications with voltage values different between input and output, the fuse model will be informed upon request.

Table 4.1: Recommended fuses

Inverter Rated Current (A)	Fuse
40	3R
50	3R
60	3R
70	5R
80	5R
90	5R
100	5R
110	12R
125	12R
140	12R
160	12R
180	18R
200	18R

The standard panels supplied for the MVW3000 are suitable for connection to medium voltage circuits capable to supply a maximum symmetrical short circuit current of 40 kA.

The standard panels supplied for the MVW3000 are suitable for connection to medium voltage circuits capable to supply a maximum symmetrical short circuit current of 40 kA.

4.1.1 Panel Constructive Aspects

The panel is made with steel sheets painted and processed (cutting, holes, folding, chemical treatment, painting and finishing) by WEG, ensuring the quality in all the levels of the manufacture process. The inverter parts that are not painted are zinc plated or have another suitable treatment in order to assure their resistance against corrosion.

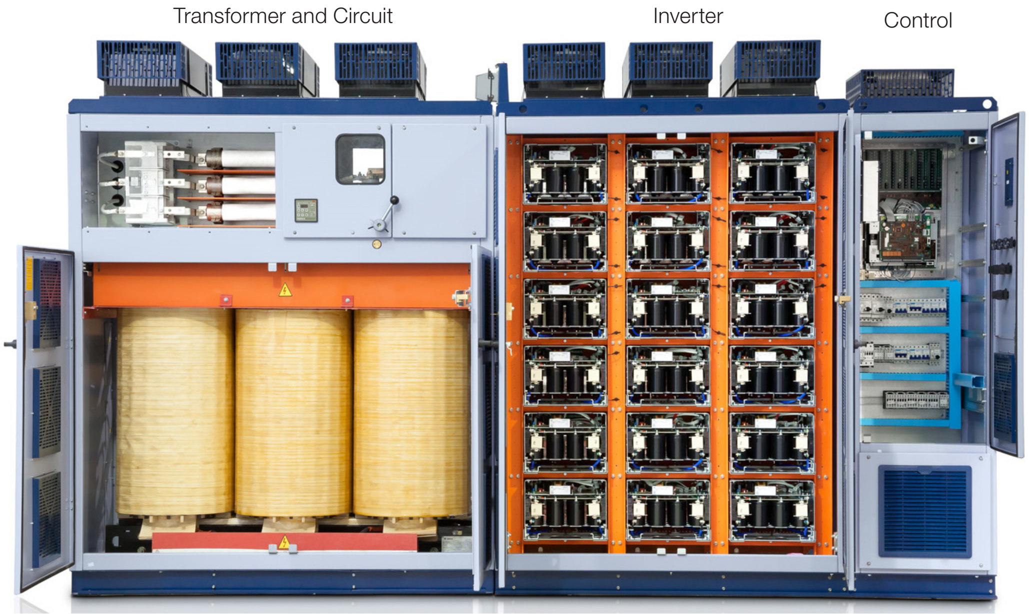


***Figure 4.2:** Panel of the 18-cell MVW3000 (Frame B6)*

The MVW3000 panel is supplied, in its standard structure, with degree of protection IP41 (openings smaller than 10 mm and protected against ingress of vertical drops). They can be supplied with distinct degrees of protection according to the customer's needs.

The panel cooling is done by means of forced convection. The air enters through the opening on the panel front doors, goes through the transformer windings and also the power heatsinks located in each power cell. The hot air leaves through the top do painel, of the panel, where the exhaust fans are located, allowing maintenance without the need to open 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 m prevents the access to the medium voltage compartment.

The MVW3000 complies with the international standards, such as harmonic limits, contained in IEEE-519 and G5/4-1 standards, and also electromagnetic emission (EMC), contained in IEC61800-3 standard.

The medium voltage compartments are mechanically and electrically interlocked so as to prevent the access to all the components that may present risk of electric shock with the system energized. Only after closing the transformer and inverter panel doors is it possible to open the grounding system and close the input switch disconnector.

In case of unlocking of the doors, the inverter will block the operation and turn off the input circuit breaker. The control panel is fed by an auxiliary power supply (220 V – 480 V), which may be blocked to prevent its activation.

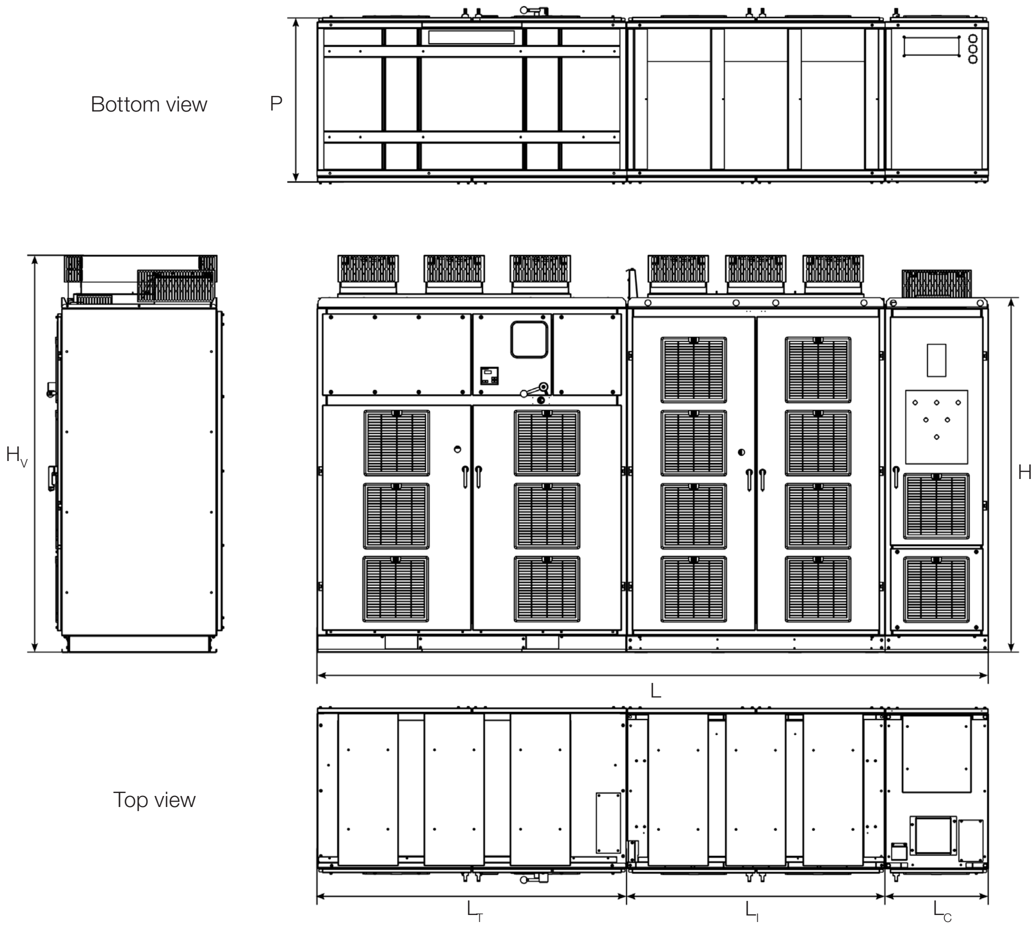


Figure 4.3: *Panel constructive aspects*

Table 4.2: *Frame sizes available for 2300 V MVW3000*

Frame Size	L_T [mm]	L_I [mm]	L_C [mm]	L [mm]	H [mm]	H_V [mm]	P [mm]	Weight kg (lb)
B2	1500	1500	600	3900	2063	2405	1100	2600 (5732)
C2								3250 (7165)

Table 4.3: *Frame sizes available for 3300 V MVW3000*

Frame size	L_T [mm]	L_I [mm]	L_C [mm]	L [mm]	H [mm]	H_V [mm]	P [mm]	Weight kg (lb)
B3	1800	1500	600	3900	2063	2405	1100	3150 (6944)
C3								3950 (8708)

Table 4.4: Frame sizes available for 4160 V MVW3000

Frame size	L_T [mm]	L_I [mm]	L_C [mm]	L [mm]	H [mm]	H_V [mm]	P [mm]	Weight kg (lb)a [kg]
B4	1800	1500	600	3900	2063	2405	1100	3550 (7826)
C4								4500 (9920)

Table 4.5: Frame sizes available for 5500 V MVW3000

Frame size	L_T [mm]	L_I [mm]	L_C [mm]	L [mm]	H [mm]	H_V [mm]	P [mm]	Weight kg (lb)
B5	1800	1500	600	3900	2063	2405	1100	4200 (9259)
C5								5450 (12015)

Table 4.6: Frame sizes available for 6600 V and 6900 V MVW3000

Frame size	L_T [mm]	L_I [mm]	L_C [mm]	L [mm]	H [mm]	H_V [mm]	P [mm]	Weight kg (lb)
B6	1800	1500	600	3900	2063	2405	1100	4850 (10692)
C6								6350 (13999)

Table 4.7: Frame sizes available for 7200 V MVW3000

Frame size	L_T [mm]	L_I [mm]	L_C [mm]	L [mm]	H [mm]	H_V [mm]	P [mm]	Weight kg (lb)
B7	3600	3000	600	7200	2063	2405	1100	6100 (13448)
C7								7850 (17306)

Table 4.8: Frame sizes available for 8000 V MVW3000

Frame size	L_T [mm]	L_I [mm]	L_C [mm]	L [mm]	H [mm]	H_V [mm]	P [mm]	Weight kg (lb)
B8	3600	3000	600	7200	2063	2405	1100	6550 (14440)
C8								8400 (18518)

4.2 POWER CELLS

4.2.1 Constructive Aspects

The power cells of the same MVW3000 have two frames available. The 140 A cell, of frambe “B”, has 9 plastic film capacitors for the DC link. And the 200 A cell, of fram “C”, with 12 capacitors. Information about power cell models and dimensions may be seen in Table 4.9 on page 4-5, as well as a cell illustration in Figure 4.4 on page 4-4.

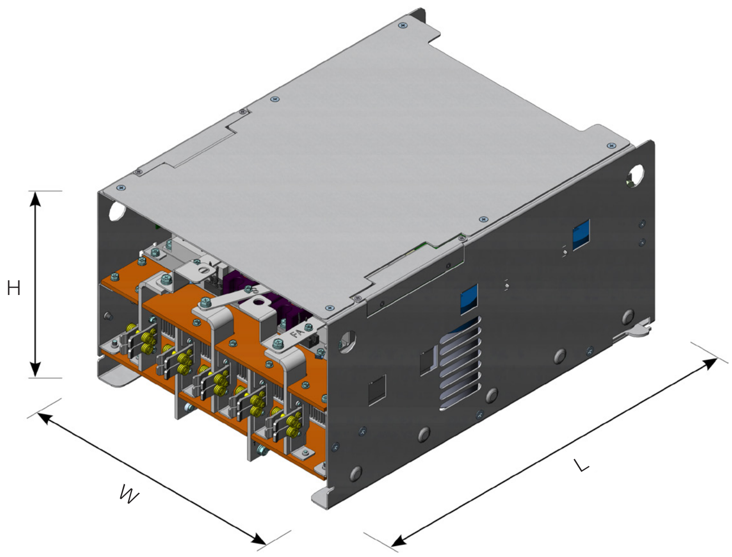


Figure 4.4: Dimensions of the cell of power of MVW3000

Table 4.9: Dimensions of the different frames available

Frame Size	H = Height (mm)	W = Width (mm)	L = Length (mm)	Weight kg (lb)
B	255	361	505	35 (77.16)
C	255	361	595	40 (88.18)

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:

- 9 or 12 capacitors (according to the model).
- 6 diodes with blocking voltage of 1.6k V.
- 4 IGBTs with blocking voltage of 1.7 kV.
- 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 4.4 on page 4-4 and Figure 4.6 on page 4-6.

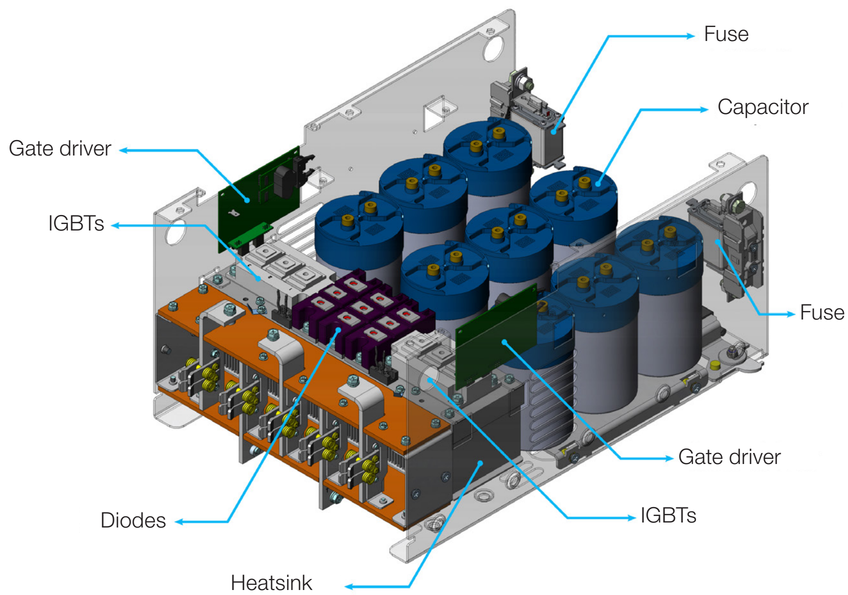


Figure 4.5: Position of the components of the MVW3000 140 A power cell

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 do not require tools, a cell can be changed in few minutes, reducing the downtime. For further information about cell installation and replacement, refer to Chapter 6 INSTALLATION, CONNECTION AND ENERGIZATION 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.

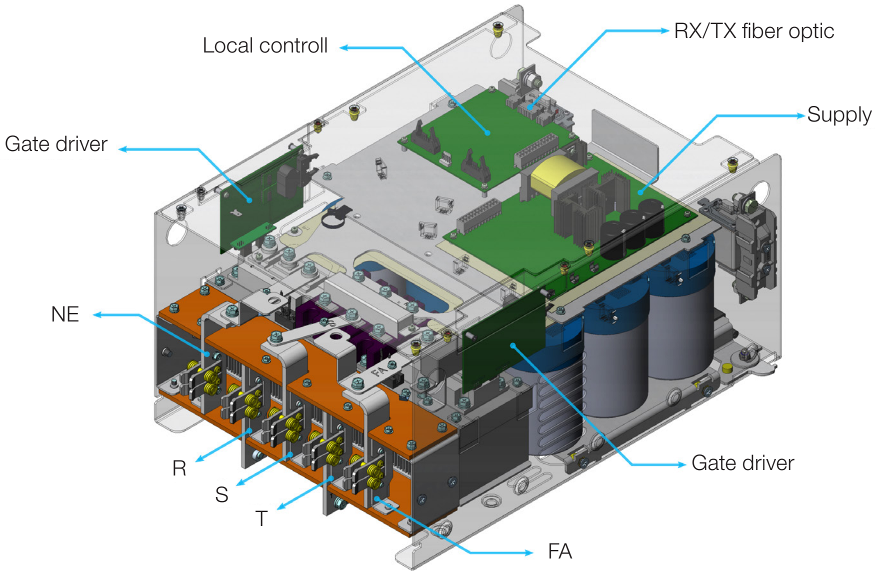


Figure 4.6: *Standard power cell boards and connections of the MVW3000 (frame B)*

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 by 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).

ATTENTION!
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.

4.3 CONTROL RACK

For the control power supply, the auxiliary voltage (220 Vac - 480 Vac) must have 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 enables better visualization and access to the analog, digital and fiber optic interfaces. For this assembly, MVC3, MVC4, FOI3 and PIC2 boards are represented.

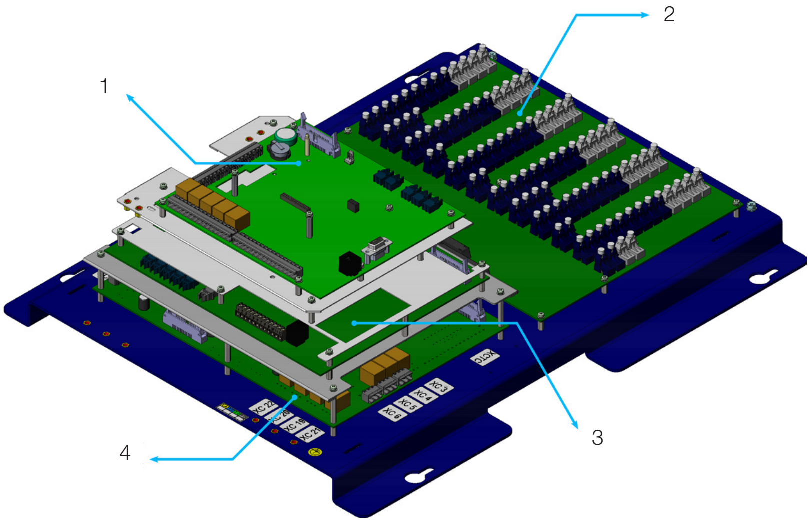


Figure 4.7: *MVW3000 standard control rack*

Lettering	**1**	**2**	**3**	**4**
Board Code	MVC4	FOI3	MVC3	PIC2
Description	User's functions board	Fiber optic interface board	Control board	Control I/O and power supply board

The control rack is supplied with 24 Vdc by the PS24 power supply, whose input is at 220 V, single-phase or three-phase. The control rack is composed of the interface and power supply board (PIC2), one control board (MVC3), the user's function board (MVC4) and the fiber optic interface board (FOI3). The MVC3 board is responsible for the motor and inverter control, and the MVC4 for the user's interface tasks. Both boards are supplied with isolated low voltages provided by the PIC2 board, where there are also opto-isolated digital inputs and relay outputs (220 Vac) for internal use of the MVW3000.

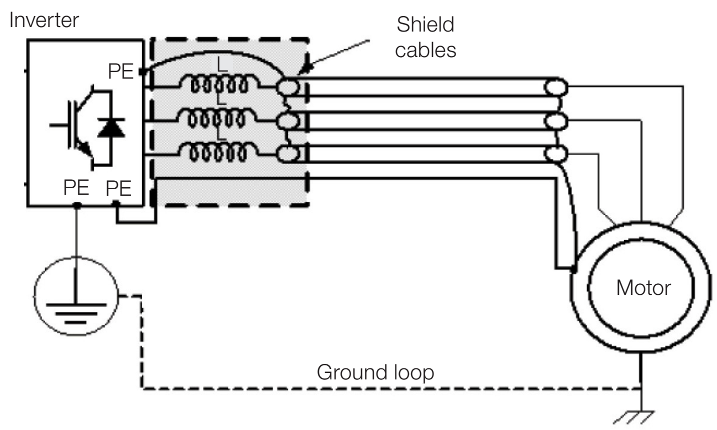
Optional Fieldbus communication and function expansion boards (EBA, EBB or EBC) can be connected to the MVC4 control board. The connections between the MVC3 board and the power stages are made with fiber-optic cables through the FOI interface boards.

ATTENTION!
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.

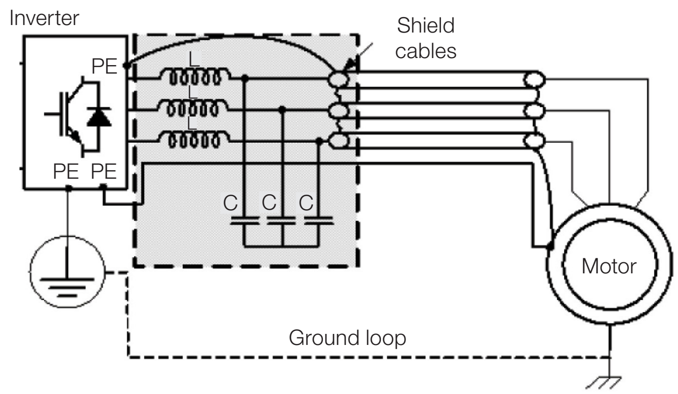
4.4 OUTPUT FILTERS

Depending on the installation conditions, it may be necessary the addition of an output filter. For drives with cables between 200 and 500 m, it is recommended to use output filter on the motor phases. For drives with long cables, above 500 m, or for motors not able to operate with PWM modulation (retrofitting applications), it is recommended to use filter type 2 (contact WEG).

The available filter models follow the voltage and current informed in Table 2.3 on page 2-5 to Table 2.10 on page 2-8.



(a) Filter type 1, for applications with cable length between 200 and 500 m.



(b) Filter type 2, for applications with cable length above 500 m and retrofitting.

Figure 4.8 (a) and (b): *Output filters for MVW3000 inverters*

5 SYNCHRONOUS MOTOR LINE

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.

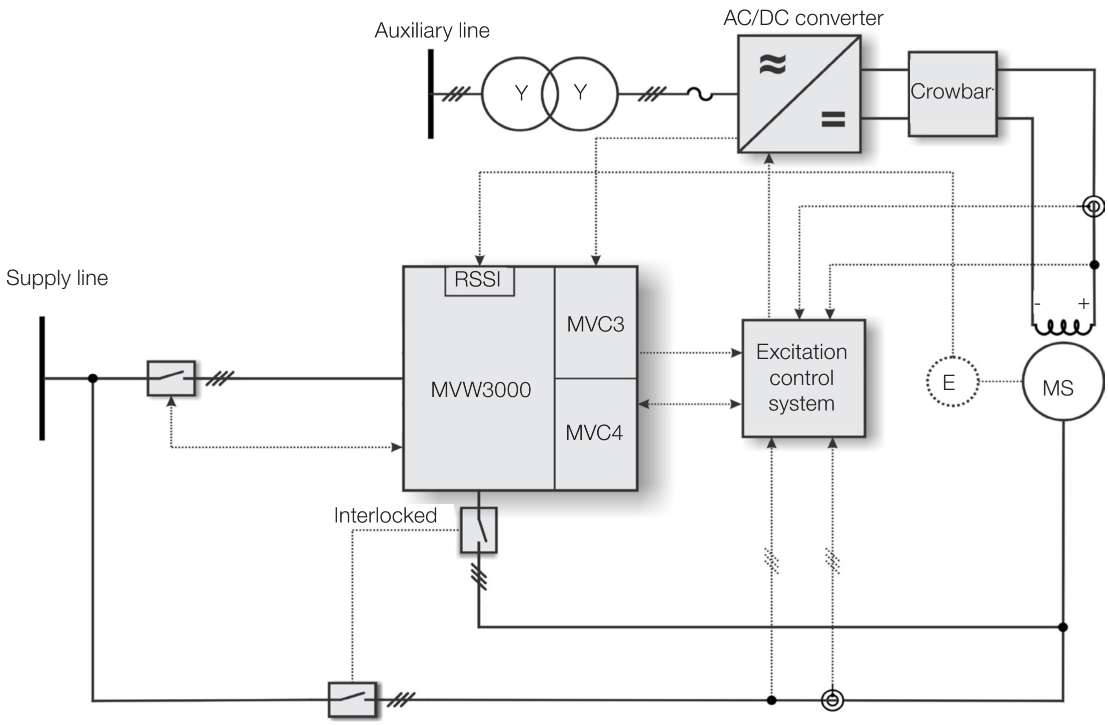


Figure 5.1: *General diagram of the inverter for synchronous motor*

5.1 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.

5.1.1 Absolute Encoder

The synchronous motor control requires the use of an absolute encoder, which must follow the following specifications:

Synchronous Serial Interface (SSI) communication protocol with RS-485 communication channel, with clock and 16 bit word size in the following format:

14 data bits
1 ZERO bit
1 even parity bit

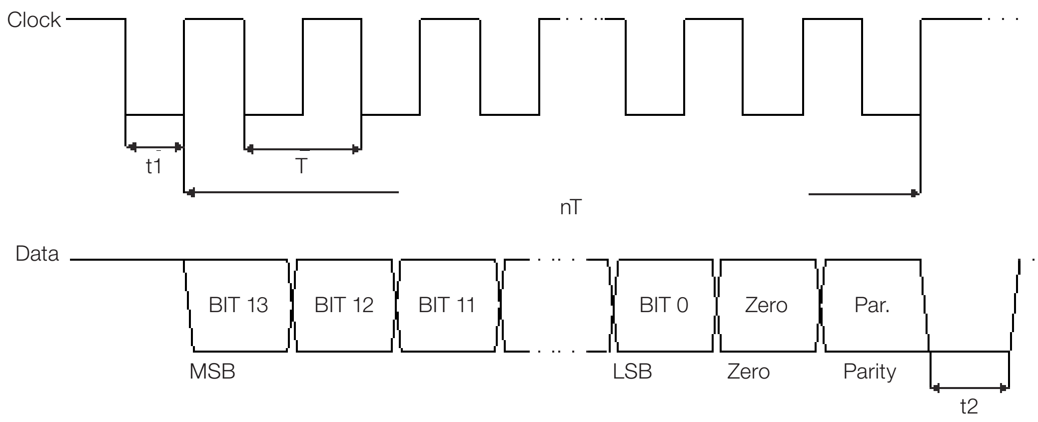


Figure 5.2: *Clock specification and data transfer for the absolute encoder*

Supply voltage of 15 V, with consumption lower than 300 mA.

Resolution of 14 bits per turn, which ensures a dynamic equivalent to the conventional incremental encoder;

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 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”.

NOTE!
The standard absolute encoder recommended for the MVW3000 is the Baumer MHAP 400 B5 XXXXSB14EZ D.
The maximum encoder cable length is 120 m.
Refer to the motor project to define the type of encoder mounting.

5.1.2 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 has the following features:

Supply voltage of 24 V DC, with consumption of up to 700 mA.

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 boards, MVC3 control and FOI3.

For electric connection, use shielded cables, keeping them at least 25 cm away from the other cables (power, control, etc.). Preferably inside a metal conduit.

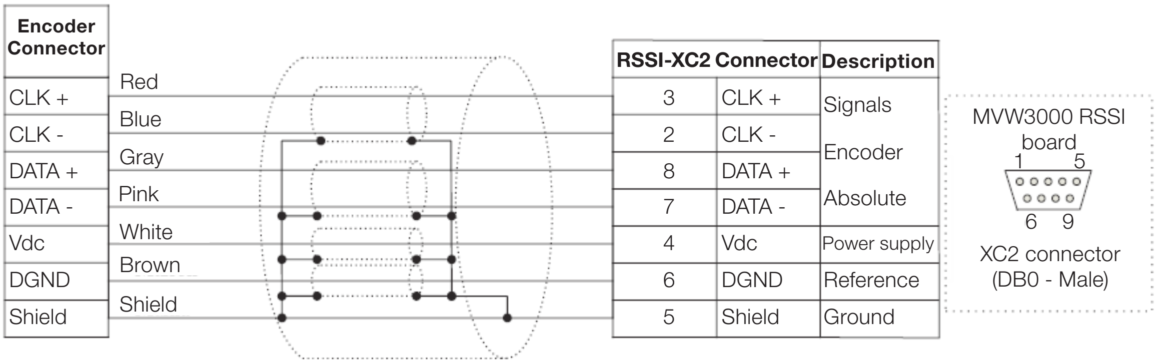


__Figure 5.3:__ RSSI - Encoder connection cable

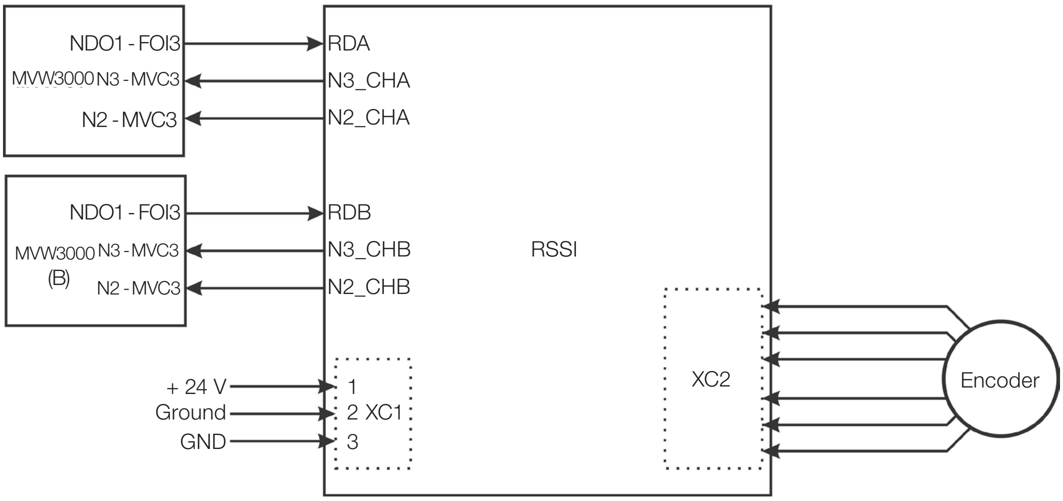


__Figure 5.4:__ Diagram of the connection with MVC3 and FOI3 boards

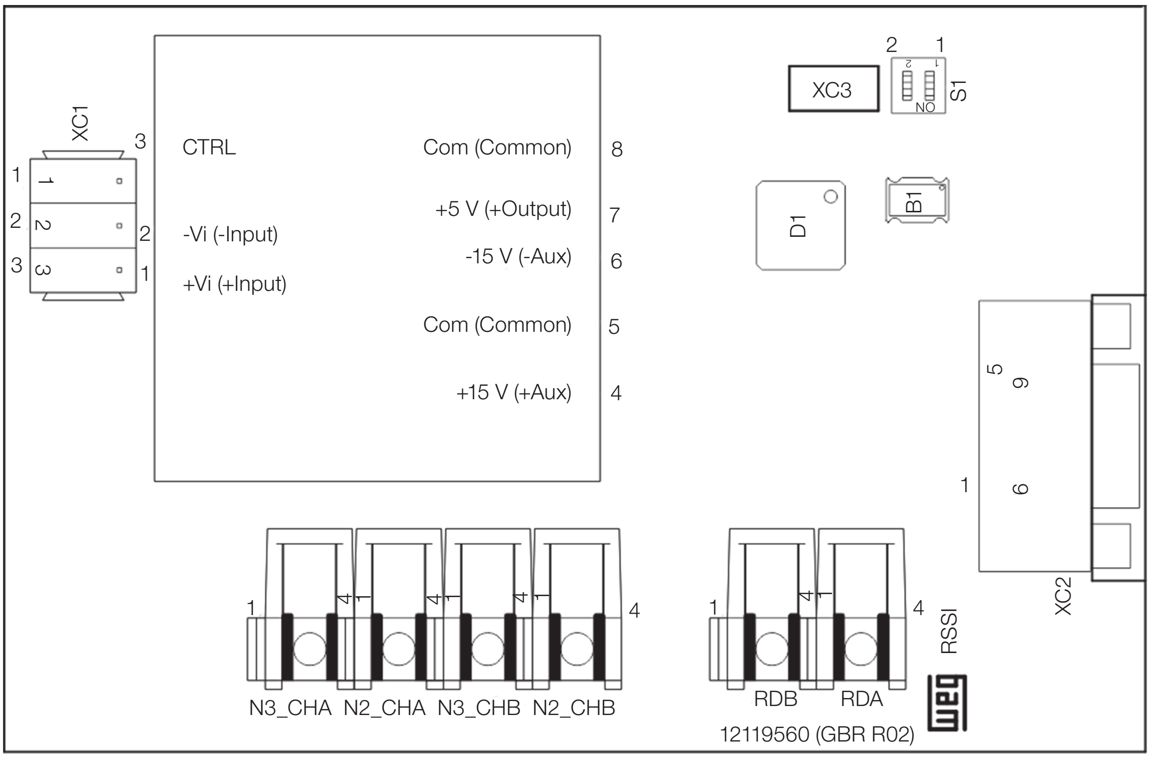


__Figure 5.5:__ RSSI board

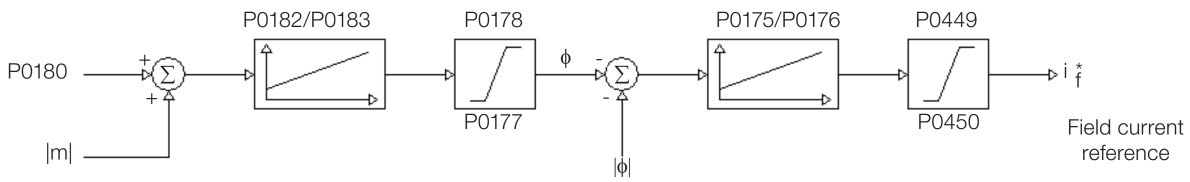
5.2 FIELD EXCITATION SET (DC WITH BRUSHES)

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 V to 10 V (AC-DC 5 V = 1 PU, observe P0462);
Feedback of the output current for the MVW3000: 0 V 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 for download on: **www.weg.net.**



|m| = modulation index modulus
ϕ = stator flux,
|ϕ| = 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 SYNCHRONOUS MOTOR LINE 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 AND ENERGIZATION

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

ATTENTION!
- 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 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.

DANGER!
- Les procédures recommandées dans cet avertissement visent à protéger l'utilisateur de la mort, de blessures graves et de dégâts matériels importants.
- Interrupteurs d'isolement de l'alimentation : Le matériel d'isolement de l'alimentation de l'onduleur et des alimentations auxiliaires doit être prévu. Il doit couper les alimentations de l'onduleur (par ex.: pendant les tâches de maintenance de l'installation).
- Cet équipement ne doit pas être utilisé comme mécanisme d'arrêt d'urgence.
- Vérifiez que l'alimentation est débranchée avant de commencer le câblage.
- Les informations suivantes ont pour but de servir de exemple pour une bonne installation. Respectez la réglementation locale applicable sur les installations électriques.

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 0 °C to 40 °C (32 °F to 140 °F) - nominal conditions (no derating required).
- From 40 °C to 50 °C (140 °F to 122 °F): current reduction of 2.5 % for each Celsius degree above 40 °C (140 °F).
- 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 (3.300 ft to 13.200 ft) - current derating of 1 % each 100 m (or 0.3 % each 100 ft) above 1000 m (3.300 ft) altitude.
- Pollution degree: 2 (according to IEC/UL standards) with non-conductive pollution.
- Condensation shall not originate conduction through the accumulated residues.

The medium voltage inverter MVW3000 is supplied in form of a panel, whose dimensions are presented in Table 4.2 on page 4-3 to Table 4.8 on page 4-4. 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.

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 lifting device used to hoist the panel and the arms is suitable for their weight and shape, refer to the Table 6.1 on page 6-2.

Table 6.1: *Panel weight (approximately)*

Frame Size	Inverter Panel Mass kg (lb)	Inverter Panel Mass + Cells kg (lb)	Transformer Panel Mass kg (lb)	Control Panel Mass kg (lb)	Total Mass kg (lb)
B2	550 (1212)	750 (1653)	1450 (3196)	400 (881)	2600 (2600)
C2	650 (1433)	900 (1984)	1900 (4188)	450 (992)	3250 (7165)
B3	550 (1212)	900 (1984)	1850 (4078)	400 (881)	3150 (6944)
C3	650 (1433)	1000 (2204)	2500 (5511)	450 (992)	3950 (8708)
B4	550 (1212)	1000 (2204)	2150 (4739)	400 (881)	3550 (7826)
C4	650 (1433)	1100 (2425)	2950 (6503)	450 (992)	4500 (9920)
B5	550 (1212)	1100 (2425)	2700 (5952)	400 (881)	4200 (9259)
C5	650 (1433)	1250 (2755)	3750 (8267)	450 (992)	5450 (12015)
B6	550 (1212)	1200 (2645)	3250 (7165)	400 (881)	4850 (10692)
C6	650 (1433)	1350 (2976)	4550 (10031)	450 (992)	6350 (13999)
B7	1100 (2425)	1850 (4078)	3850 (8487)	400 (881)	6100 (13448)
C7	1250 (2755)	2100 (4629)	5300 (11684)	450 (992)	7850 (17306)
B8	1100 (2425)	1950 (4299)	4200 (9259)	400 (881)	6550 (17306)
C8	1250 (2755)	2200 (4850)	5750 (12676)	450 (992)	8400 (18518)

Note: For models above 8 kV (8 cells per phase), the mass information will be supplied on request.

Observe the gravity center and ensure that the hoisting mechanism is adequate and safe. Use the configuration showed in the Figure 6.1 on page 6-3.

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 alteration or damage in the panel structure is noticed, then abort the hoisting and rearrange the cables or chains.

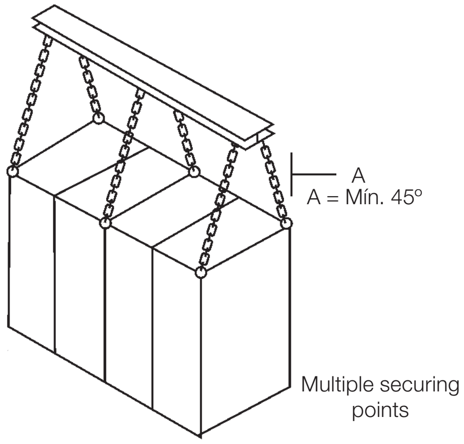


Figure 6.1: *Recommended hoisting mechanism for the panel movement*

ATTENTION!
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 movable hydraulic jacks, forklifts, rollers or other means, distribute the support points from one extreme through the other, avoiding pressure on fragile areas. Make sure that all the panel doors be closed and locked, and that the door handles be in protected position.

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

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, 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.

ATTENTION!
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.
- Contact your WEG representative or service.

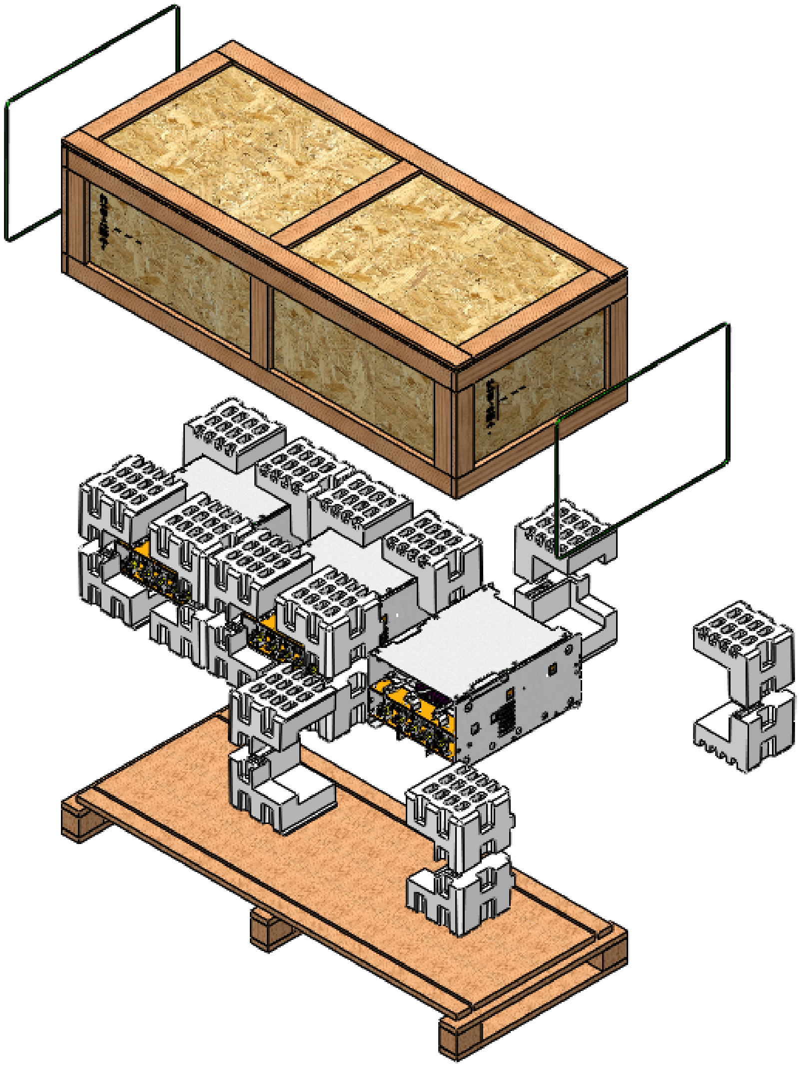


Figure 6.2: *Standard power cell with package*

6.1.6 Positioning/Mounting

The MVW3000 panel must be placed on a flat leveled surface, thus avoiding mechanical instability, door misalignment, among other problems.

ATTENTION!
Some models of the MVW3000 are transported 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 area in front of the panel must remain unobstructed, so that a total opening of the doors be possible, as well as the insertion and extraction of the arms and/or the power and control cables.

Table 4.2 on page 4-3 to Table 4.8 on page 4-4 present the dimensions of the available panels.

ATTENTION!
Observe availability and access of the electrical connections:

- Input cable for the MVW3000 panel and output for 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.

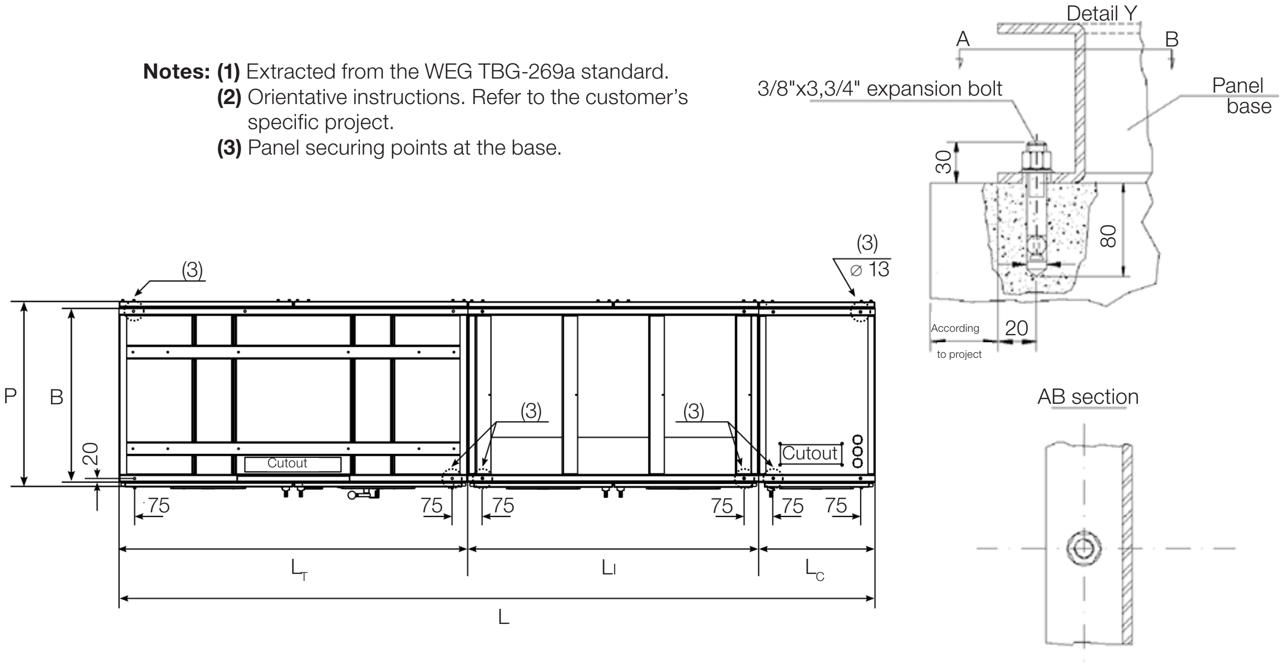


Figure 6.3: Anchoring the MVW3000 panel to the floor

NOTE!
Recommendations for anchoring the panel may vary for the several MVW3000 models. For more information refer to the specific project documentation.

6

6.1.7 Insertion of the Power Cells

Figure 6.4: Inserted power cell

Figure 6.5: Power arm insertion/extraction/movement trolley

ATTENTION!
During the power arm transport, they must have the locking mechanism active and be transported close to the floor. (Figure 6.6 on page 6-8 - picture 1).

The power arm insertion must be performed with the help of the transport trolley as shown in Figure 6.5 on page 6-6 and according to the following procedure.

1. Rotate the crank handle until the trolley reaches the floor level.

2. Remove the cell from the package and place it on the cart tray.

3. Move the cart close to the panel, lift the cell up to the necessary height and couple the cart tray to the panel support, Figure 6.6 on page 6-8 - pictures 2, 3 and 4.

4. Lock the cart wheels.

5. Push the cell, observing the alignment with the panel support, until the handles touch the panel support, (Figure 6.6 on page 6-8 - picture 5).

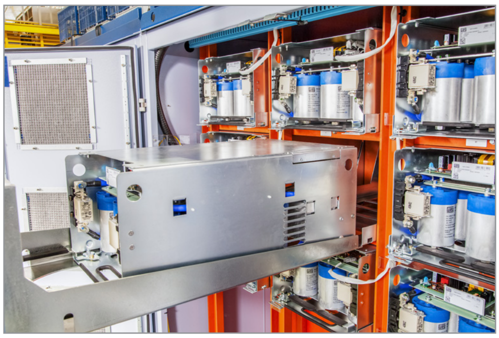
6. Push the two brackets of the insertion mechanism simultaneously until the locking system is activated, (Figure 6.6 on page 6-8 - pictures 6 and 7).

7. Lift the cart tray until it uncouple from the cell support and move the cart away from the panel (Figure 6.6 on page 6-8 - picture 8).

1

2

3



4

5

6

7

8

Figure 6.6: *Details of the cell insertion step*

6.1.8 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.

The identifications of the cables are presented in the Table 6.2 on page 6-9 and Table 6.3 on page 6-10.

Table 6.2: *Fiber optic cables identification*

Power Cell Connection	Main Control Connection	Function
U1	N5_UA1	RX
	N1_UA1	TX
U2	N6_UA1	RX
	N2_UA1	TX
U3	N7_UA1	RX
	N3_UA1	TX
U4	N8_UA1	RX
	N4_UA1	TX
U5	N5_UB1	RX
	N1_UB1	TX
U6	N6_UB1	RX
	N2_UB1	TX
U7	N7_UB1	RX
	N3_UB1	TX
U8	N8_UB1	RX
	N4_UB1	TX
V1	N5_VA1	RX
	N1_VA1	TX
V2	N6_VA1	RX
	N2_VA1	TX
V3	N7_VA1	RX
	N3_VA1	TX
V4	N8_VA1	RX
	N4_VA1	TX
V5	N5_VB1	RX
	N1_VB1	TX
V6	N6_VB1	RX
	N2_VB1	TX
V7	N7_VB1	RX
	N3_VB1	TX
V8	N8_VB1	RX
	N4_VB1	TX
W1	N5_WA1	RX
	N1_WA1	TX
W2	N6_WA1	RX
	N2_WA1	TX
W3	N7_WA1	RX
	N3_WA1	TX
W4	N8_WA1	RX
	N4_WA1	TX
W5	N5_WB1	RX
	N1_WB1	TX
W6	N6_WB1	RX
	N2_WB1	TX
W7	N7_WB1	RX
	N3_WB1	TX
W8	N8_WB1	RX
	N4_WB1	TX

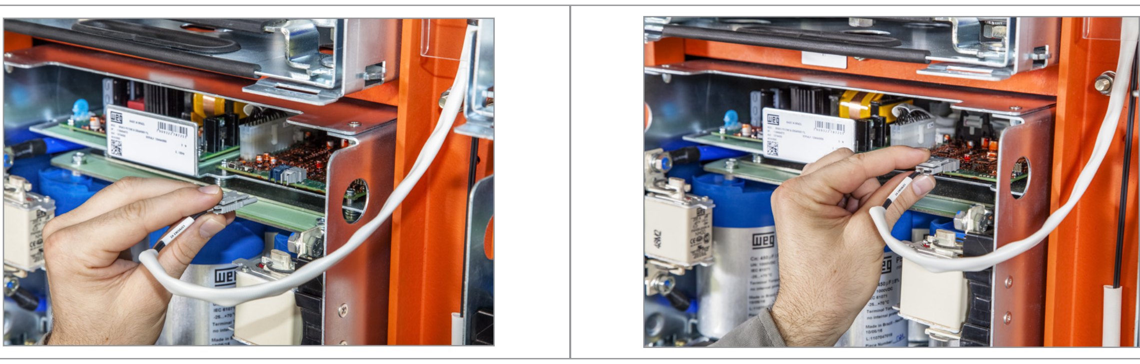


Figure 6.7: Details of the power arm supply and fiber optic cables installation stages

ATTENTION!
The fiber optic cables must be handled with care so as the material is not crushed, bent or cut. In order to insert or remove the cables, exert force on the connectors only, never on the fiber.

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

6.2 ELECTRICAL INSTALLATION

6.2.1 Power Section

The power cables that connect the grid input to the MVW3000 and those that connect the inverter panel to the medium voltage motor (Figure 6.11 on page 6-14) must be specific for medium voltage applications and sized for the rated currents.

Table 6.3: Maximum current to the power cables

	Power Cables mm² [in]: R, S, T, U, V, W	Maximum Current [A]
Single Cable	10 [0.39]	71
	16 [0.62]	96
	25 [0.98]	126
	35 [1.37]	157
	50 [1.96]	189
	70 [2.75]	241

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

Gauge of the Power Cables (S Cross Section) mm² [in]	Minimun Gauge of the Grounding Cables (S Cross Section) (PE) mm² [in]
S ≤ 16 [0.62]	S
16 [0.62] < S ≤ 35 [1.37]	16 [0.62]
35 [1.37] < S	S / 2

NOTE!
The cable cross sections/gauges presented in the Table 6.3 on page 6-10 and Table 6.4 on page 6-10 are only orientative. In order to size the cables correctly the installation conditions, the applicable standards and regulations, and the maximum allowed voltage drop must be considered.

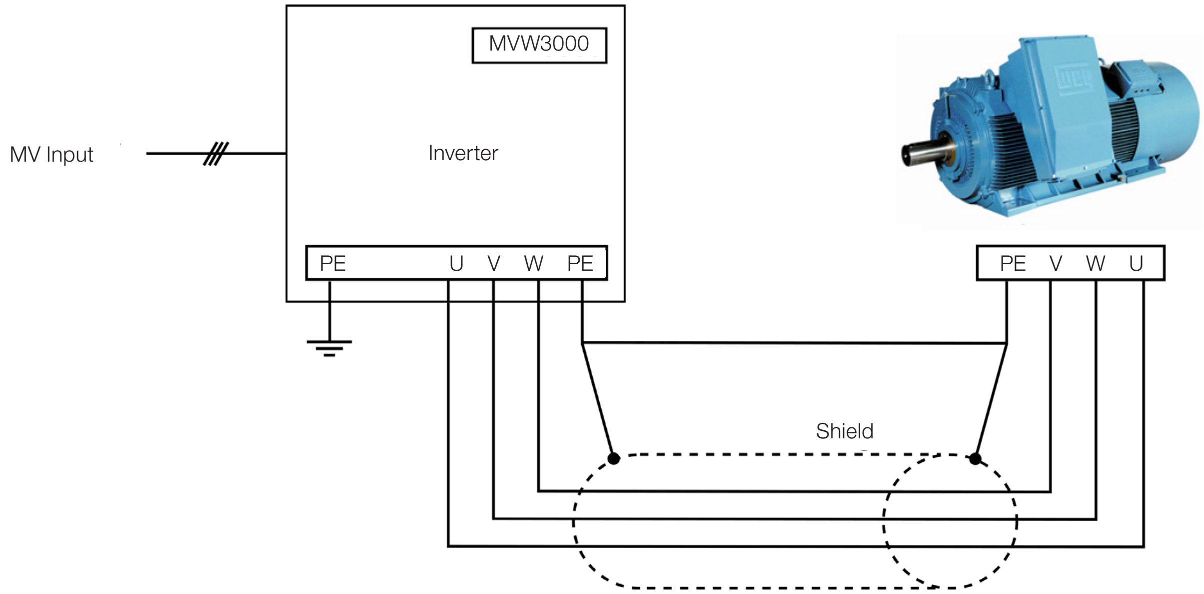


Figure 6.8: *Power and ground connections*

Table 6.5 on page 6-11 contains the minimum insulation voltages of the inverter power cables.

Table 6.5: *Minimum insulation voltage of the power cables*

Rated Voltage [kV]	Minimum Insulation Voltage [kV]
2.3	3.6/6
3.3, 4.16 and 5.5	6/10
6.3, 6.9, 7.2 and 8.0	8.7/15
10 and 11	12/20
13.2 and 13.8	15/25

Commercial examples:
Belden: 37540.
Cofiban: Cofialt 7 kV (without shield).
Pirelli: Eprotenax 6/10 kV.
Ficap: Fibep or EPDry 6/10 kV.

6

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

Tighten the connections with the appropriate torque.

Table 6.6: *Power connections cable lugs and tightening torque*

Terminal	Torque [Nm] ±20 %
M8	15
M10	30
M12	60

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 6.4 on page 6-10. Connect the inverter to a specific grounding rod or to the general ground system (resistance ≤ 10 Ohms).

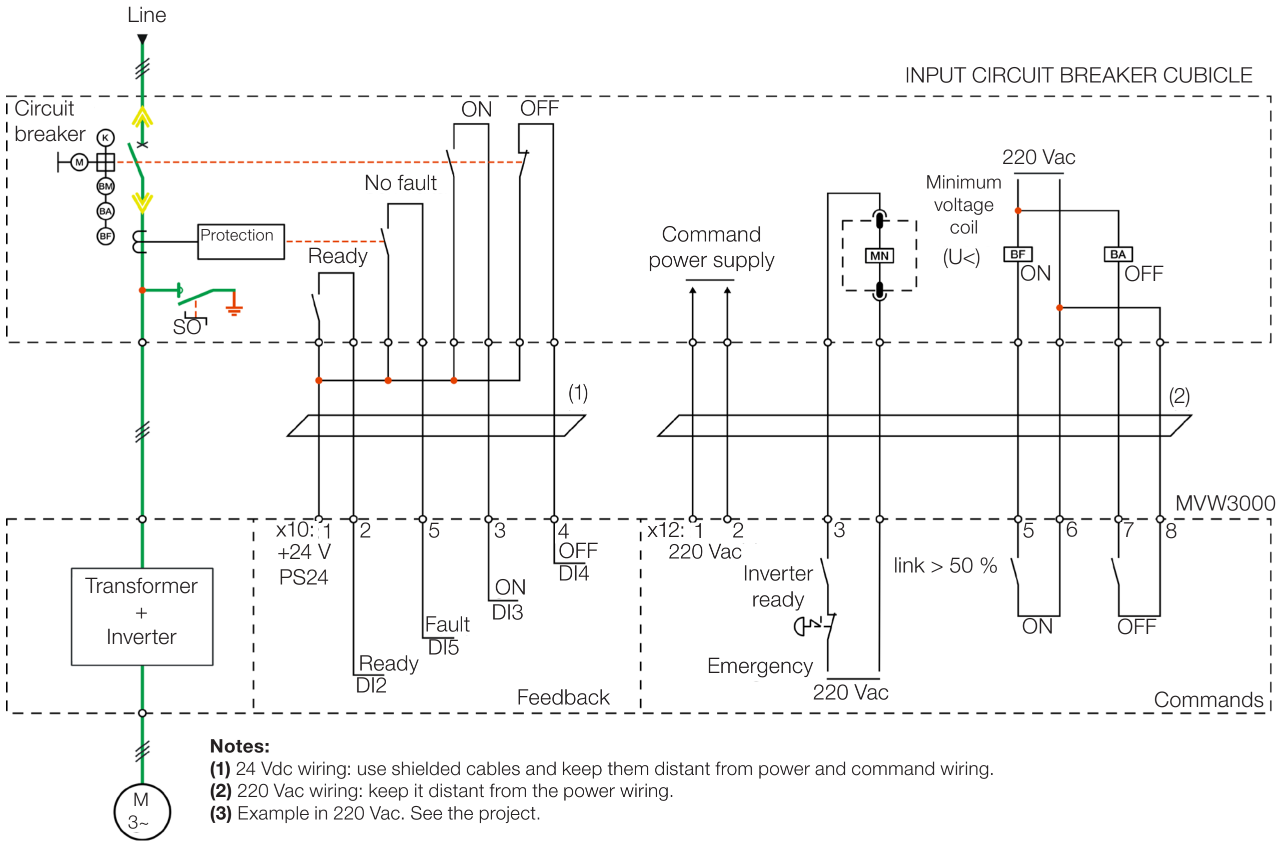
DANGER!
Il est obligatoire de connecter l'onduleur à un connecteur de mise à la terre (PE). La connexion de mise à la terre doit suivre les règlementations locales. Utilisez au moins des conducteurs avec le calibre de fil indiqué dans le Table 6.4 on page 6-10. Connectez l'onduleur à une tige de mise à la terre spécifique ou au système de mise à la terre général (résistance ≤ 10 ohms).

6.2.2 Input Cubicle

The MVW3000 operates the input circuit breaker. The power supply for the circuit breaker circuits comes from 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.

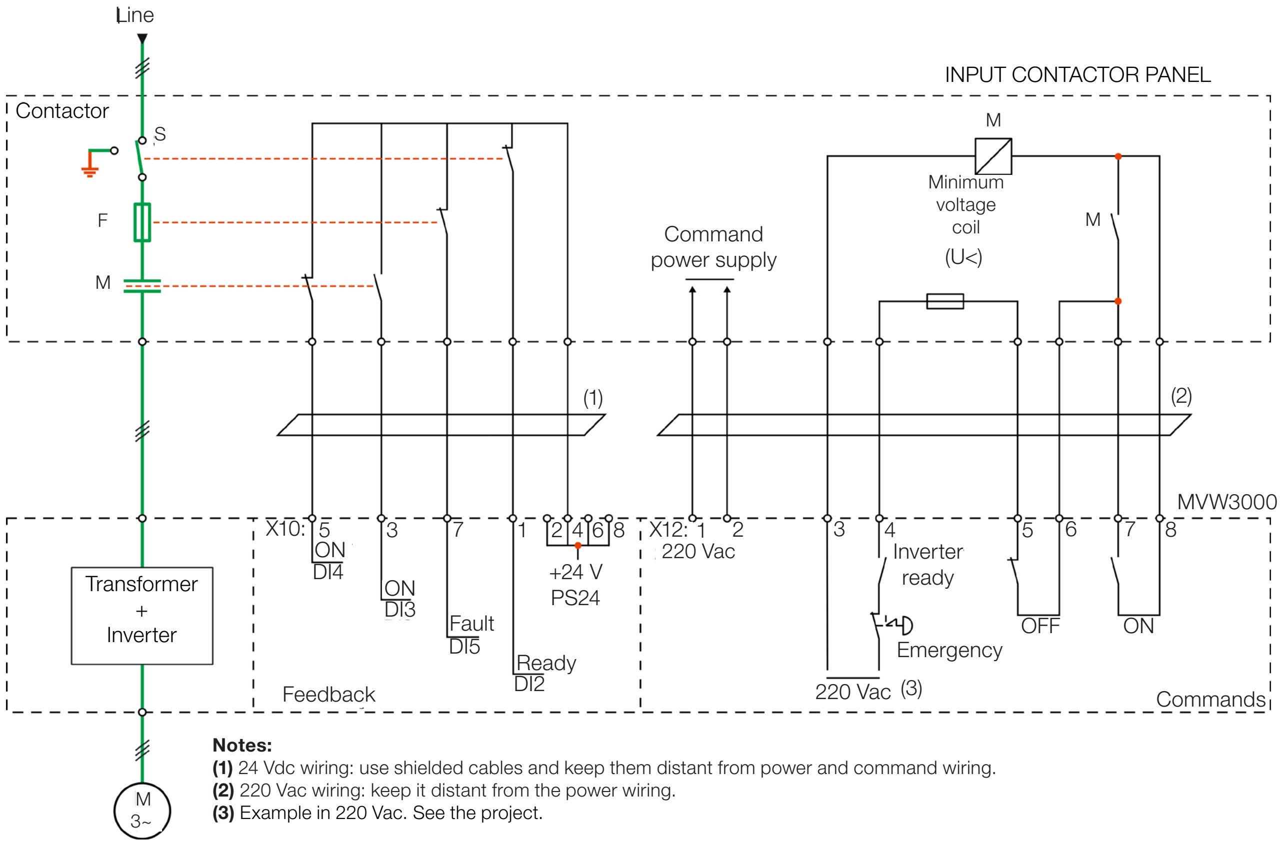
NOTE!
Those signals must be dry contact (potential free).
Emergency circuits must be associated to the **READY** signal and never to the **TRIP** signal.



Notes:
(1) 24 Vdc wiring: use shielded cables and keep them distant from power and command wiring.
(2) 220 Vac wiring: keep it distant from the power wiring.
(3) Example in 220 Vac. See the project.

__Figure 6.9:__ Connections of the inverter input circuit breaker for situations where it is supplied separately

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.



Notes:
(1) 24 Vdc wiring: use shielded cables and keep them distant from power and command wiring.
(2) 220 Vac wiring: keep it distant from the power wiring.
(3) Example in 220 Vac. See the project.

Figure 6.10: *Connections of the inverter input contactor for situations where it is supplied separately*

NOTE!
The connection strips of Figure 6.9 on page 6-12 and Figure 6.10 on page 6-13 (X10 and X12) may change according to the project. Always refer to the project that comes with the product.

ATTENTION!
The input circuit breaker must only be closed by the inverter, otherwise the transformer and the inverter may be damaged.

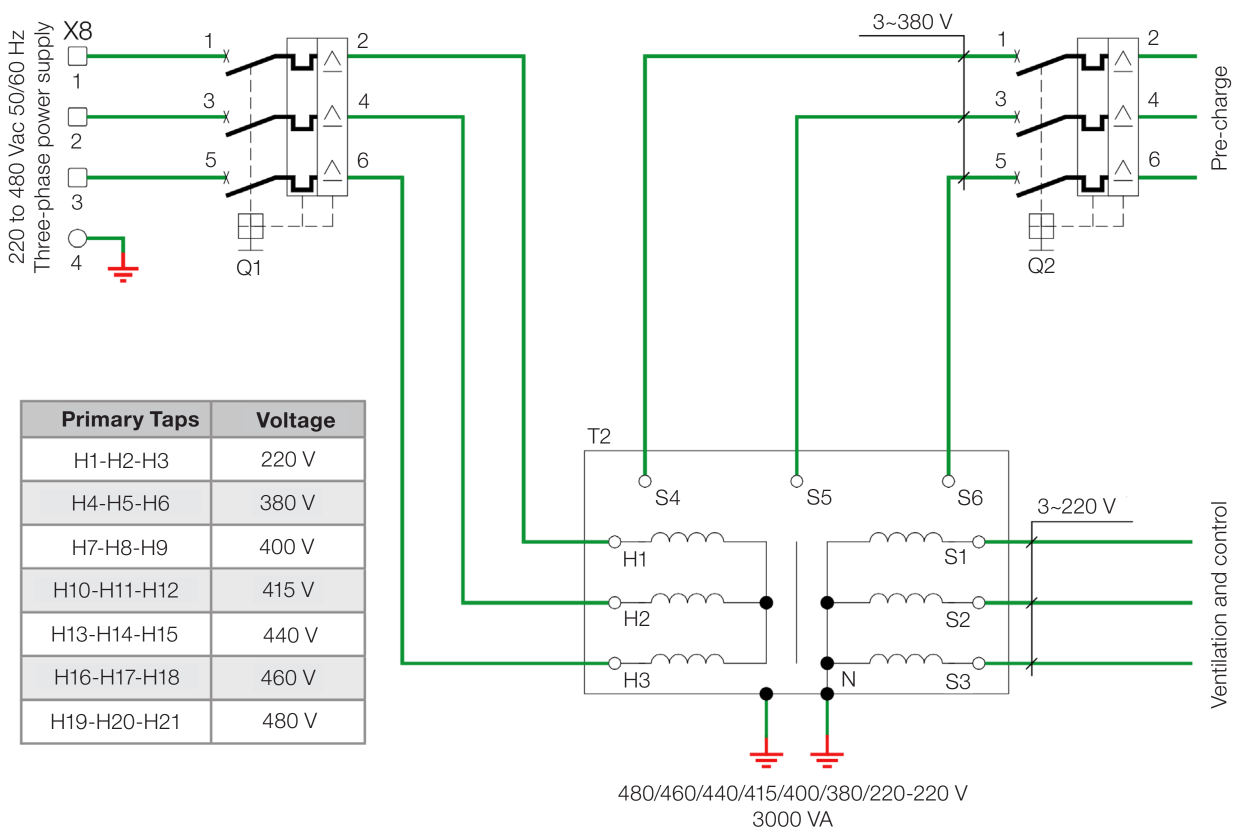
DANGER!
Although the inverter commands the opening of the circuit breaker, there is no guarantee of its opening. In order to open the medium voltage cabinets for maintenance, follow all the procedures of safe de-energization (refer to the Item 6.3.4 Safe De-energization Instructions on page 6-17).

DANGER!
Bien que l'onduleur commande l'ouverture du coupe-circuit, il n'y a pas de garantie qu'il s'ouvre. Afin d'ouvrir les armoires moyenne tension pour la maintenance, suivez toutes les procédures de mise hors tension (élément Item 6.3.4 Safe De-energization Instructions on page 6-17).

6.2.3 Low Voltage Auxiliary Supply

Control column power supply nominal voltage selection

An auxiliary voltage supply (220 V-480 V) 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 Taps	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 6.11: *Auxiliary power supply*

6.3 ENERGIZATION, START-UP AND SAFE DE-ENERGIZATION

This section provides the following information:

- How to check and prepare the inverter before powering-up.
- How to power-up and verify the energization success.
- How to operate the inverter when installed according to the standard project (refer to the Section 6.2 ELECTRICAL INSTALLATION on page 6-10 and the attached electric project).
- How to de-energize the inverter safely.

6.3.1 Pre-power Checks

The inverter must have already been installed according to the Chapter 6 INSTALLATION, CONNECTION AND ENERGIZATION 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.

DANGER!
- Débranchez toujours toutes les alimentations avant d'effectuer des branchements.
- Bien que l'onduleur commande l'ouverture de l'armoire d'entrée, il n'y a aucune garantie de son ouverture et ni qu'aucune tensions sont présentes.

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

1. Check if all the power, grounding and control connections are correct and tightened.

2. Clean the inverter internally, remove all packing material and installation residues from within the MVW3000 cabinets.

3. Check all motor connections and verify whether its voltage, current and frequency match the inverter specifications.

4. If it is possible, decouple the motor mechanically from the load. If the motor cannot be decoupled, then make sure that rotation in any speed direction (Forward or reverse) is not hazardous to people or to the machine.

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 keypad 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 AND ENERGIZATION on page 6-1.

DANGER!
- Des tensions élevées peuvent être présentes même après déconnexions de l'alimentation.
- La séquence suivante est valable pour l'onduleur du MVW3000 standard. L'onduleur doit déjà avoir été installé et programmé, comme décrit respectivement dans le Chapter 6 INSTALLATION, CONNECTION AND ENERGIZATION 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 (H1) at the control column door is on, indicating that it is already possible to initiate the inverter pre-charge.

3. Initiate the pre-charge / power section energization.
The MVW3000 inverter pre-charge command must be given 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.

ATTENTION!
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 – Fault in the closing of the input switchgear.
F0017 – Input switchgear not ready.
F0020 – Time exceeded in the pre-charge process.
See the description of those faults/alarms in the programming manual available for download on: **www.weg.net**.

NOTE!
The last speed reference value, set via the ▲ and ▼ keys, is saved in the memory (P0120 = 1). If you want to change this value before enabling the inverter, change it through the parameter P0121 - (Keypad Speed Reference), which stores the keypad speed references.

NOTES:

1. If the motor speed direction is inverted, switch off the inverter following the safe de-energization instructions and swap two of the motor cables.
The HMI must indicate the same direction seen looking against the motor shaft end.

2. It 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 P0136 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 on: **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.

ATTENTION!
If the inverter receives a general enabling or a start command before the pre-charge has been finished (inverter still in undervoltage state), the command will be ignored and a warning message "inverter undervoltage" will be displayed on the HMI.

6.3.4 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.

DANGER!
- Bien que l'onduleur commande l'ouverture de l'armoire d'entrée, il n'y a aucune garantie de son ouverture et ni qu'aucune tensions sont présentes, parce que les condensateurs rester chargé pendant un long moment et ils peuvent également être facturés par le biais de l'alimentation auxiliaire (pré-charge).
- Pour ouvrir les armoires moyenne tension moyenne, suivez toutes les procédures de mise hors tension de sécurité décrites ci-dessous.

1. Decelerate the motor to a complete stop.

2. See the DC link voltage of the installed power cells at parameters P1000 to P1031 on the HMI.

3. Press the "POWER OFF" pushbutton. The input transformer cubicle is switched off at this moment, and the "INPUT ON" pilot light going off indicates it.

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

4. Monitor the DC link voltage decrease through the respective parameters on the HMI. Even with the indication of zero volt, wait for ten minutes so as to ensure the full discharge of the DC link capacitors.

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

6. At the input transformer circuit breaker cubicle, extract the circuit breaker from its operation position and close the transformer primary winding grounding switch. Lock the cubicle with the key and/or put a warning sign "System in maintenance".

7. Switch off the Q2 circuit breaker in the control column and lock it in the open position with a padlock and/or put a warning sign "System in maintenance".

8. Switch off the Q1 circuit breaker in the control column. Remove the auxiliary power supply.

It is only after the sequence of procedures here that medium voltage compartment doors can be opened.

DANGER!
Even after the DC link voltage parameters indicate 0 V on the HMI, 250 V may still be present on the DC link of the power cells. Wait for ten minutes, and the cabinet doors may be opened.

DANGER!
Même lorsque les paramètres de tension du câble CC indiquent 0 V sur l'IHM, une tension de 250 V pourra malgré tout être présente sur le bus CC des batteries.
Merci d'attendre dix minutes et les portes de l'armoire devraient s'ouvrir.

6

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.

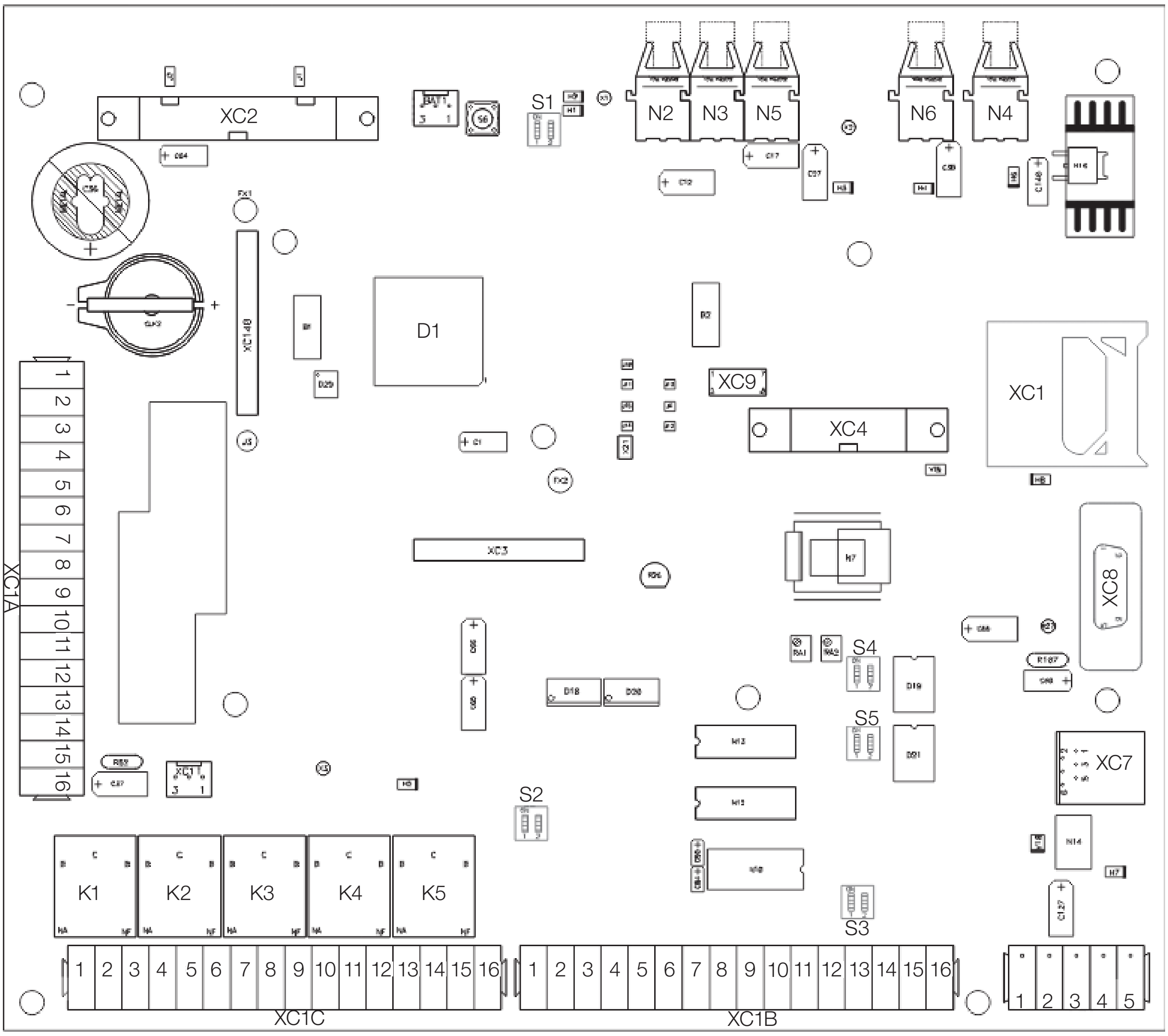
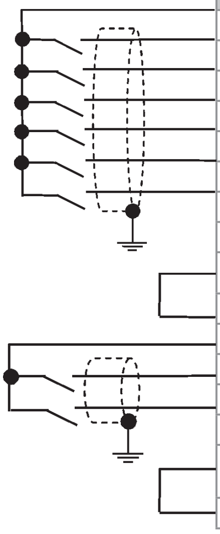


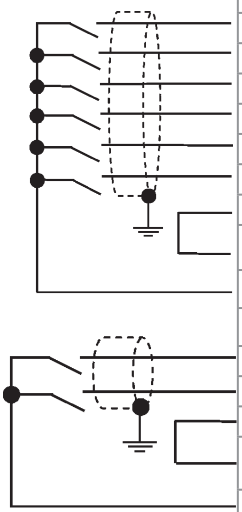
Figure 7.1: *MVC4 - Customer connectors*

7



Terminal Strip XC1A		Factory Standard Function	Specifications
1	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ±8 %, capacity: 90 mA
2	DI1	Start / Stop	6 isolated digital inputs Minimum high level: 18 Vdc Maximum low level: 3 Vdc Maximum voltage: 30 Vdc Input current: 11 mA @ 24 Vdc
3	DI2	Direction of rotation (remote)	
4	DI3	No function	
5	DI4		
6	DI5	JOG (Remote mode)	
7	DI6	Ramp 2 Selection	
8	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ± 8 %, capacity: 90 mA
9	COM	Digital inputs DI1 to DI6 common point	-
10	DGND*	0 V reference of the 24 Vdc supply	Grounded
11	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ± 8 %, capacity: 90 mA
12	DI9	No function	Identical to the DI1 to DI6 specification
13	DI10		
14	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ± 8 %, capacity: 90 mA
15	COM	Digital inputs DI9 and DI10 common point	-
16	DGND*	0 V reference of the 24 Vdc supply	Grounded

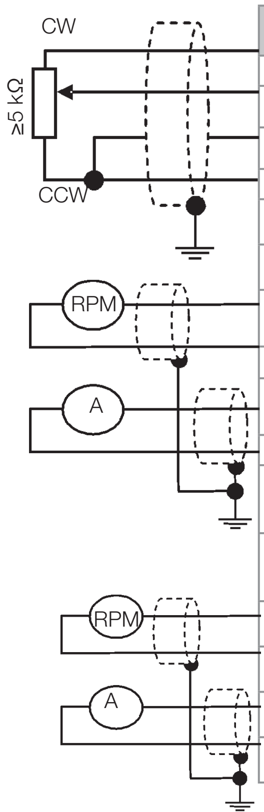
Figure 7.2: *XC1A terminal strip description: active high digital inputs*



Terminal Strip XC1A		Factory Standard Function	Specifications
1	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ± 8 %, capacity: 90 mA
2	DI1	Start / Stop	6 isolated digital inputs Minimum high level: 18 Vdc Maximum low level: 3 Vdc Maximum voltage: 30 Vdc Input current: 11 mA @ 24 Vdc
3	DI2	Direction of rotation (remote)	
4	DI3	No function	
5	DI4		
6	DI5	JOG (Remote mode)	
7	DI6	Ramp 2 Selection	
8	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ± 8 %, capacity: 90 mA
9	COM	Digital inputs DI1 to DI6 common point	-
10	DGND*	0 V reference of the 24 Vdc supply	Grounded
11	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ± 8 %, capacity: 90 mA
12	DI9	No function	Identical to the DI1 to DI6 specification
13	DI10		
14	24 Vdc	Supply for the digital inputs	Isolated 24 Vdc ± 8 %, capacity: 90 mA
15	COM	Digital inputs DI9 and DI10 common point	-
16	DGND*	0 V reference of the 24 Vdc supply	Grounded

Figure 7.3: *XC1A terminal strip description: active low digital inputs*

7



Terminal Strip XC1B		Factory Default Function	Specifications
1	+ REF	Positive reference for potentiometer	+5.4 V ±5 %, capacity: 2 mA
2	AI1+	Analog input 1: speed reference (remote mode)	Differential, resolution: 10 bits, Impedance: 400 kΩ [0 to 10 V] 500 Ω (0 to 20) mA/(4 to 20) mA]
3	AI1-		
4	- REF	Negative reference for potentiometer	- 4.7 V ± 5 %, capacity: 2 mA
5	AI2+	Analog input 2: no function	Differential, resolution: 9 bits, Impedance: 400 kΩ [-10 V to +10 V] 500 Ω [0 to 20) mA/(4 to 20) mA]
6	AI2-		
7	AO1	Analog output 1: speed	(0 to 10) V, R_L ≥ 10 kΩ (Maximum load) Resolution: 11 bits
8	DGND	0 V Reference for analog outputs	Grounded through a 5.1 Ω resistor
9	AO2	Analog output 2: motor current	0 to +10 V, R_L ≥ 10 kΩ (Maximum load) Resolution: 11 bits
10	DGND	0 V Reference for analog outputs	Grounded through a 5.1 Ω resistor
11	AI5+	Analog input 5: no function	Isolated analog input signal: (0 to 10) V or (0 to 20) mA / (4 to 20) mA Resolution: 10 bits Impedance: 400 kΩ [0 V to 10 V] 500 Ω [(0 to 20) mA/(4 to 20) mA]
12	AI5-		
13	AO5	Analog output 5: speed	Isolated analog output signals: (0 to 20) mA / (4 to 20) mA Scales: Refer to parameter descriptions Resolution: 11 bits (0.05 % of the full scale) R_L ≤ 600 Ω
14	GNDA05	0 V Reference for analog output 5	
15	AO6	Analog output 6: motor current	
16	GNDA06	0 V Reference for analog output 6	

Figure 7.4: *XC1B terminal strip description: analog inputs and outputs*

Table 7.1: *XC1C terminal strip description: relay outputs*

Terminal Strip XC1C		Factory Default Function	Specifications
1	RL1 NA	Relay output 1- without error	Contact capacity: 1 A 240 Vac
2	RL1 C		
3	RL1 NF		
4	RL2 NA	Relay output 2 - N > Nx	
5	RL2 C		
6	RL2 NF		
7	RL3 NA	Relay output 3 - N* > Nx	
8	RL3 C		
9	RL3 NF		
10	RL4 NA	Relay output 4 - no function	
11	RL4 C		
12	RL4 NF		
13	RL5 NA	Relay output 5 - no function	
14	RL5 C		
15	RL5 NF		
16	-	-	-

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

***Table 7.2:** Configuration of the switches*

Signal	Factory Default Function	Setting Element	Selection
AI1	Speed reference	S2.A	OFF - (0 to 10) V [(1)] ON - (0 to 20) mA / (4 to 20) mA
AI2	No function	S2.B	OFF - (0 to 10) V [(1)] ON - (0 to 20) mA / (4 to 20) mA
AI5	No function	S3.A	OFF - (0 to 10) V [(1)] ON - (0 to 20) mA / (4 to 20) mA
AO5	Speed	S4.A	OFF - (0 to 20) mA [(1)] ON - (4 to 20) mA
AO6	Motor current	S5.A	OFF - (0 to 20) mA [(1)] ON - (4 to 20) mA

(1) Factory default.

Related parameters: P0221, P0222, P0234 to P0240.

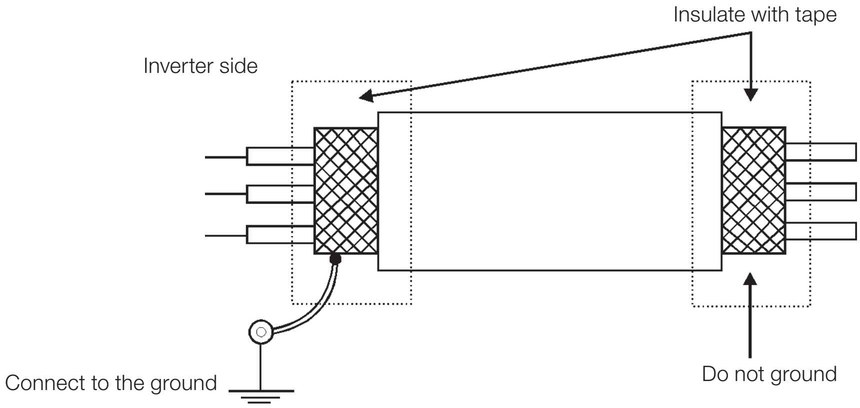
During the signal and control wiring installation, pay attention to:

1. Cable gauge 0.5 mm² to 1.5 mm².

2. Maximum torque: 0.50 N.m (4.50 lbf.in).

3. XC1A, XC1B and XC1C wiring must be made with shielded cables and be separated from other cables (power, 110/220 V command, etc.). If crossing of these cables is unavoidable, install them perpendicularly, keeping a minimum separation distance of 5 cm (2 in) at the crossing point.

Connect the shield as shown below:



The shield connection screws are located on the MVC4 board and on its mounting plate.

***Figure 7.5:** 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 do the EBA/EBB boards. Next, the detailed description of those boards is presented.

7.2.1 EBA (I/O Expansion Board A)

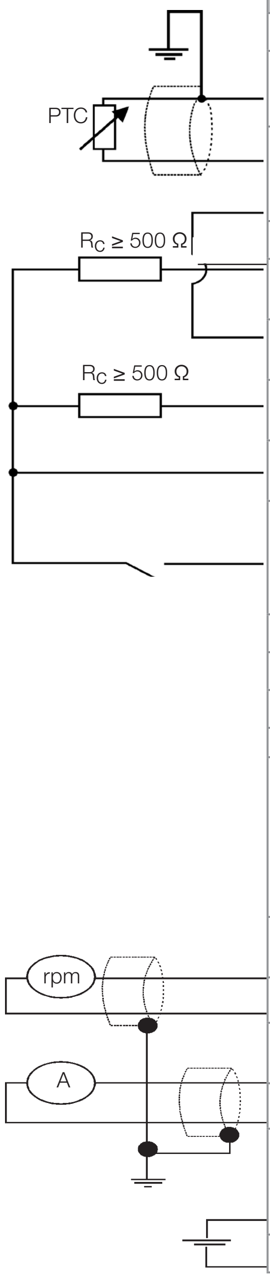
The EBA board can be supplied in different configurations, created from the combination of specific functions.

Table 7.3 on page 7-5 contains the available configurations.

Table 7.3: *EBA board versions and available features*

Available Features	EBA Board models - Code		
	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
Analog differential input (AI4): 14 bits (0.006 % of the full scale range), bipolar: -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]), bipolar: -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 serial interface RS-485 does not allow the use of RS-232 card standard MVC2 or MVC4. They cannot be used simultaneously.



Terminal Strip XC4		Factory Default Function	Specifications
1	NC	Not connected	-
2	DI8	Motor thermistor input 1 - PTC 1 (see P0270 in the programming manual)	Actuation 3.9 kΩ, Release:1.6 kΩ Minimum resistance: 100 Ω
3	DGND (DI8)	Motor thermistor input 2 - PTC 2 (see P0270 in the programming manual)	Reference to DGND (DI8) through a 249 Ω resistor
4	DGND	0 V reference of the 24 Vdc	Grounded via a 249 Ω resistor
5	DO1	Transistor output 1: not used	Isolated, open collector, 24 Vdc, 50 mA maximum, eequired load (Rc) ≥ 500 Ω
6	COMUM	Common point for Digital Input DI7 and Digital Outputs DO1 and DO2	-
7	DO2	Transistor output 2: not used	Isolated, open collector, 24 Vdc, 50 mA maximum, required load (Rc) ≥ 500 Ω
8	24 Vdc	Power Supply for the 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	Serial RS-485 isolada
11	A-LINE	RS-485 A-LINE (-)	
12	B-LINE	RS-485 B-LINE (+)	
13	AI4 +	Analog input 4: Speed reference Program P0221 = 4 or P0222 = 4	Differential analog input programmable at P0246: -10 V to +10 V or (0 to 20) mA/(4 to 20) mA Resolution: 14 bits (0.006 % of full scale range) Impedance: 40 kΩ (-10 V 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)	Analog outputs signals: -10 V to +10 V Scales: see P0255 and P0257 in the programming manual available for download on: **www.weg.net** Resolution: 14 bits (0.006 % of ±10 V range) 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	Available to be connected to an external power supply to feed the encoder repeater output (XC8)	External power supply: 5 V to 15 V Consumption: 100 mA @ 5 V not including the outputs
20	COM 1	0 V reference of the external power supply	

Figure 7.6: *Terminal Block description (complete EBA board)*

7

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 7.4 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.

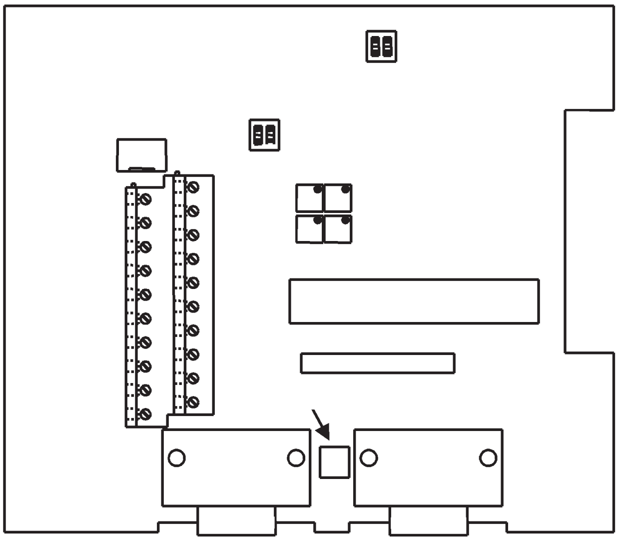


Figure 7.7: *EBA board installation procedure*

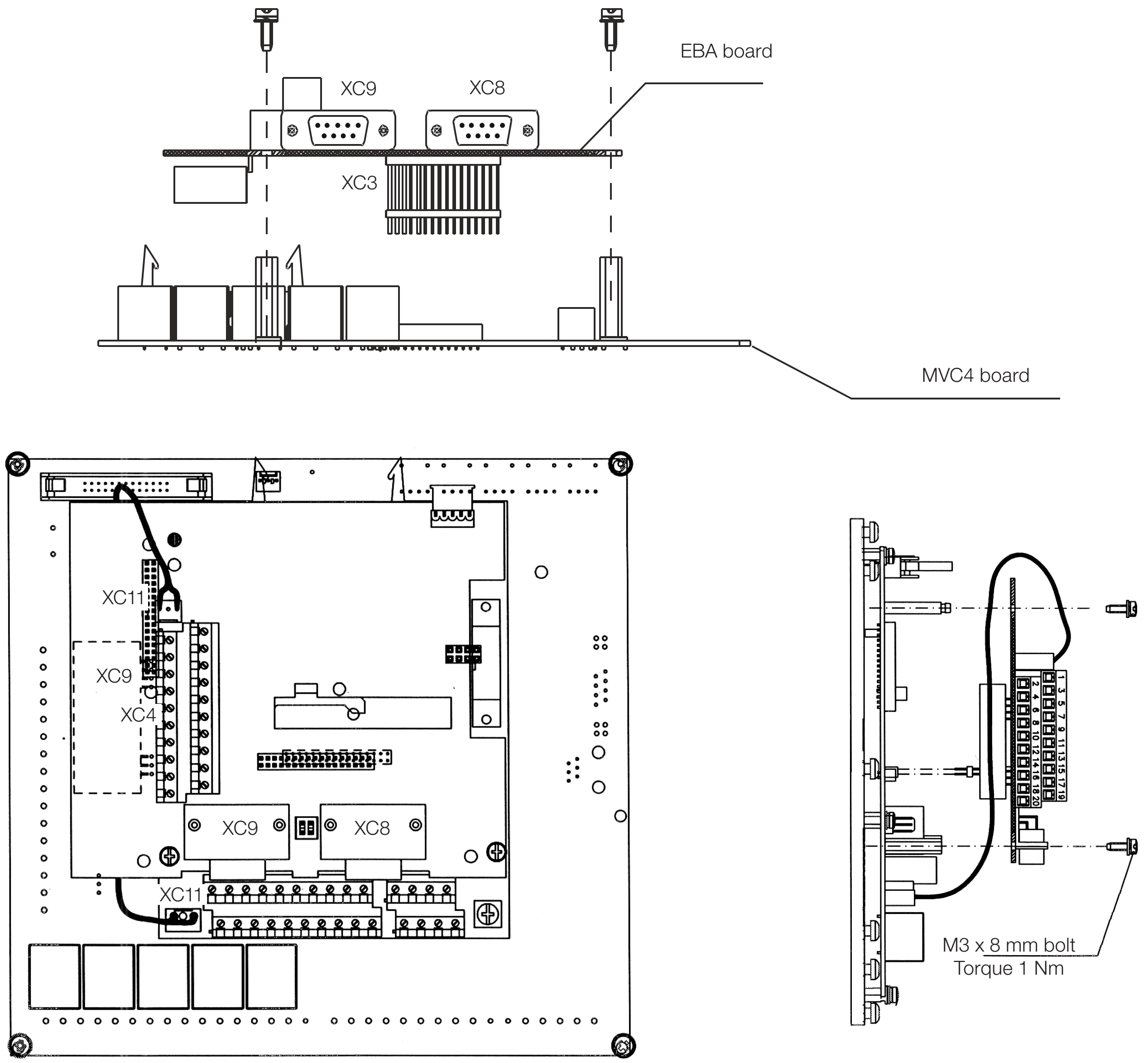


Figure 7.8: *EBA board installation procedure*

Table 7.4: *EBA board configuration of setting elements*

Switch	Signal – Factory Default	OFF (Standard)	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 120 Ω termination
S3.2	RS-485 A - LINE (-)		

Note: Both switches, S3.1 and S3.2, must be adjusted for the same option.

Table 7.5: *EBA board trimpot configurations*

Trimpot	Function	Factory Default Function
RA1	AO3 - offset	Motor speed
RA2	AO3 - gain	
RA3	AO4 - offset	Motor current
RA4	AO4 - gain	

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 (I/O Expansion Board B)

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

The available functions are presented in the Table 7.6 on page 7-9.

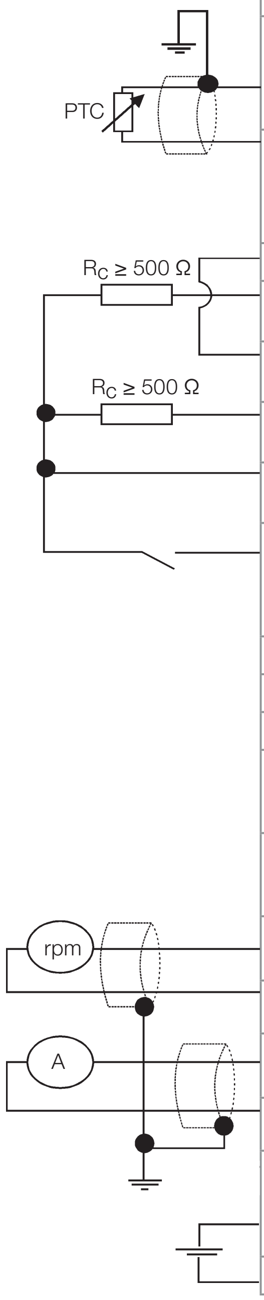
Table 7.6: *EBB board versions and available features*

Available Features	EBB Board Models - Code				
	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 bit 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	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

* Board with 5 V encoder power supply.

NOTE!
The use of the RS-485 serial interface does not allow the use of the standard RS-232 input - they cannot be used simultaneously. The analog outputs AO1' and AO2' have the same functions and parameters as AO1 and AO2 on the MVC4 control board.

7



Terminal Strip XC5		Factory Default Function	Specifications
1	NC	Not connected	-
2	DI8	Motor thermistor input 1 - PTC 1 (see P0270 in the programming manual)	Actuation 3.9 kΩ, Release: 1.6 kΩ Minimum resistance: 100 Ω
3	DGND (DI8)	Motor thermistor input 2 - PTC 2 (see P0270 in the programming manual)	Reference to DGND (DI8) through a 249 Ω resistor
4	DGND	0 V reference of the 24 Vdc	Grounded via a 249 Ω resistor
5	DO1	Transistor output 1: not used	Isolated, open collector, 24 Vdc, 50 mA maximum, required load (RL) ≥ 500 Ω
6	COMUM	Common point for Digital Input DI7 and Digital Outputs DO1 and DO2	-
7	DO2	Transistor output 2: not used	Isolated, open collector, 24 Vdc, 50 mA maximum, required load (RL) ≥ 500 Ω
8	24 Vdc	Power Supply for the 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 port
11	A-LINE	RS-485 A-LINE	
12	B-LINE	RS-485 B-LINE	
13	AI3 +	Analog input 3: speed reference Program P221 = 3 or P222 = 3	Isolated analog input programmable at P243: (0 to 10) V or (0 to 20) mA/(4 to 20) mA Resolution: 10 bits (0.1 % of full scale range) 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)	Isolated analog outputs signals: (0 to 20) mA / (4 to 20) mA Scales: see the description of parameters P0251 and P0253 in the programming manual available for download on: **www.weg.net** (P0251 and P0253) Resolution: 11 bits (0.5 % of full scale range) 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	Available to be connected to an external power supply to feed the encoder repeater output (XC8)	External power supply: 5 V to 15 V Consumption: 100 mA @ 5 V, not including the outputs
20	COM 1	0 V reference of the external power supply	

Figure 7.9: *XC5 Terminal Block description (complete EBB board)*

ATTENTION!
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 via S4, S5, S6 and S7 DIP switches (refer to the Table 7.7 on page 7-12).

3. Carefully insert XC3 connector (EBB) into the female connector XC3 on the MVC4 control board. Make sure that all pins fit in the XC3 connector.

4. Press on the EBB 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 EBB board to the XC11 connector on the MVC4 control board.

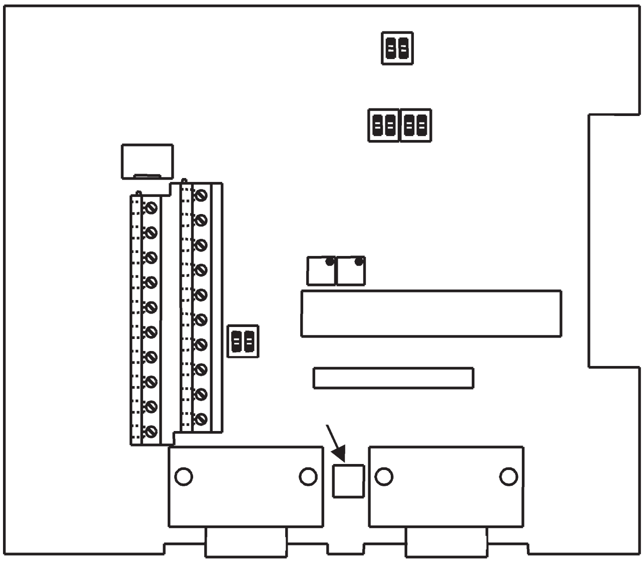


Figure 7.10: *EBB board layout*

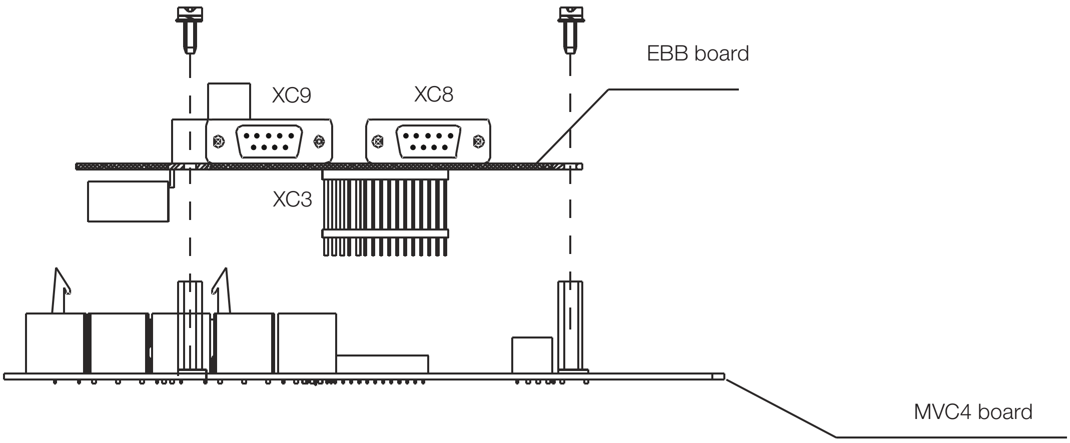


Figure 7.11: *EBB board installation procedure*

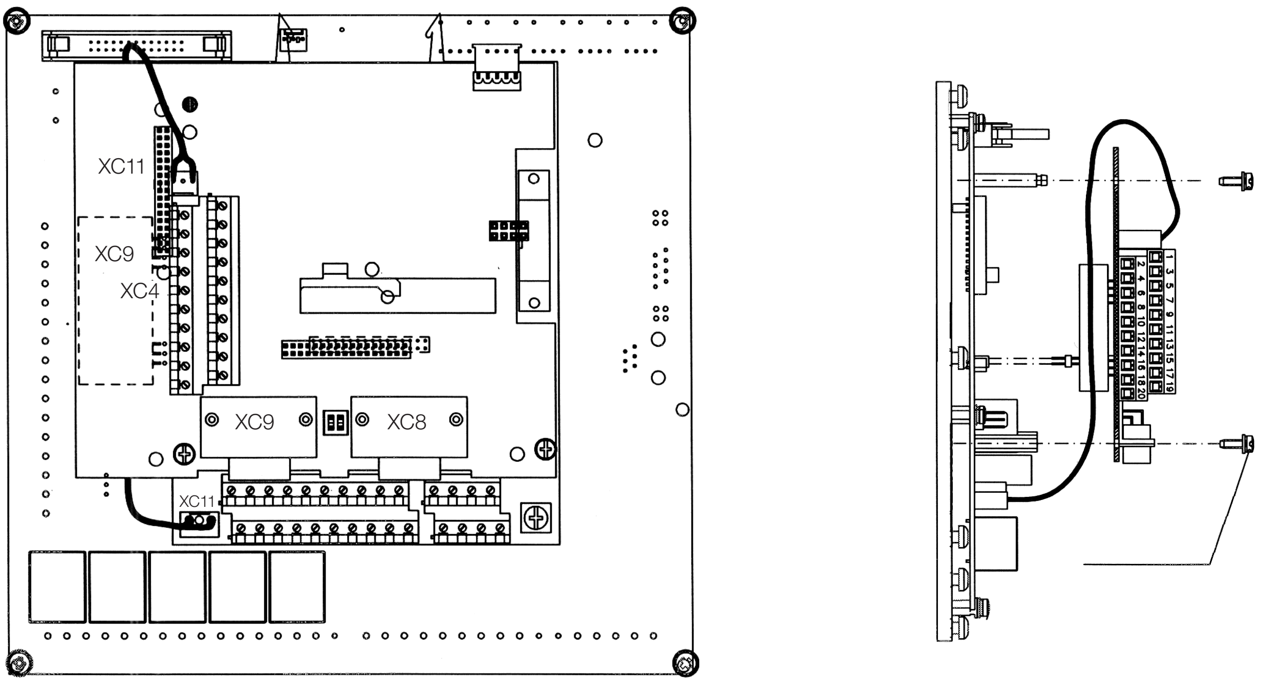


Figure 7.12: EBB board installation procedure

Table 7.7: EBB board DIP switch configurations

Switch	Signal – Factory Default	OFF	ON
S4.1	AI3 - Speed reference	(0 to 10) V (1)	(0 to 20) mA or (4 to 20) mA
S5.1 and S5.2	AO1 - Speed	(0 to 20) mA (2)	(4 to 20) mA (1)
S6.1 and S6.2	AO2 - Motor current		
S7.1 and S7.2	RS-485 B - LINE (+)	Without termination (1)	Without termination (120 Ω)
	RS-485 A - LINE (-)		

(1) Factory default setting. Note: Each group of switches must be set for the same option (ON or OFF). E.g., S6.1 and S6.2 = ON.
(2) When the outputs are set to (0 to 20) mA, it may be necessary to readjust the full scale.

Table 7.8: EBB board trimpot configurations

Trimpot	Function	Factory Default Function
RA5	AO1 Full scale adjustment	Motor speed
RA6	AO2 Full scale adjustment	Motor current

NOTE!
The external signal and control wiring must be connected to XC5 (EBB), 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).

7.2.3 PLC2

The PLC2 board adds to the MVW3000 inverter important PLC (Programmable Logic Controller) functions, enabling the execution of complex interlocking programs, using the board digital inputs and outputs, as well as the digital and analog inputs and outputs of the inverter itself, which may be accessed by the user's program.

NOTE!
For more information on the PLC2 board, refer to the PLC2 V1.5x specific manual.

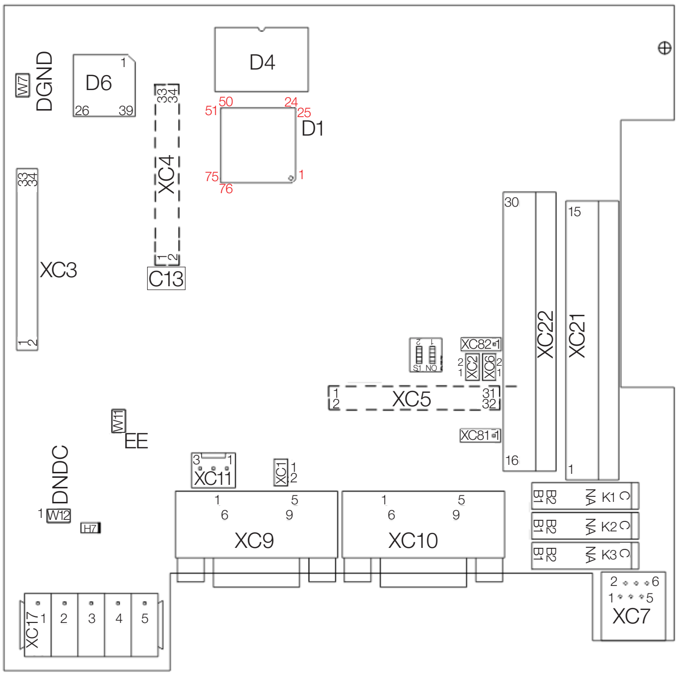
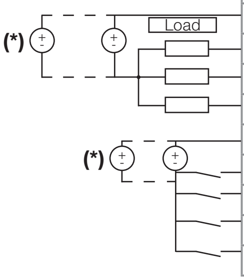


Figure 7.13: PLC2 connectors

The connectors and their terminals function are described below.

XC21 Connector: Relay Outputs and Digital Inputs

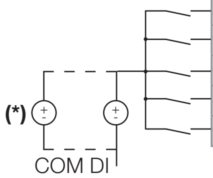


XC21 Connector			Function	Specification
1	C	DO1	Digital relay outputs	Contact capacity: 3 A 250 Vac
2	N			
3	C	DO2		
4	NA			
5	C	DO3		
6	NA			
7	COM DO		Reference for digital outputs DO4, DO5, DO6	-
8	DO4		Bidirectional opto-isolated digital outputs	Maximum voltage: 48 Vdc Current capacity: 500 mA
9	DO5			
10	DO6			
11	COM DI		Reference for digital inputs DI1 to DI9	-
12	DI9		Bidirectional isolated digital Inputs	Input voltage: (15 to 30) Vdc Input current: 11 mA @ 24 Vdc
13	DI8			
14	DI7			
15	DI6			

Figure 7.14: Description of XC21 connector

ATTENTION!
(*) External power supply.

XC22 Connector: Transistor Outputs and Digital Inputs



XC22 Connector			Function	Specificationss
16	PTC1		Motor thermistor input	Actuation: 3.9 k Release: 1.6 k Minimum resistance: 100 Ω
17	PTC2		PTC	
18	GND ENC		Reference for the power supply of the encoder input	-
19	+ ENC		Encoder input power supply	Controlled 5 Vdc or (8 to 24) Vdc Current consumption: 50 mA + Encoders current **(**)**
20	-	AO2	Analog output 2	(-10 to +10) Vdc or (0 to 20) mA 12 Bits
21	+			
22	-	AO1	Analog output 1	(-10 to +10) Vdc or (0 to 20) mA 12 Bits
23	+			
24	-	AI1	Differential analog input 1	(-10 to +10) Vdc or (-20 to 20) mA 14 Bits
25	+			
26	DI1		Bidirectional, isolated digital inputs	Input voltage: (15 to 30) Vdc Input current: 11 mA @ 24 Vdc
27	DI2			
28	DI3			
29	DI4			
30	DI5			

Figure 7.15: *Description of XC22 connector*

ATTENTION!
(*) External Power supply.
(**) For current, the S1 switch must be set 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, $\overline{A}$, B, $\overline{B}$, Z and $\overline{Z}$.
- "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:

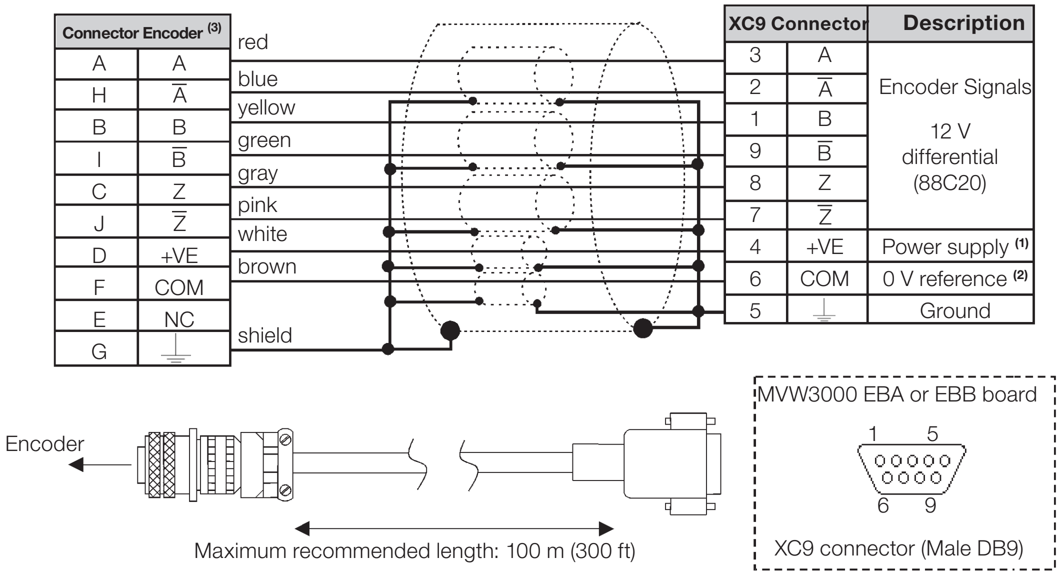
- Couple the encoder directly to the motor shaft (use a flexible coupling without torsional flexibility).
- Both the shaft and the metallic frame of the encoder must be electrically isolated from the motor (3 mm (0.119 in) minimum distance).
- Use high quality flexible couplings to prevent mechanical oscillation or backlash.

The electrical connections must be made with shielded cable, maintaining a minimum distance of about 25 cm (10 in) from other wires (power, control cables, etc.). If possible, install the encoder cable in a metallic conduit.

During the commissioning, it is necessary to program the control type, P0202 = 4 (Vector with Encoder), in order to operate with speed feedback via 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.

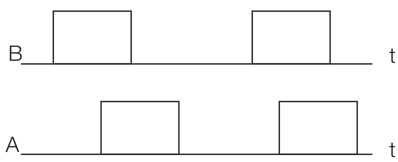


(1) Power supply voltage 12 Vdc / 220 mA for encoder.
(2) Referenced to ground via 1 μF in parallel with 1 kΩ.
(3) Connector pinout valid for HS35B Dynapar encoder. For other encoder models, verify the correct connection in order to meet the required sequence.

Figure 7.16: *Encoder input*

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

Sequence of the encoder signals:

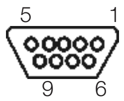


Motor running in forward direction

Figure 7.17: *Encoder signals*

MVW3000 EBA or EBB board

XC8 connector		Description
3	A	Encoder signals Line driver differential (88C30) Average current: 50 mA high level
2	$\overline{A}$	
1	B	
9	$\overline{B}$	
8	Z	
7	$\overline{Z}$	
4	+V (*)	Supply(*)
6	COM 1 (*)	0 V reference
5	⏚	Ground



XC8 connector (female DB9)

(*) Connection of the external power supply: 5 V to 15 V, consumption: 100 mA @ 5 V not including the outputs.

Note: The external power supply can also be connected at:
XC4: 19 and XC4: 20 (EBA) or
XC5: 19 and XC5: 20 (EBB)

NOTE!
There is no internal power supply for XC8 on the expansion boards EBA and EBB.

Figure 7.18: *Encoder signal repeater output*

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, $\overline{A}$, B and $\overline{B}$.
- "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.

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 pins of the connector XC3 (EBC1) into the female connector XC3 of the MVC4 control board. Make sure that all pins fit in the XC3 connector.

3. Press on the board center (near to XC3) until the connector is completely inserted.

4. Secure the board to the 2 metallic spacers with the 2 provided bolts.

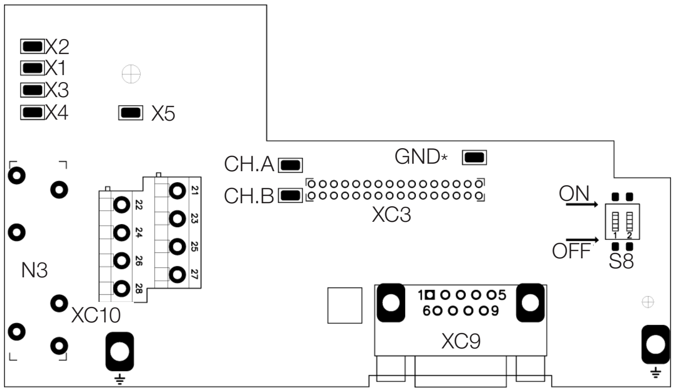


Figure 7.19: *EBC1 board layout*

NOTE!
The terminals XC10:22 and XC10:23 (see Figure 7.19 on page 7-17), should only be used for encoder supply, when the encoder power supply is not coming from the DB9 connector.

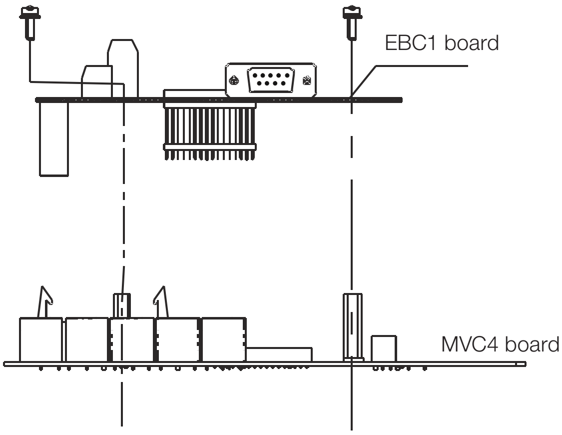


Figure 7.20: *EBC1 board installation procedure*

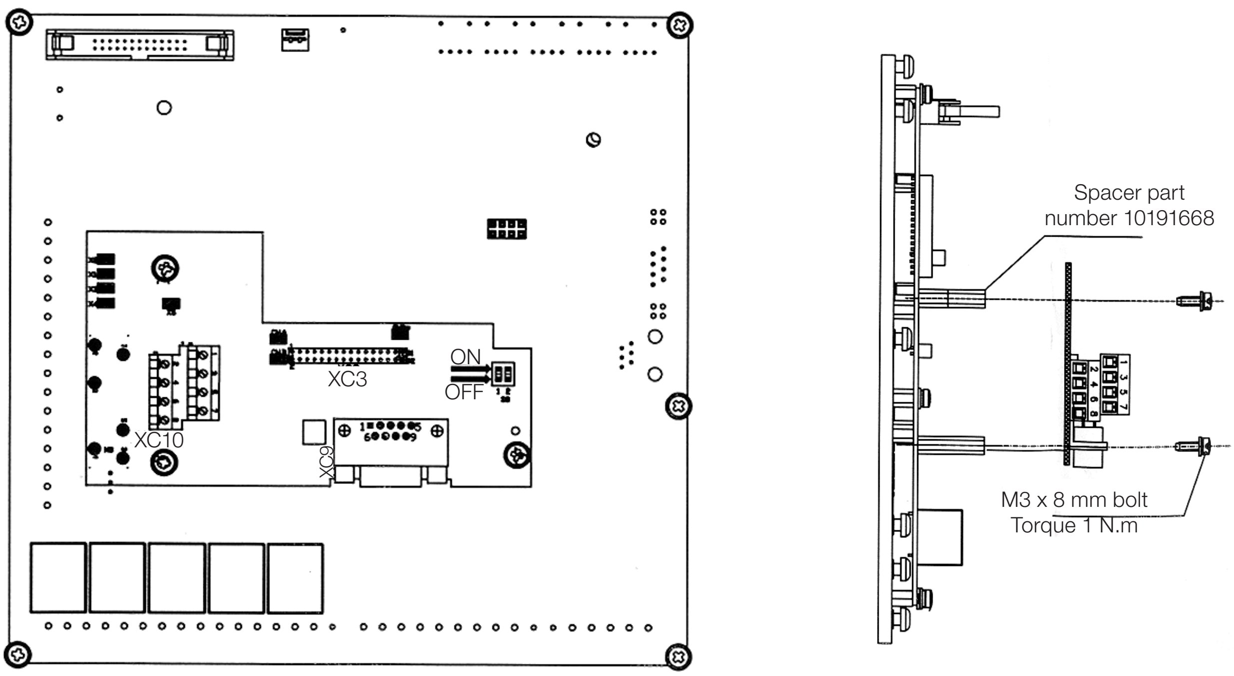


Figure 7.21: *EBC1 board installation procedure*

CONFIGURATIONS:

Table 7.9: *EBC1 board configurations*

Expansion Board	Power Supply	Encoder Voltage	Necessary Setting
EBC1.01	External 5 V	5 V	Commutate switch S8 to ON, see Figure 7.19 on page 7-17
	External 8 V to 15 V	8 V to 15 V	None
EBC1.02	Internal 5 V	5 V	None
EBC1.03	Internal 12 V	12 V	None

ENCODER MOUNTING:

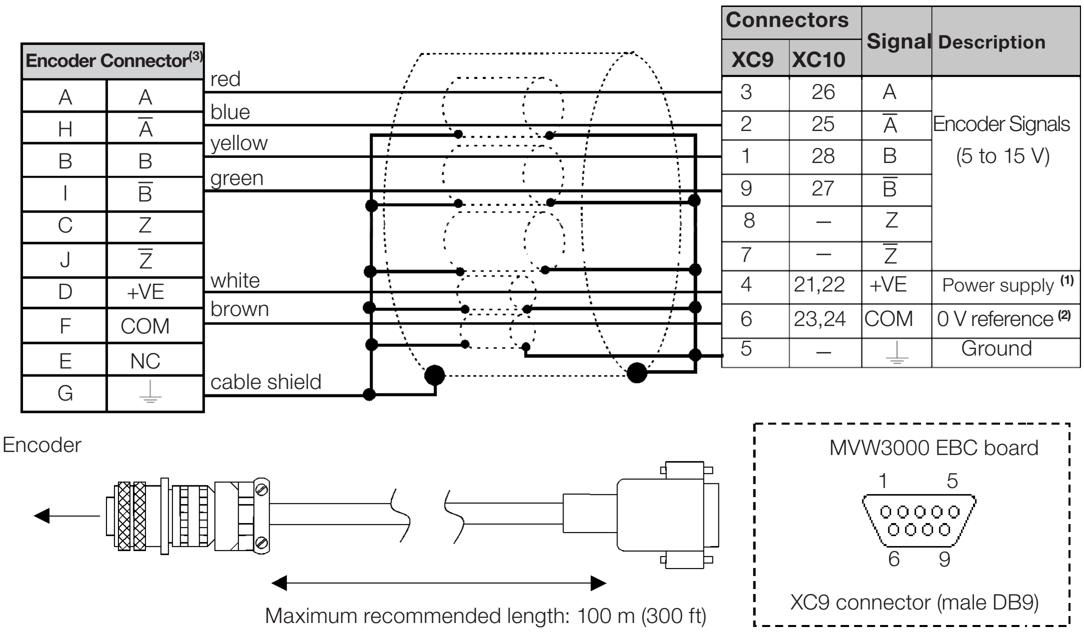
Follow the recommendations bellow when mounting the encoder on the motor:

- Couple the encoder directly to the motor shaft (use a flexible coupling without torsional flexibility).
- Both the shaft and the metallic frame of the encoder must be electrically isolated from the motor (3 mm (0.119 in) minimum distance.
- Use high quality flexible couplings to prevent mechanical oscillation or backlash.

The electrical connections must be made with shielded cable, maintaining a minimum distance of about 25 cm (10 in) from other wires (power, control cables, etc.). If possible, install the encoder cable in a metallic conduit.

During the commissioning, it is necessary to program the control type, P0202 = 4 (Vector with Encoder), in order to operate with speed feedback via incremental encoder.

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



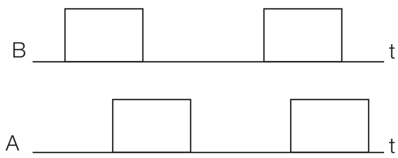
(1) External encoder power supply: 5 to 15 Vdc. Consumption of 40 mA plus the encoder consumption;
(2) 0 V reference of the power supply voltage;
(3) Connector pinout valid for HS35B Dynapar encoder. For other encoder models, verify the correct connection in order to meet the required sequence.

Figure 7.22: *EBC1 encoder input*

7

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

Sequence of the encoder signals:



Motor running in forward direction

Figure 7.23: *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.
- PS24 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

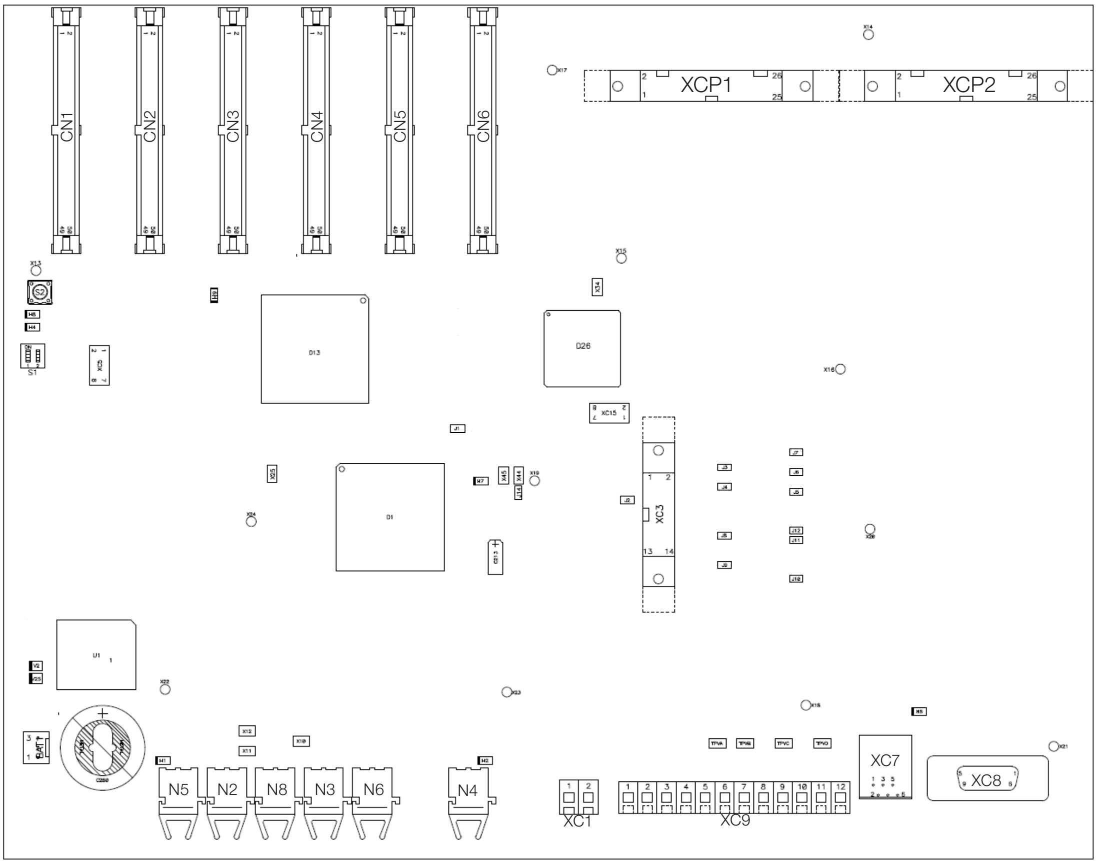


Figure 7.24: *MVC3 board connections*

Table 7.10: *XC9 terminal strip connections*

XC9 Terminal Strip		Factory Standard Function	Specifications
1	+5V4	Positive reference for potentiometer	+5.4 V ±5 % capacity: 2 mA
2	AI1-	Analog input 1: 0 - no function (P0740)	Differential, resolution 11 bits Impedance: 400 kΩ [-10 V to 10 V]
3	AI1+		
4	-4V7	Negative reference for potentiometer	-4.7 V ±5 % capacity: 2 mA
5	AO1+	Analog output 1: 2 - Iu (P0652)	-10 V to 10 V, RL ≥ 10 kΩ (Maximum load) Resolution 11 bits
6	AGND		
7	AO2+	Analog output 2: 5 - modulation index (P0654)	-10 V to 10 V, RL ≥ 10 kΩ (Maximum load) Resolution 11 bits
8	AGND		
9	AO3+	Analog output 3: 2 - Iu (P0656)	-10 V to 10 V, RL ≥ 10 kΩ (Maximum load) Resolution 11 bits
10	AGND		
11	AO4+	Analog output 4: 5 - modulation index (P0658)	-10 V to 10 V, RL ≥ 10 kΩ (Maximum load) Resolution 11 bits
12	AGND		

Table 7.11: *XC1 terminal strip description*

XC1 Terminal Strip		Factory Standard Function	Specifications
1	AI2-	Analog input 2: 0 - no function (P0744)	Differential, resolution 11 bits Impedance: 400 kΩ [-10 V to 10 V]
2	AI2+		

Note: AI2 is not implemented in the MVC1, only in the MVC3.

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

7

8 SPECIAL FUNCTIONS

8.1 LOAD SHARE FUNCTION "MASTER/SLAVE"

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 of 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 (Master) and torque limitation mode (Slave (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 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 master 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 master inverter sends the slaves 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 salve inverter(s) to follow an external torque reference, which will be sent by the master inverter.

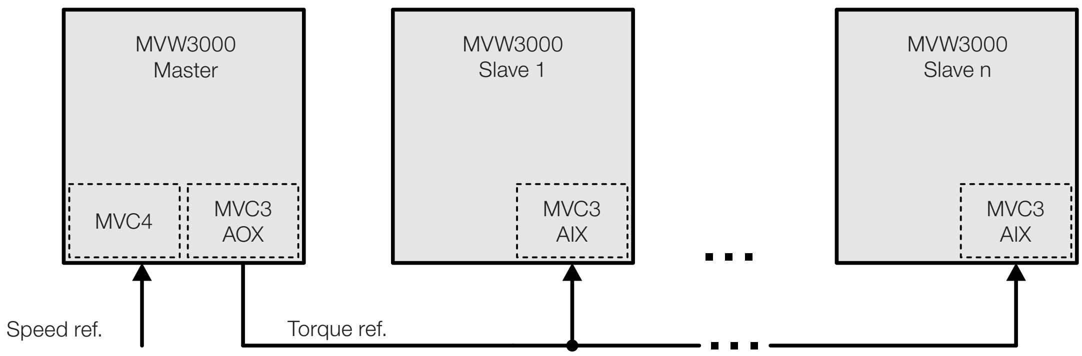


Figure 8.1: *General operation scheme of the function*

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

<u>Master:</u>

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

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

Slave(s):

On the slave inverter(s), it is necessary to parameterize an analog input of MVC3 board to receive the torque reference sent by the master 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 master inverter operates in speed control mode, while the slave inverter operates in torque current regulation mode. Besides the limit value of the torque current, the slave 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 slave inverter(s) must be set to a value slightly above the master inverter reference. It is recommended to apply an offset to the analog inputs of the slave(s) greater than 5 % added to the reference sent by the master inverter; the ideal value may vary according to the application.

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

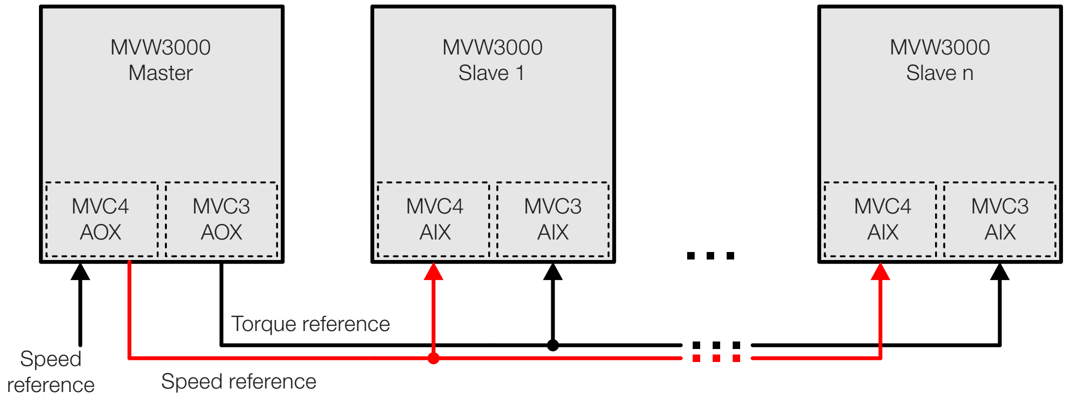


Figure 8.2: *General operation scheme of the function*

Therefore, the inverters must be parameterized as follows:

Master:

Parameterize one of the analog outputs of the MVC3 board to send the torque current limit to the slave 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).

Slave:

The slave inverter(s) requires the parameterization of an analog input of the MVC3 board to receive the torque current limit sent by the master 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 (Input AI1 Offset) = 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 master 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.

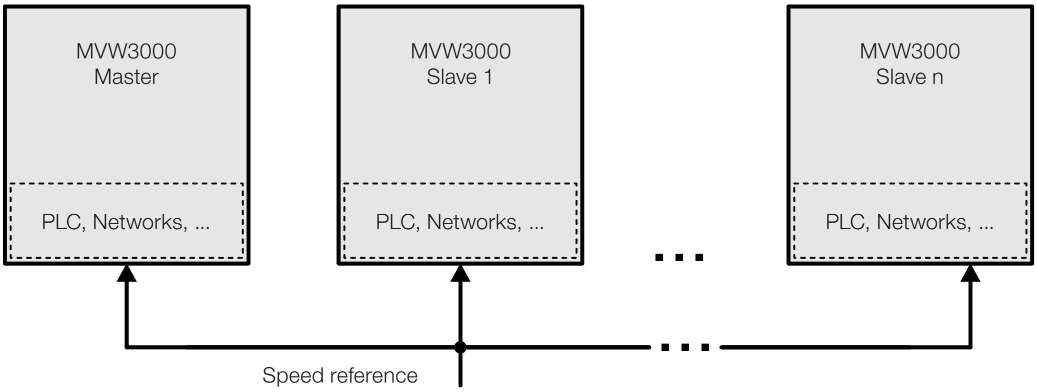


Figure 8.3: *General operation scheme of the function*

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 parameterization, 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” signals must be sent to all inverters at the same time. There are several ways to meet this requirement and the most appropriate way 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.

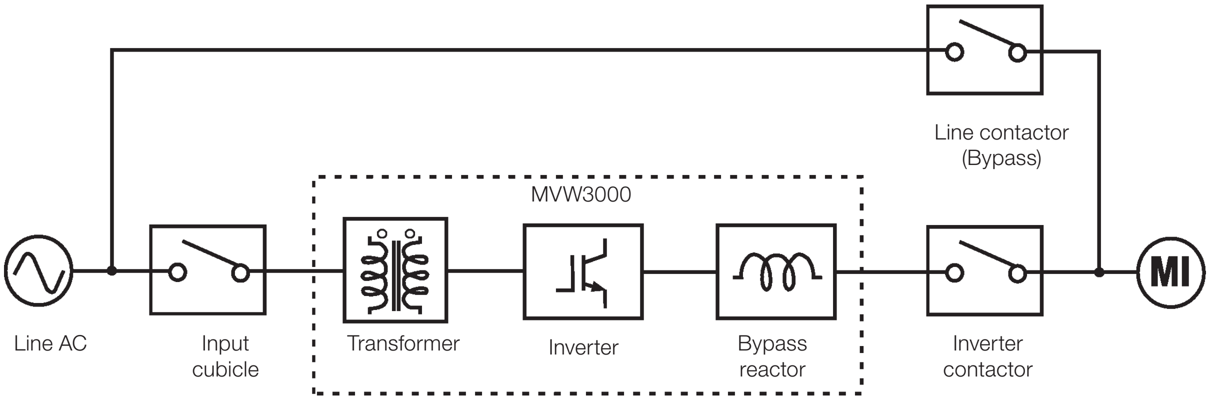


***Figure 8.4:** General scheme of synchronous transfer*

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) equal to the line voltage to which the motor will be transferred. In the operation with synchronous bypass, 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 line 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 one DO (RL1 to RL5) to indicate that the synchronism with the line 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 is a quick description of each parameter, as well as 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 P632 so as to signal synchronism OK.

- **P0630 = 60 s** Synchronism with the network time out. Time counted from the drive of the MVC4 DI, which starts searching until the signaling of synchronism OK. If this time is exceeded, A0008 will be indicated.

8

- **P0631 = adjusted in the application** Delay of DI13 of the PIC2 board used to disable the inverter after the bypass. This time is used to compensate the delay of the bypass circuit, preventing the motor from remaining for a period without voltage.

- **P0632 = 1966** Phase error between the network and inverter voltage used in conjunction with P0629 to indicate synchronism OK. **(P0632/65536)*360° = value in degrees**.

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

Adjust is possible between (-180 ° and +180 º). **(P0636/65536)*360 ° = value in degrees**.

Operating Sequency

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

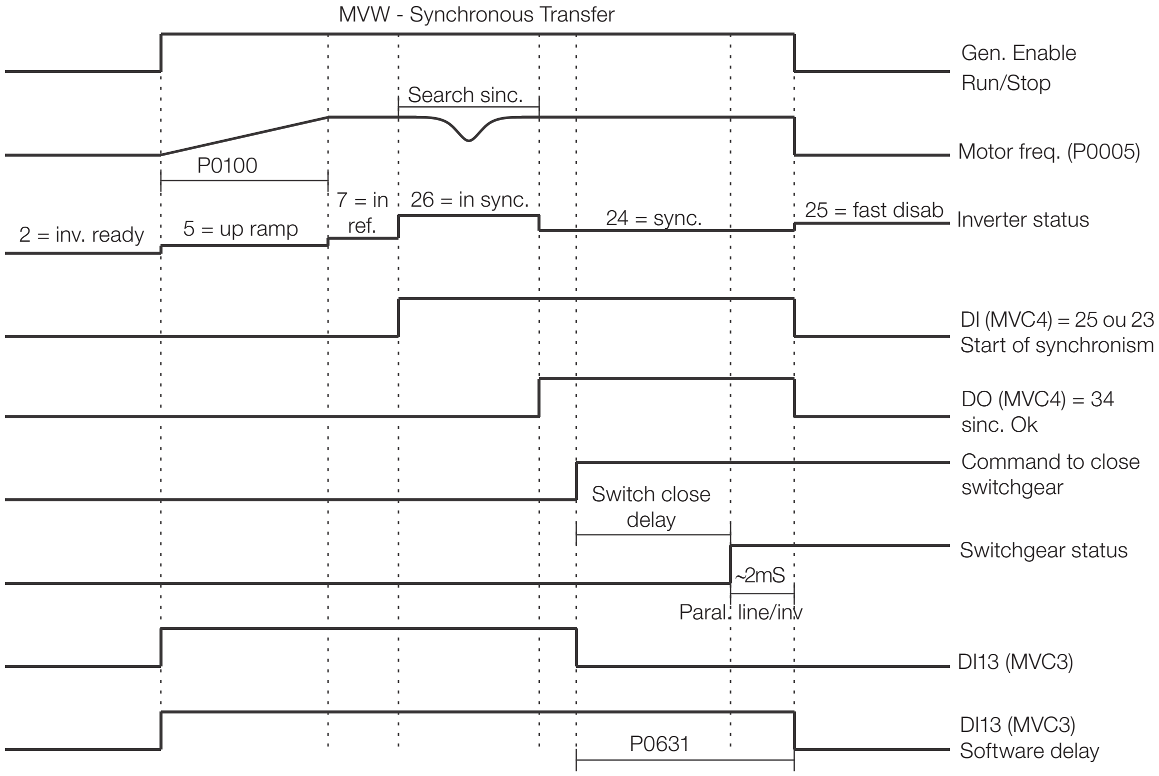


***Figure 8.5:** Operating diagram of the synchronous transfer function*

8.3 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 worth of notice that, after this process, the inverter continues to operate normally only by reducing its maximum output voltage capacity proportionally to the number of cells in bypass. Control techniques will be used for the application to continue operating normally. For applications that do not withstand low voltage operation, it is recommended to use an MVW3000 with voltage rating above the motor rated voltage. Check the cell redundancy options available with your authorized WEG representative.

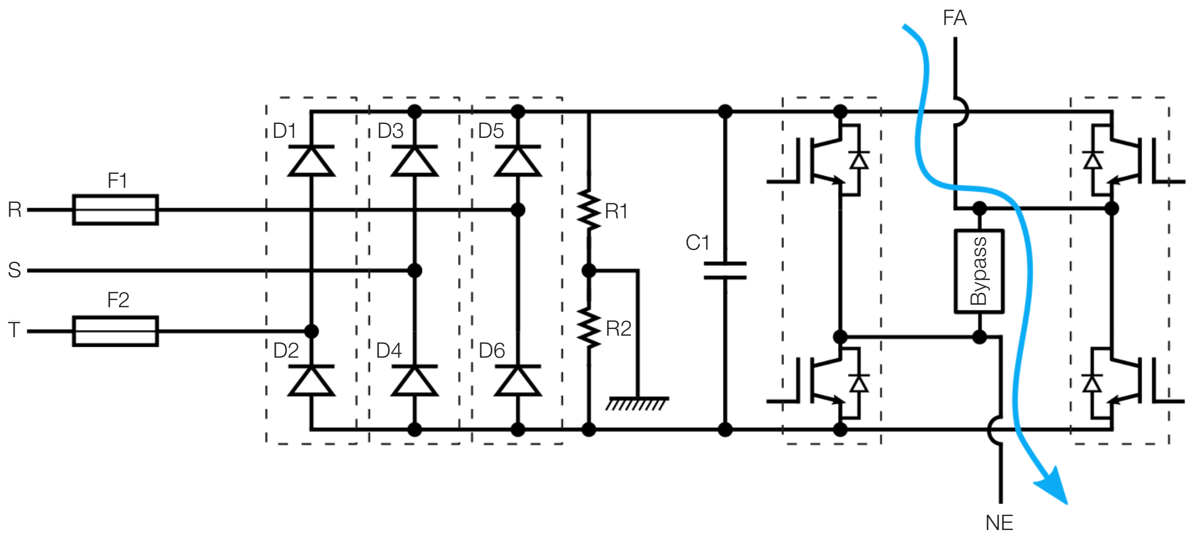


Figure 8.6: *Power cell with bypass system active*

Figure 8.6 on page 8-6 shows the power cell operation 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. However, the maximum voltage available at the motor terminals will be smaller due to the connection in series. In addition, the inverter output becomes unbalanced, jeopardizing the motor operation. That problem can be circumvented by using the technique of adjusting the amplitude between the inverter 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 and have a smaller impact of the cell bypass on the application voltage. To exemplify how the technique works, a 9-cell (3 per phase) MVW3000 is represented for 9 power supplies (3 in series per phase, connected in Y). Under normal inverter operation, with all the cells operating, the phase voltages are shifted by 120° between each other, and the line voltages have the same amplitude, as shown in Figure 8.7 on page 8-7 (a).

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

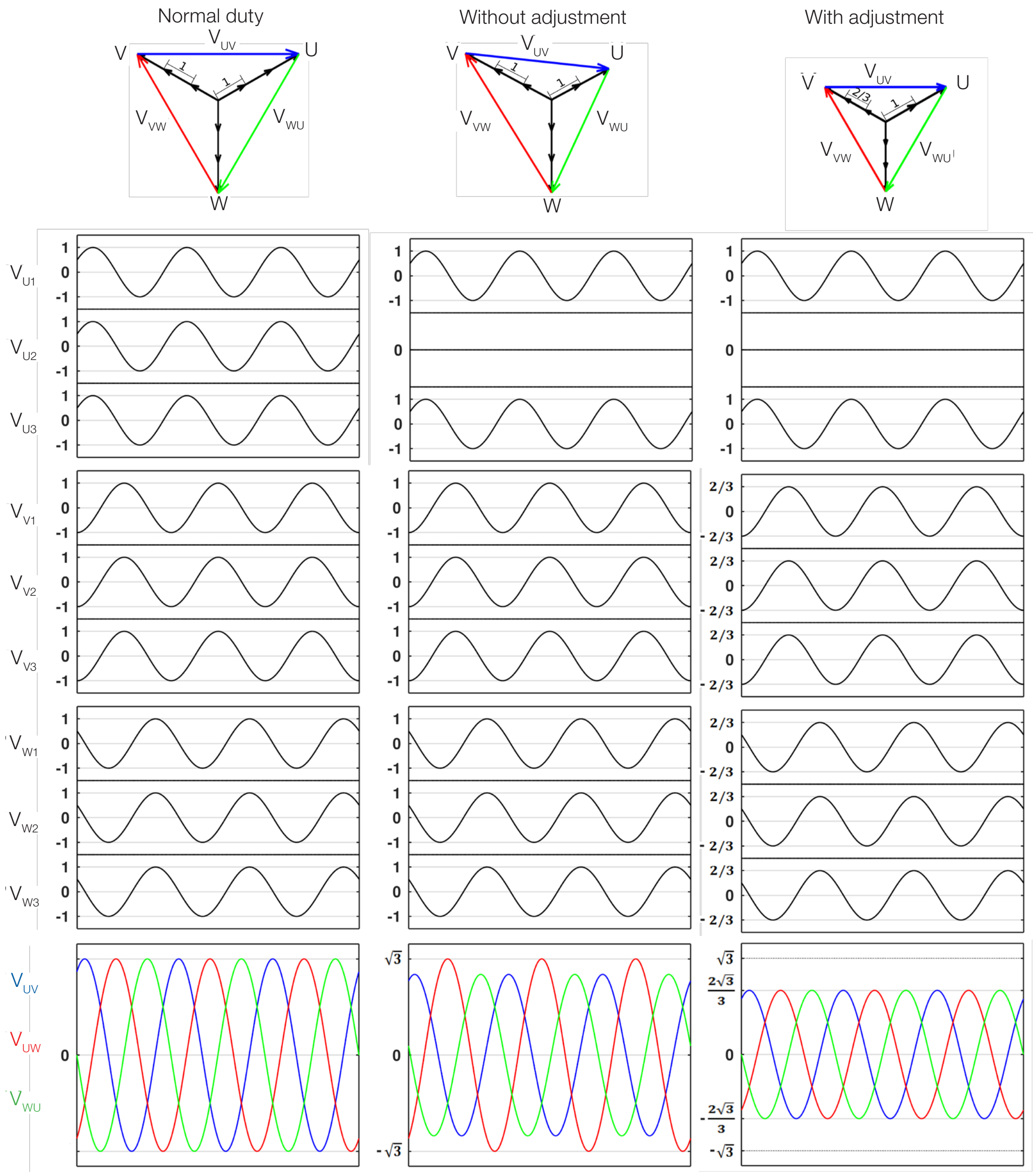


Figure 8.7: *Diagram of the phase voltages of each cell and of the phasor diagrams and in the time of the line voltages*

With the angle adjustment, presented in Figure 8.7 on page 8-7 (c), it is possible to observe that the line voltages remain balanced. The phase voltage amplitudes are controlled to ensure the line voltage balance. 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 only one cell on inverters with 2 to 12 cells per phase (range of possible values for the MVW3000).

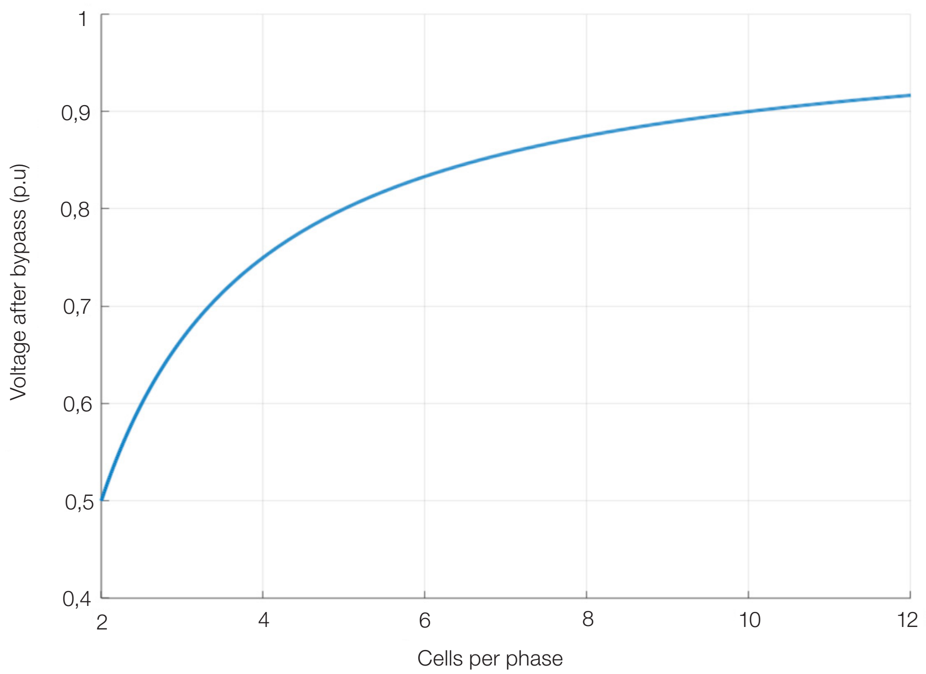


Figure 8.8: *Voltage after bypass of one cell*

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

9 COMMUNICATION NETWORKS

The MVW3000 can be connected to communication networks allowing its control and parameterization. Therefore, it is necessary to install an optional electronic board according to the desired Fieldbus standard.

NOTE!
The chosen Fieldbus option can be specified in the suitable field of the MVW3000 model coding. In such case, the MVW3000 will be supplied with all the necessary components already installed in the product. In case of a later purchase of the Fieldbus optional kit, the user must install it.

9.1 FIELDBUS KIT

9.1.1 Installation of the Fieldbus Kit

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

NOTE!
Follow the safety notes presented in the Chapter 1 SAFETY NOTICES on page 1-1.

In case there is a function expansion board (EBA/EBB/EBC) installed, it will be necessary to remove it for a while so as to allow the installation of the chosen Fieldbus Kit.

1. Power down control Rack.

2. Remove the bolt from the metallic spacer next to the XC140 connector (MVC4 board).

3. Carefully fit the male XC140 connector into the correspondent MVC4 connector. Verify the exact coincidence of all the XC140 connector pins (Figure 9.1 on page 9-1).

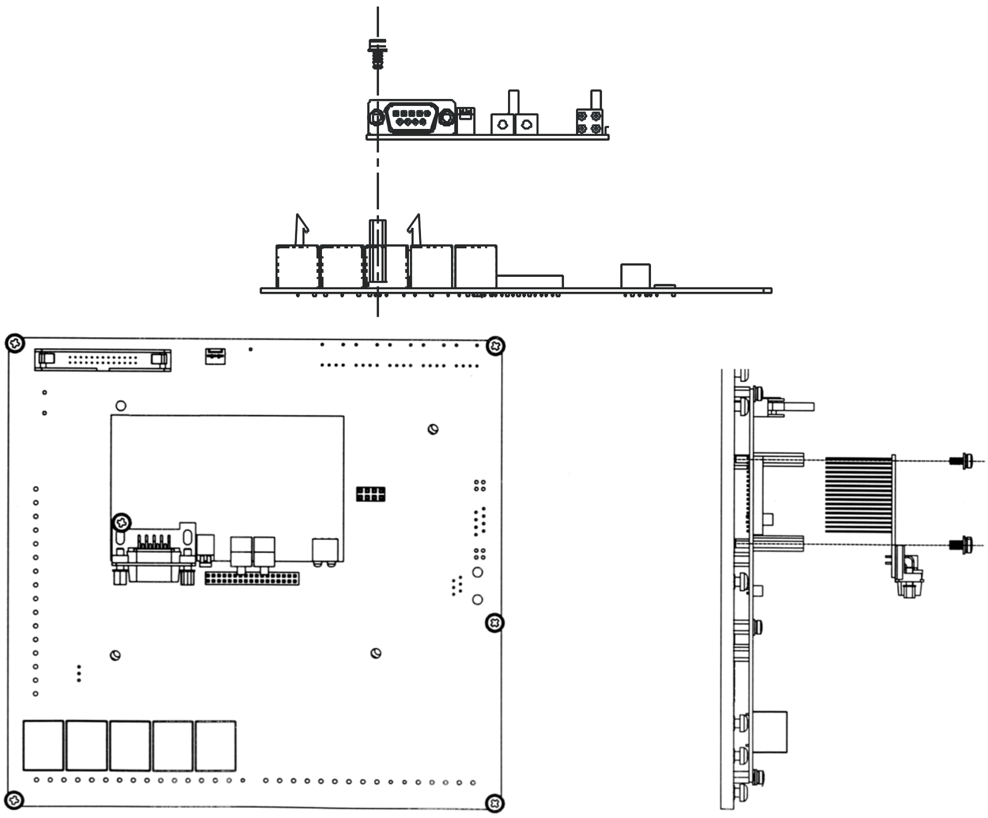


Figure 9.1: *Fieldbus electronic board installation*

4. Press the board close to XC140 and on the bottom right corner until the complete insertion of the connector and the plastic spacer.

5. Secure the board to the metallic spacers with the provided bolt.

6. Connect one end of the Fieldbus cable to the MVW3000 control rack, according to the Figure 9.3 on page 9-2.

7. Connect the other end of the Fieldbus cable to the Fieldbus board, according to the Figure 9.3 on page 9-2.

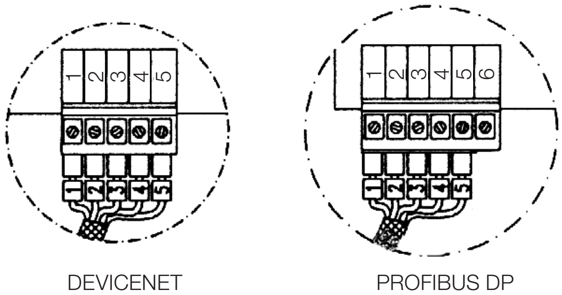


Figure 9.2: Connection to the Fieldbus board

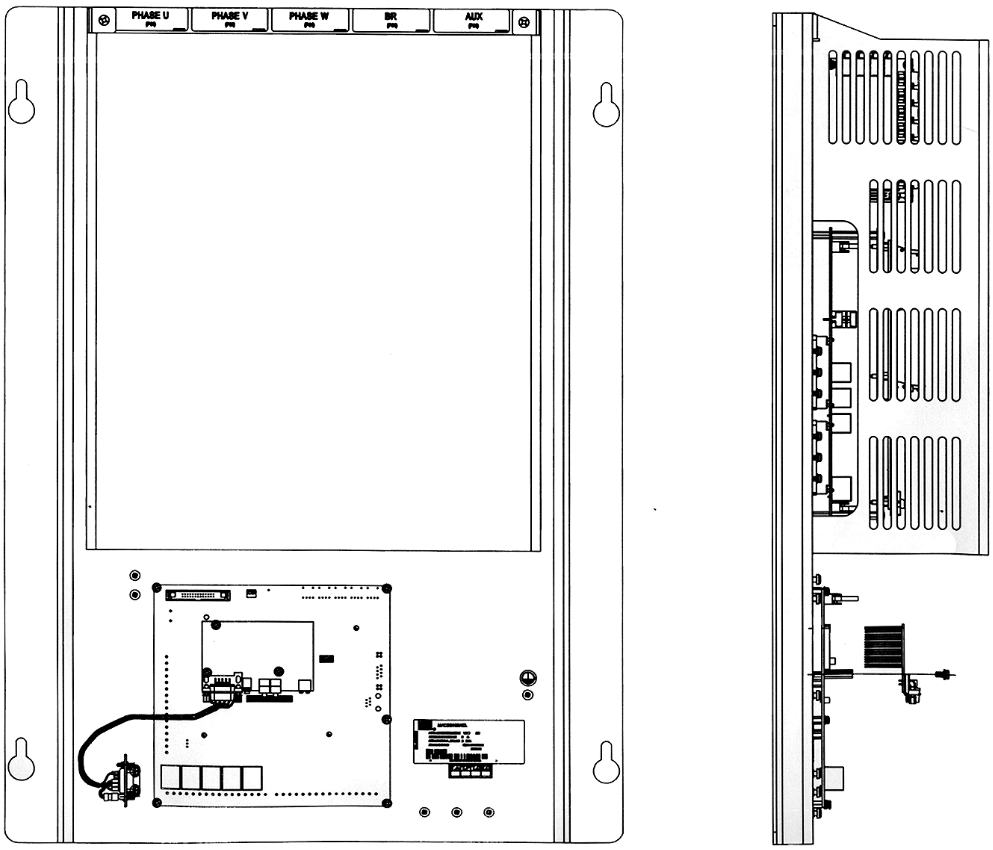


Figure 9.3: Connection to the Fieldbus board

9.1.2 Profibus DP

The inverter that is fitted with the Profibus DP Kit operates in slave mode, allowing the reading/writing of its parameters through a master. The inverter does not start the communication with other nodes, it only answers to the master controls. The physical medium uses a two-conductor twisted-pair cable (RS-485) allowing data transmission at baud rates between 9.6 kbits/s and 12 Mbits/s. The Figure 9.4 on page 9-3 shows an overview of a Profibus DP network.

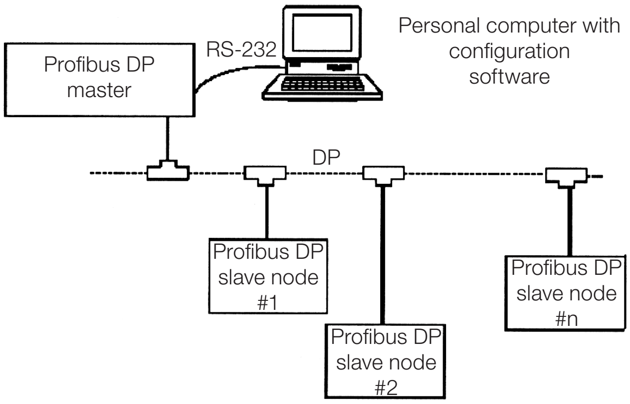


Figure 9.4: *Profibus DP network*

Fieldbus Type: Profibus DP EN 50170 (DIN 19245).

Physical Interface

- Transmission medium: Profibus busbar line, type A or B as specified in EN50170.
- Topology: Master-Slave communication.
- Insulation: the bus is fed by a DC/DC converter, which is galvanically isolated from the remaining electronics, and the signals A and B are isolated by means of optocouplers.
- It allows the connection/disconnection of a node without affecting the network.

Inverter user Fieldbus connector.

D-sub 9-pin female connector, pin assignment according to Table 9.1 on page 9-3.

Table 9.1: *Profibus DP DB9 pinout*

Pin	Name	Function
1	Not connected	-
2	Not connected	-
3	B-Line	RxD/TxD positive, according to the 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	RxD/TxD negative, according to the RS-485 specification
9	Not connected	-
Frame	Shield	Connected to the protective ground (PE)

Line Termination
The initial and the end points of the network must present the characteristic impedance, in order to prevent reflections. The DB9 cable male connector has the suitable termination resistor. When the inverter is the first or the last of the network, the termination resistor switch must be set to “ON”. Otherwise, leave the switch in the “OFF”position. The terminating switch of the Profibus DP board must be set to 1 (OFF).

Baudrate
The baud rate of a Profibus DP network is defined during the master configuration and only one rate is allowed in the same network. The Profibus DP board has automatic baud rate detection and the user does not need to configure it on the board. The supported baud rates are 9.6 kbits/s, 19.2 kbits/s, 45.45 kbits/s, 93.75 kbits/s, 187.5 kbits/s, 500 kbits/s, 1.5 Mbits/s, 3 Mbits/s, 6 Mbits/s and 12 Mbits/s.

Node Address
The node address is established by means of two rotating switches on the electronic Profibus DP board, allowing the addressing from 1 to 99. Looking at the board with the inverter in normal position, the leftmost switch sets the ten of the address, while the rightmost switch sets the units of the address:

Address = (leftmost rotary switch x 10) + (rightmost rotary switch x 1).

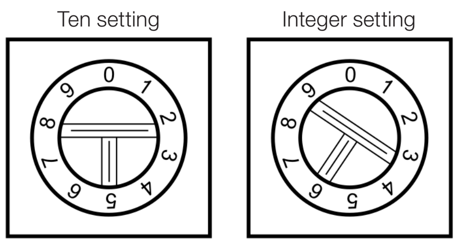


Figure 9.5: *Node address*

> **NOTE!**
> The node address must not be changed with the network in operation.

Configuration File (GSD File)
Each element of a Profibus DP network is associated to a GSD file that has all information about the element operation. This file is supplied together with the product and is used by the network configuration program.

Signaling
The electronic board has a bicolor LED indicating the status of the Fieldbus according to the Table 9.2 on page 9-4.

Table 9.2: *Fieldbus status LED signaling*

LED Color	Frequency	Status
Red	2 Hz	Fault during the test of the ASIC and Flash ROM
Green	2 Hz	Board has not been initialized
Green	1 Hz	Board has been initialized and is operating
Red	1 Hz	Fault during the RAM test
Red	4 Hz	Fault during the DPRAM test

> **NOTE!**
> The red signalizations may indicate hardware problems on the electronic board. Its reset is performed by cycling the power of the inverter. If the problem persists, replace the electronic board.

The board also has other four LEDs grouped at the right bottom corner, indicating the Fieldbus network status do Fieldbus according to Figure 9.6 on page 9-4 and Table 9.3 on page 9-5 below.

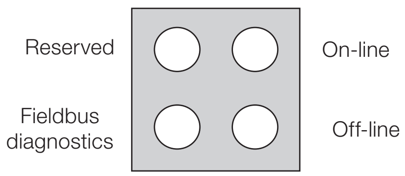


Figure 9.6: *LEDs indicating the status of the Profibus DP network*

Table 9.3: Profibus DP network status LEDs

LED	Color	Function
Fieldbus diagnostics	Red	It indicates the following faults on the Fieldbus side: Flashing 1 Hz - Configuration error: the IN/OUT area size set at board initialization is different from the size set during the network configuration. Flashing 2 Hz - Error in the user parameter data: the size/content of the user parameter data set at board initialization is different from the size/content set during the network configuration. Flashing 4 Hz - Profibus Communication ASIC initialization error. OFF - No present problems.
On-line	Green	Indicates that the board is on-line in Fieldbus network: ON - The board is on-line and the data exchange is possible. OFF - The board is not on-line.
Off-line	Red	Indicates that the board is off-line in Fieldbus network: ON - The board is off-line and the data exchange is not possible. OFF - The board is not off-line.

NOTE!
When power is applied to the drive and both on-line and off-line LEDs on the Profibus DP board flash alternately, then a network address configuration or an installation problem may be present.

- Check the installation and the network node address.
- Use of related Profibus DP/Parameters of the MVW3000. See Item 9.1.6 Fieldbus Application/ MVW3000 Related Parameters on page 9-7.

9.1.3 DeviceNet

The DeviceNet communication is used for industrial automation, mainly for the control of valves, sensors, input/ output units and automation equipment. The DeviceNet communication link is based on a communication protocol "broadcast oriented", the Controller Area Network (CAN). The physical medium of the DeviceNet network consists of a shielded cable comprising a twisted pair and two wires for the external power supply. The baud rate can be set to 125 kbits/s, 250 kbits/s or 500 kbits/s. Figure 9.7 on page 9-5 shows a general view of a DeviceNet network.

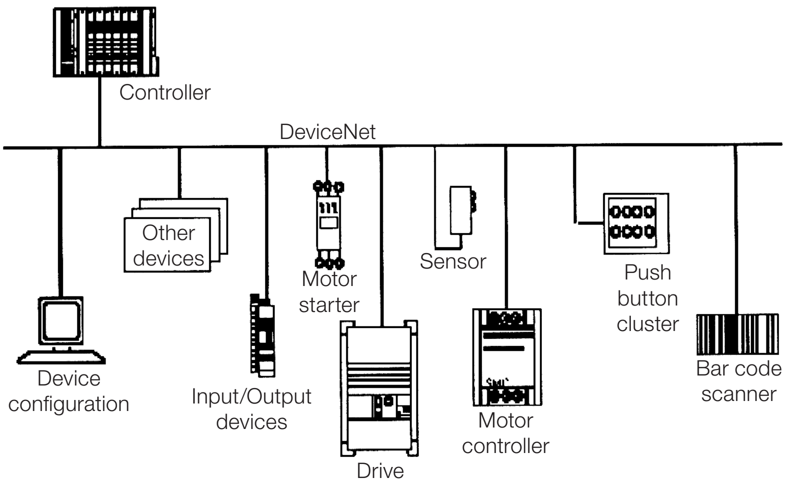


Figure 9.7: DeviceNet network

Inverter user Fieldbus connector.

5-way plug-in connector with screw terminal, pin assignment according to Table 9.4 on page 9-5.

Table 9.4: DeviceNet terminal block pinout

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

Line Termination
The initial and the end points of the network must present the characteristic impedance, in order to prevent reflections. Thus a 121 Ω/0.5 W resistor must be connected between the terminals 2 and 4 of the Fieldbus terminal block.

Baudrate/Node Address
There are three different baudrates for DeviceNet: 125 kbits/s, 250 kbits/s and 500 kbits/s. Choose the baudrate by setting the DIP switches on the electronic board, before the network configuration. The node address is selected through the six DIP switches on the electronic board, permitting addressing from 0 to 63.

Baudrate [bits/s]	DIP Switches 1 and 2
125 k	00
250 k	01
500 k	10
Reserved	11

Address	DIP3 to DIP8
0	000000
1	000001
2	000010
⋮	⋮
61	111101
62	111110
63	111111

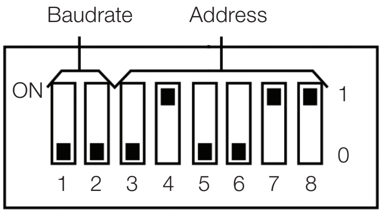


***Figure 9.8:** DeviceNet baudrate and node address configuration*

Configuration File (EDS File)
Each element of a DeviceNet network is associated to an EDS file, which has all information about the element. This file supplied with the product is used by the network configuration program.

By means of the parameter P0309 it is possible to select 2, 4 or 6 input/output words, when P0309 is programmed 4, 5 or 6, respectively (refer to the Item 9.1.6 Fieldbus Application/MVW3000 Related Parameters on page 9-7).

Define in the network configuration program the number of exchanged words, according to the number selected at the parameter P0309. The type of connection used for data exchange must be "Polled I/O".

NOTE!
The PLC (master) must be programmed for Polled I/O connection.

Signaling
The electronic board has a bicolor LED indicating the status of the Fieldbus according to the Table 9.2 on page 9-4.

NOTE!
The red signalizations may indicate hardware problems on the electronic board. Its reset is performed by cycling the power of the inverter. If the problem persists, replace the electronic board.

The board also has other four LEDs grouped at the right bottom corner, indicating the Fieldbus network status according to Figure 9.9 on page 9-6 and Table 9.5 on page 9-7 below.

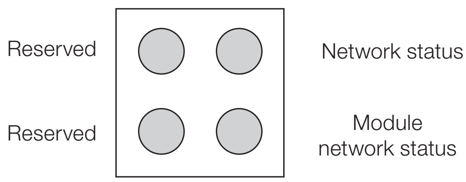


***Figure 9.9:** LEDs indicating the status of the DeviceNet network*

Table 9.5: DeviceNet network status LEDs

LED	Color	Description
Module Network Status	Off	Without supply
Module Network Status	Red	Nonrecoverable fault
Module Network Status	Green	Operational board
Module Network Status	Flashing red	Minor fault
Network Status	Off	Without supply/off-line
Network Status	Green	Operative link, connected
Network Status	Red	Link critical fault
Network Status	Flashing green	On-line, not connected
Network Status	Flashing red	Connection timeout

NOTE!
- Refer to the Item 9.1.6 Fieldbus Application/MVW3000 Related Parameters on page 9-7 for DeviceNet application/MVW3000 related parameters.
- The company HMS Industrial Networks AB has developed the communication board that comes with the product. Therefore, the network configuration software will not recognize the product as the MVW3000 frequency inverter, but as the "Anybus-S DeviceNet" at the "Communications Adapter" category. The differentiation will be done using the device network address, adjusted according to the Figure 9.9 on page 9-6 and the Table 9.5 on page 9-7.

9.1.4 DeviceNet Drive Profile

NOTE!
Refer to the DeviceNet Drive Profiles manual.

9.1.5 Ethernet

NOTE!
Refer to the Ethernet SSW-06 manual.

9.1.6 Fieldbus Application/MVW3000 Related Parameters

There are two main parameters: P0309 and P0313.

P0309 - defines the used Fieldbus protocol (Profibus DP or DeviceNet) and the number of variables (I/O) exchanged with the master (2, 4 or 6). The parameter P309 has the following options:

0 = Inactive.
1 = Profibus DP 2 I/O.
2 = Profibus DP 4 I/O.
3 = Profibus DP 6 I/O, (for Profibus DP).
4 = DeviceNet 2 I/O.
5 = DeviceNet 4 I/O.
6 = DeviceNet 6 I/O, (for DeviceNet).
7 = Modbus-RTU 2 I/O.
8 = Modbus-RTU 4 I/O.
9 = Modbus-RTU 6 I/O.
10 = Devicenet Drive Profile.
11 = Ethernet IP 2 I/O.
12 = Ethernet IP 4 I/O.
13 = Ethernet IP 6 I/O.

P0313 - defines the inverter behavior when the physical connection with the master is interrupted and/or the Fieldbus board is inactive (A0128, A0129 or A0130 indicated on the display).

The parameter P0313 has the following options:
0 = disables the inverter by using the Start/Stop controls via deceleration ramp.
1 = disables the inverter by using the General Enabling, motor coasting.
2 = the inverter status is not changed.
3 = the inverter goes to Local mode.

9.1.6.1 Variables Read From the Inverter

1. Inverter logical status.

2. Motor speed, for the option P0309 = 1 or 4 (2I/O) - read 1 and 2.

3. Digital input status (P0012).

4. Parameter contents, for the option P0309 = 2 or 5 (4I/O) - read 1, 2, 3 and 4.

5. Parameter contents, for the option (P0009).

6. Motor current (P0003), for the option P3009 = 3 or 6 (6I/O) - read 1, 2, 3, 4, 5 and 6.

1. Status word (EL):
The status word is composed by a total of 16 bits, 8 high order bits and 8 low order bits. It has the following construction:

High-order bits - they indicate the status of the associated function.
EL.15 - Active error: 0 = No, 1 = Yes.
EL.14 - PID Regulator: 0 = Manual, 1 = Automatic.
EL.13 - Undervoltage of the electronics power supplies: 0 = Without, 1 = With.
EL.12 - Local/Remote command: 0 = Local, 1 = Remote.
EL.11 - JOG command: 0 = Inactive, 1 = Active.
EL.10 - Forward/Reverse: 0 = Reverse, 1 = Forward.
EL.09 - General enabling: 0 = Disabled, 1 = Enabled.
EL.08 (*) - Start/Stop: 0 = Stop, 1 = Start.

(*) O EL.08 = 1, means the inverter received the Run/Stop command via networks. This EL is not intended to signal that the motor is effectively spinning.

Low-order bits -they indicate the error code number, i.e., 03, 07 or 87 (57h).

For further information on the faults and alarms, refer to the programming manual available for download on: **www.weg.net**.

2. Motor speed:
This variable is shown by using 13-bit resolution plus signal. Thus, the rated value will be equal to 8191 (1FFFh) (Forward) or -8191 (E001h) (Reverse) when the motor is running at synchronous speed (or base speed, for instance 1800 rpm for a IV-pole motor, 60 Hz).

3. Digital input status:
It presents the parameter P0012 contents, where 1 indicates an active input and 0 indicates an inactive input.

For further information on parameters, refer to the programming manual available for download on: **www.weg.net**.

The digital inputs of this WORD are distributed as follows:

Bit.7 - DI1 status.	Bit.2 - DI6 status.
Bit.6 - DI2 status.	Bit.1 - DI7 status.
Bit.5 - DI3 status.	Bit.0 - DI8 status.
Bit.4 - DI4 status.	Bit.8 - DI9 status.
Bit.3 - DI5 status.	Bit.9 - DI10 status.

4. Parameter contents:
This position allows reading the contents of inverter parameters, which are selected at the position 4 - Number of the parameters to be read - of the variables written in the inverter. The read values have the same order of magnitude of those described in the product manual or showed on the HMI.
The values are read without the decimal point, if that is the case.
Examples:
1. HMI displays 12.3, the Fieldbus reading will be 123.
2. HMI displays 0.246, the Fieldbus reading will be 246.

There are some parameters whose representation on the LED display can suppress the decimal position when the values are higher than 99.9. These parameters are P0100, P0101, P0102, P0103, P0156, P0157, P0158, P0169 (for P0202 < 3), P0290 and P0401.
Example: Indication on the LED display: 130.
Indication on the LCD : 130.0, Fieldbus reading is: 1300.
The reading of parameter P0006 via Fieldbus has the meaning presented in the detailed description of the parameters, refer to the programming manual available for download on: **www.weg.net**.

5. Torque current:
This position indicates P009 parameter contents, without the decimal point. A low pass filter with a time constant of 0.5 s filters this variable.

6. Motor current:
This position indicates P003 parameter contents, without the decimal point. A low pass filter with a time constant of 0.3 s filters this variable.

9.1.6.2 Variables Written in Inverter

The variables are written in the following order:
1. Control word.

2. Motor speed reference, for the option P309 = 1 or 4 (2I/O) - it writes in 1 and 2.

3. Status of the digital outputs.

4. Number of the parameters to be read, for the option P0309 = 2 or 5 (4I/O) - it writes in 1, 2, 3 and 4.

5. Number of the parameter to be changed.

6. Content of the parameter to be changed, selected in the previous position, for the option P0309 = 3 or 6 (6I/O) - it writes in 1, 2, 3, 4, 5 and 6.

1. Control word (C.L.):
The control word is composed by a total of 16 bits, 8 high order bits and 8 low order bits. It has the following construction:

High-order bits - they select the functions to be controlled, when the correspondent bits are set to 1.
CL.15 - Inverter fault reset.
CL.14 - Without function.
CL.13 - To save the changes of parameters P0169/P0170 in the EEPROM.
CL.12 - Local/Remote command.
CL.11 - Jog command.
CL.10 - Forward/Reverse.
CL.09 - General Enabling.
CL.08 - Start/Stop.

Low-order bits - they determine the activation of the functions selected in the high-order bits,
CL.7 - Inverter fault reset: every time it changes from 0 to 1 it causes an inverter reset, except for the errors (except A0124, A0125, A0126 and A0127);
CL.6 - No function.
CL.5 - To save P169/P170 in the EEPROM: 0 = to save, 1 = not to save.
CL.4 - Local/Remote command: 0 = Local, 1 = Remote.
CL.3 - Jog command: 0 = Inactive, 1 = Active.
CL.2 - Forward/Reverse: 0 = Reverse, 1 = Forward.
CL.1 - General enabling: 0 = Disabled, 1 = Enabled.
CL.0 - Start/Stop: 0 = Stop, 1 = Start.

> **NOTE!**
> - The inverter will only execute the command defined in the low-order bit if the correspondent high-order bit is set to 1 (one). If the high-order bit is set to 0 (zero), the inverter will disregard the value of the correspondent low-order bit.
> - CL.13: The function of saving parameter content changes in the EEPROM occurs normally when the HMI is used. The EEPROM allows a limited number of writings (100.000). In applications in which the speed regulator remains saturated and torque control is required, this control can be achieved by adjusting the torque limits P169/P170 (valid for P202 > 2). Therefore, if the network master keeps writing continuously in P169/P170, then the correspondent bits must be programmed in order to avoid that every change be saved in the EEPROM by setting: CL.13 = 1 and CL.5 = 1.

In order to enable the functions of the Control Word, it is necessary to set the inverter respective parameters with the option “Fieldbus”.

a) Local/Remote Selection Source - P0220.
b) Speed Reference - P0221 and/or P0222.
c) Forward/Reverse Selection - P0223 and/or P0226.
d) General Enabling, Start/Stop Selection - P0224 and/or P0227.
e) JOG Selection - P0225 and/or P0228.

2. Motor speed reference:
This variable is presented using a 13 bit resolution. Therefore, the speed reference value for the motor synchronous speed will be equal to 8191 (1FFFh).
This value must be used only as the base speed for the calculation of the desired speed (speed reference).

Examples:
1. 4-pole, 60 Hz motor, synchronous speed = 1800 rpm and speed reference = 650 rpm.

1800 rpm - 8191
650 rpm - X ⟶ X = 2958 = 0B8Eh

This value (0B8Eh) must be written in the second word, which represents the motor speed reference (according to the beginning of this item).
2. 6-pole, 60 Hz motor, synchronous speed = 1200 rpm and speed reference = 1000 rpm.
1200 rpm - 8191
1000 rpm - X ⟶ X = 4096 = 1AAAh

This value (1AAAh) must be written in the second word, which represents the motor speed reference (according to the beginning of this item).

> **NOTE!**
> Values above 8191 (1FFFh) are allowed when speed references above the motor synchronous speed are required, as long as the maximum programmed speed reference is respected.

3. Status of the digital outputs:
It allows controlling the status of the digital outputs that have been programmed for Fieldbus at the parameters P0275 to P0282. 16 bits, with the following construction, form the word that defines the status of the digital outputs:

High-order bits: they define the outputs to be controlled, when set in 1.
Bit.08: 1 - DO1 output control.
Bit.09: 1 - DO2 output control.
Bit.10: 1 - RL1 output control.
Bit.11: 1 - RL2 output control.
Bit.12: 1 - RL3 output control.

Low-order bits: they define the status of the controlled outputs.
Bit.0 - DO1 status: 0 = inactive output, 1 = active output.
Bit.1 - DO2 status: idem.

Bit.2 - RL1 status: idem.
Bit.3 - RL2 status: idem.
Bit.4 - RL3 status: idem.

4. Number of the parameters to be read:
Through this position, the reading of any inverter parameter can be defined. The number of the parameter to be read must be programmed here, and its contents will be presented at the position 4 of the variables read from the inverter.

5. Number of the parameter to be changed: (parameter contents modification).
This position operates together with the position 6, described next.
When no parameter has to be changed, then fill this position with the code 999.

Changing process sequence:

- Keep 999 in the position 5.

- Replace 999 by the number of the parameter to be changed.

- If no error code (124 to 127) is signalized in the Status Word, then replace the parameter number by 999, in order to conclude the modification.

The modification can be verified via the HMI or by reading the parameter contents.

NOTE!
1. The command to change from scalar to vector control will not be accepted if parameters P0409 to P0413 are set to zero. That should be done via HMI.
2. Do not program P0204 = 5, because in the factory default settings P0309 = Inactive.
3. P0204 and P0408 do not accept modification via network command.
4. The parameter contents must be kept by the master during 15.0 ms.
Send a new value or write in another parameter only after this time has elapsed.

6. Content of the parameter to be changed, selected at the position 5: (Number of the parameter to be changed)
The format of the values adjusted in this position must be the ones described in the manual. The values, however, must be written without the decimal point, if this is the case. When the parameters P409 to P413 are modified, small differences in the contents may occur when comparing the value sent via Fieldbus and the value read at the position 4. (Parameter contents) or at the HMI, because of the truncating during the reading process.

9.1.6.3 Error Indications

During the Fieldbus reading/writing process the following error indications may occur and be informed at the Status Word variable:

Status Word variable indications:
A0124 - An attempt to change a parameter that can be modified only with disabled inverter.
- Parameterization error.
A0125 - Caused by:
- Reading of non-existent parameter, or
- Writing on non-existent parameter, or
- Writing on P0408 and P0204.
A0126 - An attempt to write a value out of the permitted range.
A0127 - Caused by:
a) A function selected by the Control Word has not been programmed for Fieldbus, or
b) Command of a digital output that has not been programmed for Fieldbus, or
c) An attempt to write in a read-only parameter.

The indication of the listed errors will be removed from the Status Word when the indented action is sent correctly, except for A127 (**"b"** case), whose reset is performed writing in the Control Word.

Example: Assuming that no digital output has been programmed for Fieldbus, then if the word 11h is written in the position 3, the inverter will respond indicating A127 in the Status Word. To remove this indication from the Status Word it is necessary:

1. To write zero in the position 3 (because no DO has been programmed for Fieldbus).

2. To change the Control Word variable so that the A127 indication be removed from the Status Word.

The removal of the listed errors from the Status Word can also be achieved by writing the 999 code in the position 5 of the variables written in the inverter. Except for A127 (**"b"** and **"a"** cases), whose reset occurs only through the writing in the Control Word, as exemplified above..

NOTE!
The alarms A0124, A0125, A0126 and A0127 do not cause any change in the inverter operation status.

HMI Indications:
A0129 - Inactive Fieldbus onnection
This indication occurs when the physical connection from the inverter to the master is interrupted. The action that the inverter will take when A0129 is detected is programmed at P0313. The A0129 indication is removed from the display when the HMI key is pressed.
E30 - Inactive Fieldbus board.

This indication will appear when:

1. P0309 is programmed different from Inactive, without the existence of the respective board mounted on the MVC4 board XC140 connector, or

2. The Fieldbus board exists but it is defective, or

3. The board exists; however, the model programmed in P0309 does not match the used board model.
   The action that the inverter will take when A0130 is detected is programmed at P0313. The E30 indication is removed from the display when the HMI key is pressed.

9.1.6.4 MVW3000 Variable Addressing at the Fieldbus Devices

The variables are arranged in the Fieldbus device memory from 00h on, for both writing and reading. What deals with the address differences is the protocol itself, and the communication board. The manner the variables are arranged in each address of the Fieldbus device memory depends on the equipment that is being used as master. In an A PLC, for instance, the variables are arranged High and Low, whereas in a B PLC the variables are arranged Low and High.

9.2 WEGBUS SERIAL

The basic purpose of the serial communication is the physical connection of the inverters in an equipment network configured in the following form:

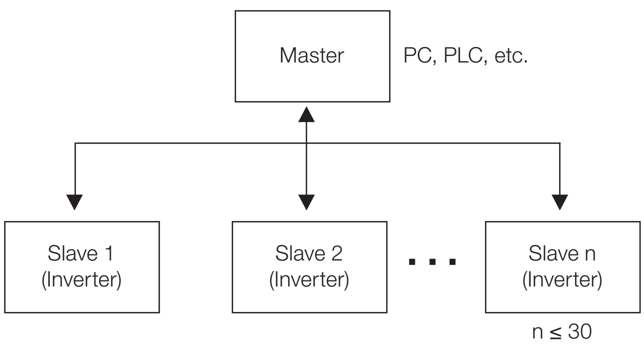


Figure 9.10: *Serial configuration*

The inverters have a software for the interface data transmission/reception control, to make it possible the receiving of data sent by the master as well as the transmission of data requested by it. The baudrate is 9600 bits/s, following an exchange protocol of the request/response type, using ASCII characters.

The master will have the means to do the following operations regarding each inverter:

IDENTIFICATION

- Network address.
- Inverter type (model).
- Software version.

COMMAND

- General Enabling/Disabling.
- Enable/Disable by ramp (Run/Stop).
- Speed direction.
- Speed reference.
- Local/Remote.
- JOG.
- Fault RESET.

STATUS ACKNOWLEDGMENT

- Ready.
- Sub.
- Run.
- Local/Remote.
- Fault.
- JOG.
- Speed direction.
- Setting mode after the reset to the factory default.
- Setting mode after changing from V/F mode to Vector mode.

PARAMETER READING

PARAMETER MODIFICATION

Typical examples of network use:

- PC (master) for parameterization of one or several inverters at the same time.
- SDCD monitoring inverter variables.

- PLC controlling the operation of an inverter in an industrial process.

Description of the Interfaces
The physical connection between the inverters and the network master is performed according to one of the standards below:
1. RS-232 (point-to-point, up to 10 m).
2. RS-485 (multipoint, galvanic isolation, up to 1000 m).

RS-485

This interface allows the connection of up to 30 inverters to a master (PC, PLC, etc.), attributing to each inverter an address (1 to 30) that must be set at each one. In addition to these 30 addresses, there are two other addresses available to perform special tasks:

Address 0: any inverter in the network is inquired, regardless of its address. Only one inverter must be connected to the network (point-to-point) in order to prevent short-circuits in the interface lines.

Address 31: um command can be transmitted simultaneously to all the inverters in the network, without acceptance acknowledgment.

List of the addresses and the correspondent ASCII characters:

Table 9.6: *ASCII characters*

ADDRESS (P0308)	ASCII		
	CHAR	DEC	HEX
0	@	64	40
1	A	65	41
2	B	66	42
3	C	67	43
4	D	68	44
5	E	69	45
6	F	70	46
7	G	71	47
8	H	72	48
9	I	73	49
10	J	74	4A
11	K	75	4B
12	L	76	4C
13	M	77	4D
14	N	78	4E
15	O	79	4F
16	P	80	50
17	Q	81	51
18	R	82	52
19	S	83	53
20	T	84	54
21	U	85	55
22	V	86	56
23	W	87	57
24	X	88	58
25	Y	89	59
26	Z	90	5A
27	]	91	5B
28	\	92	5C
29	[	93	5D
30	^	94	5E
31	_	95	5F

Other ASCII characters used by the protocol:

Table 9.7: ASCII characters used in protocol

ASCII		
CODE	**DEC**	**HEX**
0	48	30
1	49	31
2	50	32
3	51	33
4	52	34
5	53	35
6	54	36
7	55	37
8	56	38
9	57	39
=	61	3D
STX	02	02
ETX	03	03
EOT	04	04
ENQ	05	05
ACK	06	06
NAK	21	15

The connection between the network nodes is performed through a pair of wires. The signal levels are according to RS-485 EIA STANDARD, with differential receivers and transmitters. Expansion boards EBA.01, EBA.02 or EBB.01 (refer to Item 7.2.1 EBA (I/O Expansion Board A) on page 7-5 and the Item 7.2.2 EBB (I/O Expansion Board B) on page 7-9).

When the master does only have a RS-232 interface, then a RS232/RS485 converter must be used.

RS-232

With the RS-232 interface the connection of one master to one slave is possible (point-to-point). Data can be exchanged in a bidirectional way, but not simultaneously (HALF DUPLEX).

The logic levels follow the RS-232 EIA STANDARD, which determines the use of unbalanced signaling. In the present case, one wire is used for transmission (TX), other for reception (RX) and another for ground (0 V). This configuration is the minimal "3-wire" RS-232 connection (3-wire economy model).

Note: refer to the Item 9.2.4 RS-232 and RS-485 Physical Connection on page 9-23 which describes the physical connection.

9.2.1 Protocol Definitions

Used Terms

- Parameters: are those existent in the inverter, whose visualization or modification is possible through the HMI.
- Variables: are values with specific functions in the inverter and can be read and, in some cases, modified by the master.
- Basic Variables: Are those that can only be accessed through the serial communication.

Diagram:

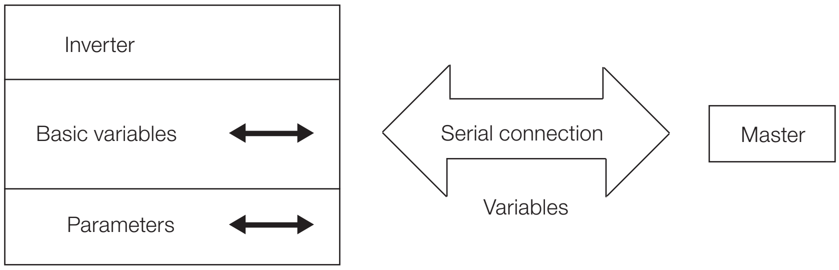


Figure 9.11: *Scheme of basic variables*

Parameter/Variable Resolutions

During parameter reading/writing their decimal points are disregarded in the values received/sent via telegrams, whereas the basic variables V04 (Serial Reference) and V08 (Motor Speed) that are standardized as 13 bit (0 to 8191).

Examples:

- Writing: If the purpose is to change the P0100 content to 10.0 s, 100 must be sent (disregarding the decimal point).

- Reading: If 1387 (disregarding the decimal point) is read from P0409, them its value is 1.387.

- Writing: in order to change V04 content to 900 rpm one must send:

$$V04 = \frac{900 \times 8191}{P0208} = 4096$$

Assuming that P0208 = 1800 rpm

- Reading: If 1242 is read from V08 the corresponding value is given by:

$$V08 = \frac{1242 \times P0208}{8191} = 273 \text{ rpm}$$

Assuming that P0208 = 1800 rpm

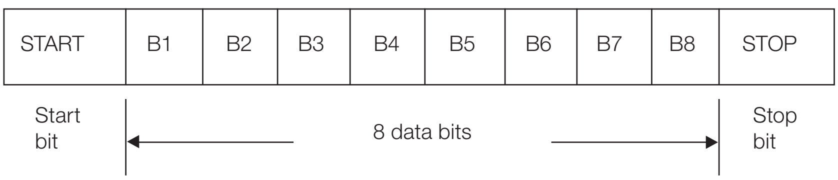
Character Format

- 1 start bit.

- 8 data bits (they codify text and transmission characters, taken from the 7-bit code, according to ISO 646 and complemented for even parity [eighth bit]).

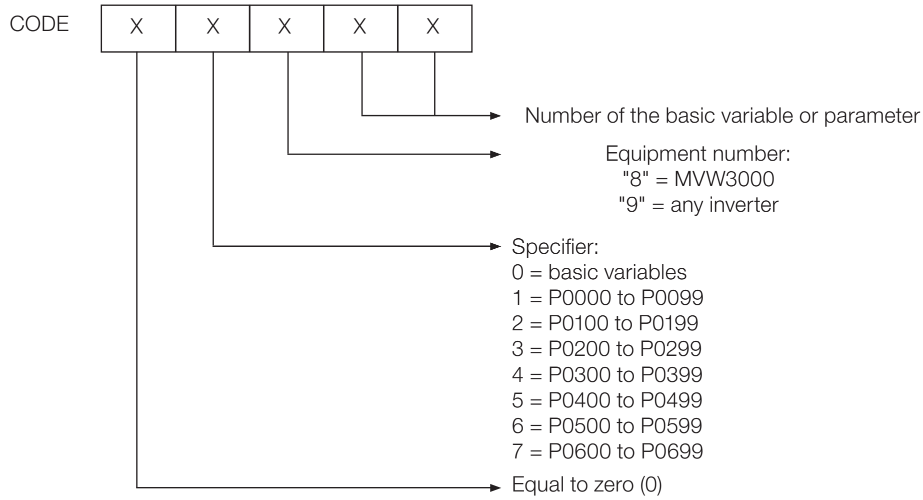
- 1 stop bit.

After the start bit goes the least significant bit:



9.2.2 Variable Code

V00 (code 00800):
Inverter model indication (reading variable).
The reading of this variable allows identifiying the inverter type. For the MVW3000, this value is 8, as follows:



V02 (code 00802):
Inverter status indication (reading variable).

- Status word (byte-high).
- Código de erros (byte-low).

Where:
Status Word:

EL15	EL14	EL13	EL12	EL11	EL10	EL9	EL8

- EL8: 0 = Enable by ramp (run/stop) inactive / 1 = Enable by ramp active.
- EL9: 0 = General enable inactive / 1 = General enable active.
- EL10: 0 = Reverse / 1 = Forward.
- EL11: 0 = JOG inactive / 1 = JOG active.
- EL12: 0 = Local / 1 = Remote.
- EL13: 0 = Without undervoltage / 1 = With undervoltage.
- EL14: 0 = Manual (PID) / 1 = Automatic (PID).
- EL15: 0 = Without fault / 1 = With fault.

Error code: error number in hexadecimal format.
Examples:
F0001 → 01h
F0087→ 57h

V03 (code 00803):
Selection of logical command.
Writing variable, whose bits have the following meaning:

High-order bits: desired action mask. In order that the action be possible, the correspondent bit must be set in 1.

CL15	CL14	CL13	CL12	CL11	CL10	CL9	CL8

MSB LSB

- CL8: 1 = Enable ramp (run/stop).
- CL9: 1 = General Enable.
- CL10: 1 = Forward/Reverse.
- CL11: 1 = JOG.
- CL12: 1 = Local/Remote.
- CL13: Not used.
- CL14: Not used.
- CL15: 1 = Inverter "RESET".

Low-order bit: logic level of the desired action.

CL7	CL6	CL5	CL4	CL3	CL2	CL1	CL0

MSB LSB

- CL0: 1 = Enable (run) / 0 = Disable by ramp (stop).
- CL1: 1 = Enable / 0 = General disable (stop by inertia).
- CL2: 1 = Forward / 0 = Reverse.
- CL3: 1 = JOG active / 0 = JOG inactive.
- CL4: 1 = Remote / 0 = Local.
- CL5: Not used.
- CL6: Not used.
- CL7: Transition from 0 to 1 in this bit "RESETS" the inverter in case it is in some fault condition.

NOTE!
- A disable command via digital input has higher priority than the Control Word enabling.
- In order to enable the inverter it is necessary that CL0 = CL1 = 1, and that there is no external disabling command.
- If CL0 and CL1 are set to 0 simultaneously, than general disable occurs.

V04 (code 00804):
Serial speed reference (reading/writing variable).
It allows sending the speed reference to the inverter, as long as P0221 = 9 for Local situation, or P0222 = 9 for Remote situation. This variable has a 13 bit resolution (refer to the Item 9.2.1 Protocol Definitions on page 9-15).

V06 (code 00806):
Status of the operation modes (reading variable).

EL2 7	EL2 6	EL2 5	EL2 4	EL2 3	EL2 2	EL2 1	EL2 0

MSB LSB

- EL2.0: 1 = during the Guided Start-up Routine after a reset to the factory default/first power-up.

- The inverter will enter this operation mode when it is powered-up for the first time or when the factory default parameters are loaded (P0204 = 5 or 6). In this mode only the parameters P0023, P0201, P0295, P0296, P0400, P0401, P0402, P0403 and P0406 will be accessible. If an attempt to access another parameter is done, the inverter will respond with A0125. In order to get more details, refer to the Item 6.3.1 Pre-power Checks on page 6-14.

- EL2.1: 1 = during the adjusting mode after changing from V/F to Vector Mode.

- The inverter will enter this operation mode when the control mode is changed from V/F (P0202 = 0, 1 or 2) to Vector (P0202 = 3 or 4). In this mode only the parameters P0023, P0201, P0295, P0296, P0400, P0401, P0402, P0403 and P0406 will be accessible. If an attempt to access another parameter is done, the inverter will respond with A0125.

- EL2.2: 1 = performing the self-tuning.

- EL2.3: not used.

- EL2.4: not used.

- EL2.5: not used.

- EL2.6: not used.

- EL2.7: not used.

V07 (code 00807):
Status of the operation modes (reading/writing variable).

CL2 7	CL2 6	CL2 5	CL2 4	CL2 3	CL2 2	CL2 1	CL2 0

MSB LSB

- CL2.0: 1 - it leaves the Guided Start-up Routine after a reset to the factory default.

- CL2.1: 1 - it leaves the adjusting mode after changing from V/F to Vector mode.

- CL2.2: 1 - it aborts the self-tuning.

- CL2.3: 1 - not used.

- CL2.4: 1 - not used.

- CL2.5: 1 - not used.

- CL2.6: 1 - not used.

- CL2.7: 1 - not used.

V08 (code 00808):
Motor Speed in 13 bit resolution (reading variable).
It allows reading the motor speed with a 13 bit resolution (refer to the Item 9.2.1 Protocol Definitions on page 9-15).

V09 (code 00809). Reading:
b0: 1 - reversing SG (Forward/Reverse).
b1: 1 - active alarm.
VB 12 (code 005012). Status of the Digital Outputs:
It allows controlling the status of the digital outputs that have been programmed for Serial at the parameters P0275 to P0280.

16 bits, with the following construction, form the word that defines the status of the digital outputs:

High-order bits: they define the outputs to be controlled, when set in 1.
Bit.08: 1 - DO1 output control.
Bit.09: 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.

Low-order bits: they define the status of the controlled outputs.
Bit.0: - DO1 status: 0 = inactive output, 1 = active output.
Bit.1: - DO2 status: 0 = inactive output, 1 = active output.
Bit.2: - RL1 status: 0 = inactive output, 1 = active output.
Bit.3: - RL2 status: 0 = inactive output, 1 = active output.
Bit.4: - RL3 status: 0 = inactive output, 1 = active output.
Bit.5: - RL4 status: 0 = inactive output, 1 = active output.
Bit.6: - RL5 status: 0 = inactive output, 1 = active output.

Parameters Related to the Serial Communication

Table 9.8: *Parameters Related to the Serial Communication*

Parameter Nr.	Parameter Description
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	JOG Selection - Local Situation
P0226	Forward/Reverse Selection - Remote Situation
P0227	Start/Stop Selection - Remote Situation
P0228	JOG Selection - Remote Situation
P0308	Inverter address in the serial communication network (range from: 1 to 30)

For further details on the parameters above, refer to the programming manual available for download on: **www.weg.net**.

Errors Related to the Serial Communication

They operate in the following way:

- The do not disable the inverter.
- They do not commutate fault relays.
- They are reported in the Status Word (V02).

Type of errors:

- A0122: erro de paridade longitudinal (BCC).
- A0124: parameterization error (occurrence of some of the situations indicated in the Table 9.9 on page 9-21 or when there is an attempt to change a parameter that cannot be changed with a rotating motor).
- A0125: nonexistent variable or parameter.
- A0126: value out of the range.
- A0127: an attempt to write in a read-only variable or a disabled control word command.

Table 9.9: Incompatibility between parameters - F0083

1	Two or more parameters among P0264, P0265, P0266, P0267, P0268, P0296 and P0270 equal to (LOC/REM).
2	Two or more parameters among P0265, P0266, P0267, P0268, P0269 and P0270 equal to 6 (ramp 2).
3	P0265 equal to 8 and P0266 different from 8 or vice-versa (Forward Run / Reverse Run).
4	P0221 or P0222 equal to 8 (Multispeed) and P0266 ≠ 7 and P0267 ≠ 7 and P0268 ≠ 7.
5	[P0221 = 7 and P0222 = 7] and [(P0265 ≠ 5 or P0267 ≠ 5) or (P0266 ≠ 5 or P0268 ≠ 5)] (with reference = E.P. and without DIx = Accelerate E.P. or without DIx = Decelerate E.P.).
6	[P0221 ≠ 7 or P0222 ≠ 7] and [(P0265 = 5 and P0267 = 5 or P0266 = 5 and P0268 = 5)] (without reference = E.P. and with DIx = Accelerate E.P. or with DIx = Decelerate E.P.).
7	P0265 or P0267 or P0269 equal to 14 and P0266 and P0268 and P0270 different from 14 (with DIx = Start, without DIx = Stop).
8	P0266 or P0268 or P0270 equal to 14 and P0265 and P0267 and P0269 different from 14 (without Start, with Stop).
9	P220 > 1 and P0224 = P0227 = 1 and without DIx = Start/Stop or DIx = Fast Stop and without DIx = General Enable.
10	P0220 = 0 and P0224 = 1 and without DIx = Start/Stop or Fast Stop and without DIx = General Enable.
11	P0220 = 1 and P0227 = 1 and without DIx = Start/Stop or Fast Stop and without DIx = General Enable.
12	DIx = Start and DIx = Stop, however P0224 ≠ 1 and P0227 ≠ 1.
13	Two or more parameters among P0265, P0266, P0267, P0268, P0269 and P0270 equal to 15 (Man/Aut).
14	Two or more parameters among P0265, P0266, P0267, P0268, P0269 and P0270 equal to 17 (Disables Flying Start).
15	Two or more parameters among P0265, P0266, P0267, P0268, P0269 and P0270 equal to 18 (DC Link Regulator).
16	P0264 = 1 (DI2 = LOC/REM) and P0226 = 4 (Selection of Fwd / Rev, Remote Situation by DI2).

NOTE!
- If in the inverter data reception a parity error is detected, then the telegram is ignored. The same will happen in cases of syntax errors.
- Examples.
- Code values different from the numbers 0 to 9.
- Separation character different from " = ", etc.

9.2.3 MVW3000 Special Parameters

In general, the parameters of an inverter store their information in 16-bit words. To know the contents of one of these parameters through a communication network (serial, fieldbus, etc.), the number of the parameter must be informed (according to the used protocol) and a 16-bit information will be received as the answer, because there is only one information word associated for each parameter.

Some of the MVW3000 parameters have more than one word of associated information, so that the access to these parameters is done in a special manner. These parameters are:

- Parameters of the last errors: 3 words per parameter.
- Date and time: P0080, P0081 - 2 words per parameter.
- Error log: P0067 - 300 words.
- Trace function data: P0555, P0557, P0559, P0561, P0563, P0565, P0567, P0569 – up to 31080 words per parameter.

To gain access to the contents of these special parameters, successive readings must be performed until all the words associated to that parameter have been obtained (the readings must be done normally, according to the specified protocol), remembering that in each reading the access to only one word (16 bits) is obtained.

NOTE!
While reading special parameters, this reading should be done in an uninterrupted form, reading the same parameter repeated times without reading any other parameter in between until all the readings of the special parameter associated words have been accomplished. If another parameter is read before the conclusion of the reading of all the words, then when it is read again it sends the first associated word again.

Parameters of the Last Errors

The registers with the information of the last ten errors (register 14, ..., 17, 60, ..., 65) have three words associated to each of them.

The first read word brings the information of the occurred error number and of the inverter status at the moment it occurred. The information is distributed among the word bits in the following way:

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Status					Error number										

The second and the third words bring the information of the date/time when the error happened. The date/time information has 32 bits and two words are necessary to represent it. In order to decode the date/time information, refer to the Item 9.2.1 Protocol Definitions on page 9-15.

For instance, in order to obtain the information of the last error (registrador 14 = read P0014 three consecutive times.

Date and Time Parameters.
The MVW3000 inverter has a real time clock with the purpose of recording date and time of events as, for instance, the occurred errors. Date and time can be adjusted through the parameters P0080 and P0081, respectively.

NOTE!
Date and time can only be modified through the local HMI.

Despite having two parameters related with the date and hour, the information is stored in a single 32-bit variable. Thus, to obtain the inverter date and time information, two readings of P0080 are necessary, since the information is stored in 32 bits, i.e., in two words.

In the first reading the inverter sends the most significant word (bits 16 to 31) and in the second reading the less significant word (bits 0 to 15).

Those 32 bits of information contain the counting of the seconds elapsed since 00:00 a.m. of January 1st, 1970. A Julian codifying routine must be used to determine the date and the hour correspondent the this counting.

Error Log Parameter.
The parameter P0067 has the information of the 100 last inverter errors. Since each error has 3 words (48 bits) of associated information, this parameter has 300 words.

Therefore, the first three readings of P067 supply the information of the last error, the three following readings of the next one, and so on until 300 readings are done. For information on the words related to an error, refer to the Item 9.2.1 Protocol Definitions on page 9-15.

Trace Function Data Parameters.
The trace function stores an enormous amount of information in each of its channels. To get access to this data, it is necessary to read the parameter related to the wanted channel (P0555, P0557, P0559, P0561, P0563, P0565, P0567, P0569).

When the first reading of a certain channel parameter is done, it responds with the number of the corresponding parameter programmed for trace.

Starting from the second reading on (in sequence), the information recorded by the trace function is sent.
In order to know how many words are associated to each channel, refer to the Section 8.1 LOAD SHARE FUNCTION “MASTER/SLAVE” on page 8-1.

Times for Telegram Reading/Writing.

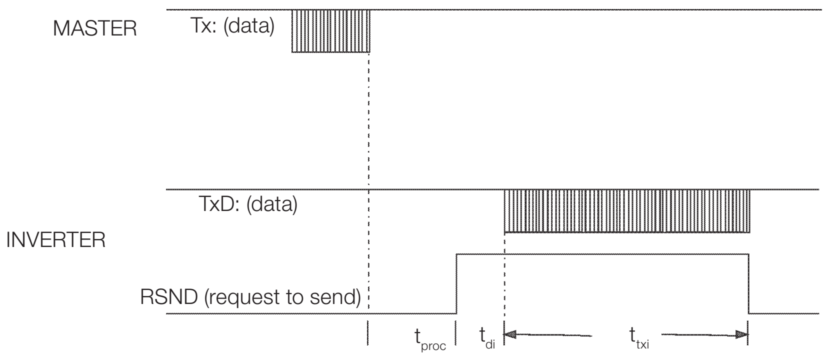


***Figure 9.12:** Time of the telegrams exchanged between Master and Inverter*

***Table 9.10:** Reading and writing time*

Time		Typical (ms)
T_{proc}		10
T_{di}		5
T_{txi}	Reading	15
	Writing	3

9.2.4 RS-232 and RS-485 Physical Connection

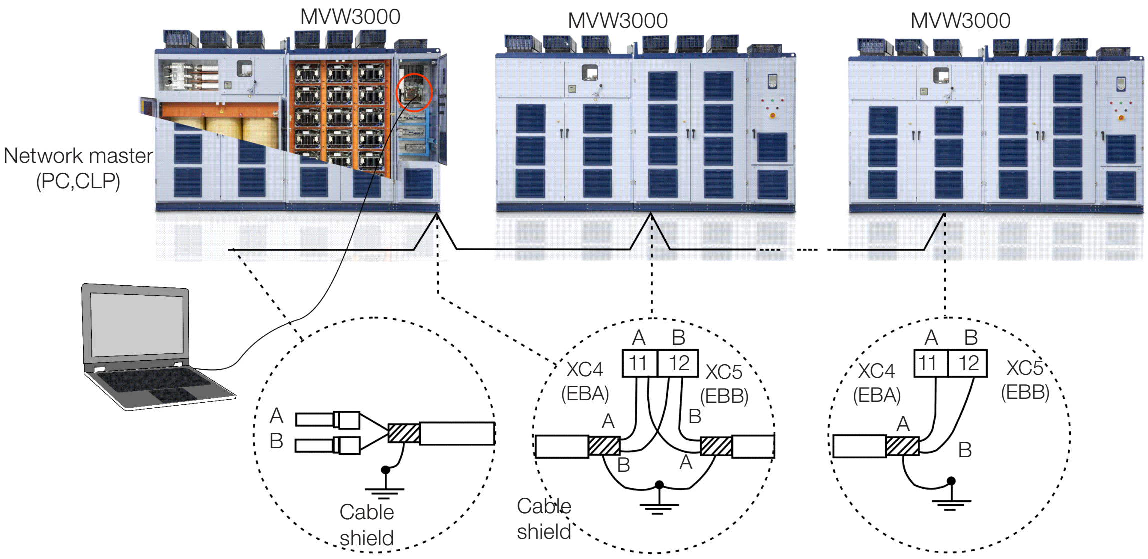


***Figure 9.13:** Connection Scheme*

Notes:

- LINE TERMINATION: add a line termination (120 Ω) at the ends, and only at the ends, of the line. Therefore, set S3.1/S3.2 (EBA) and S7.1/S7.2 (EBB) in the on position (refer to the Item 7.2.1 EBA (I/O Expansion Board A) on page 7-5 and Item 7.2.2 EBB (I/O Expansion Board B) on page 7-9).
- CABLE SHIELD GROUNDING: connect them to the equipment frames (properly grounded).
- RECOMMENDED CABLE: balanced pair, shielded.
- E.g., AFS Line, manufacturer KMP.
- The RS-485 network wiring must be separated from power cables and 110/220 V command.

- The reference signal for the RS-485 interface (SREF) should be used if the master of the network is not referenced to the ground used in the installation. For instance, in case the master is fed by an isolated power supply, it is necessary to ground that power supply reference, or take this reference signal to the rest of the system. Normally, it is only necessary to connect the A (-) and B (+) signals, without the connection of the SREF signal.

RS-232 Serial Interface Module.
The MVW3000 serial interface connection is available at the MVC4 board XC7 connector (refer to the physical position in Figure 7.1 on page 7-1).

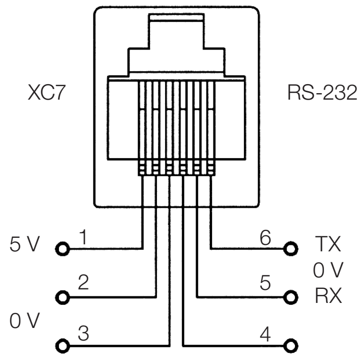


Figure 9.14: *XC7 (RJ12) connector signal description*

NOTE!
- The RS-232 wiring must be separated from power cables and 110/220 V command.
- It is not possible to use RS-232 and RS-485 simultaneously.

9.3 MODBUS-RTU

9.3.1 Introduction to the Modbus-RTU Protocol

The Modbus protocol was initially developed in 1979. Nowadays it is an open protocol, widely spread and used by many manufacturers in several equipments. The MVW3000 Modbus-RTU communication was developed based in 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 the messages used by the elements that compose the Modbus network, the services (or functions) that can be made available through the network, and how these elements exchange date in the network.

9.3.1.1 Transmission Modes

Two transmission modes are defined in the protocol specification: ASCII and RTU. The modes define how the bytes of the message are transmitted. It is not possible to use both transmission modes in the same network.

In the RTU mode each transmitted package has 1 start bit, eight data bits, 1 parity bit (optional) and 1 stop bit (2 stop bits if the parity bit is not used). Therefore, the bit sequence for the transmission of one byte is the following:

Start	B0	B1	B2	B3	B4	B5	B6	B7	Parity or Stop	Stop

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

9.3.1.2 RTU Mode Message Structure

The Modbus-RTU network operates in the master-slave system, where up to 247 slaves may exist, but with just one master. Every communication begins with the master doing a request to a slave, and then the slave responds to the master what had been requested. In both telegrams (request and response), the used structure is the same: address, function code, data and CRC. Only the data field may have a changeable size, depending on what is being requested.

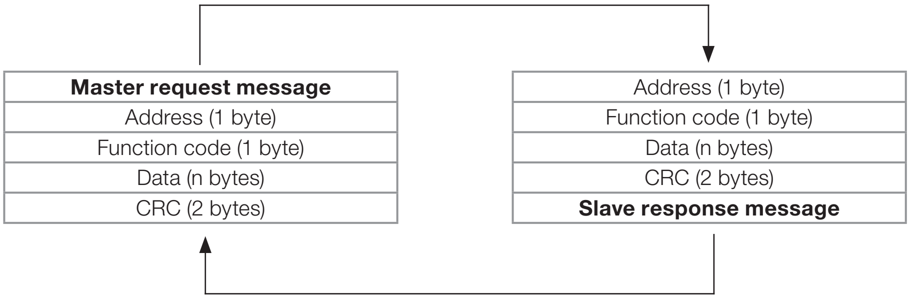


Figure 9.15: *Telegram structure*

Address:
The master initiates the communication by sending one byte with the address of the slave to which the message is destined.

By sending the response, the slave also initiates the message with its own address. The master can also send a message destined to address 0 (zero), which means that the message is intended to all network slaves (broadcast). In this case, no slave will answer to the master.

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

In the MVW3000 all data are available as holding type registers (referenced from the address 40000 or '4x'). Besides these registers, the inverter status (enabled/disabled, with or without error, etc.) and the command for the inverter (Start/Stop, Forward/Reverse, etc.) can be also accessed through the coil read/write functions, or the internal bits (referenced from the address 00000 or '0x' on).

Data Field:
This field has a variable length. The format and the content of this field depend on the used function and the transmitted values. This field is described together with the functions (refer to the Item 9.3.3 Detailed Description of the Functions on page 9-30).

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

CRC calculation is started by loading a 16-bit variable (mentioned from now on as CRC variable) with FFFFh value. The next steps are executed according to the following routine:

1. The first message byte (Only the data bits. Start bit, parity bit and stop bit are not used) is submitted to an XOR logic (exclusive OR) with the 8 least significant bits of the CRC variable, returning the result to the CRC variable.

2. Then the CRC variable is shifted one position to the right, in the direction of the least significant bit and the position of the most significant bit is filled with 0 (zero).

3. After this shift, the flag bit (bit that has been shifted out the CRC variable) is analyzed, resulting in the following:

- If the bit value is 0 (zero), no change is made.
- If the bit value is 1, the CRC variable content is submitted to XOR logic with a constant value A001h, and the

result is returned to the CRC variable.

4. Repeat steps 2 and 3 until eight shifts have been done.

5. Repeat the steps 1 to 4, by using the next message byte until the whole message have been processed.

The final content of the CRC variable is the CRC field value that is transmitted at the end of the message. The least significant part is transmitted first (CRC-), and then the most significant part (CRC+) is transmitted.

Time between Messages:

In the RTU mode, there is no specific character indicating the beginning or the end of a telegram. Therefore, what indicates when a new message starts or when it finishes is the absence of data transmission in the network, during a minimum period of 3.5 times the transmission time of a data word (11 bits). Therefore, if a telegram has initiated after the minimum time without transmission has elapsed, the network elements will assume that the received character represent the beginning of a new telegram. And in the same way, the network elements will assume that the telegram has reached the end after lapsing this time elapses again.

If during the transmission of a telegram, the time between bytes is greater than this minimum time, the telegram will be considered invalid, because the inverter is going to discard the already received bytes and it will assemble a new telegram with the bytes that are being transmitted.

Table 9.11 on page 9-26 presents the times for three different communication rates.

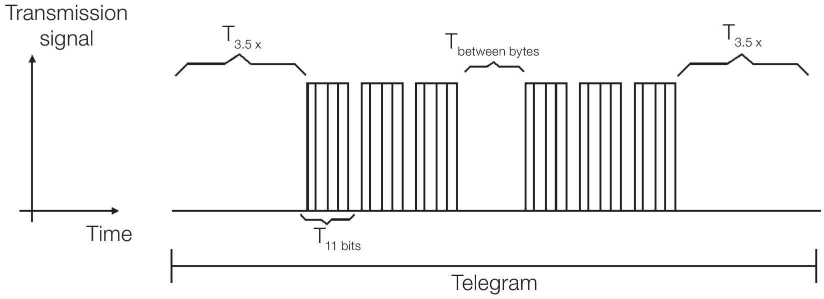


Figure 9.16: *Time between bytes in a telegram transmission*

Table 9.11: *Telegram transmission time*

Baudrate	$T_{11\ bits}$	$T_{3,5x}$
9600 kbits/sec	1.146 ms	4.010 ms
19200 kbits/sec	573 µs	2.005 ms
38400 kbits/sec	285 µs	1.003 ms

T 11 bits = time to transmit one word of the message.
T between bytes = time between bytes (cannot be longer than T 3.5x).
T 3.5x = minimum interval indicating the begin and the end of the message (3.5 x T 11bits).

9.3.2 Operation of the MVW3000 in the Modbus-RTU Network

The MVW3000 frequency inverters operate as Modbus-RTU network slaves, and all the communication initiates with the Modbus-RTU network master requesting some service to a network address.

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

RS-232 and RS-485 Interface Description:

The MVW3000 frequency inverters use a serial interface to communicate with the Modbus-RTU network. There are two possibilities for the physical connection between the network master and an MVW3000:
RS-232:

- The interface is used for a point-to-point connection (between a single slave and the master).

- Maximum distance: 10 meters.
- Signal levels according to EIA PADRÃO RS-232C.
- Three wires: transmission (TX), reception (RX) and return (0 V).

RS-485:

- This interface is used for multipoint connection (several slaves and the master).
- Maximum distance: 1000 meters (using shielded cables).
- Signal levels according to EIA PADRÃO RS-485.
- The EBA or the EBB expansion board, which have interface for the RS-485 communication, must be used.

Note: refer to the Item 9.2.4 RS-232 and RS-485 Physical Connection on page 9-23 which describes how to make the physical connection.

Inverter Configurations in the Modbus-RTU Network
In order that the inverter be able to communicate properly in the network, besides the physical connection, it is necessary to configure the inverter address, as well as the baudrate and the type of existent parity.

Inverter address in the Network:
It is defined through the parameter 308.

- If the type of serial communication (P0312) is configured for Modbus-RTU, it is possible to select addresses from 1 to 247.
- Each slave in the network must have an address different from the others.
- The network master does not have an address.
- It is necessary to know the address of the slave even when the connection is point-to-point.

Baudrate and Parity:

- Both configurations are defined through the parameter P0312.
- Baudrates: 9600, 19200 or 38400 kbits/seg.
- Parity: None, Odd Parity or Even Parity
- All slaves, and also the network master, must use the same baudrate and parity.

Access to the Inverter Data:

Through the network, it is possible to access all the parameters and basic variables available for the MVW3000:

- Parameters: they are those existing in the inverters, whose visualization and modification is possible through the Human-Machine Interface (HMI) (refer to the Parameter Quick Reference).
- Basic Variables: they are internal inverter variables, and they can only be accessed via serial communication. It is possible through the basic variables, for instance, to change the speed reference, read the status, enable or disable the inverter, etc. (refer to the Item 9.2.2 Variable Code on page 9-17).
- Register: name used to represent either parameters or the basic variables during the data transmission.
- Internal Bits: they are bits accessed only by the serial, used for the inverter command and status monitoring.

The Item 9.2.1 Protocol Definitions on page 9-15 defines the parameter and variable resolutions when transmitted via serial. Available functions and response times:

In the Modbus-RTU protocol specification it is defined the functions used to access the type of registers described in the specification. In the MVW3000, parameters and basic variables were defined as being holding type registers (referenced as 4x). Besides these registers, it is also possible to access directly internal command and monitoring bits (referenced as 0x). To access these bits and registers, the next services (or functions) for the MVW3000 frequency inverters were made available:

Read Coils
Description: reading of internal bit blocks or coils.

Function code: 01.
Broadcast: not supported.
Response time: 5 to 10 ms.

Read Holding Registers
Description: reading of register blocks of the holding type.
Function code: 03.
Broadcast: not supported.
Response time: 5 to 10 ms.

Write Single Coil
Description: writing in a single internal bit or coil.
Function code: 05.
Broadcast: supported.
Response time: 5 to 10 ms.

Write Single Register
Description: writing in a single register of the holding type.
Function code: 06.
Broadcast: supported.
Response time: 5 to 10 ms.

Write Multiple Coils
Description: writing in internal bit blocks or coils.
Function code: 15.
Broadcast: supported.
Response time: 5 to 10 ms.

Write Multiple Registers
Description: writing in register blocks of holding type.
Function code: 16.
Broadcast: supported.
Response time: 10 to 20 ms for each written register.

Read Device Identification
Read Device Identification.
Function code: 43.
Broadcast: not supported.
Response time: 5 to 10 ms.

Note: Modbus-RTU network slaves are addressed from 1 to 247. The master uses the address 0 to send messages that are destined to all slaves (broadcast).
Data Addressing and Offset:

The data addressing in the MVW3000 is done with offset equal to zero, meaning that the number of the address is equal to the given number. The parameters are made available starting from the address 0 (zero), while the basic variables are made available starting from the address 5000. In the same way, the status bits are made available starting from the address 0 (zero) and the command bytes are made available beginning from the address 100.

Table 9.12 on page 9-29 shows the bit, parameter and basic variable address:

Table 9.12: *Bit, parameter and basic variable address*

Parameters		
Parameter Number	**Modbus Address**	
	Decimal	**Hexadecimal**
P0000	0	00h
P0001	1	01h
⋮	⋮	⋮
P0100	100	64h
⋮	⋮	⋮

Basic Variables		
Variable Number	**Modbus Address**	
	Decimal	**Hexadecimal**
V00	5000	1388h
V01	5001	1389h
⋮	⋮	⋮
V08	5008	1390h

Status Bits		
Bit Number	**Modbus Address**	
	Decimal	**Hexadecimal**
Bit 0	00	00h
Bit 1	01	01h
⋮	⋮	⋮
Bit 7	07	07h

Command Bits		
Bit Number	**Modbus Address**	
	Decimal	**Hexadecimal**
Bit 100	100	64h
Bit 101	101	65h
⋮	⋮	⋮
Bit 107	107	6Bh

Note: all the registers (parameters and basic variables) are treated as holding type registers, referenced starting from 40000 or 4x, while the bits are referenced starting from 0000 or 0x.

The status bits have the same functions of the bits 8 to 15 of the Status (basic variable 2). These bits are available just for reading, and any writing command returns an error to the master.

Table 9.13: *Status Bit*

Status Bit	
Bit Number	**Function**
Bit 0	0 = Enable by ramp inactive 1 = Enable by ramp active
Bit 1	0 = General Enable inactive 1 = General Enable active
Bit 2	0 = Direction of rotation reverse 1 = Direction of rotation forward
Bit 3	0 = JOG inactive 1 = JOG active
Bit 4	0 = Local 1 = Remote
Bit 5	0 = No undervoltage 1 = Undervoltage
Bit 6	No function
Bit 7	0 = Without fault 1 = With fault

The command bits are available for reading and writing, and have the same function of the bits 0 to 7 of the Control Word (basic variable 3), without the necessity, however, of the mask use. Writing in the basic variable 3 has influence in the state of these bits.

Table 9.14: *Command Bits*

Command Bit	
Bit Number	**Function**
Bit 100	0 = Disable ramp (Stop) 1 = Enable ramp (Run)
Bit 101	0 = General Disable 1 = General Enable
Bit 102	0 = Direction of rotation reverse 1 = Direction of rotation forward
Bit 103	0 = Deactivates JOG 1 = Activates JOG
Bit 104	0 = Go to Local mode 1 = Go to Remote mode
Bit 105	No function
Bit 106	No function
Bit 107	0 = Does not reset the inverter 1 = Resets the inverter

9.3.3 Detailed Description of the Functions

This item presents a detailed description of functions available at the MVW3000 for Modbus-RTU communication. In order to elaborate the telegrams, it is important to observe the following:

- The values are always transmitted in hexadecimal format.
- The address of one piece of data, the number of data and the value of the 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 form to represent a bit depends on the used function.
- Both the request and response telegrams, cannot be longer than 128 bytes.
- The resolution of each parameter or basic variable is as described in the Item 9.2.1 Protocol Definitions on page 9-15.

9.3.3.1 Function 01 - Read Coils

It reads the contents of a group of internal bits that must necessarily be in a numerical sequence. This function has the following structure for the request and response telegrams (the values are always hexadecimal, and each field represents one byte:

Table 9.15: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Address of the initial bit (byte high)	Field Byte Count (number of data bytes)
Address of the initial bit (byte low)	Byte 1
Number of bits (byte high)	Byte 2
Number of bits (byte low)	Byte 3
CRC-	etc a
CRC+	CRC-
-	CRC+

Each response bit is placed at a position of the data bytes sent by the slave. The first byte, from the bits 0 to 7, receives the first 8 bits from the initial address indicated by the master. The other bytes (if the number of the read bits is greater than 8) remain in the same sequence. If the number of the read bits is not a multiple of 8, the remaining bits of the last byte must be filled with 0 (zero).

Example: reading the status bits for general enable (bit 1) and Forward/Reverse (bit 2) of then MVW3000 at the address 1:

Table 9.16: *Example of telegram structure*

Request (Master)		Response (Slave)	
Field	**Value**	**Field**	**Value**
Slave address	01h	Slave address	01h
Function	01h	Function	01h
Initial byte address (byte high)	00h	Byte Count	01h
Initial byte address (byte low)	01h	Status of bits 1 and 2	02h
Number of bits (byte high)	00h	CRC-	D0h
Number of bits (byte low)	02h	CRC+	49h
CRC-	ECh	-	-
CRC+	0Bh	-	-

As the number of read bits in the example is smaller than 8, the slave required only 1 byte for the response. The value of the byte was 02h, which as binary value will have the form 0000 0010. As the number of read bits is equal to 2, only the two less significant bits, that have the value 0 (General Enable inactive) and 1 (Forward) are of interest. The other bits, as they had not been requested, are filled out with 0 (zero).

9.3.3.2 Function 03 - Read Holding Register

It reads the contents of a group registers that must necessarily be in a numerical sequence. This function has the following structure for the request and response telegrams (the values are always hexadecimal, and each field represents one byte):

Table 9.17: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Address of the initial register (byte high)	Campo Byte Count
Address of the initial register (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+	etc
-	CRC-
-	CRC+

Example: reading of the motor speed (P0002) and motor current (P0003) from the MVW3000 at the address 1:

Table 9.18: *Example of telegram structure*

Request (Master)		Response (Slave)	
Field	**Value**	**Field**	**Value**
Slave address	01h	Slave address	01h
Function	03h	Function	03h
Initial register (byte high)	00h	Byte Count	04h
Initial register (byte low)	02h	P0002 (high)	05h
Number of registers (byte high)	00h	P0002 (low)	84h
Number of registers (byte low)	02h	P0003 (high)	00h
CRC-	65h	P0003 (low)	35h
CRC+	CBh	CRC-	7Ah
-	-	CRC+	49h

Each register is always formed by two bytes (high and low). For the example, we have P002 = 0384h, that in decimal number is equal to 900. As this parameter does not have a decimal place, the actual read value is 900 rpm.

In the same way we will have a motor current value at P0003 = 0035h, which corresponds to 53 decimal. As the current has one decimal digit resolution, the read value is 5.3 A.

9.3.3.3 Function 05 - Write Single Coil

This function is used to write a value to a single bit. The bit value is represented by using two bytes, where FF00h represents the bit that is equal to 1, and 0000h represents the bit that is equal to 0 (zero). It has the following structure (the values are always hexadecimal, and each field represents one byte):

Table 9.19: *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 (byte high)
Bit value (byte low)	Bit value (byte low)
CRC-	CRC-
CRC+	CRC+

Example: to activate the start command (bit 100 = 1) of an MVW3000 at the address 1:

Table 9.20: *Example of telegram structure*

Request (Master)		Response (Slave)	
Field	Value	Field	Value
Slave address	01h	Slave address	01h
Function	05h	Function	01h
Bit number (byte high)	00h	Bit number (byte high)	01h
Bit number (byte low)	64h	Bit number (byte low)	02h
Bit value (byte high)	FFh	Bit value (byte high)	D0h
Bit value (byte low)	00h	Bit value (byte low)	49h
CRC-	CDh	CRC-	CDh
CRC+	E5h	CRC+	E5h

For this function, the slave response is an identical copy of the request sent by the master.

9.3.3.4 Function 06 - Write Single Register

This function is used to write a value to a single register. This function has the following structure (values are always hexadecimal values, and each field represents one byte):

Table 9.21: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Register address (byte high)	Register address (byte high)
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: Writing a speed reference (basic variable 4) equal to 900 rpm, to an MVW3000 at the address 1.

It is useful to remember that the value for the basic variable 4 depends on the used motor type and that the value 8191 is equal to the rated motor speed. In this case, we suppose that the used motor has a rated speed of 1800 rpm, thus the value to be written into the basic variable 4 for a speed of 900 rpm is half of 8191, i.e., 4096 (1000h).

Table 9.22: Example of telegram structure

Request (Master)		Response (Slave)	
Field	Value	Field	Value
Slave address	01h	Slave address	01h
Function	06h	Function	06h
Register (byte high)	13h	Register (byte high)	13h
Register (byte low)	8Ch	Register (byte low)	8Ch
Value (byte high)	10h	Value (byte high)	10h
Value (byte low)	00h	Value (byte low)	00h
CRC-	41h	CRC-	41h
CRC+	65h	CRC+	65h

For this function, the slave response will be again a copy identical to the request made by the master. As already informed above, the basic variables are addressed from 5000, thus the basic variable 4 will be addressed at 5004 (138Ch).

9.3.3.5 Function 15 - Write Multiple Coils

This function allows writing values for a group of bits that must be in numerical sequence. This function can also be used to write a single bit (the values are always hexadecimal, and each field represents one byte).

Table 9.23: Telegram structure

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Initial bit address (byte high)	Initial bit address (byte high)
Initial bit address (byte low)	Initial 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 Field (number of data bytes)	CRC-
Byte 1	CRC+
Byte 2	-
Byte 3	-
etc a	-
CRC-	-
CRC+	-

The value of each bit that is being sent is placed at a position of the data bytes sent by the master.

The first byte, in the bits 0 to 7, receives the 8 first bits by starting from the initial address indicated by the master.

The other bytes (if the number of written bits is greater than 8) remain in sequence. If the number of inscribed bits is not a multiple of 8, the remaining bits of the last byte must be filled in with 0 (zero).

Example: Writing of the commands for start (bit 100 = 1), general enable (bit 101 = 1) and Reverse speed direction (bit 102 = 0), to an MVW3000 at the address 1:

Table 9.24: Example of telegram structure

Request (Master)		Response (Slave)	
Field	Value	Field	Value
Slave address	01h	Slave address	01h
Function	0Fh	Function	0Fh
Initial bit (byte high)	00h	Initial bit (byte high)	00h
Initial bit (byte low)	64h	Initial bit (byte low)	64h
Number of bits (byte high)	00h	Number of bits (byte high)	00h
Number of bits (byte low)	03h	Number of bits (byte low)	03h
Byte Count	01h	CRC-	54h
Value for the bits	03h	CRC+	15h
CRC-	BEh	-	-
CRC+	9Eh	-	-

As only three bits are being written, the master needed only one byte to transmit the data. The transmitted values are in the three less significant bits of the byte that contains the value for the bits. The other bits of this byte remained with the value 0 (zero).

9.3.3.6 Function 16 - Write Multiple Registers

This function allows writing values to a group of registers that must be in numerical sequence. This function can also be used to write a single register (the values are always hexadecimal values and each field represents one byte).

Table 9.25: *Telegram structure*

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
Initial register address (byte high)	Initial register address (byte high)
Initial register address (byte low)	Initial 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 Field (number of data bytes)	CRC-
Data 1 (high)	CRC+
Data 1 (low)	-
Data 2 (high)	-
Data 2 (low)	-
etc	-
CRC-	-
CRC+	-

Example: Writing an acceleration time (P0100) of 1.0 s and a deceleration time (P0101) of 2.0 s, to an MVW3000 at the address 20:

Table 9.26: *Example of telegram structure*

Request (Master)		Response (Slave)	
Field	**Value**	**Field**	**Value**
Slave address	14h	Slave address	14h
Function	10h	Function	10h
Registrador inicial (high)	00h	Registrador inicial (high)	00h
Registrador inicial (low)	64h	Registrador inicial (low)	64h
Nº de registradores (high)	00h	Nº de registradores (high)	00h
Nº de registradores (low)	02h	Nº de registradores (low)	02h
Byte Count	04h	CRC-	02h
P0100 (high)	00h	CRC+	D2h
P0100 (low)	0Ah	-	-
P0101 (high)	00h	-	-
P0101 (low)	14h	-	-
CRC-	91h	-	-
CRC+	75h	-	-

Considering that the two parameters have a resolution of one decimal place, in order to write 1.0 and 2.0 seconds, the values 10 (000Ah) and 20 (0014h) must be transmitted, respectively.

9.3.3.7 Function 43 - Read Device Identification

It is an auxiliary function, which allows reading the manufacturer name, model and firmware version of the product. It has the following structure:

Table 9.27: Telegram structure

Request (Master)	Response (Slave)
Slave address	Slave address
Function	Function
MEI Type	MEI Type
Read Code	Conformity Level
Object Number	More Follows
CRC-	Next Object
CRC+	Number of Objects
-	Object Code
-	Object Length
-	Object Value
-	CRC-
-	CRC+

The fields are repeated according to the number of objects.

This function allows reading three information categories: Basic, Regular and Extended, and each category is formed by a group of objects. Each object is formed by a sequence of ASCII characters. For the MVW3000 only basic information is available, composed by three objects:

- Object 00 - VendorName: Always ‘WEG’.
- Object 01 - ProductCode: Formed by the product code (MVW3000), plus the inverter rated current.
- Object 02 - MajorMinorRevision: indica a versão de firmware do inversor, no formato ‘VX.XX’.

The Read Code indicates the information categories being read, and whether the objects are being accessed in a sequence or individually. In the case, the inverter supports the codes 01 (basic information in sequence), and 04 (individual access to the objects).

The remaining fields for MVW3000 have fixed values.

Example: Sequential reading of basic information, starting from the object 00 of an MVW3000 at the address 1:

Table 9.28: Example of telegram structure

Request (Master)		Response (Slave)	
Field	Value	Field	Value
Slave address	01h	Slave address	01h
Function	2Bh	Function	2Bh
MEI Type	0Eh	MEI Type	0Eh
Read Code	01h	Read Code	01h
Object Number	00h	Conformity Level	51h
CRC-	70h	More Follows	00h
CRC+	77h	Next Object	00h
-	-	Number of Objects	03h
-	-	Object Code	00h
-	-	Object Length	03h
-	-	Object Value	‘WEG’
-	-	Object Code	01h
-	-	Object Length	0Eh
-	-	Object Value	‘MVW3000 7.0A’
-	-	Object Code	02h
-	-	Object Length	05h
-	-	Object Value	‘V2.09’
-	-	CRC-	B8h
-	-	CRC+	39h

In this example, the object values were not represented in hexadecimal, but using the corresponding ASCII characters. For the object 00, for instance, the value ‘WEG’ was transmitted as being three ASCII characters that in hexadecimal have the values 57h (W), 45h (E) and 47h (G).

9.3.4 ModBus RTU Communication Error

Errors may occur in telegram transmission through the network, or in the contents of the received telegrams. According to the type of error, the inverter may or may not send a response to the master:

When the master sends a message to an inverter configured at a specific network address, the inverter will not respond to the master if the following occurs:

- Parity bit error.
- CRC error.
- Timeout between transmitted bytes (3.5 times the transmission time of a 11 bit word).

In the case of a successful reception, during the telegram processing the inverter may detect problems, and send an error message, indicating the type of problem found:

- Invalid function (error code = 1): the requested function has not been implemented for the inverter.
- Invalid data address (error code = 2): the data address (register or bit) does not exist.

Data value invalid (error code = 3): this error occurs in the following conditions:

- Value is out of the permitted range.
- Writing in data that cannot be changed (read-only register, or one that does not allow changing with enabled inverter, or Status Word bits.
- Writing in a Control Word function that has not been enabled via serial interface.

Error Messages
When any error occurs in the message content (not during the data transfer), the slave must return a message indicating the error type that occurred. The errors that may occur in the MVW3000 during the message processing are invalid function (code 01), invalid data address (code 02), and invalid data value (code 03) errors.

The messages sent by the slave have following structure:

Table 9.29: *Telegram structure*

Response (Slave)
Slave address
Function code
(with most significant bit to 1)
Error code
CRC-
CRC+

Example: The master requests the slave at address 1 to write in the parameter 89 (inexistent parameter):

Table 9.30: *Example of telegram structure*

Request (Master)		Response (Slave)	
Field	**Value**	**Field**	**Value**
Slave address	01h	Slave address	01h
Function	06h	Function	86h
Register (high)	00h	Error code	02h
Register (low)	59h	CRC-	C3h
Value (high)	00h	CRC+	A1h
Value (low)	00h	-	-
CRC-	59h	-	-
CRC+	D9h	-	-

WEG Drives & Controls - Automação LTDA.
Jaraguá do Sul - SC - Brazil
Fone 55 (47) 3276-4000 - Fax 55 (47) 3276-4020
São Paulo - SP - Brazil
Fone 55 (11) 5053-2300 - Fax 55 (11) 5052-4212
automacao@weg.net
www.weg.net