

QDRIVE MV-ML

Medium Voltage
Multi Level Drives

DANIELI AUTOMATION



5	Intro
6	QDrive MV Multilevel
8	Technical Data
12	Cabinet layout
14	Ratings & dimensions
18	Maintenance
22	Drive system supervision
24	Remote Teleservice
26	Auxiliaries cabinets



DANIELI AUTOMATION MV MULTILEVEL QDRIVES

MV-ML QDrive is a series of medium-voltage, variable-frequency drives for applications where reliability, performance and easy maintenance are fundamental requirements. Built around the most up-to-date IGBT technology, the multi-level structure makes it suitable for driving any motor (old or new) at variable speed up to 11 kV and up to 10 MW. Its unique features, compact construction and proven efficiency make it the right choice for any application in the field of metals, mining, water & fumes treatment, and in general in process industry. The high power quality at its output makes it the ideal solution for retrofitting an existing motor to variable speed for energy saving - especially when driving fans and pumps. Its multi-pulse diode front end (DFE) configuration, fed by its integrated transformer, reduces grid harmonics to a minimum - in full compliance with the most severe norms and grid codes.

QDrive MV Multi-Level

Danieli Automation MV-ML QDrives are Medium Voltage multi-level drives based on IGBT cascaded H bridges cells (CHB), in 3L NPC topology, air and water cooled no-regenerative type, with output voltage levels from 3.3 kV up to 11 kV and output power that ranges from 200 kVA (at 3.3kV) up to 16000 kVA (at 11 kV).

On supply line side, using multi-level conversion method with multi-windings transformers, the resulting multi-pulses input side current has a very low harmonics content and conforms easily to the IEEE519-1992 and IEC 61000 requirements, without having to use harmonic filters.

On output side the motor friendly multi-level voltage waveform allows to convert easily existing fixed speed Direct On-Line Motors to a state of art Variable Speed Drive system, without requiring cumbersome sinusoidal filters to preserve motor insulation integrity.

The CHB converter structure is realised using standardised power modules cells air or water cooled, in a easy to service and maintain modular structure. The cells could be easily extracted from the cabinet structure, on a supporting sliding system.

The basical drive configuration can be supplied also adding various options to fullfill special operational customer needs.

The drive could be operated in scalar control, sensorless field oriented control and in sensed field oriented control (with encoder) to meet application drive system static and dynamic process requirements. Main applications are machines and plants in metal and in the process industry.



Applications examples are: pumps, fans, compressors, conveyors, extruders and separators, kilns, grinders, shredders.

- > Ready-to-connect cabinet unit
- > Design focused on easy maintenance and quick power module replacement (a lifting trolley allows converter power cells very fast substitution)
- > Modular design with up to 5 CHB power cells for each phase for 11kV converter series
- > Cabinet design focused on safety
- > Fully-digital vector closed-loop control, for synchronous and induction motors
- > High degree of efficiency
- > High control accuracy and dynamic response
- > Extremely low line harmonics spectrum
- > Simple and fast commissioning
- > Extremely reliable in operation and almost maintenance-free

- > Simple operator control and monitoring
- > Advanced diagnostic and maintenance functionalities
- > Fast parameterization and signal tracing with converter operator panel and PC based QDrive Configurator Tool
- > Maximum flexibility and optimum interaction with existing automation overriding control system
- > Various Fieldbus Interfaces are available (Profibus, CANopen, DeviceNet, Ethernet, exc.)
- > Possibility of I/O terminals expansion according to the application requirements
- > PLC functionalities embedded into drive control unit (CodeSys)
- > Users could add their own programs in CodeSys for any additional need
- > Inbuilt remote access for Teleservice option



Technical data

General Electrical Data

Power switches elements	IGBTs
Drive arrangement	Single unit in cascaded 3L-NPC H-cell topology no-regenerative type with 6 or 12 pulses type diode bridges
Rated output voltage types	3.3 kV – 4.16kV – 6.6 kV – 11 kV
Efficiency	typ. => 97% (including multi-winding transformer)
Motor type	Induction or Synchronous with separate dc excitation
Main supply voltage (50/60 Hz)	Output voltage +/- 10% typically (different input voltages possible upon request)
Inverter output frequency	Typ. 50/60 Hz – up to 75 Hz
Braking method	Natural deceleration by load torque
Input power factor	Typ. better than 0.95 depending on output load
Output current overload capability (see drive ratings table for In values)	110% for 60 sec every 300 sec with base current of In 125% for 60 sec every 600 sec with base current of In
Transformer configuration	Multi-windings multi-pulse (see relevant table)
Type of control	Scalar control, FOC sensorless / sensed
Speed accuracy	0.5% @ 100% speed (FOC sensorless)
Torque accuracy	Better than $\pm 5\%$ of rated motor torque (FOC sensed and motor rated current $\geq 80\%$ of converter rated current)
Auxiliary voltages range	380...480 Vac 50/60 Hz
UPS for control unit	Integrated into converter cabinet auxiliary section as standard
Installation place	Indoor (clean electrical room typically), with site altitude up to 1000 m a.s.l. Atmosphere: general clean environment, free from corrosive gas, dust and explosive/flammable gas
Electrical room operating temperature range	10 - 35 °C without derating - from 36°C to 45°C with derating (standard version)
Humidity	90% relative humidity max (no condensation)
External cooling water operating temperature range	10 - 32 °C (water cooled type only)
Drive switchboard cabinet short circuit withstanding	10 kA for 1 sec, 25 kA peak
Protection degree	IP42 (higher protection degree available upon request, see options)
Power losses to air	For sizing of cooling equipment, max heat losses into air to be considered is about 3.5 kW/100 kVA of output power (i.e. for 1000 KVA output type consider approx 35 kW of heat losses, including transformer)
Sound pressure	Less than 80db (A) at 1 m from enclosure
Control unit interface to overriding control system	Profibus as standard or other fieldbuses available
Applicable standards	IEC 60146 – IEC 61800-3/4/5 – IEC 60071-1– IEC 60204-11 – EN 62271

Optional System Components

EXC - Field exciter converter cabinet	Unidirectional thyristor LV AC/DC converter with crowbar, incoming line circuit breaker (DA standard cabinet type)
MCS - Auxiliary motors control starters cabinet	Cabinet with starters, feeders for aux. loads for control unit with drive system supervision panel (OP2) – typically needed for large motors in IC37AW86 cooling method
HIVT - High input voltage transformer version	Special multi-winding transformer version with input voltage higher than 11kV (possible classes up to 36kV)
IBC - Input bypass cabinet	Input bypass circuitry to bypass inverter unit and providing DOL supply for the driven motor
SIBC - Synchronised input bypass	Control & Hardware for Synchronised Input Bypass
IOVS - Input side overvoltage suppressor	With this option an overvoltage suppressor is installed on integrated transformer primary connections
OIC - Output isolater cubicle	Output motor isolator & grounding switch
WCV - Water cooling version	Solution with CHB in water cooled version with cabinet Water Cooling Unit (WCU)
HPDV5 - for IP54 protection degree	Cabinet enclosures in IP54
CU IBA - Control unit with IBA interface	Hardware and Software for IBA diagnostic Interface (Special CPU with reflective memory)
UPS - for control unit	Integrated into converter cabinet auxiliary section
AUX HF - HF aux power supply for CHB	Auxiliary high frequency power supply with proper insulation for CHB power module control units
EXT AUX - External aux for motor and accessories	Remote I/Os modules for motor PT100s, heat exchanger signals & starters, lube units signals
FLY REST - Flying restart	Control & Hardware for restarting the drive on a rotating motor
ENC FOC - Encoder module for FOC	Encoder reading module for Field Oriented Control for induction and synchronous (SESM) motors
L OP - Larger OP	Larger operator panel instead of the standard OP1 type
MAINT TROLLEY	Maintenance tool for power cell replacement

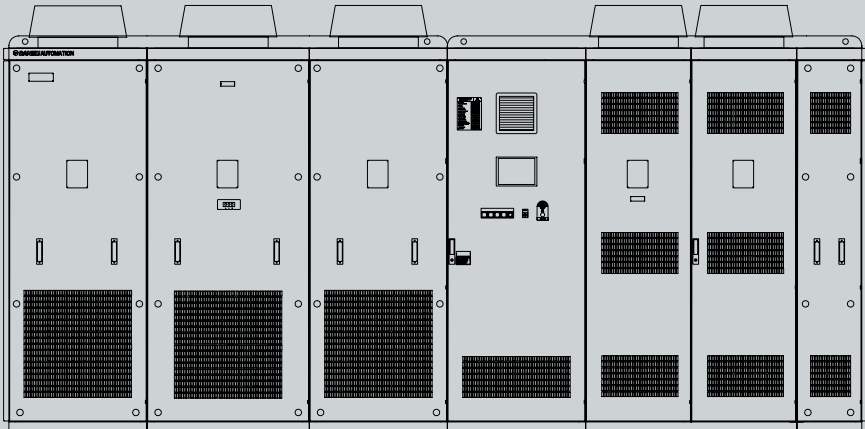






**QDRIVE MV
MULTILEVEL
Cabinet layout**

**Typical single
drive arrangement**



INCOMING LINE
AND MAIN TRANSFORMER SECTION

CONTROL
SECTION

INVERTER AND
TERMINAL UNIT



**QDRIVE MV
MULTILEVEL
Cabinet layout**

**Ratings and
dimensions**

Indicated transformer rated power is for 50 Hz network. Shown dimensions could vary according to selected options and are intended just for reference.

3.3 kV type QDrive MV-ML - 6 CHB power cells

DA code	Converter output rated power S_N (kVA)	Converter output rated current I_N (A)	OVL 125% (60s every 600s) I_{MAX} (A)	Multi-winding transformer rated power (kVA)
QDML100INV-35A-V3.3	200	35	43.7	235
QDML100INV-52A-V3.3	300	52	65	350
QDML100INV-73A-V3.3	420	73	91.3	490
QDML100INV-107A-V3.3	612	107	133.8	710
QDML100INV-147A-V3.3	840	147	183.8	975
QDML100INV-192A-V3.3	1100	192	240	1280
QDML100INV-227A-V3.3	1300	227	283.8	1510
QDML100INV-262A-V3.3	1500	262	327.5	1750
QDML100INV-306A-V3.3	1750	306	382.5	2030
QDML100INV-350A-V3.3	2000	350	437.5	2350
QDML100INV-402A-V3.3	2300	402	502.5	2670
QDML100INV-472A-V3.3	2700	472	590	3135
QDML100INV-525A-V3.3	3000	525	656.3	3480
QDML100INV-612A-V3.3	3500	612	765	4060
QDML100INV-700A-V3.3-W	4000	700	875	4650

4.16 kV type QDrive MV-ML - 6 CHB power cells

DA code	Converter output rated power S_N (kVA)	Converter output rated current I_N (A)	OVL 125% (60s every 600s) I_{MAX} (A)	Multi-winding transformer rated power (kVA)
QDML100INV-35A-V4.16	252	35	43.7	292
QDML100INV-52A-V4.16	375	52	65	435
QDML100INV-73A-V4.16	526	73	91.3	610
QDML100INV-107A-V4.16	770	107	133.8	895
QDML100INV-147A-V4.16	1060	147	183.8	1230
QDML100INV-192A-V4.16	1385	192	240	1605
QDML100INV-227A-V4.16	1636	227	283.8	1898
QDML100INV-262A-V4.16	1890	262	327.5	2190
QDML100INV-306A-V4.16	2205	306	382.5	2560
QDML100INV-350A-V4.16	2520	350	437.5	2925
QDML100INV-402A-V4.16	2900	402	502.5	3360
QDML100INV-472A-V4.16	3400	472	590	3945
QDML100INV-525A-V4.16	3785	525	656.3	4388
QDML100INV-612A-V4.16	4410	612	765	5116
QDML100INV-700A-V4.16-W	5045	700	875	5850

Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm) + 300 mm cooling fan on the roof (*) WCU unit included	Weight (kg) (*) WCU unit included
6.4	Air	A	4100 x 2200 x 1500	4800
9.5	Air	A	4100 x 2200 x 1500	4850
13.4	Air	A	4100 x 2200 x 1500	4940
20	Air	A	4100 x 2200 x 1500	5080
27	Air	A	4100 x 2200 x 1500	5250
35.2	Air	B	4600 x 2350 x 1500	5830
41.5	Air	B	4600 x 2350 x 1500	5980
48	Air	B	4600 x 2350 x 1500	6130
56	Air	B	4600 x 2350 x 1500	6370
64	Air	B	4800 x 2350 x 1500	6750
73.5	Air	C	5100 x 2350 x 1500	7620
86.3	Air	C	5200 x 2350 x 1500	8240
96	Air	C	5300 x 2350 x 1600	8700
112	Air	C	5400 x 2350 x 1600	9500
128	Water	C	7000 x 2350 x 1700 (*)	11000 (*)

Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm) + 300 mm cooling fan on the roof (*) WCU unit included	Weight (kg) (*) WCU unit included
8	Air	A	4100 x 2200 x 1500	4800
12	Air	A	4100 x 2200 x 1500	4900
16.8	Air	A	4100 x 2200 x 1500	5040
24.6	Air	A	4100 x 2200 x 1500	5180
34	Air	A	4100 x 2200 x 1500	5400
44.5	Air	B	4600 x 2350 x 1500	6050
52.3	Air	B	4600 x 2350 x 1500	6230
60.4	Air	B	4600 x 2350 x 1500	6580
70.5	Air	B	4700 x 2350 x 1500	7070
80.8	Air	B	4800 x 2350 x 1500	7560
92.7	Air	C	5400 x 2350 x 1500	8430
108.5	Air	C	5500 x 2350 x 1500	9170
120.8	Air	C	5500 x 2350 x 1600	9740
141	Air	C	5600 x 2350 x 1600	10500
162	Water	C	7200 x 2350 x 1700 (*)	12100 (*)

**QDRIVE MV
MULTILEVEL
Cabinet layout**

**Ratings and
dimensions**

Indicated transformer rated power is for 50 Hz network. Shown dimensions could vary according to selected options and are intended just for reference.

6.6 kV type QDrive MV-ML - 9 CHB power cells

DA code	Converter output rated power S_N (kVA)	Converter output rated current I_N (A)	OVL 125% (60s every 600s) I_{MAX} (A)	Multi-winding transformer rated power (kVA)
QDML100INV-35A-V6.6	400	35	43.7	465
QDML100INV-52A-V6.6	595	52	65	690
QDML100INV-73A-V6.6	835	73	91.3	970
QDML100INV-107A-V6.6	1225	107	133.8	1425
QDML100INV-147A-V6.6	1680	147	183.8	1950
QDML100INV-192A-V6.6	2195	192	240	2500
QDML100INV-227A-V6.6	2595	227	283.8	3010
QDML100INV-262A-V6.6	2995	262	327.5	3475
QDML100INV-306A-V6.6	3500	306	382.5	4060
QDML100INV-350A-V6.6	4000	350	437.5	4650
QDML100INV-402A-V6.6	4595	402	502.5	5330
QDML100INV-472A-V6.6	5395	472	590	6260
QDML100INV-525A-V6.6	6000	525	656.3	6960
QDML100INV-612A-V6.6	7000	612	765	8120
QDML100INV-700A-V6.6-W	8000	700	875	9280

11 kV type QDrive MV-ML - 15 CHB power cells

DA code	Converter output rated power S_N (kVA)	Converter output rated current I_N (A)	OVL 125% (60s every 600s) I_{MAX} (A)	Multi-winding transformer rated power (kVA)
QDML100INV-35A-V11	667	35	43.7	773
QDML100INV-52A-V11	990	52	65	1148
QDML100INV-73A-V11	1390	73	91.3	1612
QDML100INV-107A-V11	2038	107	133.8	2364
QDML100INV-147A-V11	2800	147	183.8	3250
QDML100INV-192A-V11	3660	192	240	4250
QDML100INV-227A-V11	4325	227	283.8	5020
QDML100INV-262A-V11	4992	262	327.5	5791
QDML100INV-306A-V11	5830	306	382.5	6763
QDML100INV-350A-V11	6670	350	437.5	7740
QDML100INV-402A-V11	7660	402	502.5	8886
QDML100INV-472A-V11	8995	472	590	10435
QDML100INV-525A-V11	10000	525	656.3	11600
QDML100INV-612A-V11	11660	612	765	13525
QDML100INV-700A-V11-W	13340	700	875	15470

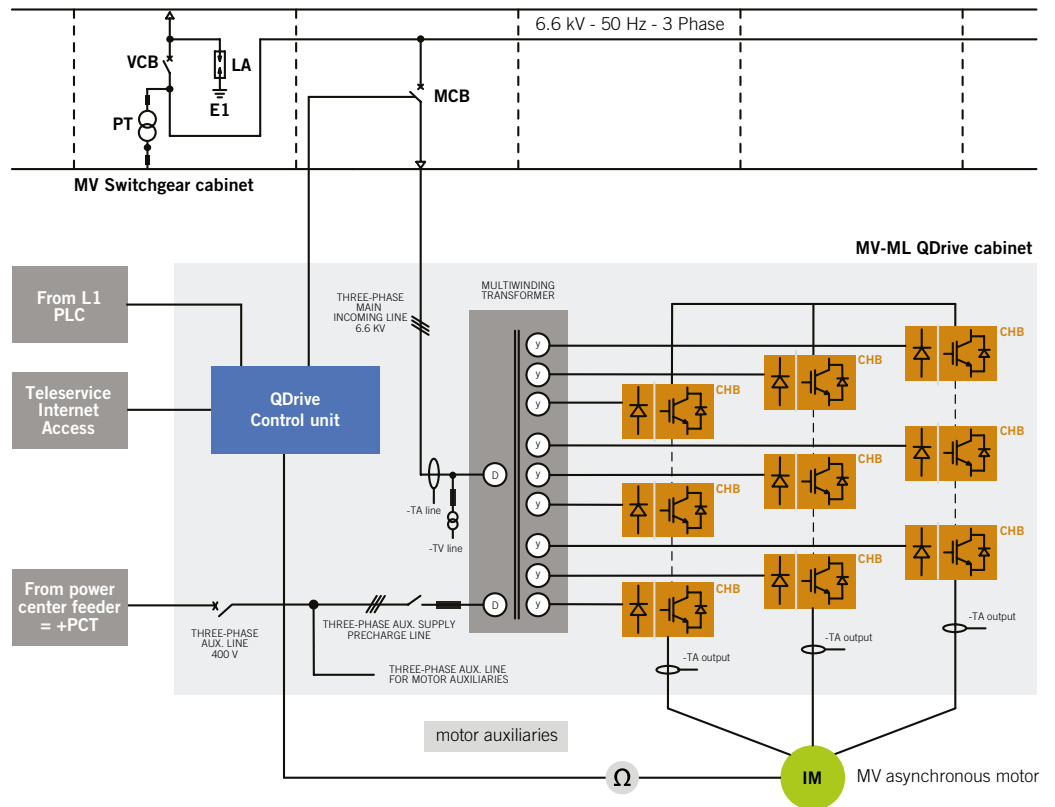
Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm) + 300 mm cooling fan on the roof (*) WCU unit included	Weight (kg) (*) WCU unit included
12.8	Air	A	4400 x 2200 x 1500	5120
19	Air	A	4400 x 2200 x 1500	5260
26.7	Air	A	4750 x 2200 x 1500	5440
39.2	Air	A	4750 x 2200 x 1500	5730
53.8	Air	A	5250 x 2350 x 1500	6100
70.2	Air	B	5250 x 2350 x 1500	7260
83	Air	B	5250 x 2350 x 1500	7880
95.8	Air	B	5600 x 2350 x 1500	8500
112	Air	B	5600 x 2350 x 1500	9300
128	Air	B	5600 x 2350 x 1500	10100
147	Air	C	6250 x 2350 x 1500	10950
172.6	Air	C	6600 x 2750 x 1700	12100
192	Air	C	6900 x 2750 x 1700	12940
223.8	Air	C	7200 x 2750 x 1700	12350
256	Water	C	9200 x 2750 x 1700 (*)	17800 (*)

Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm) + 300 mm cooling fan on the roof (*) WCU unit included	Weight (kg) (*) WCU unit included
21.3	Air	A	6200x2350x1700	6600
31.7	Air	A	6200x2350x1700	6800
44.5	Air	A	6300x2350x1700	7080
65.2	Air	A	6300x2350x1700	7820
89.6	Air	A	6500x2350x1700	8980
117	Air	B	7300x2750x1700	10600
138.4	Air	B	7300x2750x1700	11270
159.7	Air	B	7500x2750x2000	12200
186.6	Air	B	7800x2750x2000	13400
213.4	Air	B	7900x2750x2000	14600
245	Air	C		
287.7	Air	C		
320.1	Air	C		
373.2	Air	C		
426.8	Water	C		

Call our sales representatives for overall dimensions and weights of converter cabinet sizes higher than 402 A

QDRIVE MV MULTILEVEL
 Power part main features

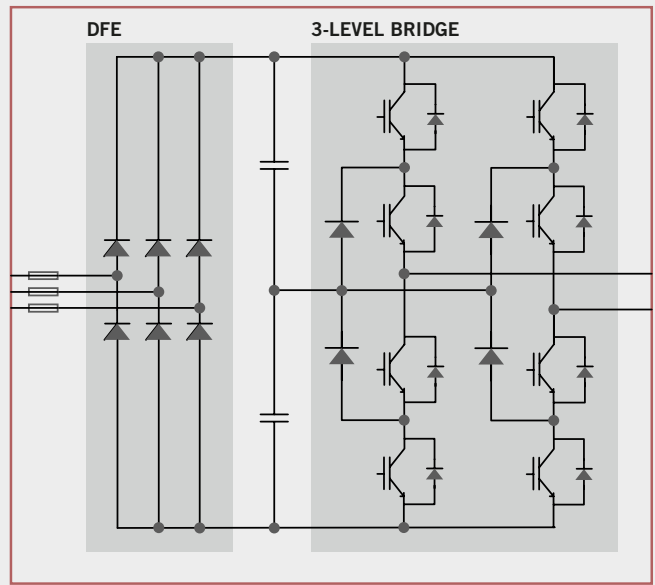
Concept Single Line diagram



Cascaded 3L-NPC H-Bridge multilevel topology with DFE 6 pulses version - 6.6kV type shown (3 CHB cells for each phase)

Output voltage (kV)	3.3	4.16	6.6	11
Number of CHB cells for each phase	2	2	3	5
Phase shift between secondaries windings of each group	30	30	20	12
Output waveforms voltage levels (line to line voltage)	17	17	25	41
Three groups of "n" windings	2	2	3	5
Number of secondaries windings	6	6	9	15
MV supply line side "pulses" in input current	12	12	18	30

Multi-winding transformer configurations according to output voltage levels - CHB with input diode bridge 6 pulses version

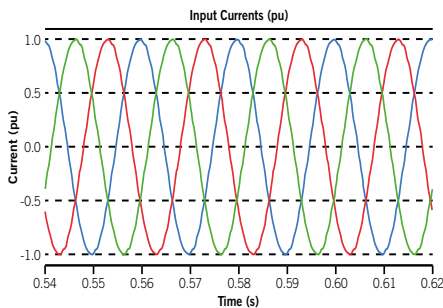


CHB-cell converter detail - 6 pulses input diode bridge

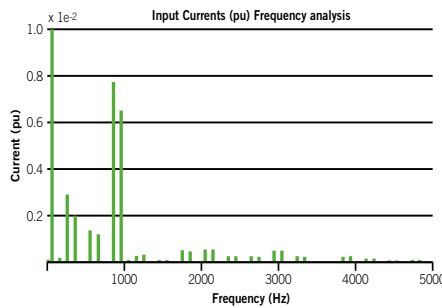
Typical waveforms & line current harmonics spectrum

The use of multi-windings transformer combined with CHB converter topology and particular modulation technique allows to achieve an excellent behaviour

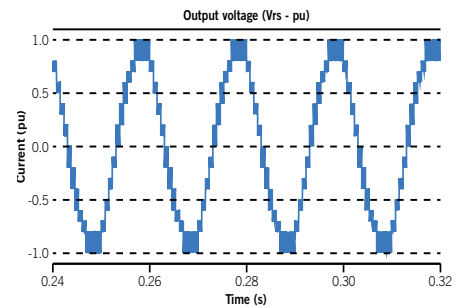
on the MV supply network, in terms of power factor and line current harmonics, in full compliance with IEEE and IEC relevant standards.



Input Current waveform for 50 Hz output

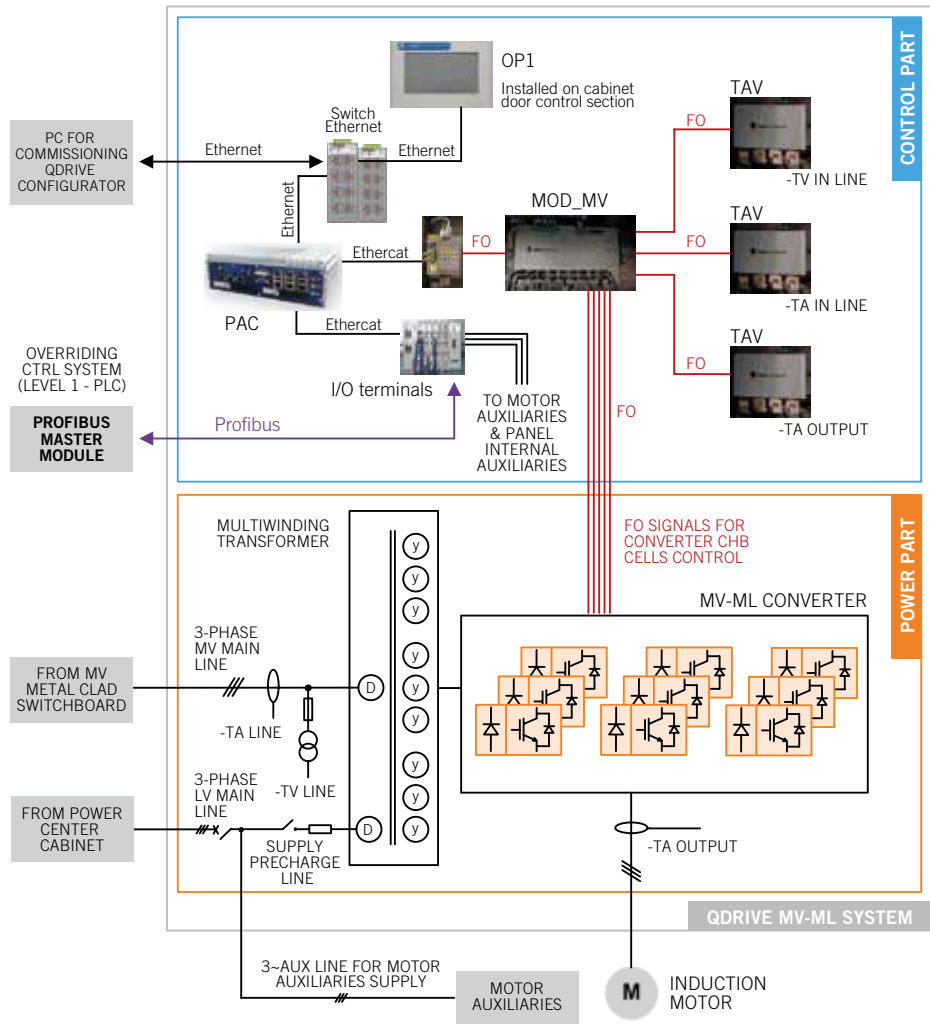


Typical line current harmonics spectrum (p.f. = 0.95, Thd_i < 5%)



Output Voltage waveform for 50 Hz output

QDRIVE MV MULTILEVEL
Control Architecture



Control architecture of MV-ML Qdrive system

The control structure is based on powerful state-of-the-art Danieli Automation Process Automation Controller (DA-PAC) that communicates with power part centralised controller (MOD-MV) with Ethercat optical fiber fast link. Each CHB power module is equipped with a control board (MOD-CHB) that communicates with the MOD-MV through a

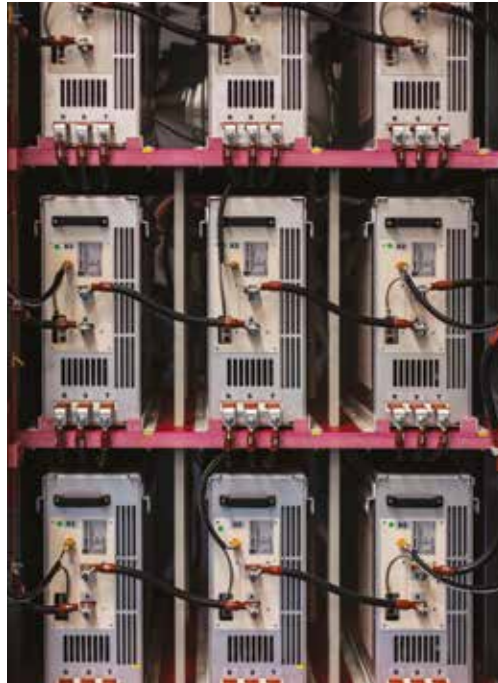
proprietary UART protocol via optical fiber link, and there is a back-up isolated power supply system for CHB controllers; UPS for control system is always included.

This configuration allows detailed maintenance and troubleshooting in all operating conditions. The control unit handles the drive system and its auxiliary system, monitoring the transformer, the converter power part and the motor, for

safe operation and quick fault tracing. The control system software is written in CoDeSys, a powerful IDE IEC - 61131-3 compliant language, which is an industrial standard for automation and real-time fast control system. The controller could be interfaced with any overriding control system using any type of fieldbus, and it's equipped with remote access facility to allow teleservicing and system monitoring.



QDRIVE 3L-NPC
Maintenance



Simple and fast maintenance is a key factor for reliable equipments. The design of the power modules, realized with wheeled frames, allows a fast and easy replacement in about 30 minutes.

Moreover, special tools or lifting device are not necessary for modules substitution. Anyhow, maintenance trolley and power module handling frame are included in the supply.



MV Drive system supervision

OP Operator Panels

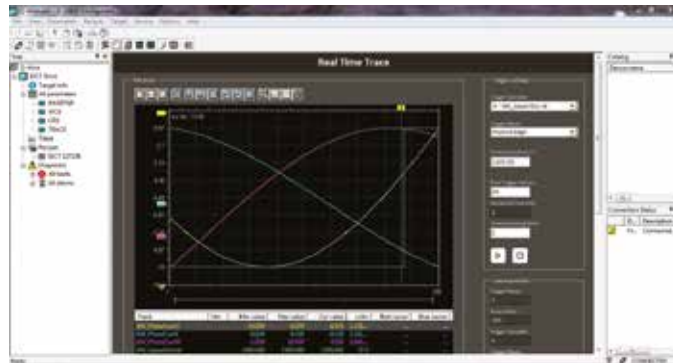
- > Operator panel
- > Drive system supervisor panels
- > PC commissioning tools



Converters Operator Panel (OP) and Drive system supervisor panel

The MV drive system is equipped with two operator panels (colour touch panels), one for AFE and Inverter parametrization (OP1, located on the control unit door), while the other is for the

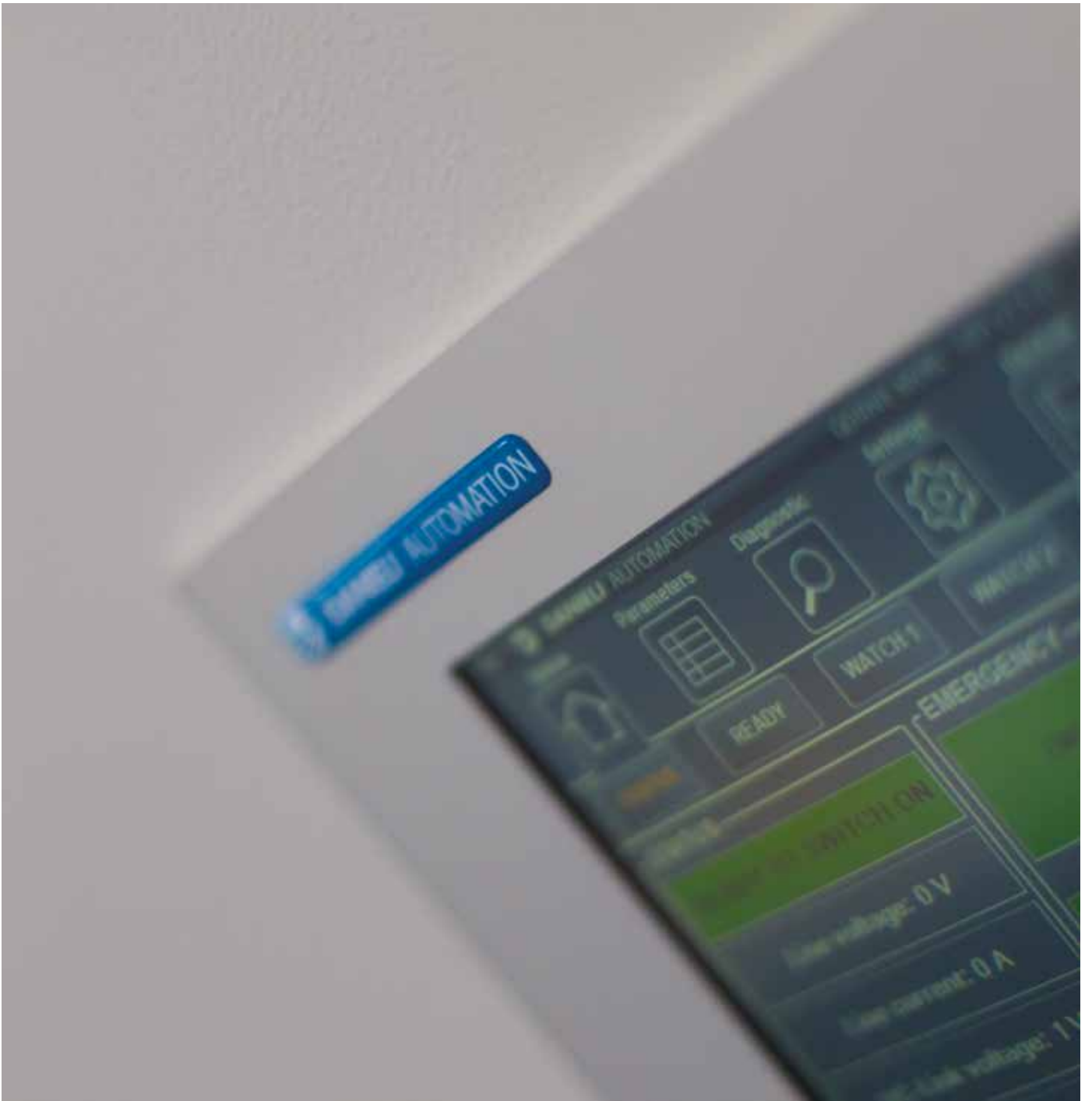
complete drive system monitoring and it is normally located on auxiliary MCS cabinet door (OP2). Through the panels it is possible to perform extensive drives units and systems components parametrization, monitoring, servicing and troubleshooting.



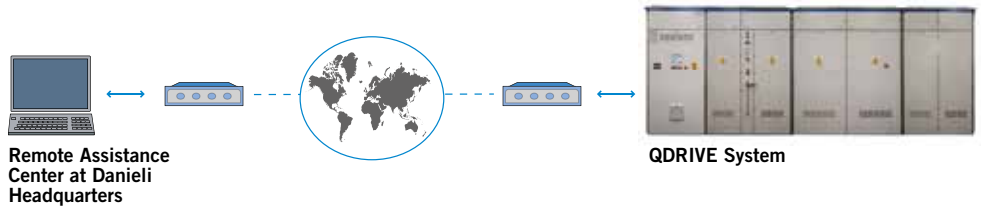
Powerful PC commissioning tool

The drive control unit could be easily interfaced to a PC, using Ethernet with a simple patch cable. Danieli Automation has developed a powerful software tool application - QDrive Configuration Tool - that allows drive parametrization, tuning, accurate and fast signal tracing, saving-retrieving drives parameters and advanced troubleshooting.

Parameter	Name	Value	Unit	Min	Max	Step	Group	Unit	Group
00001	AFE_1	400V	V	0.00	10000.00	10000.00	V	V	V
00002	AFE_2	400V	V	0.00	10000.00	10000.00	V	V	V
00003	AFE_3	400V	V	0.00	10000.00	10000.00	V	V	V
00004	AFE_4	400V	V	0.00	10000.00	10000.00	V	V	V
00005	AFE_5	400V	V	0.00	10000.00	10000.00	V	V	V
00006	AFE_6	400V	V	0.00	10000.00	10000.00	V	V	V
00007	AFE_7	400V	V	0.00	10000.00	10000.00	V	V	V
00008	AFE_8	400V	V	0.00	10000.00	10000.00	V	V	V
00009	AFE_9	400V	V	0.00	10000.00	10000.00	V	V	V
00010	AFE_10	400V	V	0.00	10000.00	10000.00	V	V	V
00011	AFE_11	400V	V	0.00	10000.00	10000.00	V	V	V
00012	AFE_12	400V	V	0.00	10000.00	10000.00	V	V	V
00013	AFE_13	400V	V	0.00	10000.00	10000.00	V	V	V
00014	AFE_14	400V	V	0.00	10000.00	10000.00	V	V	V
00015	AFE_15	400V	V	0.00	10000.00	10000.00	V	V	V



Remote Teleservice



Danieli Automation provides Remote Teleservice, a flexible and effective service solution to reduce assistance costs and optimize intervention time. The Teleservice is designed to allow the connection of QDrive control unit with the remote assistance stations located at Danieli headquarters in Italy,

to allow the troubleshooting and monitoring of the QDrive system. Teleservice assures a remote non-stop service and a reliable support for a quick solution of unexpected malfunctions, with the following benefits:

- > Immediate intervention of a specialist at any time.

- > Limits or avoids the specialist's travelling time and costs.
- > Increase the power of the internal team by accessing a virtually unlimited remote resource for problem solving.



Auxiliaries cabinets

- > EXC
- > AUX MCS

Auxiliary cabinets designed for QDrive are based on the well-proven Danieli Automation low-voltage power switchboards standard design.



EXC - Field Exciter converter cabinet for synchronous motor DC excitation

The unit includes market-type LV AC/DC compact converter with protection crowbar.

The cabinet has incoming line circuit breaker and it is controlled from QDrive Control unit through Internal Profibus network.

AUX MCS - Auxiliary system motors control starter cabinet

This unit includes all the needed power starters and feeders for the MV drive system, UPS for control unit and Drive system supervision panel (OP2).

All contained in a DA standard cabinet type.



HEADQUARTERS



DANIEMI

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