

QDrive

MV Multi-Level Drives



DANIELI AUTOMATION

Know-How in Process Control

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MV MULTI-LEVEL DRIVES

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 13000 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 (Converter Bypass unit - Converter Synch. Bypass Unit - Output isolator unit) 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.

Danieli Automation MV Multi-Level QDrive, modular design and sturdy construction, to better meet customer's requirement.

MV Multi-Level QDRIVE

Main features & technical data



Danieli Automation MV Multi-Level Drives hardware features

- > 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

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 ± 5% of rated motor torque (FOC sensed and motor rated current ≥ 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 enviroment, 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	IP32 (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

Options

EXC - Field exciter converter cabinet for synchronous motor dc excitation	Unidirectional thyristor LV AC/DC converter with crowbar, incoming line circuit breaker (DA standard cabinet type)
AUX_MCS - Auxiliary system 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
HPV - Higher Pulses Version - 12 pulses input diode front-end (standard version 6 pulse)	To double the number of MV supply line input current pulses
HIVT - High Input Voltage Transformer Version	Special multi-winding transformer version with input voltage higher than 11kV (possible classes up to 36kV) without any additional external MV/MV transformer
IBC - Input bypass cubicle	Input bypass circuitry to bypass inverter unit and providing DOL supply for the driven motor without synch. bypass
SIBC - Synchronised Input Bypass cubicle	Input bypass circuitry to bypass inverter unit and providing DOL supply for the driven motor with synch. bypass
INRL - Converter Transformer Inrush current limiter	Converter transformer Inrush current limiter circuitry on primary side
IOVS - Input Side Overvoltage suppressor	With this option an overvoltage suppressor is installed on integrated transformer primary connections
OIC - Output Isolator Cubicle	Output motor isolator & grounding switch
WCV - Water Cooled Version	Solution with CHB in water cooled version with cabinet Water Cooling Unit (WCU)
HPDV4 for IP43 protection degree	Cabinet enclosures in IP43
HPDV5 for IP54 protection degree	Cabinet enclosures in IP54, it has also an appropriate number of cooling units installed on the roofs

MV Multi-Level QDRIVE

Cabinet Layout



Typical cabinet layout - Air-cooled type



INCOMING LINE
AND MAIN TRANSFORMER SECTION

CONTROL
SECTION

INVERTER
AND TERMINAL UNIT

MV Multi-Level QDRIVE

Ratings and dimensions

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	225
QDML100INV-52A-V3.3	300	52	65	335
QDML100INV-73A-V3.3	420	73	91.3	470
QDML100INV-107A-V3.3	612	107	133.8	690
QDML100INV-147A-V3.3	840	147	183.8	950
QDML100INV-192A-V3.3	1100	192	240	1250
QDML100INV-227A-V3.3	1300	227	283.8	1460
QDML100INV-262A-V3.3	1500	262	327.5	1685
QDML100INV-306A-V3.3	1750	306	382.5	1970
QDML100INV-350A-V3.3	2000	350	437.5	2250
QDML100INV-402A-V3.3	2300	402	502.5	2585
QDML100INV-472A-V3.3	2700	472	590	3035
QDML100INV-525A-V3.3	3000	525	656.3	3375
QDML100INV-612A-V3.3	3500	612	765	3935
QDML100INV-700A-V3.3-W	4000	700	875	4500

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	285
QDML100INV-52A-V4.16	375	52	65	425
QDML100INV-73A-V4.16	526	73	91.3	595
QDML100INV-107A-V4.16	770	107	133.8	870
QDML100INV-147A-V4.16	1060	147	183.8	1195
QDML100INV-192A-V4.16	1385	192	240	1560
QDML100INV-227A-V4.16	1636	227	283.8	1840
QDML100INV-262A-V4.16	1890	262	327.5	2125
QDML100INV-306A-V4.16	2205	306	382.5	2480
QDML100INV-350A-V4.16	2520	350	437.5	2840
QDML100INV-402A-V4.16	2900	402	502.5	3260
QDML100INV-472A-V4.16	3400	472	590	3830
QDML100INV-525A-V4.16	3785	525	656.3	4255
QDML100INV-612A-V4.16	4410	612	765	4960
QDML100INV-700A-V4.16-W	5045	700	875	5675

Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm) (*) WCU unit included	Weight (kg) (*) WCU unit included
6.4	Air	A	4100x2200x1500	4800
9.5	Air	A	4100x2200x1500	4850
13.4	Air	A	4100x2200x1500	4940
20	Air	A	4100x2200x1500	5080
27	Air	A	4100x2200x1500	5250
35.2	Air	B	4600x2200x1500	5830
41.5	Air	B	4600x2200x1500	5980
48	Air	B	4600x2200x1500	6130
56	Air	B	4600x2200x1500	6370
64	Air	B	4600x2200x1500	6750
73.5	Air	C	5100x2350x1500	7620
86.3	Air	C	5200x2350x1500	8240
96	Air	C	5300x2350x1500	8700
112	Air	C	5400x2350x1500	9500
128	Water	C	7000x2350x1700 (*)	11000 (*)

Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm) (*) WCU unit included	Weight (kg) (*) WCU unit included
8	Air	A	4100x2200x1500	4800
12	Air	A	4100x2200x1500	4900
16.8	Air	A	4100x2200x1500	5040
24.6	Air	A	4100x2200x1500	5180
34	Air	A	4100x2200x1500	5400
44.5	Air	B	4600x2200x1500	6050
52.3	Air	B	4600x2200x1500	6230
60.4	Air	B	4600x2200x1500	6580
70.5	Air	B	4700x2200x1500	7070
80.8	Air	B	4800x2200x1500	7560
92.7	Air	C	5400x2350x1500	8430
108.5	Air	C	5500x2350x1500	9170
120.8	Air	C	5500x2350x1500	9740
141	Air	C	5600x2350x1500	10500
162	Water	C	7200x2350x1700 (*)	12100 (*)

MV Multi-Level QDRIVE

Ratings and dimensions

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	450
QDML100INV-52A-V6.6	595	52	65	668
QDML100INV-73A-V6.6	835	73	91.3	938
QDML100INV-107A-V6.6	1225	107	133.8	1376
QDML100INV-147A-V6.6	1680	147	183.8	1890
QDML100INV-192A-V6.6	2195	192	240	2470
QDML100INV-227A-V6.6	2595	227	283.8	2920
QDML100INV-262A-V6.6	2995	262	327.5	3370
QDML100INV-306A-V6.6	3500	306	382.5	3935
QDML100INV-350A-V6.6	4000	350	437.5	4500
QDML100INV-402A-V6.6	4595	402	502.5	5170
QDML100INV-472A-V6.6	5395	472	590	6070
QDML100INV-525A-V6.6	6000	525	656.3	6751
QDML100INV-612A-V6.6	7000	612	765	7870
QDML100INV-700A-V6.6-W	8000	700	875	9010

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	750
QDML100INV-52A-V11	990	52	65	1115
QDML100INV-73A-V11	1390	73	91.3	1565
QDML100INV-107A-V11	2038	107	133.8	2295
QDML100INV-147A-V11	2800	147	183.8	3150
QDML100INV-192A-V11	3660	192	240	4115
QDML100INV-227A-V11	4325	227	283.8	4865
QDML100INV-262A-V11	4992	262	327.5	5615
QDML100INV-306A-V11	5830	306	382.5	6560
QDML100INV-350A-V11	6670	350	437.5	7500
QDML100INV-402A-V11	7660	402	502.5	8620
QDML100INV-472A-V11	8995	472	590	10120
QDML100INV-525A-V11	10000	525	656.3	11255
QDML100INV-612A-V11	11660	612	765	13120
QDML100INV-700A-V11-W	13340	700	875	15010

Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm) (*) WCU unit included	Weight (kg) (*) WCU unit included
12.8	Air	A	4400x2200x1500	5120
19	Air	A	4400x2200x1500	5260
26.7	Air	A	4500x2200x1500	5440
39.2	Air	A	4500x2200x1500	5730
53.8	Air	A	4600x2200x1500	6100
70.2	Air	B	5200x2200x1500	7260
83	Air	B	5300x2200x1500	7880
95.8	Air	B	5400x2350x1500	8500
112	Air	B	5500x2350x1500	9300
128	Air	B	5600x2350x1700	10100
147	Air	C	6500x2350x1700	10950
172.6	Air	C	6600x2350x1700	12100
192	Air	C	6900x2750x1700	12940
223.8	Air	C	7200x2750x1700	12350
256	Water	C	9200x2750x1700 (*)	17800 (*)

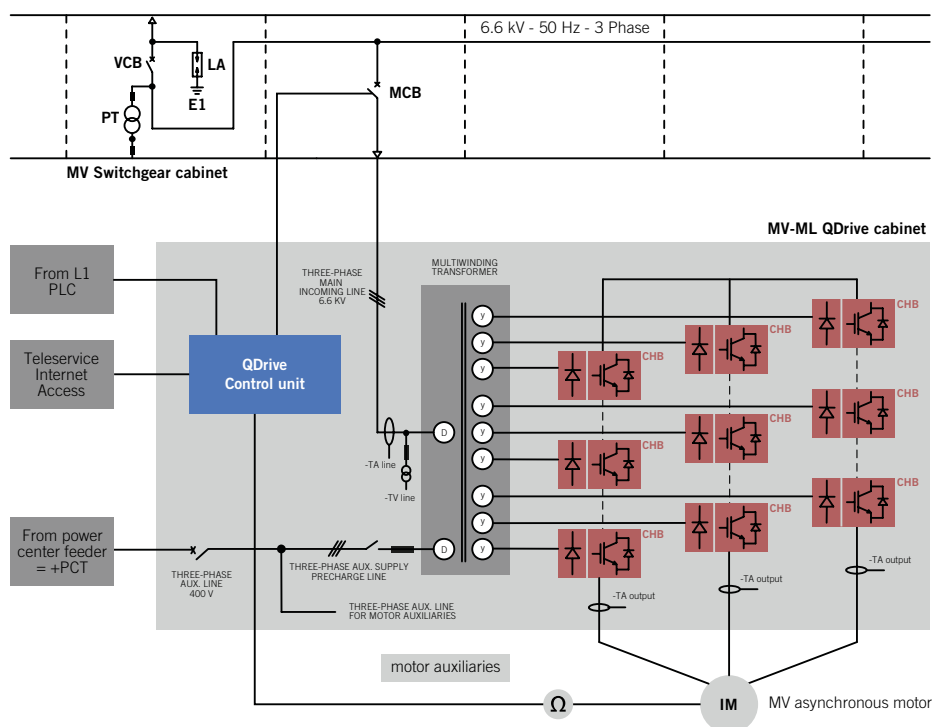
Expected power losses in air (kW)	Cooling method	CHB frame	Width x height x depth (mm)	Weight (kg)
21.3	Air	A	6200x2350x1700	6600
31.7	Air	A	6200x2350x1700	6800
44.5	Air	A	6300x2350x1700	7080
65.2	Air	A	6300x2350x1700	7820
89.6	Air	A	6500x2350x1700	8980
117	Air	B	7300x2750x1700	10600
138.4	Air	B	7300x2750x1700	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

MV Multi-Level QDRIVE

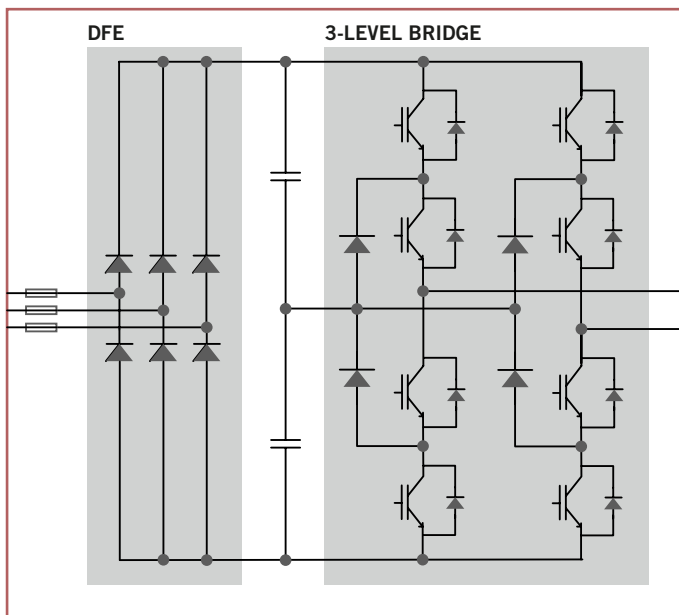
Power Part Main Features

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)





CHB-cell converter detail - 6 pulses input diode bridge

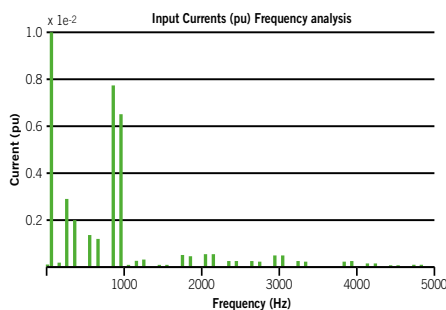
Output voltage (kV)	3.3	4.16	6.6	11
Number of CHB cells for each phase	2	2	3	5
Phase shift between secondaries windings of each group	30	30	20	12
Output waveforms voltage levels (line to line voltage)	17	17	25	41
Three groups of "n" windings	2	2	3	5
Number of secondaries windings	6	6	9	15
MV supply line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

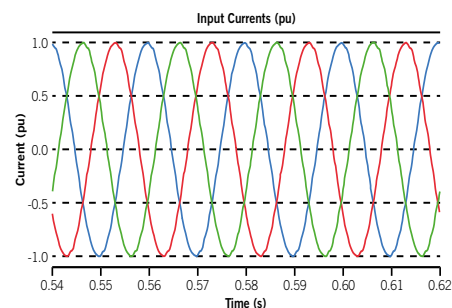


Typical waveforms & line current harmonics spectrum

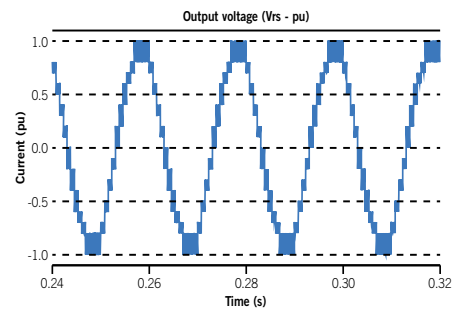
The use of multi-windings transformer combined with CHB converter typology and particular modulation technique allows to achieve an excellent behaviour on the MV supply network, in terms of power factor and line current harmonics, in full compliance with IEEE and IEC relevant standards.



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



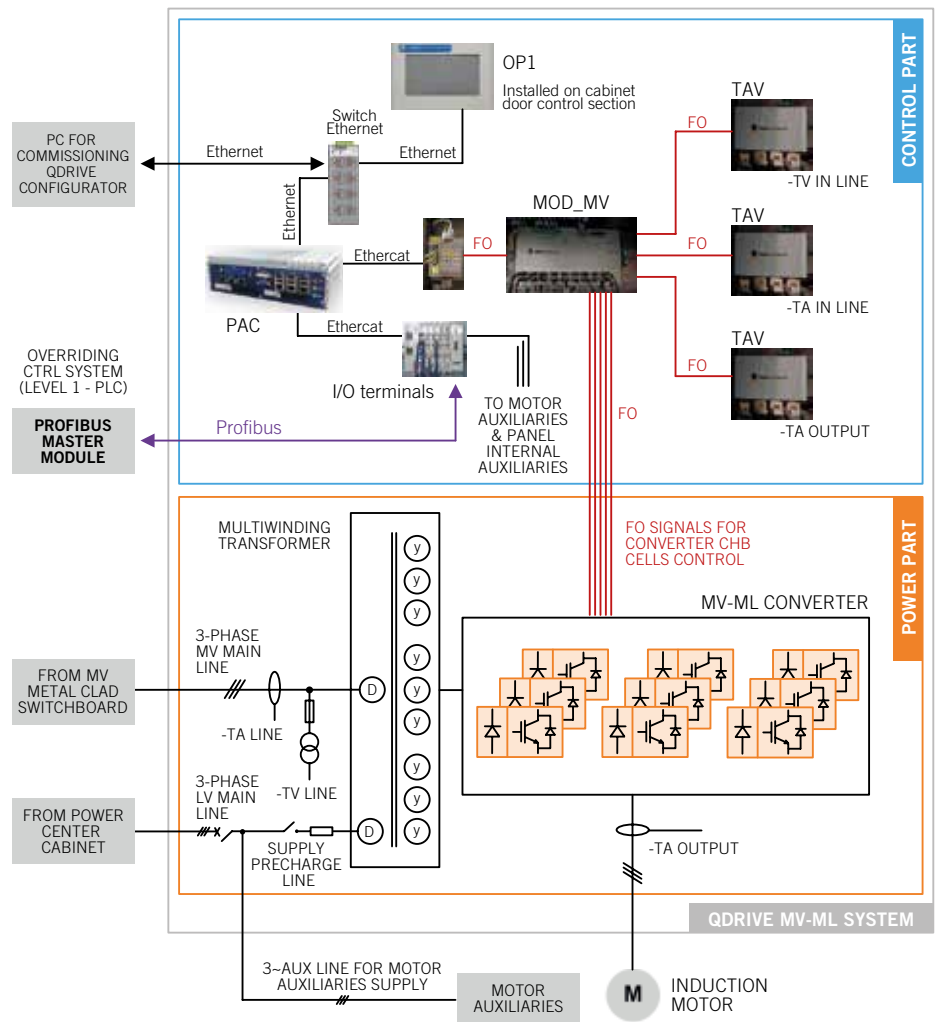
Input Current waveform for 50 Hz output



Output Voltage waveform for 50 Hz output

MV Multi-Level QDRIVE

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.



Control section



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.



Drive operator panel (OP1)

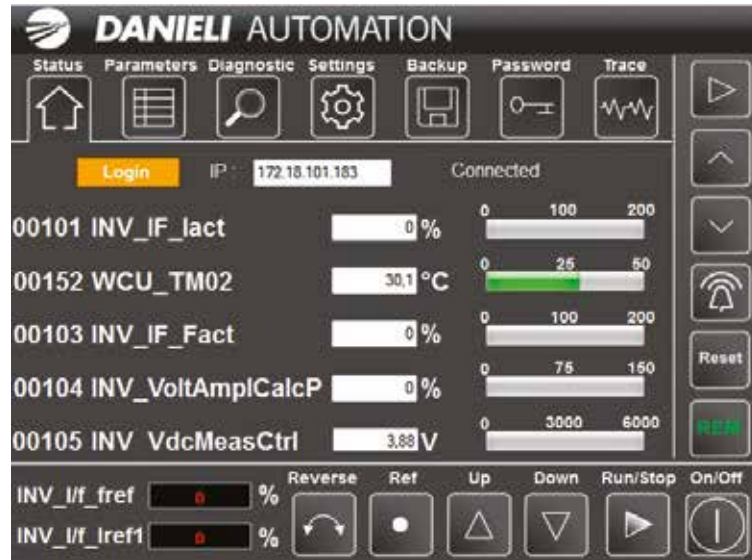
MV Multi-Level QDRIVE

Operator Panel

Converters and drive system operator panel

The drive system is equipped with a dedicated operator panel (colour touch panel) for Inverter parametrization (OP1, located on the control unit door).

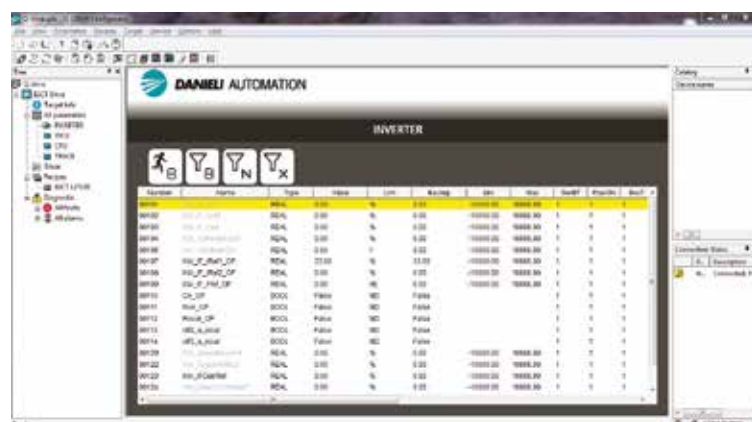
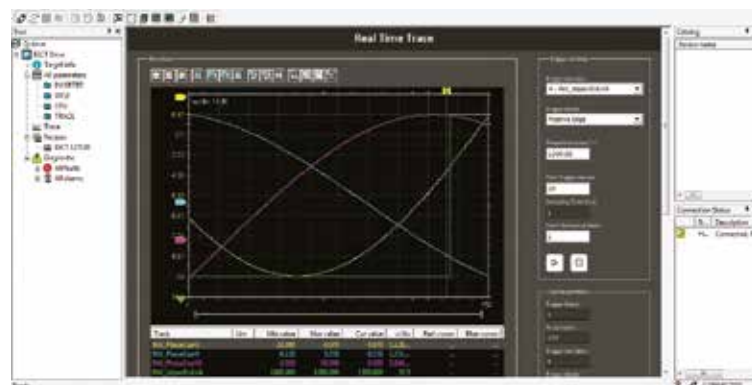
Through the panel it is possible to perform extensive drive system parametrization, monitoring and servicing; tracing of the internal control signals it is also possible without using any additional tool or pc.



Operator panel screenshot

Powerful PC commissioning tool for converters

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.



DA QDrive tool screenshots



MV Multi-Level QDRIVE

Maintenance



Simple and fast maintenance is a key factor for reliable equipments. The design of the CHB power cells and of the converter housing structure allows a fast and easy

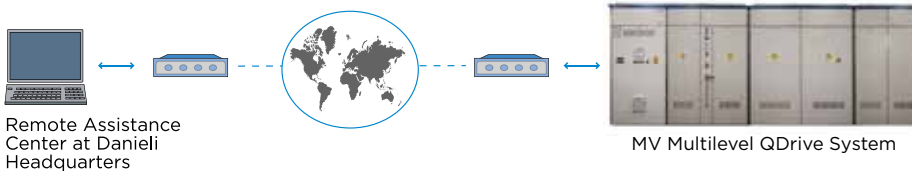
replacement of a cell in less than 30 minutes.

The CHB lifting trolley is always included in the scope of supply.



MV Multi-Level QDRIVE

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 necessary technical support and monitoring of the LV & MV drives 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.



MV Multi-Level QDRIVE

Auxiliary components



EXC - Field Exciter converter cabinet for synchronous motor dc excitation

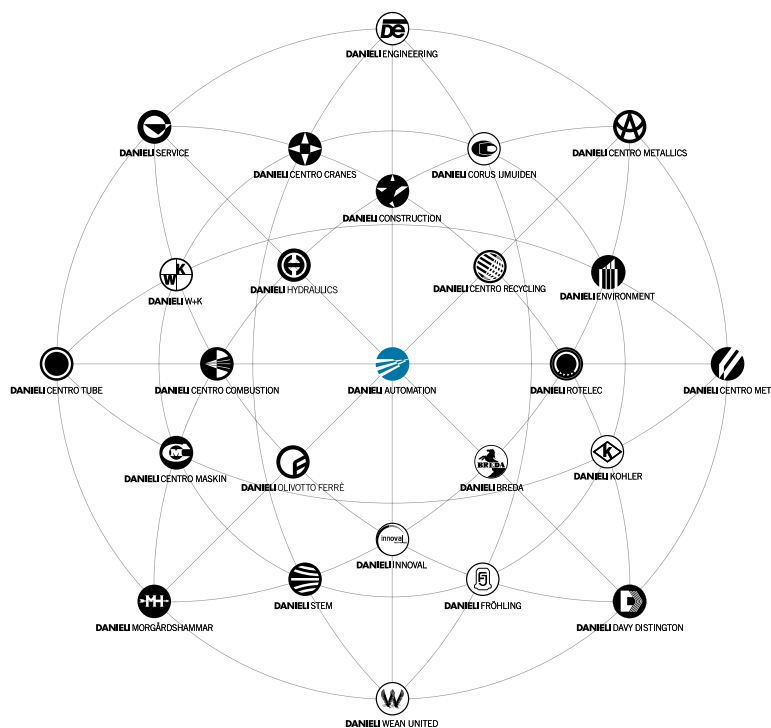
The unit includes market-type LV AC/DC compact converter with protection crowbar.

The cabinet has incoming line circuit breaker and it is controlled from QDrive Control unit through Internal Profibus network (External field exciter option).



AUX_MCS - Auxiliary system motors control starter cabinet

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



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