**Symphony™** – Medium Voltage Drives for all Applications

**New Innovation**

The world leader in installed drive kW and with over 100 years’ experience in manufacturing quality electrical equipment, ALSTOM brings further innovation to the field of drive technology with the introduction of the new and exciting air cooled version to the Symphony drive family of medium voltage AC drives – ALSTOM’s masterpiece.

Symphony drives are voltage source and incorporate an insulated gate bipolar transistor (IGBT), pulse width modulated (PWM), multi-level inverter. This multi-level inverter topology is the key to the drives. Patented in 1995, the design is solely licensed to ALSTOM. By modifying, improving and applying the latest technical advances to a design already proven in the field, ALSTOM incorporates all the best features in the Symphony drives. The air-cooled versions build on the success of the water-cooled range introduced in the mid 90’s.

**Benefits**

What makes Symphony the best drive for your application? The same features that were the key design criteria in their development:

- **Quality input** – low harmonics and high power factor minimising effect on supply network
- **Low operating cost** – high efficiency and reliability
- **Quality output** – connects to new and existing standard motors without de-rating
- **Easy to use** – advanced controller features
- **Easy to maintain** – minimal component count and modular construction

Air-cooled Symphony drives cover the power range 280 – 22,400kW, and are suitable for all general drive applications such as pumps, fans, compressors and mixers. The dynamic performance of the drive also makes it capable of meeting the higher performance demanded by rolling mills, mine winders and long conveyors.

**Input Converter**

Symphony air-cooled meets or exceeds international requirements for voltage and current harmonic distortion, including IEEE 579 (1992). The drive includes as standard an 18-pulse input converter, comprising 3 combined diode/thyristor bridges connected in series, and does not need input fuses. Thyristors are used because they provide a simple method of pre-charge via resistors. Once switched on, the thyristors in the combined bridges operate as diodes (no phase control), thereby ensuring a high input power factor, exceeding 0.95 throughout the speed range.

Depending upon specific power system requirements, Symphony can also be supplied with a range of input converter options at 24 and 36 pulse or an Active Energy Management (AEM) System.

The AEM system comprises a fully controlled IGBT input converter providing:

- Regeneration to the supply network
- Unity power factor
- Negligible harmonics sinusoidal input

For multiple drive applications, inverter bridges can be connected on a common DC bus supplied from a single input converter. This capability provides the opportunity for further reductions in space requirements and overall system cost. Symphony can also be supplied with dynamic braking for those applications requiring rapid deceleration of high inertia loads (e.g. emergency stop) or reversal of load direction on start-up (e.g. windmilling fans).

**Input Transformer**

As standard, the input transformer is included as part of the Symphony cubicle suite. The input converter design also allows the transformer to be supplied as a stand-alone unit for installation remote from the drive, which enables Symphony to meet the requirements of those sites where cooling or space restrictions are a problem. Both dry and oil cooled transformers are available.

**Input Switchgear and Protection**

The Symphony fuseless design allows the drive to be connected to an input circuit breaker without any additional isolation, switching, fusing or protection requirements. Solid state protection switches off the thyristors and trips the input supply circuit breaker on detection of a fault. This provides the fastest possible protection of the transformer secondary windings and DC link.

Symphony can also be supplied with a range of alternative input switchgear and protection options to suit the requirements of all applications and site specific configurations.
The Key to Symphony™

Multi-Level Topology

The patented multi-level inverter topology is the key to Symphony. The multi-level design provides a nearly sinusoidal output using medium voltage IGBTs, which offers significant benefits to the user:

- The nearly sinusoidal output requires minimal filtering and allows the connection of standard motors, both new and existing, without derating
- The low filtering requirement ensures minimum filter losses and does not affect dynamic performance
- The use of medium voltage IGBTs significantly reduces the number of power switching units, resulting in increased efficiency and reliability
- The multi-level inverter has excellent electro-magnetic noise compatibility and meets the latest EMC requirements
- The phase arms are inherently balanced, reducing component count and increasing reliability

Integrated Power Module

Symphony uses the latest type of medium voltage IGBT, which is the optimum switching device for the multi-level topology in this power range. IGBTs permit a higher pulse width modulation (PWM) frequency to be employed than other semiconductor switching devices, which reduces motor ripple current and torque pulsations, and increases dynamic performance. This also allows faster response under fault conditions, providing better protection.

The gate driver is mounted directly onto the IGBT, forming an integrated module. This close proximity allows closer control of IGBT switching, improving performance and at the same time reducing component count, increasing reliability and simplifying replacement.

Construction Simplicity

Modular Construction

A key design feature of Symphony is the simplicity of its modular construction and ease of maintenance. The individual input converter bridges, IGBT modules and floating capacitors are assembled as withdrawable units, reducing spare parts requirements and repair time.

Each inverter phase arm comprises three pairs of IGBTs and three floating capacitors. The capacitors are of the thin-film, self-healing type. Each pair of IGBTs switch one level of the multi-level output waveform. The modular concept leads to a very simple and compact construction.

Cooling Fans

The multiple cooling fan design allows the drive to continue to operate with the loss of any one fan, at either full or reduced load. The fans are accessible from outside the cubicle, allowing quick and easy replacement.

Easy to Maintain

The comprehensive control diagnostics and modular construction makes Symphony very quick and easy to repair. Typical replacement times are:

- IGBT module 15 mins
- Control module 15 mins
- Cooling fan 15 mins.
Output Waveform

The output waveforms generated by the multi-level inverter are naturally high grade and need minimal filtering, the output current total harmonic distortion being less than 3%. This nearly sinusoidal output ensures reliable operation with either new or existing standard motors without de-rating, irrespective of cable length.

Torque Pulsations

The high PWM switching frequency of the output waveform produces very low levels of electrically induced pulsating torques at the motor shaft. This reduces stress and the possibility of exciting mechanical resonance in the driven equipment.

Efficiency

The reduced number of power switching devices and minimal filtering requirements enable Symphony to achieve a very high converter efficiency of greater than 98%, and a typical overall drive efficiency, including input transformer, of greater than 96.5%.

Quality Output

Drive Intelligence

NoStop™ Trip Avoidance

The level of intelligence and protection in Symphony effectively eliminates the need to trip the drive to protect itself. In the advent of adverse process conditions, the drive can take intelligent action to protect itself, resulting in higher plant availability and warning of process problems before they occur.

Reliability By Design

Reliability has been specifically built into Symphony. With detailed thermal and lifetime modelling, with significantly fewer components and with environmental and user error protection built-in, the drive is inherently highly reliable.

Shock Load Withstand

The high-speed electronic protection of the power devices allows Symphony to withstand shock loads. When an instantaneous overload occurs, the output current is limited, allowing the drive to continue powering the motor without damage to itself, and if the overload is temporary, the process continues without interruption.

Supply Loss Ride-through

Symphony can ride through short breaks in the supply by regenerating energy from the load. When the supply is restored, the motor is immediately accelerated back to the desired speed.

Synchronization

Symphony can synchronise with and “catch” a spinning load making the drive suitable for all drive/bypass configurations and applications.
### Easy to Control

**Advanced Digital Controller**

The fully digital controller of the Symphony is a proven system widely used on ALSTOM drives. Software selectable motor control features are included as standard:
- Variable voltage variable frequency control (VVVF)
- Open loop vector control
- Closed loop vector control.

The controller has comprehensive built-in tests and diagnostics with on-line help to ensure maximum protection and detection of problems as they develop, not just once they have occurred. The patented control software has a very high performance dynamic control and comprehensive communication capabilities, enabling the drive to be easily integrated into SCADA and automation systems. The controller has sufficient capacity that the majority of external functions, such as motor and system auxiliaries, can be accommodated without using additional PLCs.

**ALSPA Drive Data Manager™**

The ALSPA Drive Data Manager™ redefines the keypad concept. This door mounted device, easily removed for hand held use, provides effortless interfacing to the drive:
- Menu navigation
- On-line help and diagnostics
- Quick setup procedure
- Upload/download
- File storage
- Parameter and status display

**ALSPA Drive Coach**

The Windows based Drive Coach software further simplifies the drive interface and includes the following features:
- Drive setup tool
- Parameter editor
- Upload to disk
- Drive history record viewer
- Hyperlink help facility

### Technical Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor shaft power range</strong></td>
<td>280-2240 kW (air cooled) nominal. Higher ratings on request</td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td>3 Phase, 4.16kV, +/- 10%, other voltage levels available e.g. 2.4kV, 3.3kV, 6.6kV, 10.0kV, 11.0kV, 13.8kV</td>
</tr>
<tr>
<td><strong>Supply frequency</strong></td>
<td>50/60Hz +/- 5%</td>
</tr>
<tr>
<td><strong>Auxiliary voltage</strong></td>
<td>3 phase, 400/480V, +/- 10%</td>
</tr>
<tr>
<td><strong>Supply converter</strong></td>
<td>Standard 18 pulse fully complies with IEC 61800-3 and IEEE519 optional 24, 36 pulse and Active Energy Management (AEM)</td>
</tr>
<tr>
<td><strong>Input power factor</strong></td>
<td>&gt; 0.95</td>
</tr>
<tr>
<td><strong>Output overloads</strong></td>
<td>Variable torque: 110% full load current for 60s Constant torque: 150% full load current for 60s</td>
</tr>
<tr>
<td><strong>Output voltage</strong></td>
<td>3 Phase, 0 - 2.4kV, 0 - 3.3 kV, 0 - 4.16kV</td>
</tr>
<tr>
<td><strong>Output frequency</strong></td>
<td>0 - 60Hz (up to 120Hz with derating)</td>
</tr>
<tr>
<td><strong>Inverter type</strong></td>
<td>Multi-level (4-level) inverter, Pulse Width Modulated (PWM) with IGBTs</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>&gt; 98% (x96.5% including transformer)</td>
</tr>
<tr>
<td><strong>Enclosure protection</strong></td>
<td>IP21, optional IP32</td>
</tr>
<tr>
<td><strong>Operating temperature</strong></td>
<td>0°C to 40°C, higher with derating</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>5% to 95% relative humidity non-condensing</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>Forced air cooled, fan redundancy optional</td>
</tr>
<tr>
<td><strong>Audio noise</strong></td>
<td>&lt; 85 dB(A) [1m from cubicle suite], reduced audio noise level optional</td>
</tr>
<tr>
<td><strong>Motor control type</strong></td>
<td>Variable Voltage Variable Frequency (VVVF) / Flux Vector without encoder / Flux vector with encoder</td>
</tr>
<tr>
<td><strong>Control sources</strong></td>
<td>Drive Data Manager™ Keypad. Terminals for remote control (analog and digital). Serial Links</td>
</tr>
<tr>
<td><strong>Control features</strong></td>
<td>Speed/torque/position control Skip frequencies: 4 skip bands to avoid resonances Reference sequencing: 16 preset speeds Fluxing characteristics: Fan or constant torque load characteristics Start modes: Normal and auto-synchronising Stop modes: Ramp, Coast, DC Injection PID control: Programmable analogue inputs and PID control valves Back-up control source: Programmable defaults for action upon loss of control Auto restart: Programmable number of attempts up to 20 Supply loss: Maintains synchronism with motor during supply dip History record: 10 selectable channels Trip history: Records 50 previous trips or warnings</td>
</tr>
</tbody>
</table>

Active Energy Management is an ALSTOM feature to ensure a unity power factor near sinewave current in the supply during motoring and regeneration. It removes the need for harmonic filters and braking resistors.
Electronic protection
Overcurrent, current limit, motor phase current imbalance, over and undervoltage, heat sink temperature (per heat sink), motor stall

Serial communications
RS485, RS232, with MODBUS ASCII/RTU, Optional fieldbuses, Profinet, Modbus+, WorldFIP, CANopen, DeviceNet

Standard I/O
24 Digital Inputs and 16 Digital Outputs
4 Analogue Inputs, 4 Analogue Outputs

Enhanced I/O
Optional

Standards
Complies with relevant international standards

The technical data are subject to change without notice.
Please refer to your ALSTOM Power Conversion sales office for further details and updates

Symphony Drives ratings for 4.0kV motors, 50Hz variable torque applications and 110% overload

<table>
<thead>
<tr>
<th>Reference</th>
<th>Motor Shaft Power* (kW)</th>
<th>Rated Output Current (A)</th>
<th>Max Output Current (A)</th>
<th>Width (mm)</th>
<th>Depth (mm)</th>
<th>Height** (mm)</th>
<th>Weight*** (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDM6405A</td>
<td>375</td>
<td>70</td>
<td>77</td>
<td>3000</td>
<td>800</td>
<td>2200</td>
<td>1675</td>
</tr>
<tr>
<td>VDM6410A</td>
<td>750</td>
<td>140</td>
<td>154</td>
<td>3000</td>
<td>800</td>
<td>2200</td>
<td>1770</td>
</tr>
<tr>
<td>VDM6415A</td>
<td>1120</td>
<td>210</td>
<td>231</td>
<td>3000</td>
<td>1000</td>
<td>2200</td>
<td>1995</td>
</tr>
<tr>
<td>VDM6420A</td>
<td>1500</td>
<td>280</td>
<td>308</td>
<td>3000</td>
<td>1000</td>
<td>2200</td>
<td>2175</td>
</tr>
<tr>
<td>VDM6425A</td>
<td>1865</td>
<td>350</td>
<td>385</td>
<td>3000</td>
<td>1200</td>
<td>2200</td>
<td>2495</td>
</tr>
<tr>
<td>VDM6430A</td>
<td>2240</td>
<td>420</td>
<td>462</td>
<td>3000</td>
<td>1200</td>
<td>2200</td>
<td>2765</td>
</tr>
</tbody>
</table>

* power ratings apply to typical 4 pole motors. ** without fans, fans plus 460mm. *** typical

Symphony Drives ratings for 4.0kV motors, 50Hz constant torque applications and 150% overload

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<thead>
<tr>
<th>Reference</th>
<th>Motor Shaft Power* (kW)</th>
<th>Rated Output Current (A)</th>
<th>Max Output Current (A)</th>
<th>Width (mm)</th>
<th>Depth (mm)</th>
<th>Height** (mm)</th>
<th>Weight*** (kg)</th>
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<tbody>
<tr>
<td>VDM6405A</td>
<td>280</td>
<td>52</td>
<td>77</td>
<td>3000</td>
<td>800</td>
<td>2200</td>
<td>1675</td>
</tr>
<tr>
<td>VDM6410A</td>
<td>360</td>
<td>104</td>
<td>154</td>
<td>3000</td>
<td>800</td>
<td>2200</td>
<td>1770</td>
</tr>
<tr>
<td>VDM6415A</td>
<td>840</td>
<td>156</td>
<td>231</td>
<td>3000</td>
<td>1000</td>
<td>2200</td>
<td>1995</td>
</tr>
<tr>
<td>VDM6420A</td>
<td>1120</td>
<td>208</td>
<td>308</td>
<td>3000</td>
<td>1000</td>
<td>2200</td>
<td>2175</td>
</tr>
<tr>
<td>VDM6425A</td>
<td>1400</td>
<td>260</td>
<td>385</td>
<td>3000</td>
<td>1200</td>
<td>2200</td>
<td>2495</td>
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<tr>
<td>VDM6430A</td>
<td>1680</td>
<td>312</td>
<td>462</td>
<td>3000</td>
<td>1200</td>
<td>2200</td>
<td>2765</td>
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