



ROBICON Perfect Harmony

Short overview



System overview

Product features

ROBICON Perfect Harmony

System Overview

The Topology

The System

ProToPS™

Control Interface

Motors

Applications

- Truly Scaleable Technology
- 300 kW to 30 MW (Single Channel)
- Large Number of Framesizes
- Most Motor Voltages Supported
- Low Harmonic Input
- High Efficiency and Power Factor
- Line Disturbance Immune
- New or Existing Motors
- Negligible Pulsating Torques
- High Availability



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System overview

The Harmony concept: provide an integrated VFD system

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Feature	Perfect Harmony
Isolation Transformer	Included
Harmonic Filtering	Inherent
Power Factor Correction	Inherent
Power Converter	Included
Motor Filter	Inherent

- Easy engineering
- Simple installation
- Lower installed cost.

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System overview

Product history

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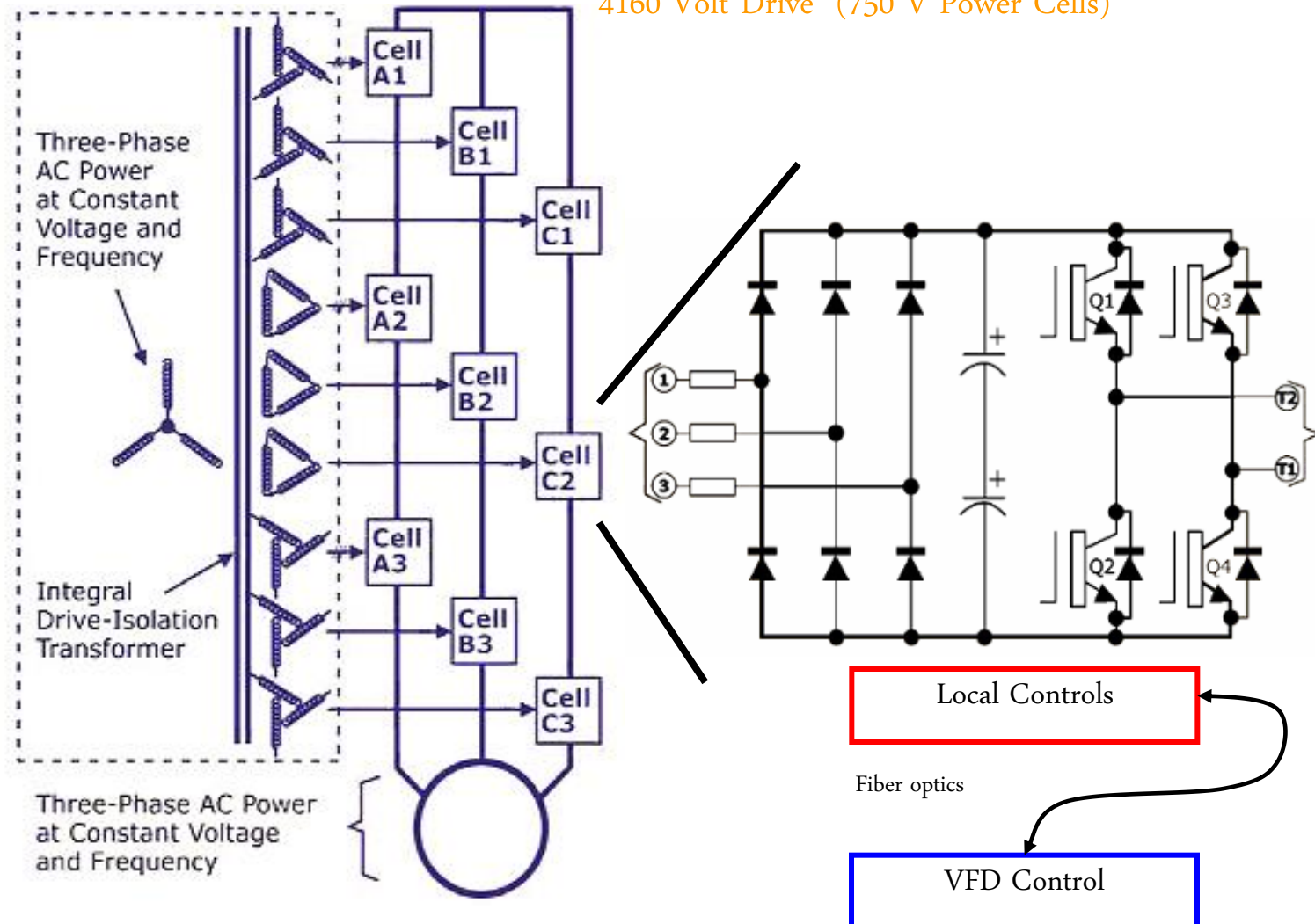
Product introduction	1994
Increased output to 6.6 KV (690 V cells)	1995
Gen II: Options program	1996
UL/CSA	1996
ProToPS™	1998
Gen III Harmony	1998
CE Mark	1999
Fast Bypass	1999
Increased max power to 19,000 kVA (1250 A – 690 V cells)	2000
Introduced Harmony HV for 13.8 KV motors	2003
Largest PWM VFD 45/60 MW with AFE	2004
3000 Perfect Harmony units sold	2005
Introduced Gen IV – smallest air-cooled MV VFD	2006



Perfect Harmony Topology

Typical Power Section Schematic

4160 Volt Drive (750 V Power Cells)



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Perfect Harmony Topology

Principle of Operation

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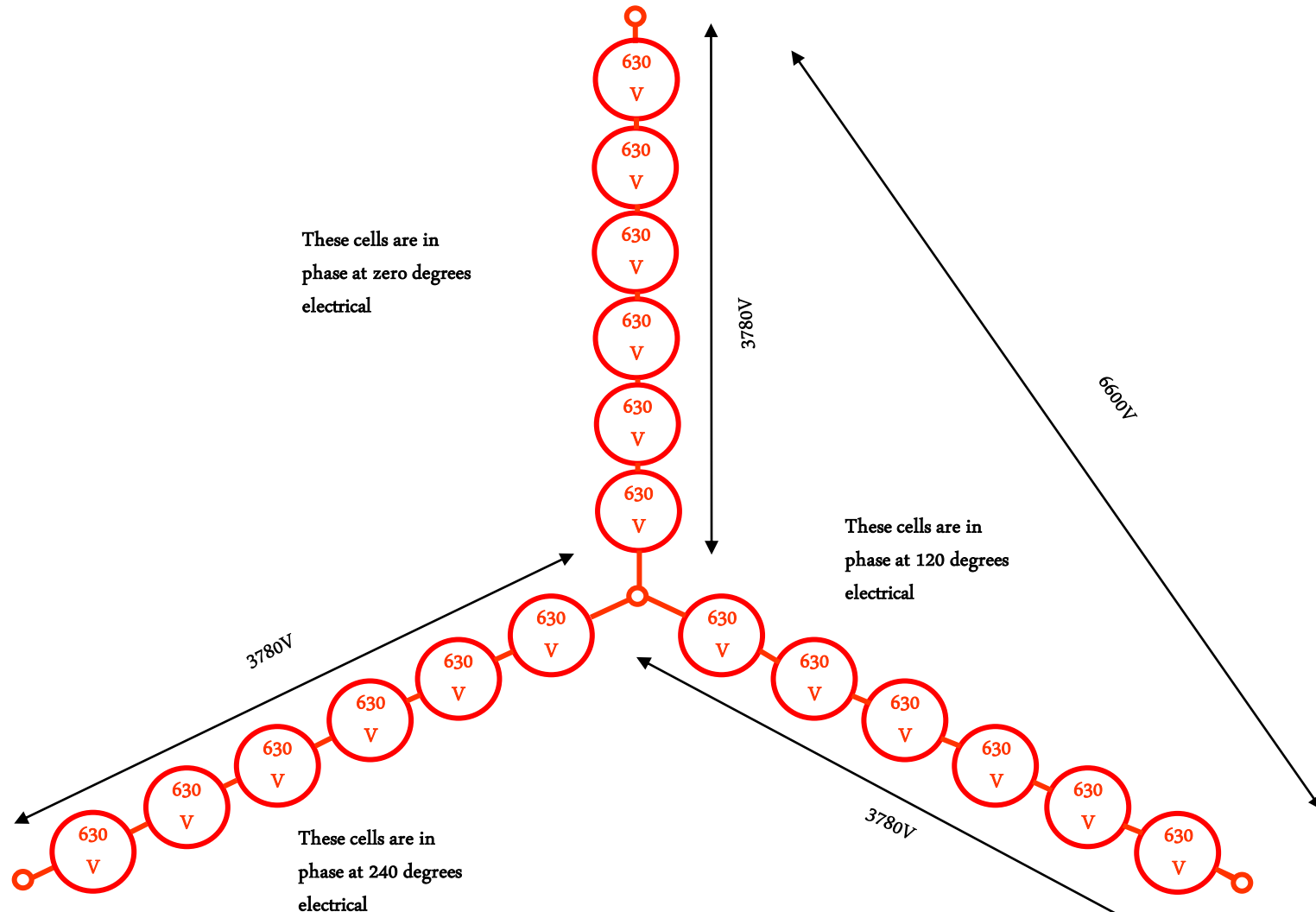
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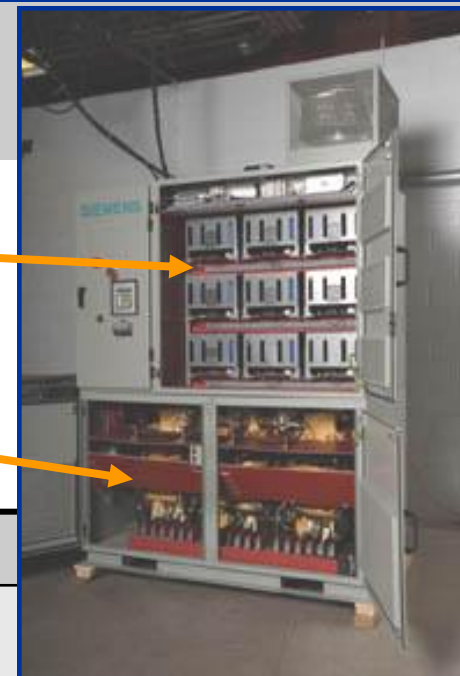


System performance

Isolation transformer

Power cells

Integrated
transformer



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Features	Customer benefits
Isolation transformer: included <ul style="list-style-type: none"> ■ No motor common mode voltage issues 	<ul style="list-style-type: none"> ■ Prevents risk of motor damage by common mode voltages ■ Enhances the retrofit capability ■ Avoids expensive motor modifications or the need for a new motor
<ul style="list-style-type: none"> ■ Continued operation with one earth fault possible 	<ul style="list-style-type: none"> ■ Increased system availability
<ul style="list-style-type: none"> ■ Isolation transformer built into drive cubicle 	<ul style="list-style-type: none"> ■ Easy plug-and-play installation: Three cables in, three cables out ■ Perfect for retrofit projects

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System performance

Input power quality

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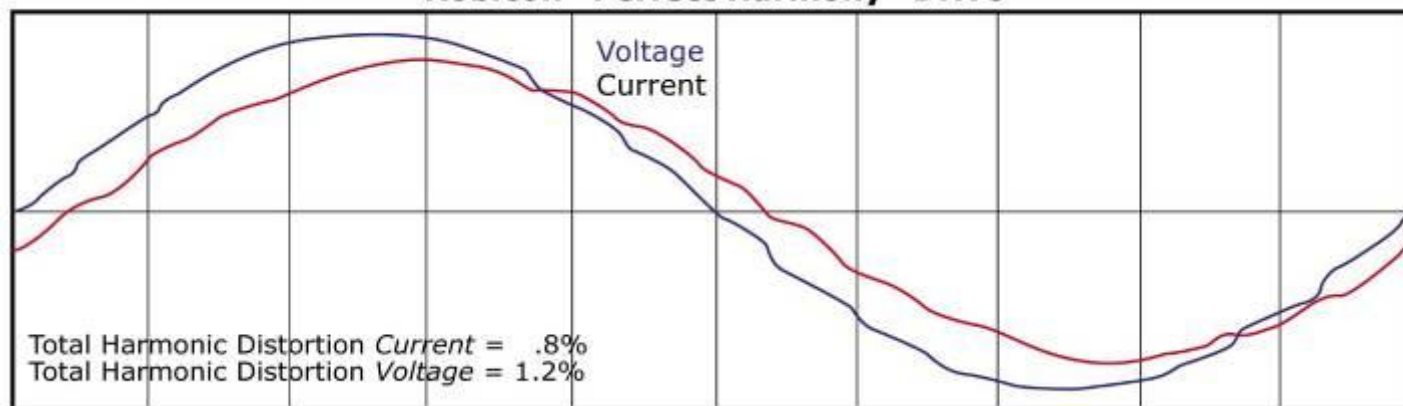
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Robicon "Perfect Harmony" Drive



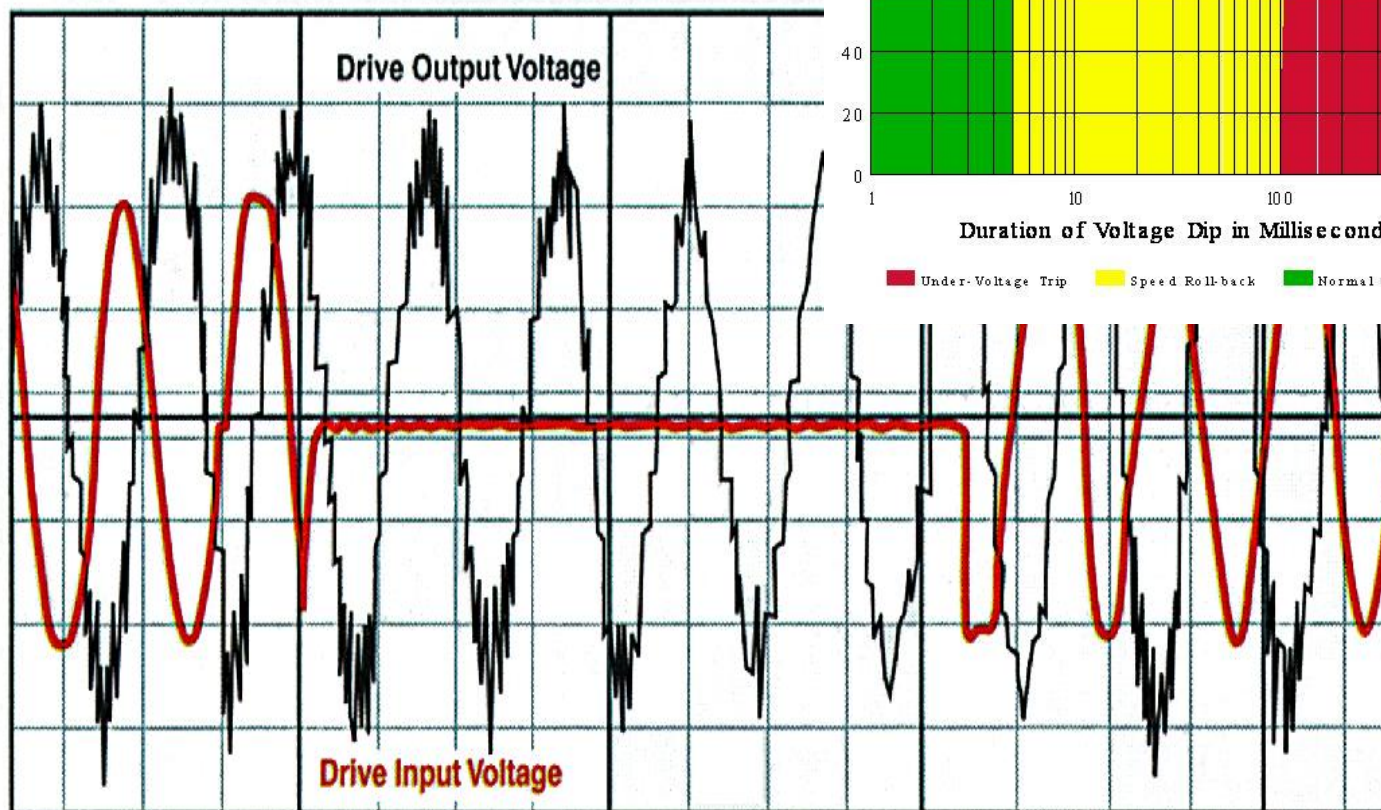
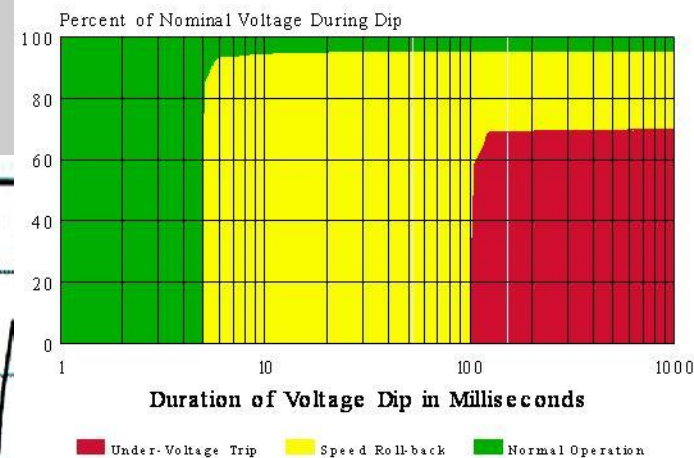
1000 HP / 750 KW VFD, 1100 kVA 5.75% Impedance Source

Features	Customer benefits
<p>Harmonic filter inherent:</p> <ul style="list-style-type: none"> ■ “Clean power” sinusoidal converter ■ Near zero harmonics 	<ul style="list-style-type: none"> ■ Meets all new requirements of IEEE 519 1992 for both current and voltage distortion ■ Eliminates needs to do harmonic analysis ■ Eliminates costly harmonic filters required for distortion control



System performance

Loss of power supply



Continued operation when line voltage lost

- Restored operation with no trip for 5 cycle power interruption
- Restart Into spinning load with no load or line disturbance as long as motor flux is present

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System performance

Motor compatibility

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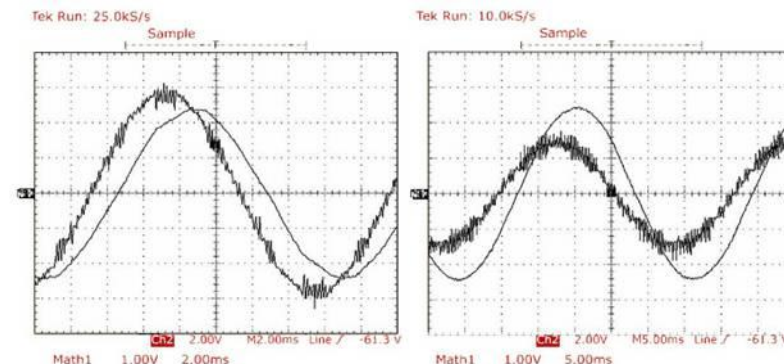
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Features	Customer benefits
Motor filter inherent: No common mode motor insulation stress	<ul style="list-style-type: none"> Drive is compatible with both new and existing motors Torque ripple 1% or less on driven load at all operating frequencies
No additional VFD induced motor heating	<ul style="list-style-type: none"> Drive can be safely applied to 1.0 service factor motors
No dv/dt problems	<ul style="list-style-type: none"> Drive creates no motor voltage insulation stress Motor does not require reinforced insulation



System performance

Motor compatibility

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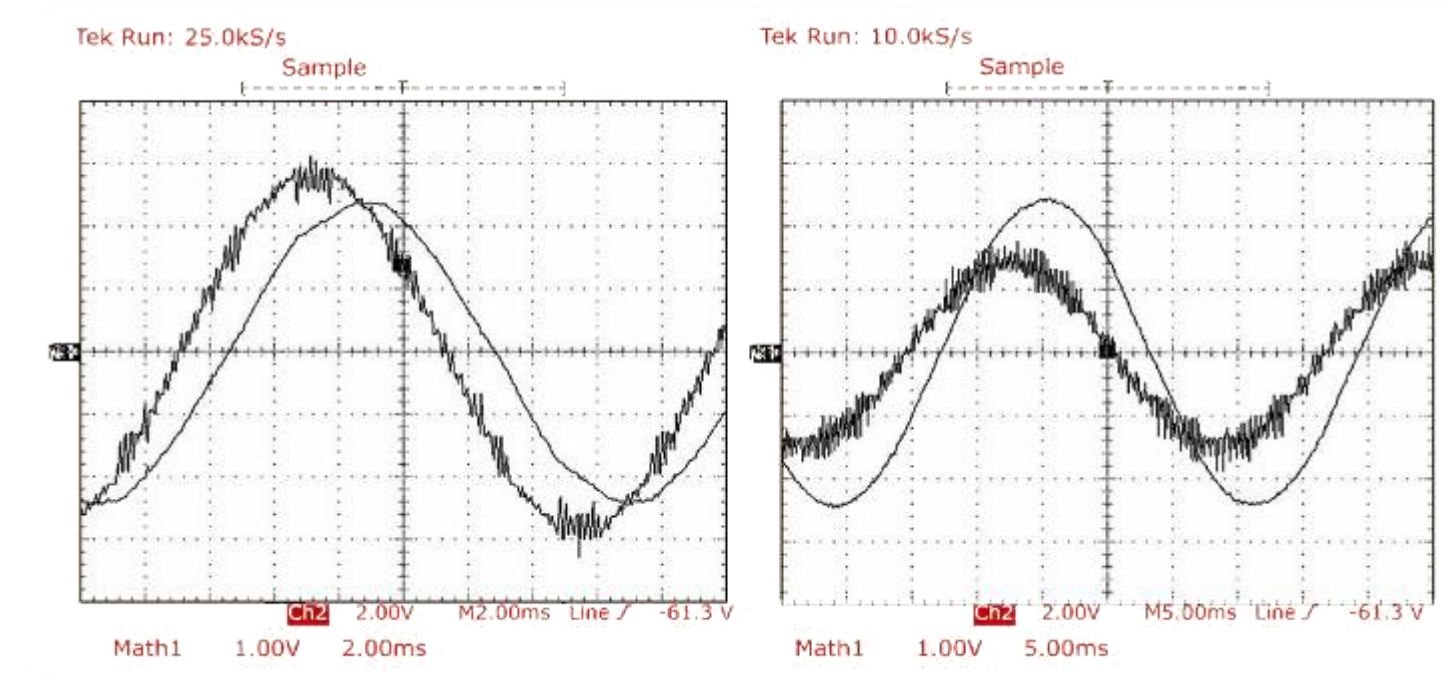
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Control Interface

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Applications

Output Waveforms @ 60 HZ and 30 HZ



Wave forms remain high quality at lower speeds due to multi-level PWM output.

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System performance

Output harmonics

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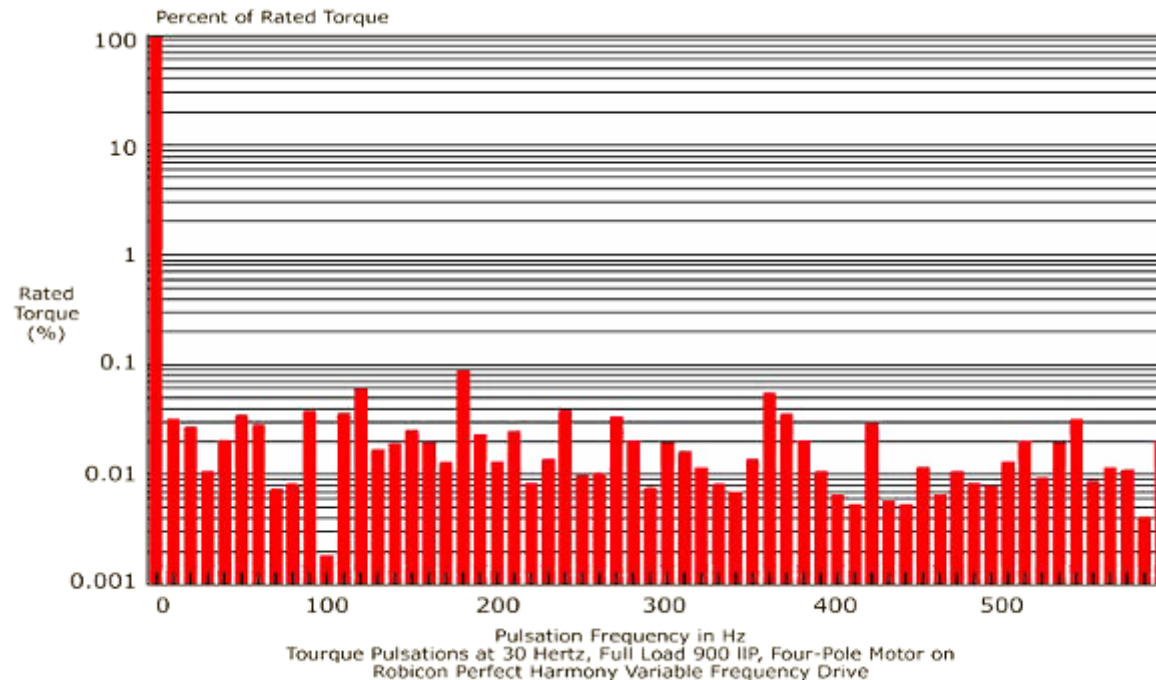
Control Interface

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Output Harmonics - Robicon Perfect Harmony Series

@ 30 HZ, Full Load



Less Than 2% VFD Induced Torque Ripple on Driven Load



System performance

Motor harmonic temperature rise

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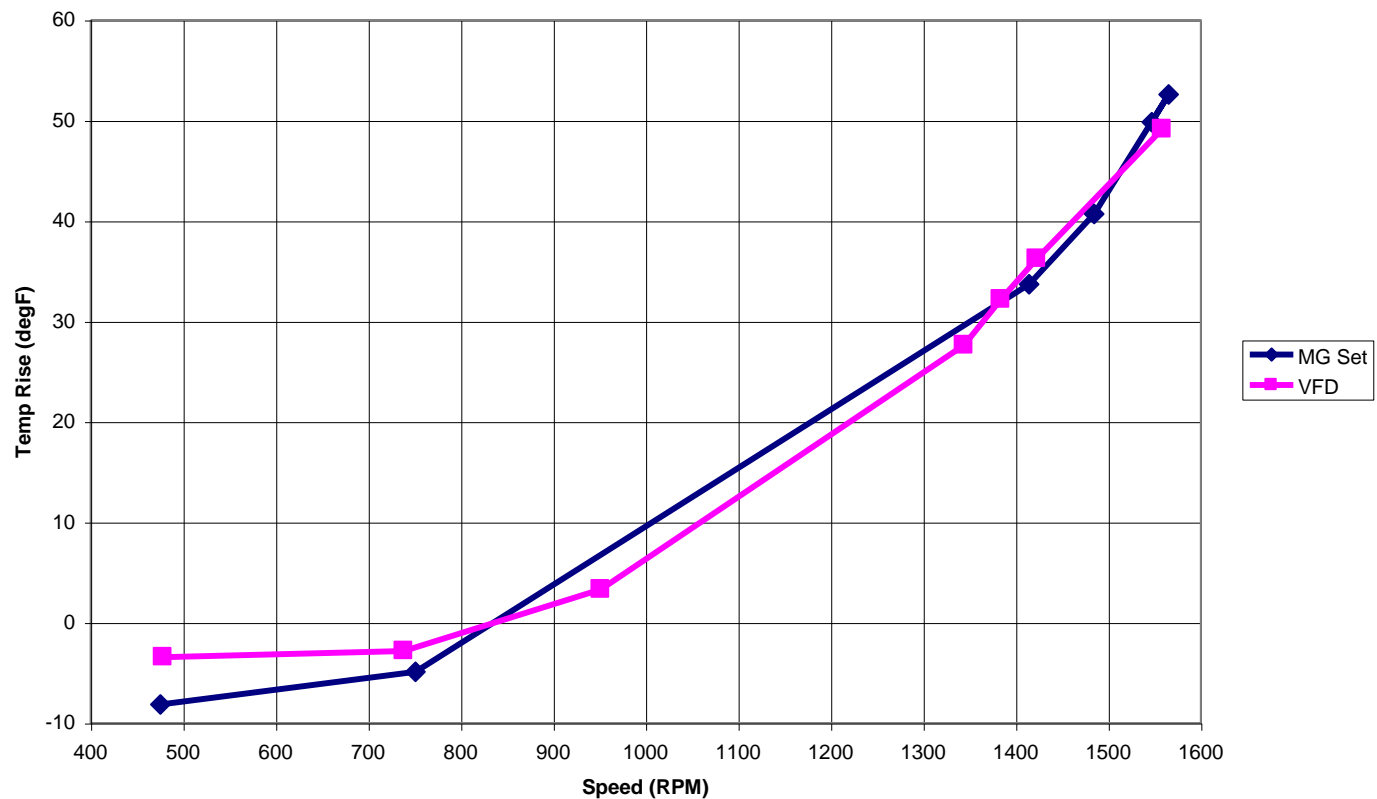
Motors

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Output Harmonics - Robicon Perfect Harmony motor operating from Generator vs. Perfect Harmony

Recirc Pump Motor 2B Temperature Rise
(Based on 3 hour Averages)





System performance

Factory integration

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Features	Customer benefits
<p>Factory integration:</p> <ul style="list-style-type: none"> ■ Fully integrated at Siemens A&D LD A ■ Complete In-factory test -tested as complete systems in our plant 	<ul style="list-style-type: none"> ■ Fast and safe commissioning at customer site ■ Comprehensive proof of performance ■ Enhances reliability by weeding out early failures

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Advanced Cell Bypass

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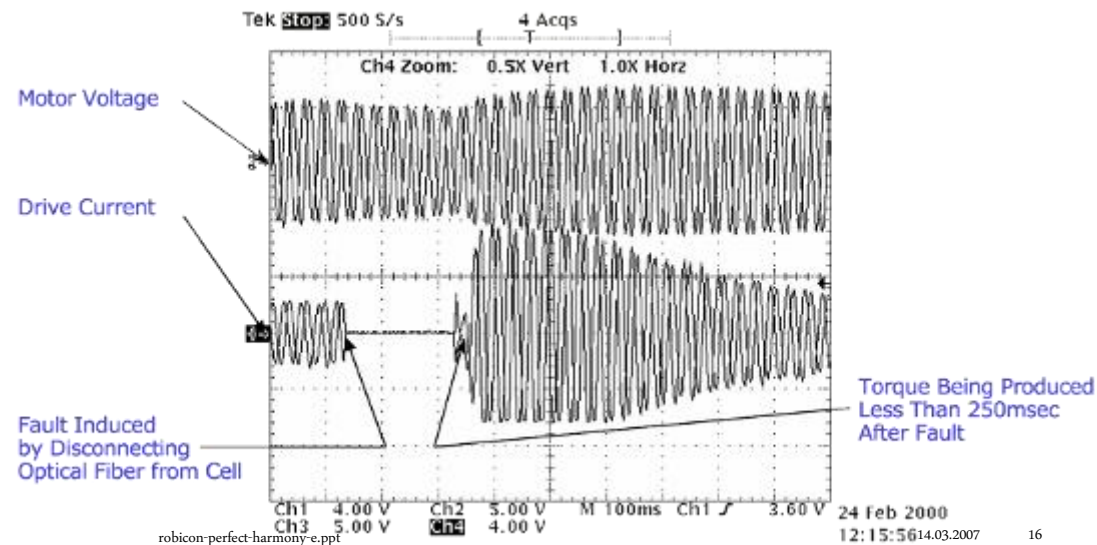
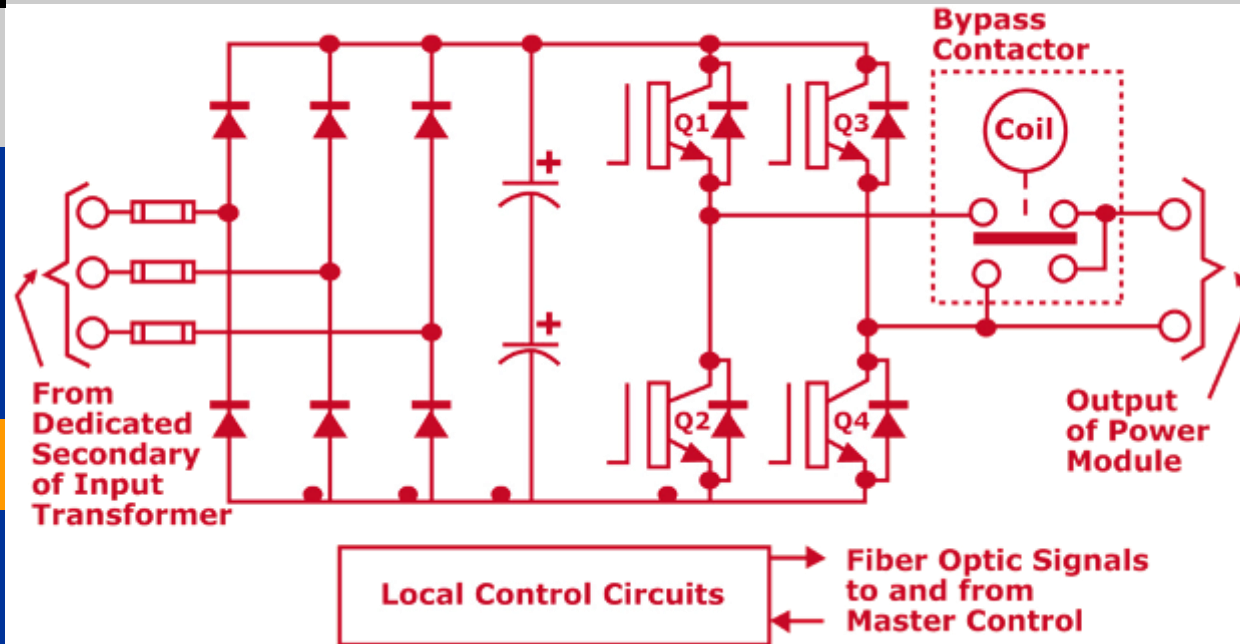
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Control Interface

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Advanced Cell Bypass Results



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ProToPS™

Bypass Contactor and Control

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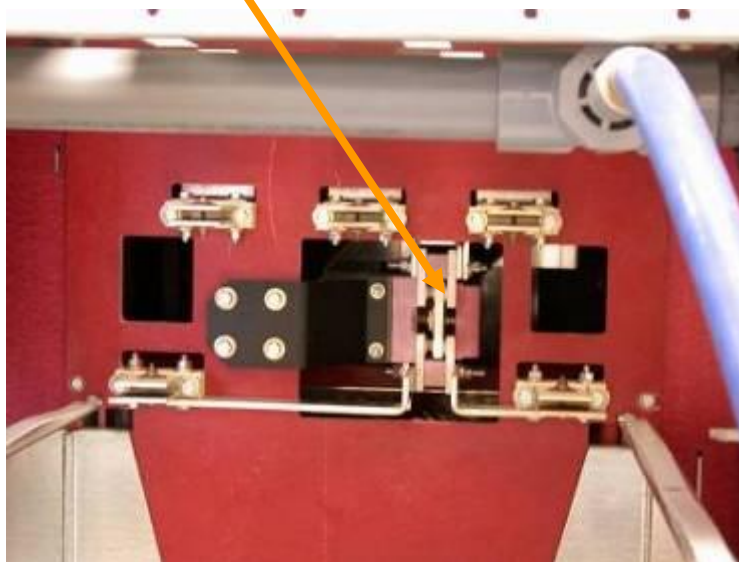
Control Interface

Motors

Applications

- Traction DC Contactor
- Automatic bypass of a failed power cell in 250 ms
- Completely redundant bypass control: Physically separate from cell
- Allows bypass down to (1) one cell per phase
- Allows unequal number of active cells per phase
- U.S. Patent No. 5,986,909 issued November 16, 1999

Bypass Contactor



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Cell Bypass Control Logic



Redundant
control

robicon-perfect-harmony-e.ppt

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Control Interface

Control

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Control Interface

Motors

Applications

Open Loop Sensorless Vector Control

- Motor-mounted encoder NOT required
- Duplicates two-quadrant DC operation
- Provides precision speed/torque control
- Features fast dynamic response
- Has low speed/high torque capability

Auto Tuning

- Provides motor information to optimize control
- Is a two-stage process
 - Stage 1: Stator resistance, leakage inductance
 - Stage 2: Motor no-load current, inertia

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Control Interface

Power monitoring

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Control Interface

Motors

Applications

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Can determine and display information about input waveform and drive output

Input display parameters

- Input voltage
- Input voltage harmonics (one at a time)
- Input current
- Input current harmonics (one at a time)
- Input PF
- Input power (kW)
- Input reactive power (kVAR)
- Input kW-Hr
- Input phase sequence
- Loss of phase
- Low voltage
- Transformer overload
- Output power (kW)
- kW-Hr
- Output current – RMS
- Output voltage – RMS
- VFD efficiency
- Motor torque
- Motor speed (RPM)
- Motor slip (%)
- Drive output frequency (Hz)
- Magnetizing current
- Torque current
- Motor flux



Control Interface

Control Drive Tool

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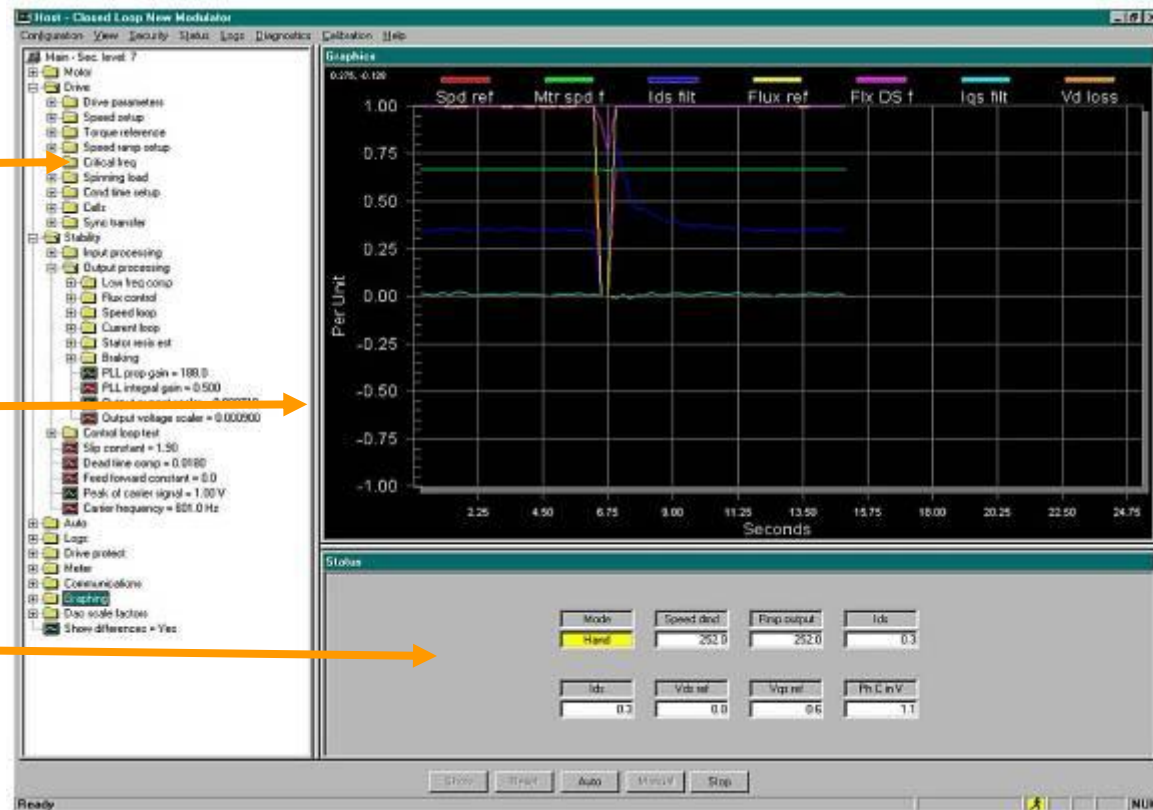
Motors

Applications

Menu structure window

Graphics window

Drive status window



- Provides Windows-based graphical user interface
- Provides full drive functionality
- Features same structure as keypad interface
- Has multiple language support



Motors

The perfect products for a broad spectrum of motors

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Applications

H-compact IEC

200 - 3000 kW

2 - 11 kV
2 - 12 pole

Squirrel cage

Cast iron housing
with cooling ribs
IP55



ANEMA

150 - 2500 HP

0.2 - 11 kV
2 - 16 pole

Squirrel cage

Cast iron housing
with cooling ribs

IP55/TEFC



H-compact PLUS IEC, ANEMA

1000 - 7000 kW
1340 - 9390 HP

3.3 - 13.2 kV
2 - 12 pole

Squirrel cage

Cast iron-/
Steel housing,
cooler assembly
IP23, IP55, WP II



ANEMA

200 - 10000 HP

0.2 - 13.8 kV
2 - 16 pole

Squirrel cage

Cast iron housing
cooler assembly

ODP, WP I, WP II,
TEAAC/TEWAC



Series 1R.5/S.5 IEC

7000 - 10000 kW

3.3 - 13.2 kV
4 - 24 pole

Squirrel cage
slip ring rotor
Synchronous

Cast iron-/
Steel housing,
cooler assembly
IP55, WP II



H-modyn IEC, ANEMA

7000 - 50000 kW
9390 - 67000 HP

6 - 13.2 kV
2 - 12 pole

Squirrel cage
Synchronous

Base frame,
Water cooling

IP55, WP II



Retrofit

- Existing motors
with standard
windings

Special motors

2000 - 65000 kW

690 V - 13.2 kV

Squirrel cage
synchronous

Example:
Highspeed
compressor
drive



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Applications

The perfect products for all applications

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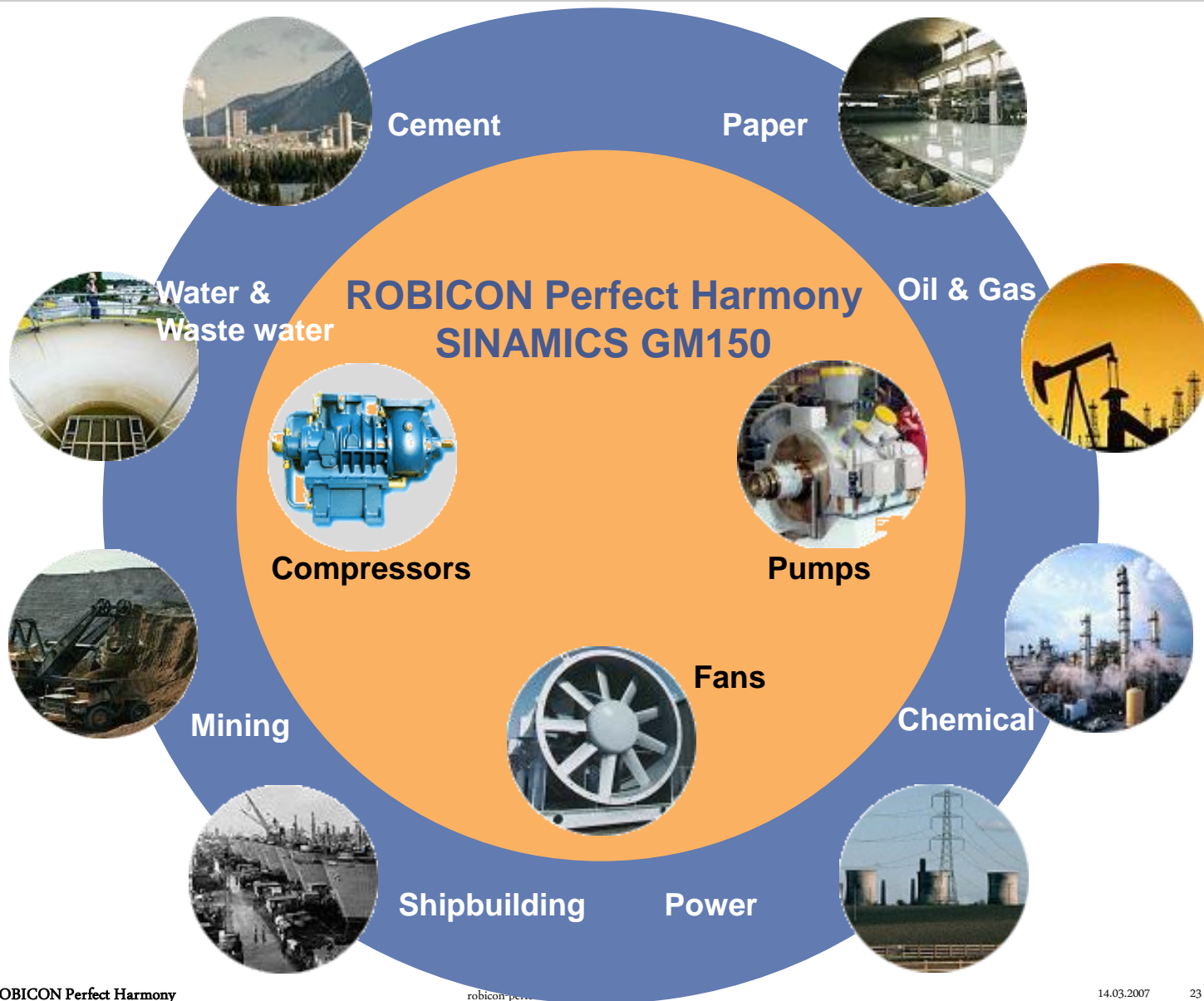
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