Automation for a Changing World

**Delta Energy-Saving Factory Automation Solutions**

www.deltaww.com

Advances in technology and progress in social and economic development have come with greater environmental degradation and increasingly negative effects on fragile ecosystems. The global energy crisis and related issues of energy shortages are becoming a matter of growing concern. The demand for new green energy resources and energy saving solutions is increasing. Many companies and industries have started to realize the importance of environmental protection and have been actively involved in energy saving and new energy solutions to reduce carbon emissions, decrease environmental pollution and lower energy consumption.

With professional technology in automation control and many years of effort in energy saving, Delta has developed a variety of energy saving products and solutions for diverse applications and industries. Our goal is to open new opportunities for the development of industries, and provide innovative, clean and efficient energy solutions for a better tomorrow.
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Challenges of Factory Automation

Implement various energy-saving solutions but still fail to lower electricity cost.

Unstable production due to fast depreciation rate of capacitors.

Government regulation and fines for high energy consumption industries and equipment.

Energy management difficult due to high electricity consumption.

Workers complain about poor parking lot environment.

More than 70% of energy cost comes from electricity.

Increasing costs for electricity production.
Challenges of Factory Automation

Energy management is difficult due to high electricity consumption.

Increasing costs for electricity and production.

Over-voltage of power distribution system is hazardous.

Unknown energy efficiency of ineffective energy-saving system.

Constructing an Energy Management System
**FEMS=Factory Energy Management System**

Delta's Factory Energy Management System (FEMS) is an energy-saving system which is able to monitor, manage and control energy supply and electricity consumption at production sites. It is used for lowering electricity consumption and optimizing energy usage.

By implementing the FEMS, an entire energy system can be linked. Through various energy management functions such as energy planning, energy monitoring, energy calculation, consumption analysis, per-unit and system management, the FEMS can provide visualization of energy usage, monitor electricity use across the entire plant and measure electricity consumption of various devices to achieve energy savings and power quality improvement.

The FEMS can help management make faster and better informed decisions by providing up-to-the-minute information and allow enterprises to reduce overall operating costs, maximize profitability, accelerate growth and increase asset efficiency.

**Four Step Approach for Energy Saving and Management**

1. Understand Current Situation and Analyze Factory Conditions
2. Find Problems and Explore Energy Saving Opportunities
3. Develop Action Plans and Efficient Energy Solutions
4. Implementation and Verification

**Understand Current Situation and Analyze Factory Conditions**

- Electricity Demand by Different End Uses
  - A variety of mixed equipment

- Increase System Capacity and Utilization of Existing Space
  - Deliver better energy performance

After using Delta's Energy-saving Core Products
Efficient Energy Monitoring and Management

1. Monitor energy consumption in real time
2. Calculate energy consumption and load characteristics
3. Optimize equipment performance and maximize energy efficiency
4. Troubleshoot power quality problems
5. Analyze energy consumption by end use and appliance
6. Analyze distribution of energy consumption

Energy Consumption by End Use and Appliances

- Energy Efficiency Indicator Analysis
- Result of Energy Saving Analysis
- Return on Investment (ROI) Verification

Distribution of Energy Consumption

- Per System Consumption
- Electricity Costs Analysis
- Electricity Consumption of On-Peak, Mid-Peak, Off-Peak, Normal Demand
- Efficient Transformers Energy Conservation
- Power Factor Improvement

Production Efficiency

Factory Electricity Comparison
FEMS System Structure

Delta's energy saving solutions include Delta's FEMS platform, industrial communication modules, and power meters. We can help customers save on energy costs and optimize their operation's energy efficiency.

1. Provides cost savings and ensures that consolidated services are available.
2. Guarantees stable and reliable energy supplies.
3. Enhances facility performance and efficiency to reduce management time and cost of power failure.
通過達能能源管理平臺及通訊轉換模組，並搭配智慧電錶可優化客戶的能源支出：

1. 全面節約能源成本，而不影響服務水準
2. 確保穩定的能源供應
3. 提高管理效率，減少停電時間和停電損失
Factory Automation

How do we keep the world alive with sustainable resources? --- Use energy wisely. "Smarter, Greener, Together" Delta pursues environmentally friendly products to make the world a better place through continuous innovation and providing diverse smart energy saving solutions.
■ HVAC (Heating, Ventilation, and Air Conditioning) Solution
Delta’s smart HVAC monitoring system induces fresh outside air based on indoor conditions and it controls air conditioning, and adjusts indoor temperature, humidity and CO2 density.

■ Power Quality Improvement
How do you improve power factor for better grid performance? How do you improve power efficiency with new devices? How do you realize the ultimate power distribution utility? The answer is to adopt Delta’s APF/ SVG/ AFE Series for power quality improvement.

■ Hybrid Energy Saving System - HES Series
A traditional injection molding machine is generally a fixed displacement system that has a pump and induction motor operate at full speed when power ON and it wastes 40%~80% of the energy. Delta’s HES system features
A. Energy-saving
B. Low oil temperature
C. Excellent reduplication rate
D. Fast frequency response
E. Strong environment adaptability

■ Air Compressor
Using a PLC to control AC motor drives provides stable pressure at a rated output.

■ Delta’s LED Technology
Using a PLC with HMI provides lighting schedule controls.

■ Delta Integrated Elevator Drive - IED Series
The IED Series integrates elevator controller and drive into one unit to simplify the procurement and maintenance process. This elevator solution saves over 60% of energy when used with a PM motor and Delta’s AFE series.
HVAC Solution for Energy Saving

Delta’s HVAC (Heating, Ventilation, and Air Conditioning) Solution adopts various industrial automation products and systems for data collection of temperature and humidity, measurement of CO₂ density, control of valve opening and closing, control of fan speed and frequency, adjustment of water flow, system monitoring, data analysis and more applications to achieve efficient energy use and save electricity.
- Smart HVAC monitoring system integrates SCADA, PLCs and AC motor drives and can achieve 20%~50% energy savings.

- Smart HVAC controlling system can automatically adjust fan frequency and chilled water zone pump based on indoor temperature. This system can also monitor the density of indoor CO₂ and lead the outside fresh air into the building to create a comfortable environment and establish an unmanned and automated HVAC control.

- All HVAC data and information are transmitted and analyzed via the Delta industrial automation control system through various communication network protocols and Web-service.

With the help of complete industrial automation control systems built in cooling towers, along with chillers, make-up air units, and office building air handling units, Delta offers an intelligent HVAC solution with scheduling function, season switching setting, electricity calculator, energy consumption analysis and more smart control functions without relying on traditional air conditioners that generate heat, consume electricity and waste energy.
Delta Factory Automation Solutions

Intelligent Sensorless Vector Control Drive
CP2000 Series

- I/O terminals for extension
- Prohibit reversion function
- Various protection functions
- Flexible pumps replacement
- Fixed-displacement control (1:4)
- Smooth switching between displacement

General Field Oriented Control Drive
C2000 Series

- Quick start
- LCD display
- Flange mounting
- Modular design
- Sleep / awaken mode
- Manual control mode
- Noise immunity design
- Heat dissipation design
- Fixed-displacement control up to 4 flows
- Smooth switching between displacements

High Performance Slim Programmable
Logic Controller DVP-SV2 Series

Module Extension
Network Extension

- Save installation space
- Strong PID control
- Max. I/O points: 512
- Data register 10k words
- Left side extension ports
- Support CANopen communication protocol

- Support Ethernet communication protocol
- Extension ability up to 64 channels
- Support floating point operation
- Basic command speed 0.24μs
- 16k steps programming capacity
- Removable terminal blocks

High Speed Intelligent Temperature Controller
DT3 Series

User Friendly
Highly Reliable
Easy to Install

- Compact Size
- Extension Allowed
- High Speed Communication
- Display Parameter Settings
- Monitoring & Control Software
Energy Saving
Cost Effective
Easy Installation

- Supports RS-232 and RS-485 Communication
- LED Backlight Automatic Turn-off Setting
- Built-in Perpetual Calendar (RTC)
- Numerical Keys with User-defined Function

High Performance Mid Range Programmable Logic Controller AH500 Series

The new generation AH Series PLC provides automation solutions for high-level applications. The combination of modularized hardware structure, advanced functions, and the highly integrated software provides a system solution for process control applications. In addition to various function blocks, excellent price/performance, and an abundant selection of extension modules, the AH Series PLC also provides exceptional system expandability, greatly reducing the system cost for a broad range of applications.

Enhanced Flexibility – Extends the System Freely

The length of extension cables between each AH500 local extension rack can reach a maximum of 100m, greatly enhancing wiring flexibility. In addition, the AH500 provides modularized backplanes and modules applicable for not only CPU racks but also for remote I/O racks. This feature improves the flexibility of system planning and reduces the additional cost that might be generated by preparing two different types of spare backplanes and modules.

Improved Maintainability – Keeps the System Running

The hot-swap function provided for AIO and DIO modules increases maintainability when I/O modules fail. The user can replace modules without stopping the operation of the CPU module, preventing a possible loss due to a pause in the system's operation.
HVAC Success Stories

**Delta Network, Inc. Office Building**

- **Saves electricity cost and provides comfortable indoor environment**
  - **Equipment:** Central HVAC system
  - **Location:** Guangdong Dongguan, China
  - **Delta service team:** Global System Integration
  - **Date:** August, 2011
  - **Products:** AC motor drives, PLCs, communication modules, SCADA
  - **Energy-saved:** 20%
  - **Return on investment:** 2.8 years

**Delta Electronics, Inc. Dongguan Plant**

- **Automatic central HVAC system saves manpower**
  - **Equipment:** Central HVAC system
  - **Location:** Guangdong Dongguan, China
  - **Delta service team:** Global System Integration
  - **Date:** January, 2012
  - **Products:** AC motor drives, PLCs, communication modules, SCADA
  - **Energy-saved:** 20%
  - **Return on investment:** 3.3 years

**Train Station**

- **Delta's AC motor drive provides fans and pumps with soft start and soft stop functions to extend the system for a longer lifespan**
  - **Equipment:** Central HVAC system
  - **Location:** Hainan, China
  - **Delta service team:** Global System Integration
  - **Date:** September, 2011
  - **Products:** AC motor drives, PLCs

**DunAn Holding Group Office Building**

- **Equipment:** Central HVAC system
  - **Location:** Zhejiang, China
  - **Delta service team:** Global System Integration
  - **Date:** April, 2011
  - **Products:** AC motor drives, PLCs
Chemical Fiber Factory

- **Equipment**: Central HVAC system
- **Location**: Jiangsu, China
- **Delta service team**: Global System Integration
- **Date**: October, 2011
- **Products**: AC motor drives, PLCs

Chemical Fiber Factory

- **Equipment**: Central HVAC system
- **Location**: Jiangsu, China
- **Delta service team**: Global System Integration
- **Date**: June, 2011
- **Products**: AC motor drives, PLCs

Delta Electronics Inc. Wujiang DP Plant

- **Equipment**: Central HVAC system
- **Location**: Jiangsu, China
- **Delta service team**: Global System Integration
- **Date**: June, 2011
- **Products**: AC motor drives, PLCs
- **Energy-saved**: 23.1%
- **Return on investment**: 0.47 years

### Technical Specifications

- **Target Temperature**: 22°C
- **Operation Mode**: Cool
- **Control Mode**: PID
- **Self Tuning Function**: OFF
- **Control Method**: Current

![Temperature Diagram]
HVAC Success Stories

Rolling Mill Production Line in Steel Plant

- **Equipment**: Central HVAC system
- **Location**: Hubei, China
- **Delta service team**: Global System Integration
- **Date**: May, 2011
- **Products**: AC motor drives, PLCs

Rolling Mill Production Line in Steel Plant

- **Equipment**: Central HVAC system
- **Location**: Hebei, China
- **Delta service team**: Global System Integration
- **Date**: May, 2011
- **Products**: AC motor drives

Textile Factory

- **Equipment**: Ventilation System
- **Location**: Hebei, China
- **Delta service team**: Global System Integration
- **Date**: May, 2011
- **Products**: AC motor drives

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Usage</th>
<th>Q'ty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VFD370F43A</td>
<td>Fan</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>VFD450F43A</td>
<td>Fan</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>VFD110F43A</td>
<td>Fan</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>VFD220F43A</td>
<td>Fan</td>
<td>2</td>
</tr>
</tbody>
</table>
Dairy Group

- **Equipment:** Ventilation System
- **Location:** Jilin, China
- **Delta service team:** Global System Integration
- **Date:** January, 2010
- **Products:** AC motor drives

Pharmaceutical Group

- **Equipment:** Ventilation System
- **Location:** Jilin, China
- **Delta service team:** Global System Integration
- **Date:** March, 2010
- **Products:** AC motor drives

Cigarette Factory

- **Equipment:** Ventilation System
- **Location:** Yunnan, China
- **Delta service team:** Global System Integration
- **Date:** June, 2010
- **Products:** AC motor drives, HMIs
Power Quality Improvement

Today’s automation equipment benefits us with greater convenience as well as cost savings from higher production efficiency. However, it also generates power quality problems that eventually lead to energy loss, increasing operation costs and higher safety concerns. For power efficiency and a clean grid, power quality improvement products are your solution.

APF2000 can filter 2nd to 50th order harmonics with compensation efficiency above 95%.

- Dynamic harmonic compensation improves power efficiency to above 95%
- Filters 2nd to 50th order harmonic current
- Simultaneously compensates harmonics and power factor
- Current source design eliminates the risk of resonance

Power Quality Problems
Typical End-User Problems

A traditional power quality improvement solution uses capacitors to solve reactive power problems but it is no longer sufficient for the industrial automation applications of today. Recent industrial automation applications adopt inverters, UPSs, switching power and many other devices that would contaminate the grid with non-sinusoidal current and generate more power quality problems including harmonic distortion and resonance. A system that continues to use capacitors as the only solution will eventually lead to device malfunction and shorten device lifespans.

### Past

**Building, Server room, Factory**

- **Main loads:** motors and linear load devices
- **Main power quality problem:** static reactive power
- **Solution:**
  
  A simple power distribution system using capacitors successfully solves all power quality problems.

### Now

**Building, Server room, Factory**

- **Main loads:** rectifiers (inverters, UPS)
- **Main power quality problem:** harmonics and reactive power
- **Solution:**
  
  A more complex power distribution system using capacitors results in new power quality problems.
Delta's Power Quality Improvement Solutions

Static Var Generator - SVG2000 Series

- Provides reactive power and harmonics compensation to private low voltage distribution system
- Available with large capacity
- Reactive power compensation and filters up to 13th order harmonics
- Provides dynamic and precise compensation to leading & lagging reactive power
- Replaces or complements the capacitor cabinet

Delta's SVG2000 Series vs General Capacitors

<table>
<thead>
<tr>
<th>Items</th>
<th>SVG2000</th>
<th>Capacitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>Prevents the occurrence of resonance and provides the system with greater stability.</td>
<td>High chance of resonance especially where harmonics are strong.</td>
</tr>
<tr>
<td>Lifespan</td>
<td>10 years normal lifespan.</td>
<td>Usually 1<del>2 years. Under high harmonics and reactive power fluctuation conditions the lifespan can be as short as 1</del>2 months.</td>
</tr>
<tr>
<td>Performance</td>
<td>Response speed 10ms; Accuracy 0.99~1.</td>
<td>Slow response by minute.</td>
</tr>
<tr>
<td>Function</td>
<td>Compensates both leading and lagging reactive power to perfectly control harmonics and reactive power.</td>
<td>Poor power quality control. Minimum compensation capacity is 80Kvar which always compensates too much or too little. Provides compensation to lagging reactive power only, does not compensate harmonics so harmonic problems can be serious.</td>
</tr>
</tbody>
</table>

System Structure

<table>
<thead>
<tr>
<th>Solutions</th>
<th>High voltage centralized control</th>
<th>Low voltage centralized control</th>
<th>Group control</th>
<th>Individual control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Input side of transformer</td>
<td>Output side of transformer</td>
<td>At different districts or different floors</td>
<td>Install before any device that causes interference</td>
</tr>
<tr>
<td>Performance</td>
<td>THDI&lt;5% THDU&lt;3% Power factor &gt; 0.96</td>
<td>THDI&lt;5% THDU&lt;3% Power factor &gt; 0.96</td>
<td>THDI&lt;5% THDU&lt;3% Power factor &gt; 0.96</td>
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</tr>
</tbody>
</table>

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Active Power Filter - APF2000 Series

Modular Design

- Dynamic harmonic compensation with efficiency above 95%
- Filters 2nd~50th order harmonics
- Compensates both harmonics and power factor simultaneously
- Balances the non-linear load of a 4-wire system
- Current source design eliminates the risk of resonance

Applications

- Metallurgy and petrochemicals industries: rectifier, converter, rolling mill, electric arc furnace, medium frequency furnace, inverter
- Chemical and electrolysis industries: rectifier, calcium carbide furnace, electric soldering, inverter
- Mechanical industries: rectifier, rolling mill, inverter, electric arc equipment
- Metal, paper, plastic processing and textile industries: rectifier, rolling mill, inverter, electric arc furnace, electric furnace
- Transportation industries: the rectifier and the inverter of electric vehicles, electric motorcycles and metro systems
- Automobile manufacturing industry: soldering equipment, car painting equipment, battery charger and inverter
- Telecommunication, medical and construction industries: server station, EPS, UPE, converter, charger, inverter
Power Quality Improvement Success Stories

Brasswork Company - Implementation of SVG2000 Series

Electroplating Workshop - Implementation of SVG2000 Series

<table>
<thead>
<tr>
<th>Mix</th>
<th>Power Factor</th>
<th>Harmonic Voltage THDU</th>
<th>Harmonic Current A</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>0.86</td>
<td>27%</td>
<td>554</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>0.98</td>
<td>3.7%</td>
<td>17</td>
<td>97%</td>
</tr>
</tbody>
</table>

Performance using Delta's SVG series

- Replace old system capacitors with the SVG2000: reduce replacement/maintenance frequency and eliminate the risk of resonance.
- Reduce total current by 1/3: reduce transformer and cable wire overheating problems. Improved power quality: excellent harmonic filtering result, extended devices lifespan and lower devices malfunction rate.
- Cost saving within one month of installation: USD 3,218 from excellent reactive power compensation performance.

Reduce total current by 48%
Brasswork Company - Implementation of SVG2000 Series

<table>
<thead>
<tr>
<th>Mix</th>
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<th>Harmonic Current A</th>
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<tr>
<td>Before</td>
<td>0.86</td>
<td>27%</td>
<td>554</td>
<td>89%</td>
</tr>
<tr>
<td>After</td>
<td>0.98</td>
<td>3.7%</td>
<td>17</td>
<td>89%</td>
</tr>
</tbody>
</table>

Paper Manufacturing Industry - Harmonic Filtering

- Influences reactive power compensation devices and inverters in the system.
- Reactive power compensators have higher risk of wire or cable overheating problems that may cause fire hazard.
- Capacitors have a short lifespan that requires frequent maintenance and replacement.
- Multiple inverters used in the system amplify harmonic distortion and increase the risk of resonance problems. The testing result indicates using capacitors to correct a harmonic problem would amplify the current distortion.

Current Waveform:

- Before
- After

Paper Manufacturing Industry - Harmonic Filtering

<table>
<thead>
<tr>
<th>High voltage power distribution</th>
<th>Low voltage power distribution, level 1</th>
<th>Diesel</th>
<th>Low voltage power distribution</th>
<th>Installation of two APF2000 (300A) at low voltage wiring side</th>
<th>Power distribution of server room and floor</th>
<th>Electroplating power source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer</td>
<td>Low voltage power distribution, level 1</td>
<td></td>
<td>Transformer</td>
<td>Installation of two APF2000 (300A) at low voltage wiring side</td>
<td>Power distribution of server room and floor</td>
<td>Electroplating power source</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power Factor</th>
<th>Active Current</th>
<th>Reactive Current</th>
<th>Apparent Current</th>
<th>Power Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>0.83~0.85</td>
<td>~1900A</td>
<td>~1100A</td>
<td>~2200A</td>
</tr>
<tr>
<td>After</td>
<td>0.94~0.96</td>
<td>~1900A</td>
<td>~700A</td>
<td>~2000A</td>
</tr>
</tbody>
</table>
Factory Automation - Energy Saving Solution for Injection Molding Machines

Plastic products are everywhere, we use them in our daily life, from electronic devices to personal care items to auto accessories and countless more.

If you wonder how plastics are turned into a variety of plastic products, the injection molding machine is the answer. During the manufacturing process, energy is consumed by four main units inside the injection
- The hydraulic pump
- The heating unit
- The cooling system
- The control system and internal components

The top energy consuming unit comes from the hydraulic system which accounts for more than 75% of an injection molding machine's total consumption. In a traditional hydraulic system, the motor can only operate at a steady speed and provide a steady amount of pressure. It can waste a large amount of energy since the required pressure and flow varies from the clamping, injection, pressure holding, cooling to ejection stages. The excess energy is adjusted by using an overflow valve and ration valve which causes energy loss of up to 40~75%.

Delta's HES series provides precise flow and pressure control for each processing stage of the injection molding machine. The system benefits with lower electricity and energy consumption, cost savings, improved product quality and advanced productivity.
Energy Consumption Comparison

- Implementation of Delta's HES Series to the injection molding machinery helps to save energy up to 75%

Application of Delta Thailand Plant

- Energy saved per injection molding machine: 6375 kWh
- Cost saved for 6375kWh: US$1485
- Replacing all 60 of the injection molding machines with the HES series brings outstanding savings of up to US$89,250

Every injection molding machine in the Delta Thailand Plant produces an average of 211,000 power supply components a month.
Energy Consumption Analysis

Power consumption before using Delta HES system (kWh)

<table>
<thead>
<tr>
<th>Starting Time</th>
<th>End Time</th>
<th>Average Power Consumption</th>
<th>Total Time (Hour)</th>
<th>Total Watts in 4 Hours</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:51</td>
<td>20:50</td>
<td>2092W</td>
<td>4</td>
<td>8368</td>
<td>2.09</td>
</tr>
</tbody>
</table>

Implementation of Delta HES system saves 1.66 kW of power per hour

Power consumption after using Delta HES system(kWh)

<table>
<thead>
<tr>
<th>Starting Time</th>
<th>End Time</th>
<th>Average Power Consumption</th>
<th>Total Time (Hour)</th>
<th>Total Watts in 4 Hours</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:31</td>
<td>21:29</td>
<td>431W</td>
<td>4</td>
<td>1724</td>
<td>0.43</td>
</tr>
</tbody>
</table>

System Structure

• AC servo drive + AC servo motor + fixed displacement pump + pressure sensor. Delta’s HES system features PID control function to provide precise pressure and flow output. It also facilitates the system with faster response speed and higher product duplication accuracy.
Energy Consumption Curve

A: HES Multi-step Speed Response Curve

Substantial energy saving with the HES system

B: HES Multi-step Pressure Holding Response Curve

Substantial energy saving with the HES system

Traditional injection molding machine with fixed displacement pump

Delta HES System

HES Multi speed response

HES Multi pressure-hold response

Clamping
Plastic Injection
Pressure Holding
Mold Feeding
Cooling
Open Mold
Ejection

23 24 25 26 27 28 29 30 31 32
0 5 10 15 20
-1000 -500 0 500 1000 1500 2000 2500 3000
-1000 -500 0 500 1000 1500 2000 2500 3000

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Factory Automation - Energy Saving Solution for Air Compressors

An air compressor is a device that converts power into kinetic energy by compressing and pressurizing air, which creates force that is useful for various purposes and widely applied for a variety of industries.

According to the design and principle of operation, air compressors are divided into two types:
1. Rotary Screw Type Compressors
2. Piston Type Compressors (Reciprocating Compressors)

An air compressor is normally connected directly to a large power consuming machine. The structure of an air compressor is complicated and the operation time required by an air compressor is long as well. To satisfy the requirements of a large power consuming machine, after extracting air from the atmosphere, the compressed air is kept in a holding tank under a pressure that is greater than atmospheric pressure. However, the air pressure variations in the tank may change rapidly. Adjusting the air inlet is the most common method to control air displacement and capacity of an air compressor.

While an air compressor controlled by Delta's energy saving solution can establish a variable air displacement and variable speed system. Many parameters such as continuous adjustment, holding pressure, air flow and air delivery can be controlled automatically. The motor speed is decreased, and the load on the motor also drops greatly. Energy consumption is reduced, thus energy saving is achieved.
Cost Analysis

Energy savings can reach **30%**

As an example, consider a load consuming 138 kW air compressor, and an average energy saving rate of 30%: Assuming electricity cost is NT$0.125/kw-hr, the annual cost saving:

\[(1104-772) \times 305 \times 0.125 = \text{US$12,698} \] (based on 305 working days per year)

Installing Delta's energy saving solution in an air compressor helps to lower the cost of system operation by 30% and save energy when the system is operated at variable-speed at the same time. Delta's energy saving solution provides high efficiency, high performance, low cost of maintenance, and long product life to customers who wish to enhance their competitive advantage while spending less.

After calculation, an estimated cost recovery period is one year.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily electricity consumption:</td>
<td>8×138=1104kWh</td>
<td>772kWh</td>
</tr>
</tbody>
</table>

Not using Delta's energy saving solution
Energy Consumption Analysis

Application of Delta Wujiang Plant 5

- Explanation: The tables below show power consumption data for the SA-5200W at power frequency and variable frequency when the SA-5250W and SA-5200W are working at the same time.

Power Consumption before using Delta's Energy Saving Solution (kWh)

<table>
<thead>
<tr>
<th>Starting Time</th>
<th>End Time</th>
<th>Average Power Consumption</th>
<th>Total Time (Hour)</th>
<th>Total Watts in 4 Hours</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 6th, 08:45 AM</td>
<td>July 7th, 08:45 AM</td>
<td>93.66365kW</td>
<td>24H</td>
<td>2247.927662kW</td>
<td>93.66365</td>
</tr>
</tbody>
</table>

Implementation of Delta’s energy saving solution for air compressor saves electricity up to 32.2% 32.2%

Power Consumption after using Delta's Energy Saving Solution (kWh)

<table>
<thead>
<tr>
<th>Starting Time</th>
<th>End Time</th>
<th>Average Power Consumption</th>
<th>Total Time (Hour)</th>
<th>Total Watts in 4 Hours</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 10th, 10:23 AM</td>
<td>July 11th, 10:23 AM</td>
<td>63.47kW</td>
<td>24H</td>
<td>1523.27kW</td>
<td>63.47</td>
</tr>
</tbody>
</table>

System Structure

![System Structure Diagram]

Displacement: 25.1cc./min
Building Automation - Energy Saving Solution for Lighting

Today, being energy-efficient and environmentally conscious has become a way of life. For various industries and many countries, how to reduce energy consumption and eliminate unnecessary electrical use has become more and more pressing. While the need to find solutions for environmental issues has become important, there are also more opportunities for a variety of businesses in the energy-saving market. The LED lighting business is a good example.

Compared to regular light bulbs, LED lights provide quick response and high intensity bright light to produce excellent and stable illumination for a variety of conditions. In addition, LED lights last longer than incandescent lights and are able to save more energy and reduce carbon dioxide emissions.

Delta's lighting energy saving solution includes Delta's LED lights incorporated with Delta's industrial automation control system. Using Delta's LED lighting energy saving solution helps provide an eco-friendly choice to reduce wasted electricity and maintenance costs to a minimum.

Energy Saving Performance

- Sets up lighting schedule and control modes via Delta's PLC and HMI
- Power consumption lower than T8 Tubes, using Delta LED Tubes can save 50% in electricity
- Energy-saving, no mercury, wide color gamut, long life up to 10 years

Application of Delta Taoyuan Technology Center

- Electricity consumption saved: 121,600 kW/year
- Electricity costs saved: US$15,200/year
- CO₂ Emission reduced by 76 tons/year
- = 6,333 trees absorbing CO₂ in 1 year

Scheduling controlled by DOP Series HMI

System Structure
Building Automation - Energy Saving Solution for Elevators

Delta introduces the elevator drive- IED series to ensure the elevator a reliable and comfortable ride. The drive is equipped with a 32-bit high speed CPU providing fast response, large output torque, precise positioning and many more excellent features, to ensure the elevator levels perfectly to each floor every time it opens the door.

When different numbers of passengers or items of weight enter the elevator, the drive calculates the required starting torque to provide a smooth ride. After the door closes, the drive quickly determines the loading to prevent any risk of elevator roll back.

Delta offers additional energy saving devices for elevator systems. The AFE2000 series Active Front End Unit improves power quality to extend the life and efficiency of the elevator. Traditional brake resistors dissipate excess energy as heat. The AFE2000 offers a better solution. It regenerates the excess energy into reusable power and supplies it back to the mains. An elevator using an AFE2000 unit with a Permanent Magnet Motor can attain more than 40% in energy savings.

Delta has developed its products to be energy-saving and environmentally-friendly, as well as to meet market requirements. The new IED series elevator integrated drives combine the host controller and drive system into one single MCU, which is convenient for procurement and installation and ensures system conformity and safety.
Energy Saving Applications

- An elevator system that adopts Delta's AFE2000 series and general permanent magnet motor saves energy up to 40%.

Delta Taoyuan Technology Center

Elevator Energy Consumption Comparisons

- Traditional elevator system: 15,209 kWh
- Delta's elevator system: 9,179 kWh
- Energy saved: 6,030 kWh

Advantages of IED Series

- Smooth start and stop, no need of load compensation
- Fast and smooth torque control after mechanical brake release
- Operation command
- DC braking
- Mechanical brake
- Start control
- Output current waveform of the drive
Delta's Regenerative Energy Solution for Elevators
Active Front End - AFE2000 Series

Replace the braking resistor with Delta’s AFE2000 series to convert regenerative energy into reusable electricity.

- THD ≤ 5%, power factor > 0.99

- Lowers harmonic distortion, improves power factor and reduces electricity consumption and cost to use power efficiently.

Improves power factor and lowers harmonic distortion

Regenerative Energy $\rightarrow$ Reusable Electricity

Regenerative Energy $\rightarrow$ Heat
System Structure

Using the AFE2000 series for an elevator system improves power quality to achieve a more efficient and stable operation and lowers electricity cost with the power regeneration function.

Wiring diagrams above are for illustration purposes only.
Building Automation - System Solution for Renewable Solar Energy

As the Earth's natural resources are finite and depleting, what resources can we use in the future? Renewable energy such as wind power, water power and solar power hold great potential. Of these, the energy source that is practically infinite, inexhaustible, non-polluting, environmentally friendly, and energy saving, is "solar energy". Relatively, it has the greatest advantage.

Today, there are two main types of solar power systems.

- First is the concentrated solar power system. A large field of tracking mirrors reflects sunlight onto the top of a central power tower and the central receiver stores the heat of the sunlight inside the tower increasing the temperature. A heat-transfer fluid inside the receiver then creates steam and drives a conventional turbine to produce electricity.

- The second type is a Photovoltaic solar power system which converts sunlight into direct current electricity. The PV panel is made of semiconductor materials which function as a battery and can be shaped into different forms. The panels can be installed on a rooftop, a building surface, windows, skylights or as part of a top cover.

Solar panels are commonly installed on a rooftop in a fixed structure. Advanced sun tracking is made possible by installing a two-axes rack onto a solar board. This allows the solar panels to turn freely toward the sunlight to receive the greatest amount of solar energy.

Delta has developed a sun tracking system that employs core technologies for use with both concentrated and photovoltaic solar power systems. Delta's sun tracking system is controlled by a PLC with GPS sensor and servo drives that adjust the solar panel surface in real time and in different positions to collect the greatest amount of sunlight. Every component of the solar board is linked to the system and contributes to energy receiving efficiency and to achieving the best energy saving results.
Energy Saving Performance

- Delta Electronics (Jiangsu) Ltd. - 2177kW Golden Sun Demonstration Project
  - Designed Service Life: **25 years**
  - Annual Average Power Generation: **2185972 kWh**
  - Annual Standard Coal Savings: **732 tons**
  - CO2 Emissions Reduced by **1808.71 tons**

Solar Energy Success Stories

- **Free Trade Zone of Datang Shanghai**
  - System Capacity: **12MWp**
- **Haining China Leather Town**
  - System Capacity: **3.6MWp**
- **World Games Stadium, Kaohsiung, Taiwan**
  - System Capacity: **1MWp**
- **U.S. Foodservice, USA**
  - System Capacity: **1.15MWp**

System Structure

- **Mains Parallel Connection**
  - Power Line
  - RS485 Line
  - RS232 Line
  - Mains Grid
  - Power Meter
  - IFD Series
  - DelSolar (Wujiang) Ltd., China Solar Power Generation Monitoring System
  - PV Inverter (Delta 20kW)
  - Solar Panels
  - Temperature Sensor
  - Temperature Sensor
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