Automation and Process Control

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Todays training outline.

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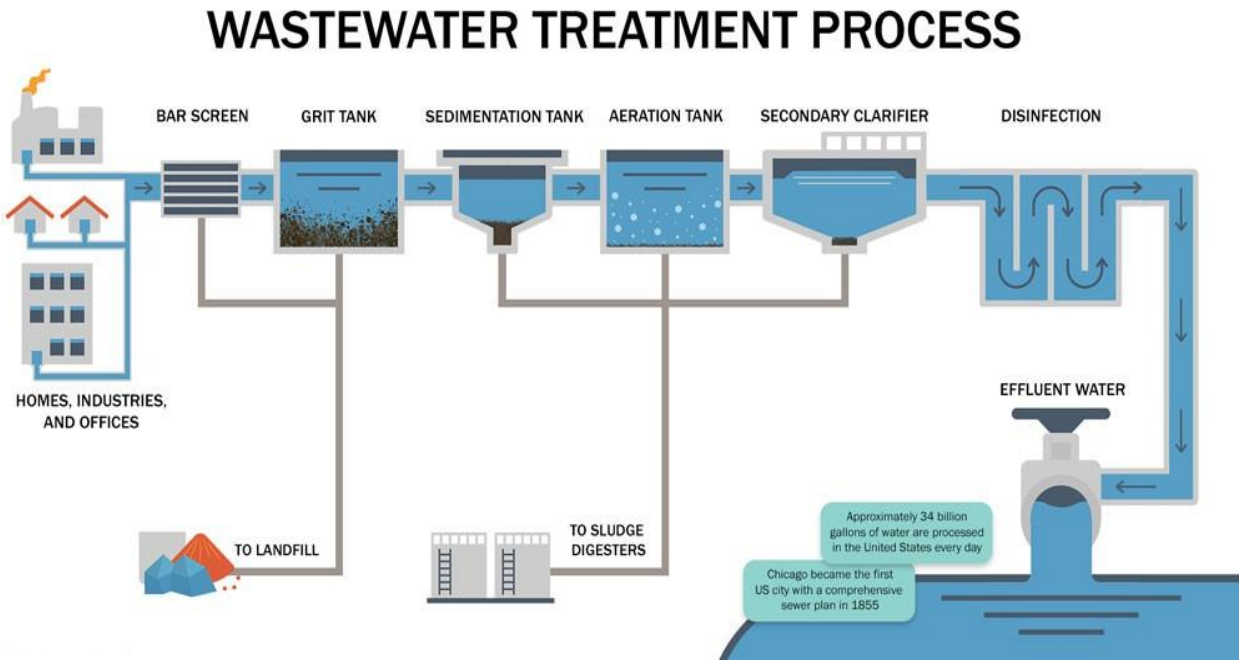
- Benefits of process control and automation
- Flow, level and blower control
- Sensors, monitoring and feedback devices
- Process controllers and PLCs
- Basic and automated variable speed drives
- Increase process throughput without additional expenditures
- Increase energy efficiency
- Monitoring systems, cloud-based monitoring, control and data storage

Automation and Process Control

- Monitors and control process 24/7
- Data access/remote monitoring of process and data (real time)
- Provides and records trends and data history
- Increases safety
- Predictive and diagnostic maintenance
- Saves energy



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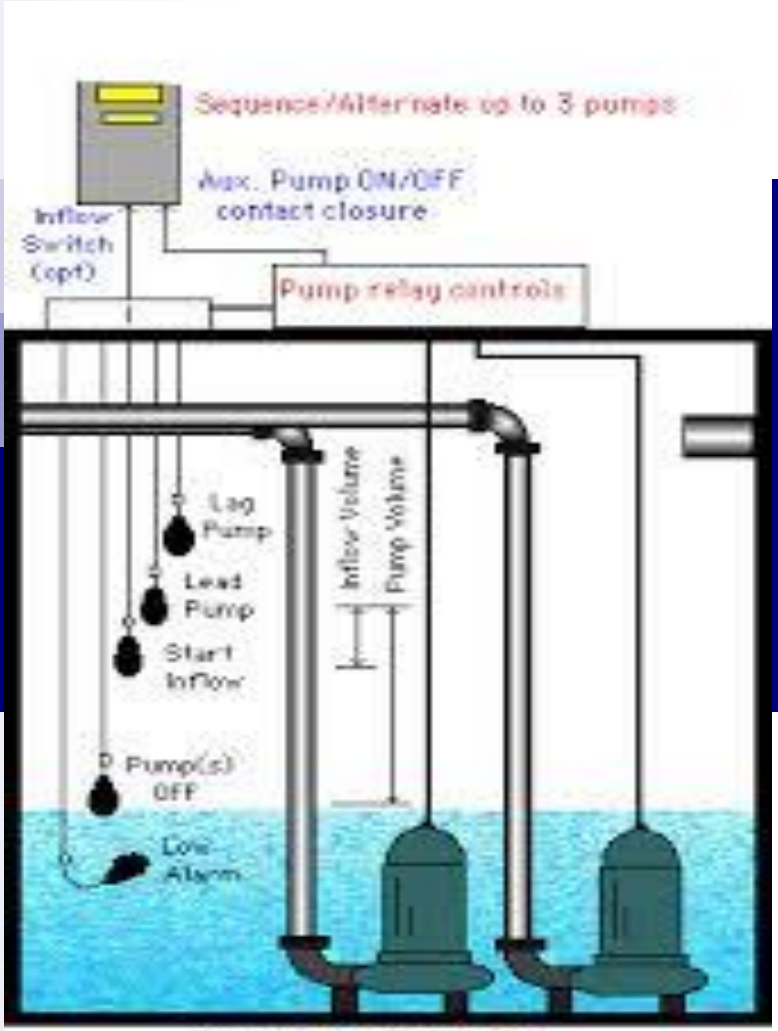
FLOAT LEVEL CONTROL SYSTEM



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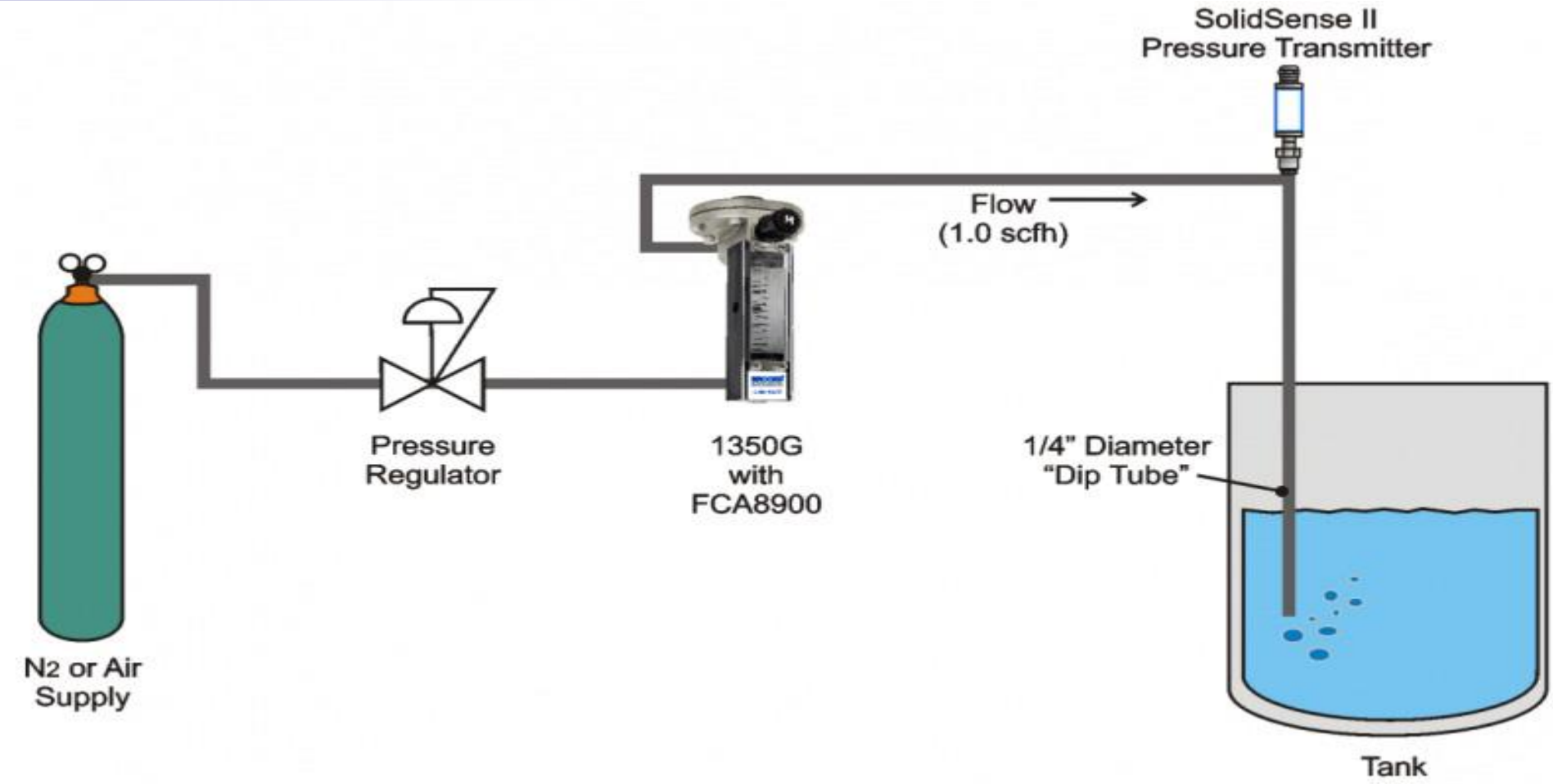
BUBBLER LEVEL CONTROL SYSTEM



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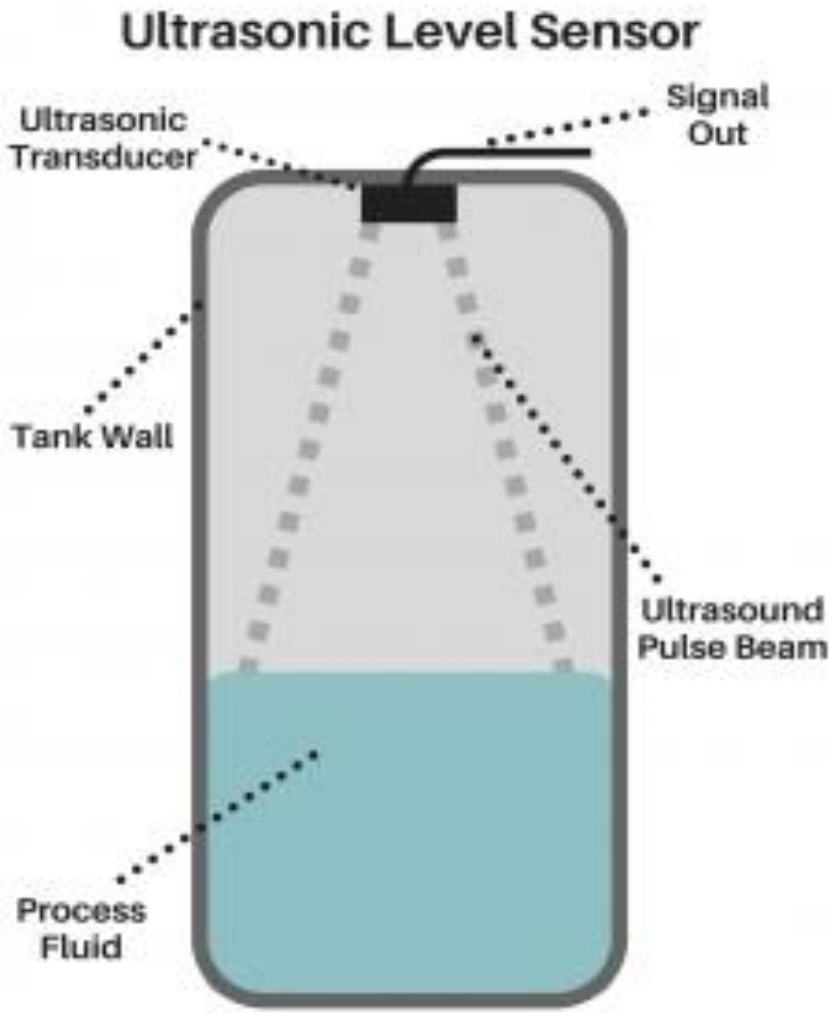
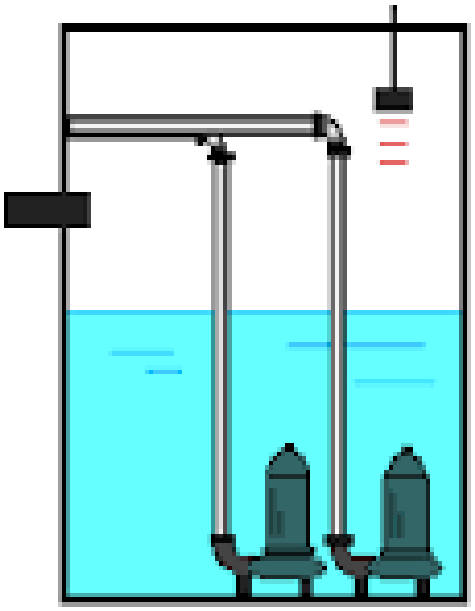
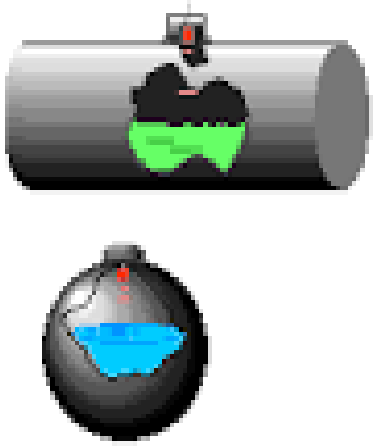

Ultrasonic Level Sensor
Ultrasonic Transducer
Signal Out
Tank Wall
Ultrasound Pulse Beam
Process Fluid

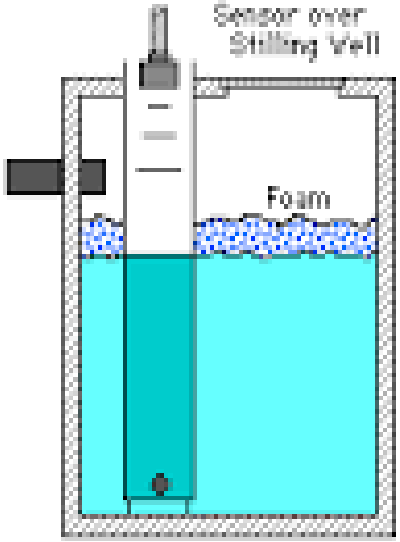
RADAR LEVEL CONTROL SYSTEM



Wet-Wells



Horizontal and Spherical tanks



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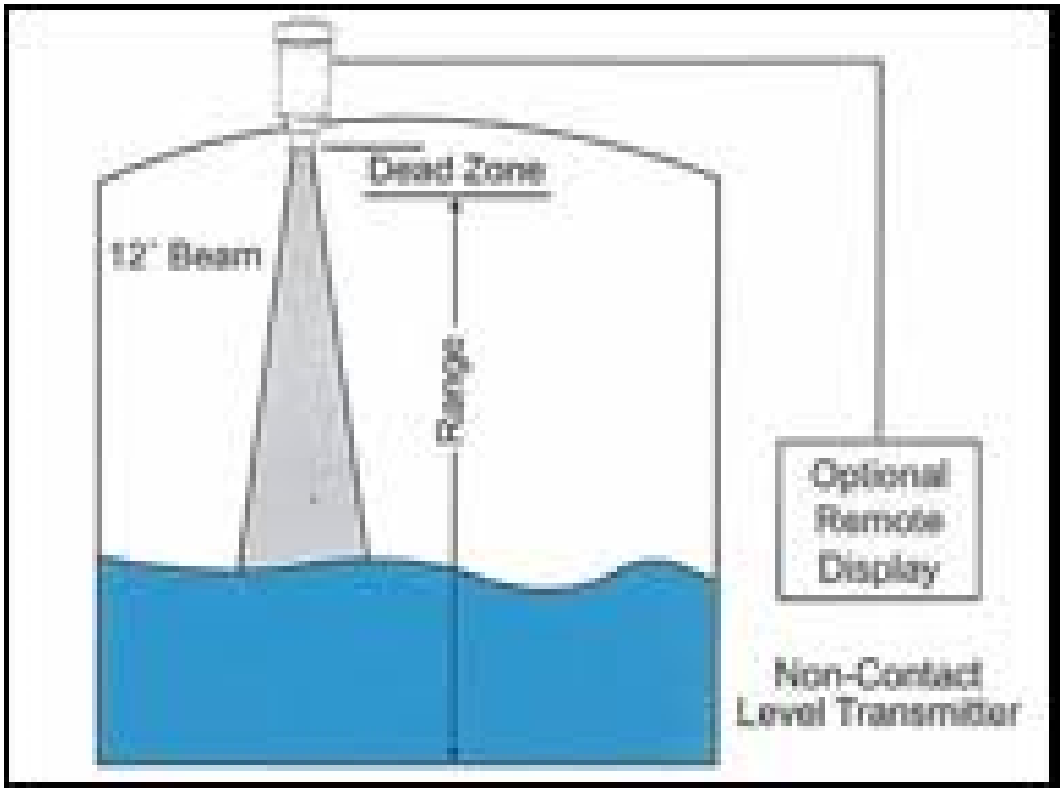
NON-CONTACT LEVEL TRANSDUCER



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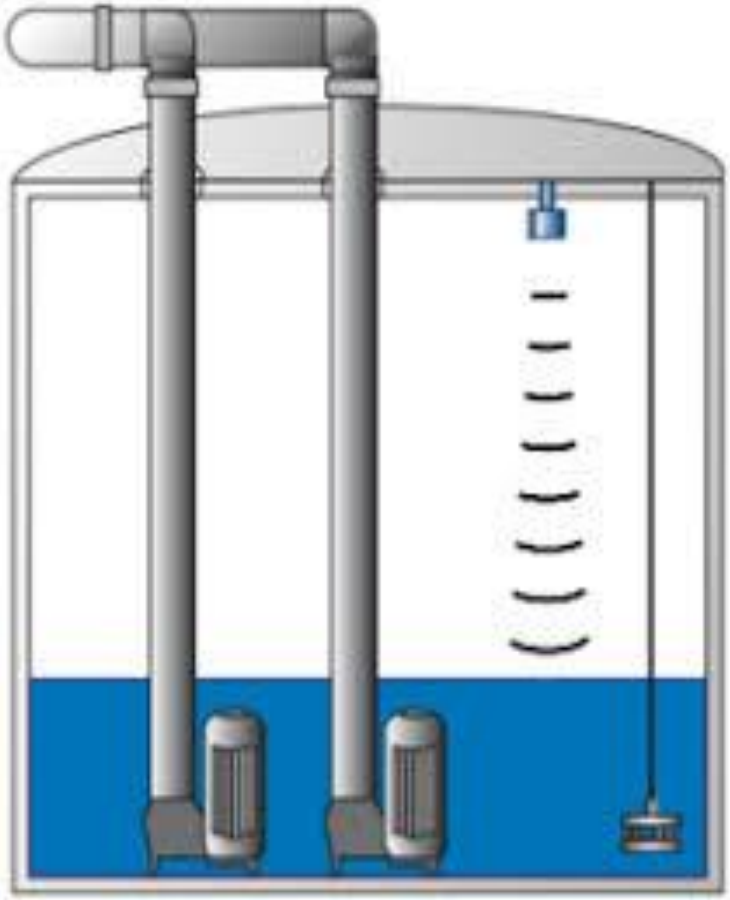
NON-CONTACT LEVEL TRANSDUCER WITH BACKUP SUBMERSIBLE



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FLOAT SWITCH

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FLOAT SWITCH CUT AWAY

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Submersible Level Transducer

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RADAR LEVEL TRANSDUCER

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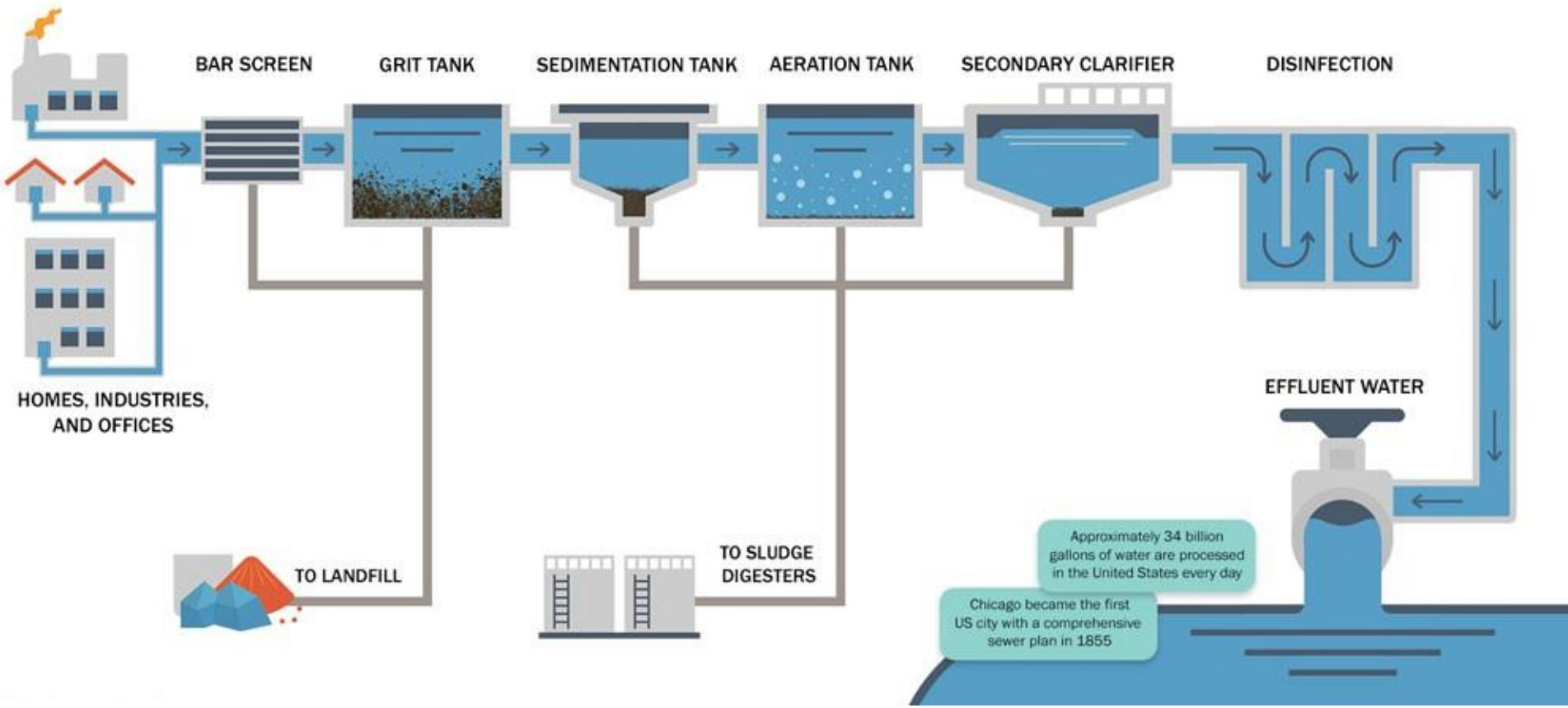
WASTEWATER TREATMENT PROCESS



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MAGNETIC FLOW METER

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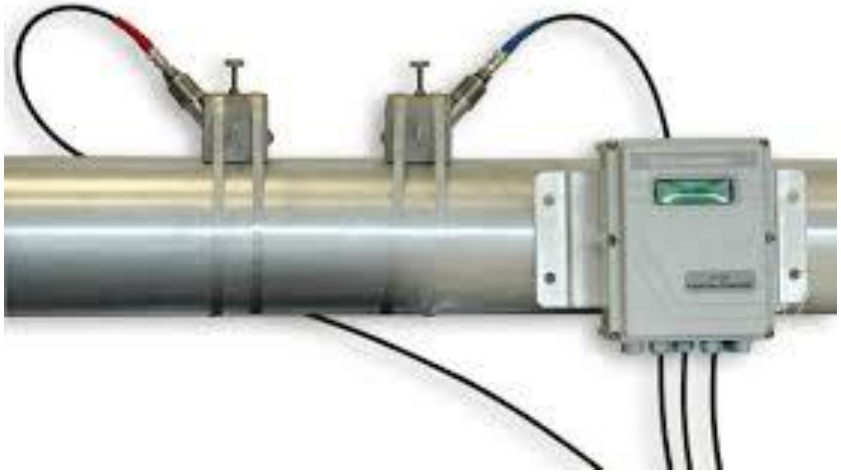
EXTERNAL CLAMP OF FLOW METER

A properly outfitted clamp-on flow meter is suitable for most wastewater applications. It performs more accurately than a traditional mechanical meter and is often more cost-effective than an electromagnetic or inline ultrasonic meter.



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Ultrasonic **Doppler flow meter** measures flows of liquids containing suspended particles or aerated liquids. The suspended particles must reflect ultrasonic energy. The **Doppler flow meter** operates by transmitting ultrasonic waves into the **flow** stream and measuring the frequency shift of the reflected wave.

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PLC and Touch Panels

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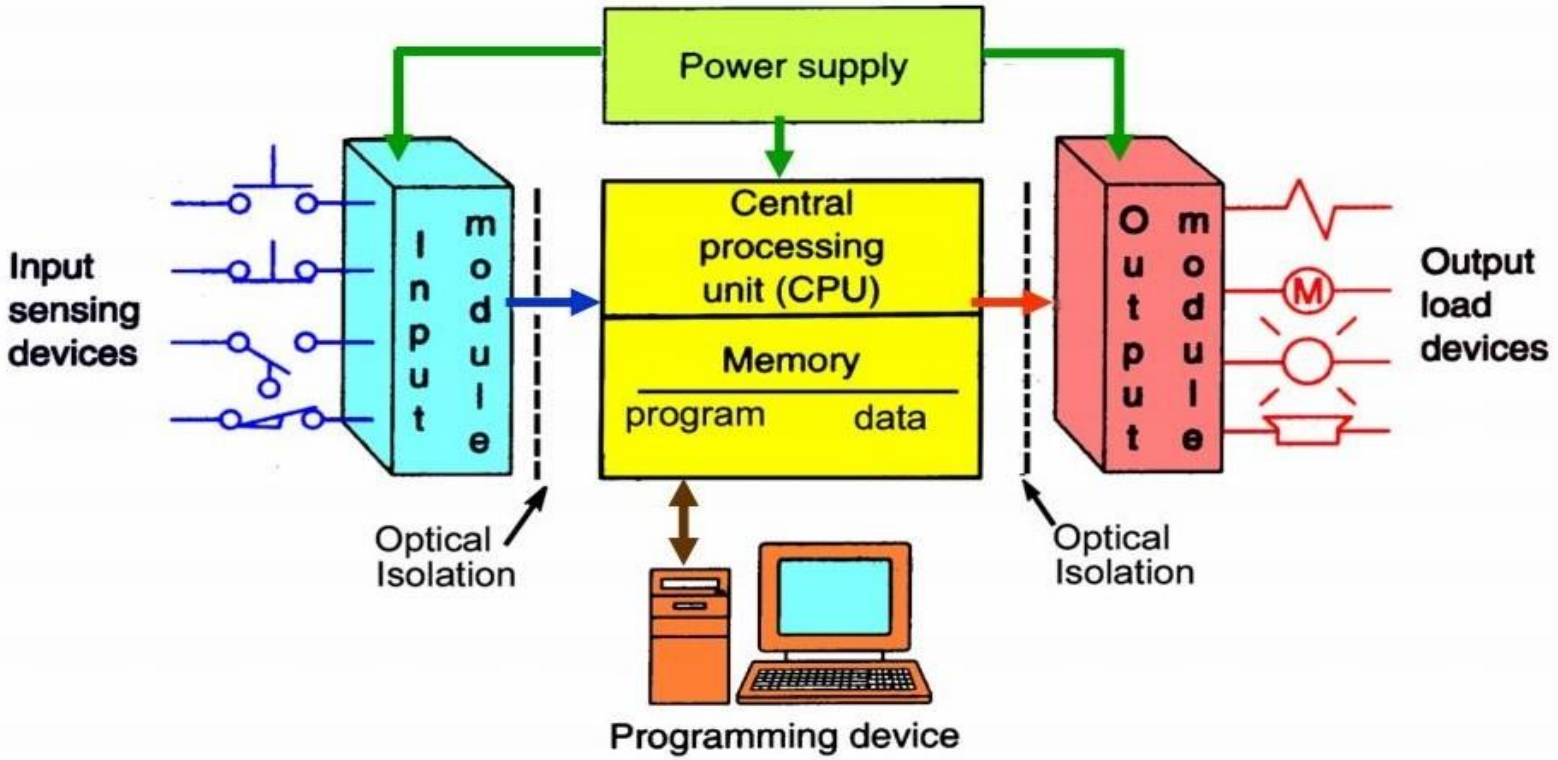
What are the Features of PLC Inputs and Outputs



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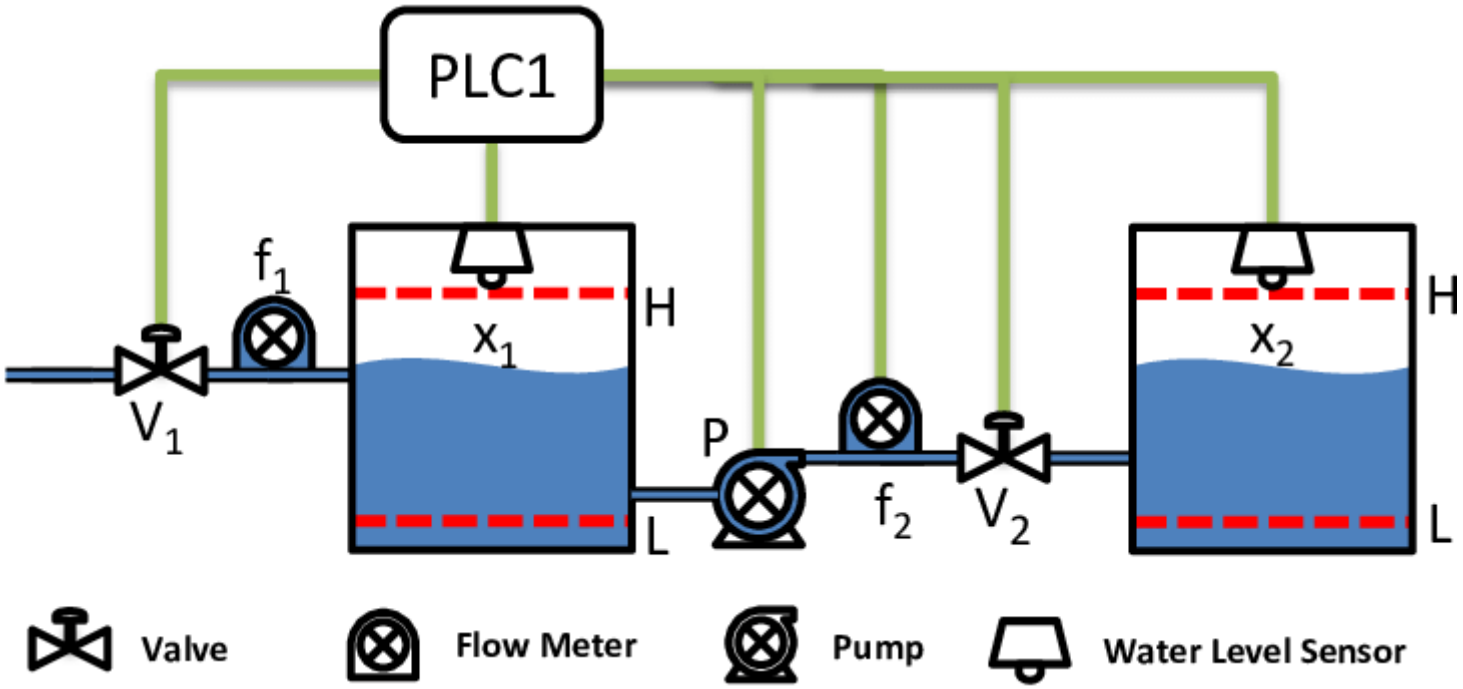
PROCESS CONTROL



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Get Wired

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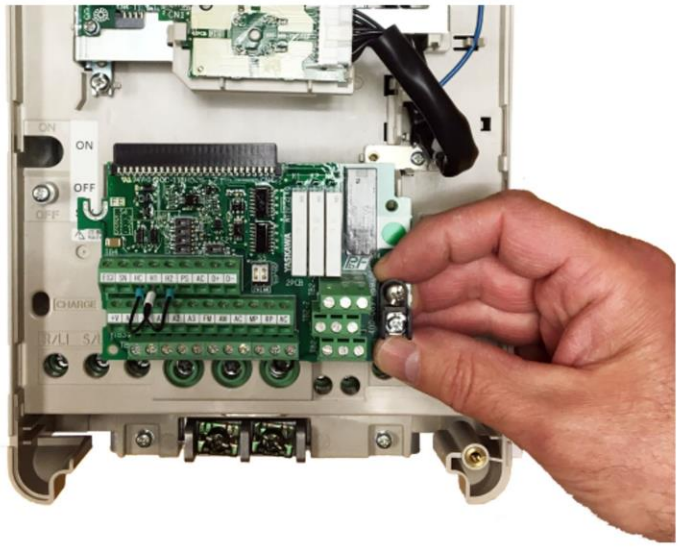
- Standard I/O
  - DI (8), DO (4), AI(3), AO(2), STO
  - 24V Supply Output (150mA)
  - 24V Control Power Input
  - RS485 (Modbus RTU)
- Optional (same as 1000 series)
  - Additional Analog and Digital I/O
  - 120V DI
  - Encoder Feedback
    - Incremental
    - Absolute



A variable frequency drive can be controlled by Digital and Analog Inputs. Drive status can be obtained by the VFDs relay, digital and analog outputs to and from a PLC.

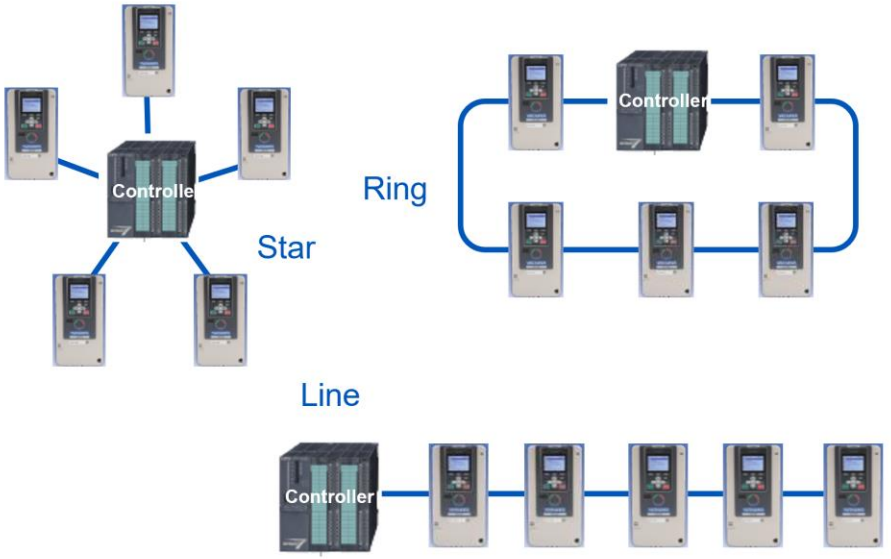
Connect to any network

DeviceNet EtherNet/IP EtherCAT ETHERNET POWERLINK CC-Link

CANopen Modbus MECHATROLINK PROFINET PROFIBUS

Todays VFDs are network compatible. All drive data is available on the network.

Connect in any topology



Typical VFD network architectures.

AUTOMATION & CONTROL

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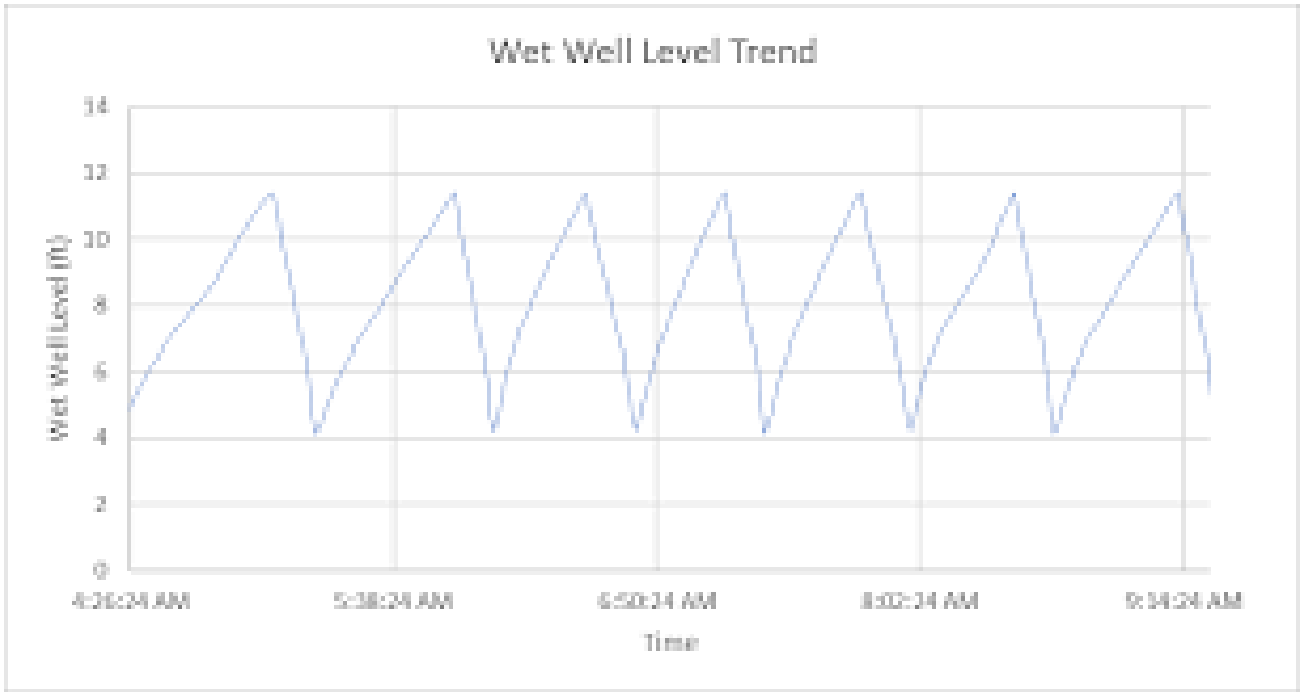
PUMP DOWN CONTROLLER



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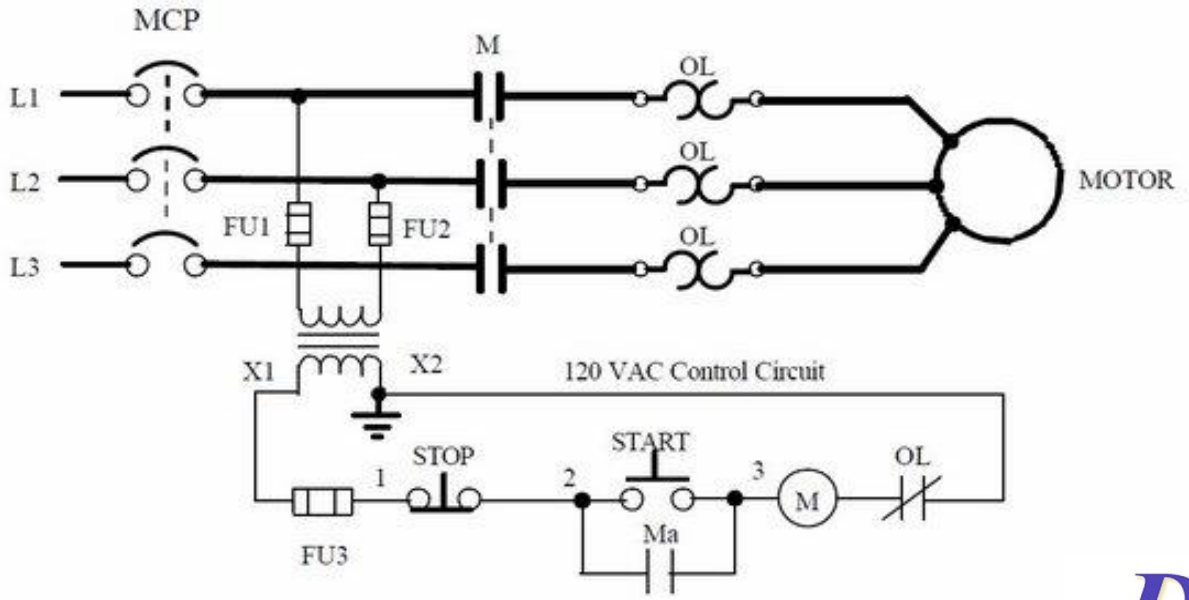
PUMP MOTOR STARTER

- What is a motor starter?



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Lowered plant energy and chemical use

Energy use is one of the highest costs at any wastewater treatment plant. Upgrades to traditional systems can lower these costs, but they don't solve the problems posed by a lack of data about plant equipment and processes. Automated treatment systems can reduce the total amount of energy and water treatment chemicals that a plant needs to use in day-to-day operations.

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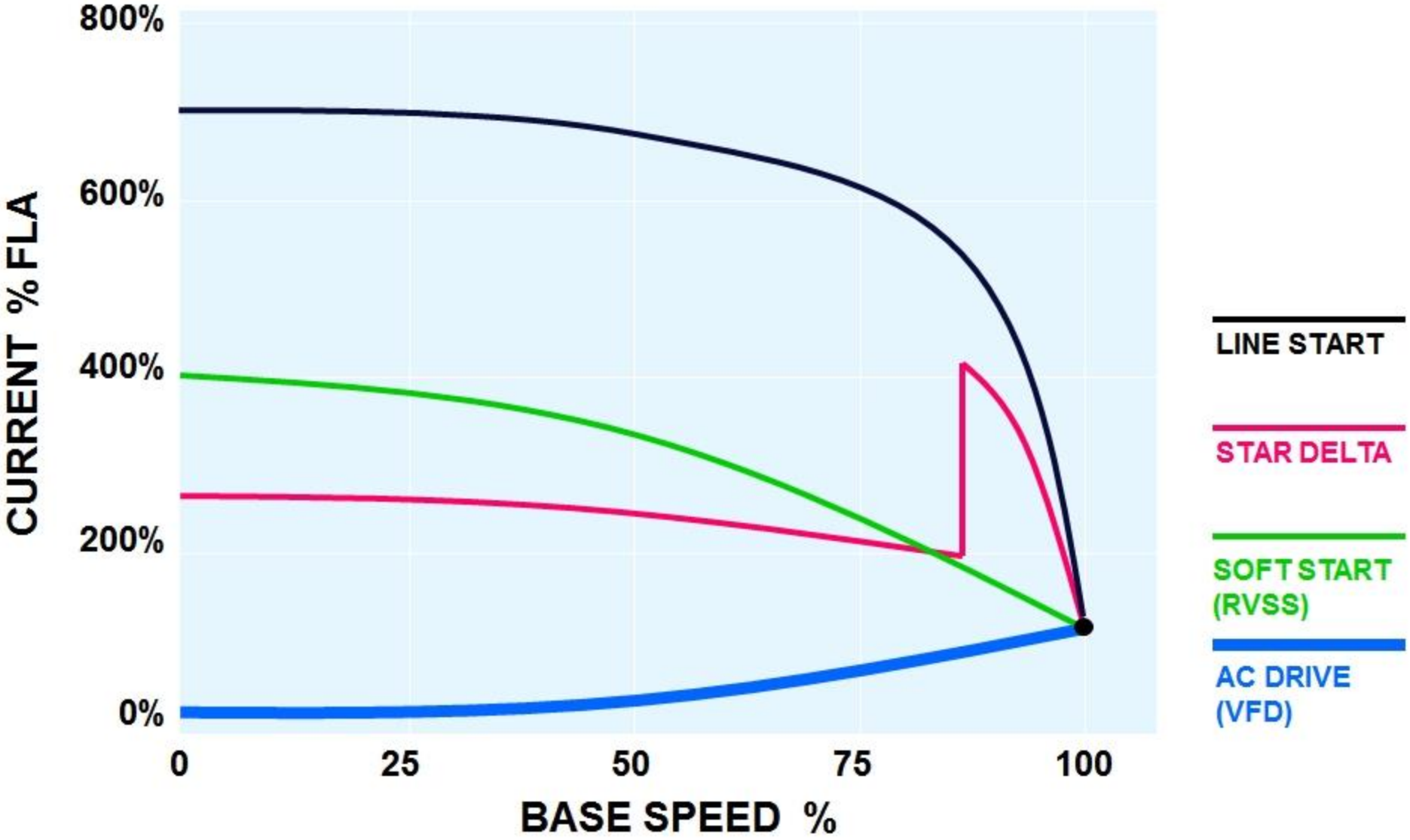
AC MOTOR STARTING CURRENTS

Accelerating to full speed - variable torque load



100HP MOTOR - 125 FULL LOAD AMPS - 75 kW

700% X 125AMPS = 875AMPS PEAK DEMAND or 655kW

Electricity use is metered (and you are charged) in two ways by your utility: first, based on your total **consumption (kW/Hour)** in a given month, and second, your **peak demand,** based on the highest capacity you required during the given billing period.

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VFD BASICS

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Variable Frequency Drives

- Power Source
- 208 VAC, 230VAC Single and Three Phase
- 460VAC Three Phase
- 2300VAC Three Phase
- 4160VAC Three Phase

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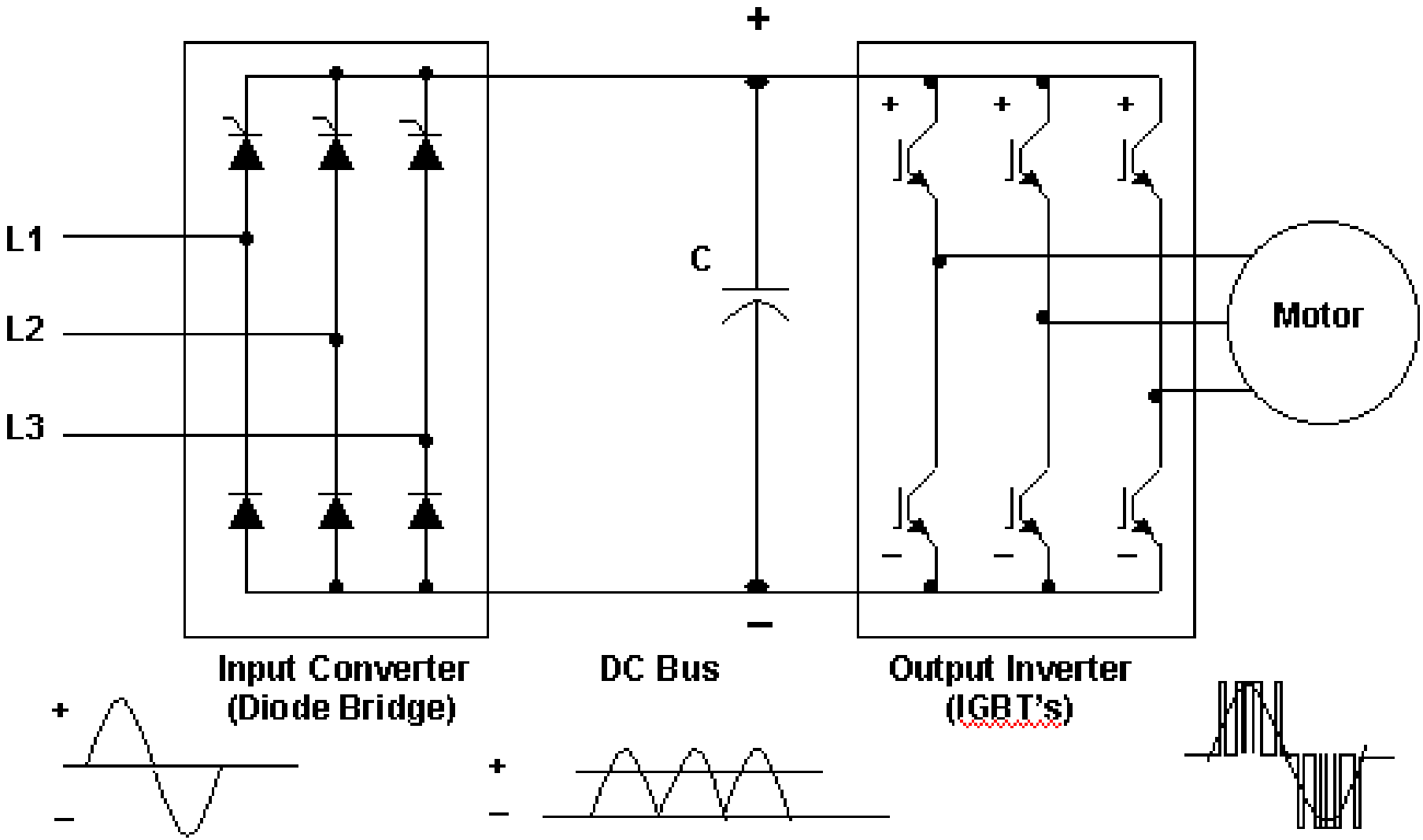
Power Diagram of VFD



Don't do it!

Tools & Safety Issues

- Don't take short cuts
  - Always measure
  - use good test leads and other tools
  - know the power rating of the equipment
  - be sure you use the right tool
  - lock-out Tag-out
  - know who's around the equipment
  - inspect for broken parts before starting
  - walk the equipment to insure your safety, the safety of others and the equipment.

Motors and Loads

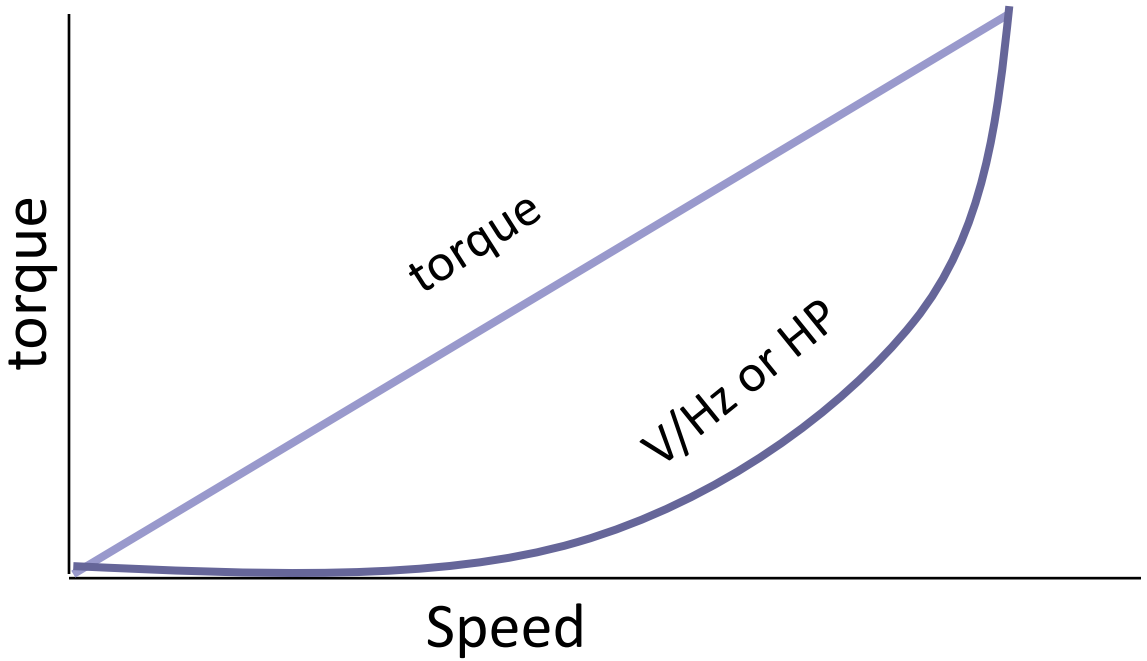
- All VFDs spin motors of different voltages, and sizes
- Loads can be constant torque application or variable torque applications

Variable torque

The Load

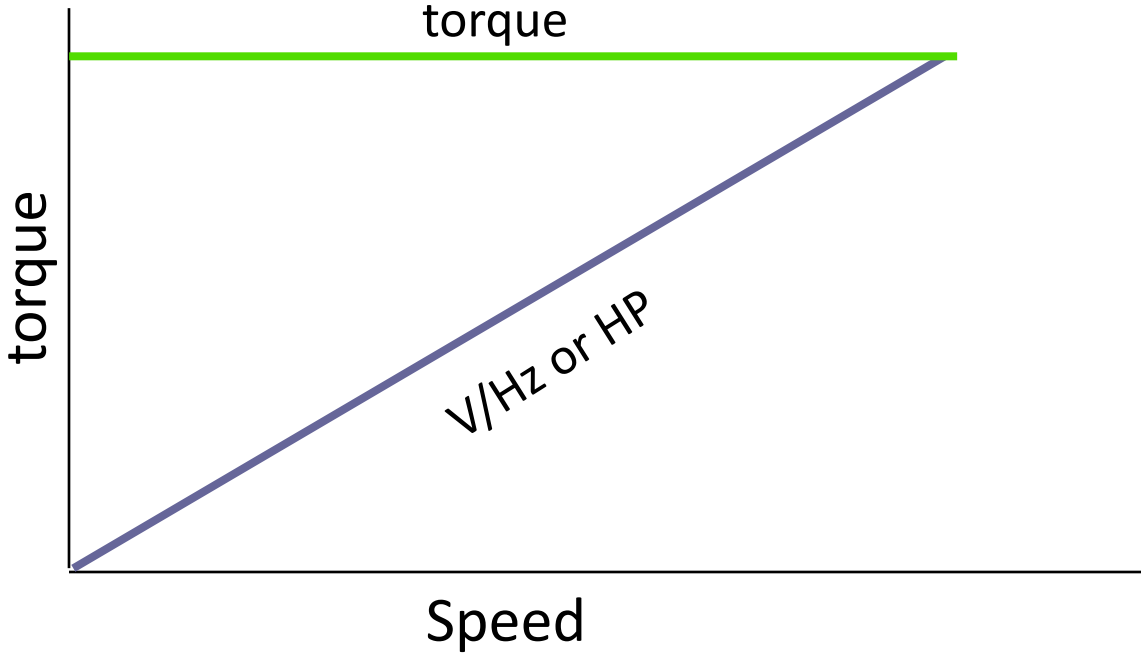
The Torque Varies by the Square of the speed

The HP Varies by the Cube of the speed



Constant torque

The Torque remains constant from a low speed to base speed



- The application is a 1800 RPM centrifugal pump. The pump requires a 100 horsepower motor.
- Payback on investment

100 HP Variable Frequency Drive	$ 6,000.00
Input & output Reactors	$ 1,000.00
Installation & Start-Up	$ 2,400.00
Total	$ 9,400.00
Savings per year operating at 90% speed	$ 3,340.00
Savings per year operating at 80% speed	$ 6,681.00

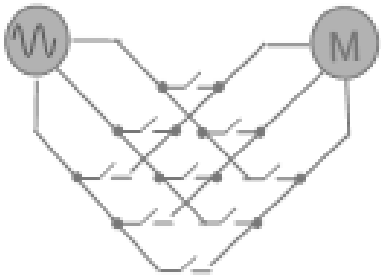
VFD Packaged Considerations

- ENCLOSURE
- COOLING
- POWER DIST.
- DRIVE/STARTER
- CONTROL PWR.
- AUTOMATION
- HARMONICS
- DV/DT
- PROGRAM
- START-UP

NEW EMERGING TECHNOLOGIES

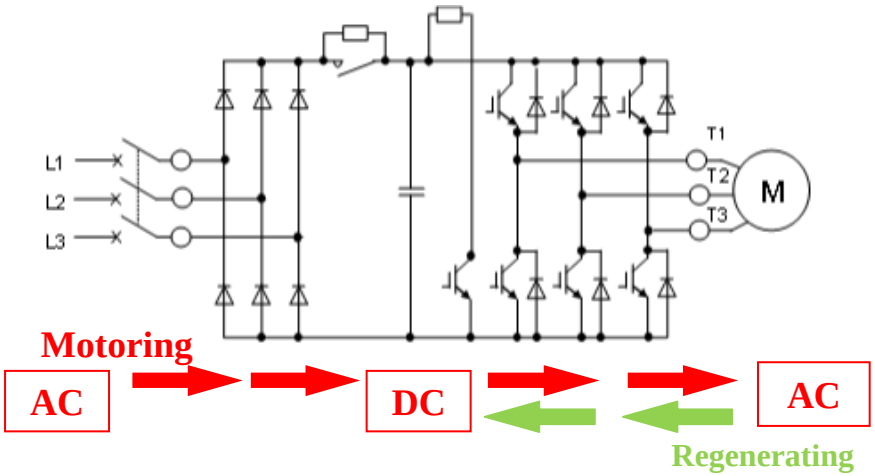
Matrix Theory

- The Matrix Drive creates precise control of voltage and frequency from 3ph AC power by connecting 9 bi-directional switches like a matrix.
- Differing from conventional drives, the Matrix Drive has no DC link circuit with diode and main capacitor, thus resulting higher efficiency.
- Typical harmonics associated with charging and discharging of DC link capacitors is not present with the Matrix drive.
- The Matrix Drive can return power during regeneration which can be re-used by loads connected to the same power source.

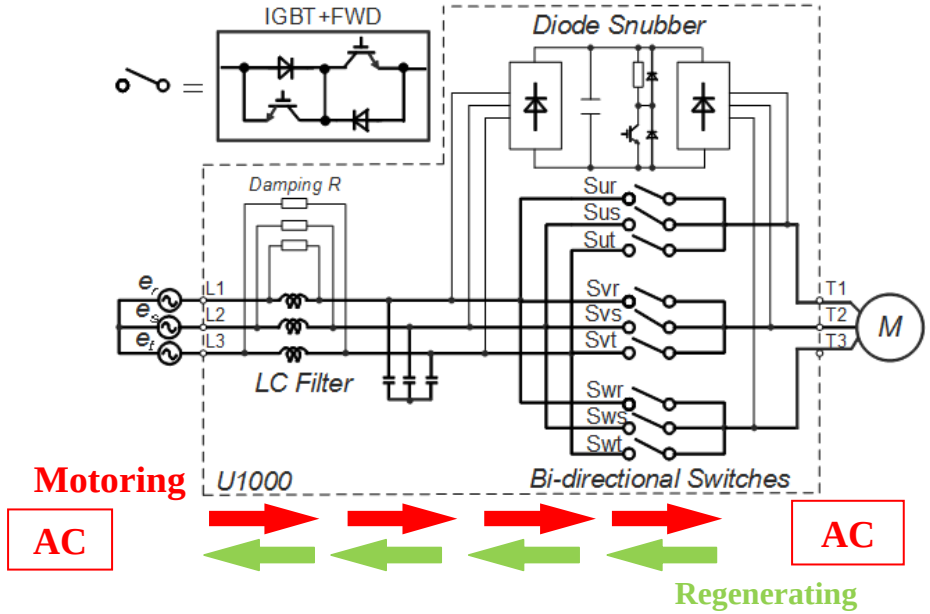


【9 bi-directional switches】

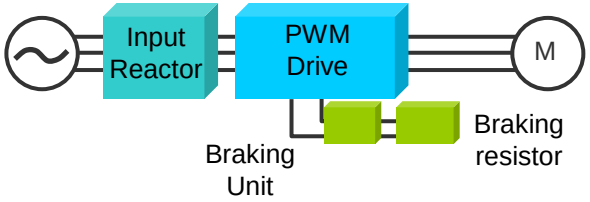
【Circuit configuration - general-purpose drive】



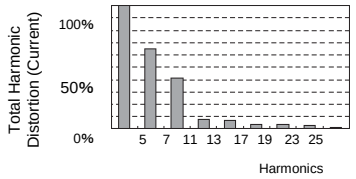
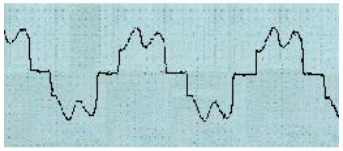
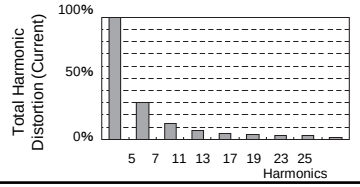
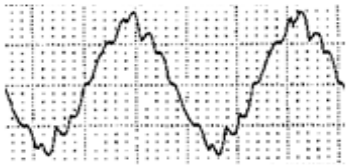
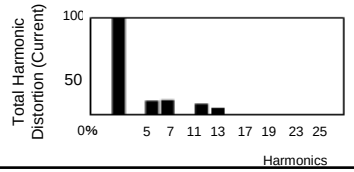
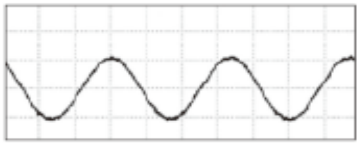
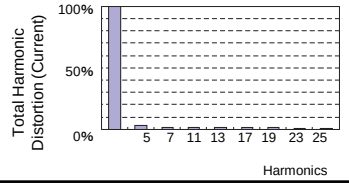
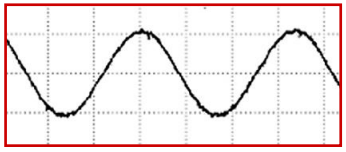
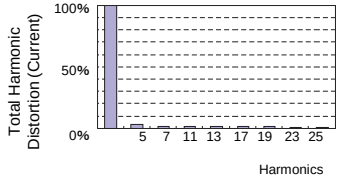
【Circuit configuration – U1000 Matrix】



Comparison to Conventional Drives

MATRIX DRIVE		****	****	****	****	****
Active Front End + General-Purpose Drive		****	****	***	****	**
General-Purpose Drive		**	**	***	*	**

Harmonic Performance Comparison

	Current Waveform	Current Spectrum	iTHD
AC drive without reactor			~ 80%
AC drive with DC reactor			~ 40%
AC drive with multi-pulse			6 - 12%
AC drive with AFE			≤ 5%
Matrix			≤ 5%

Cloud Based Monitoring Systems

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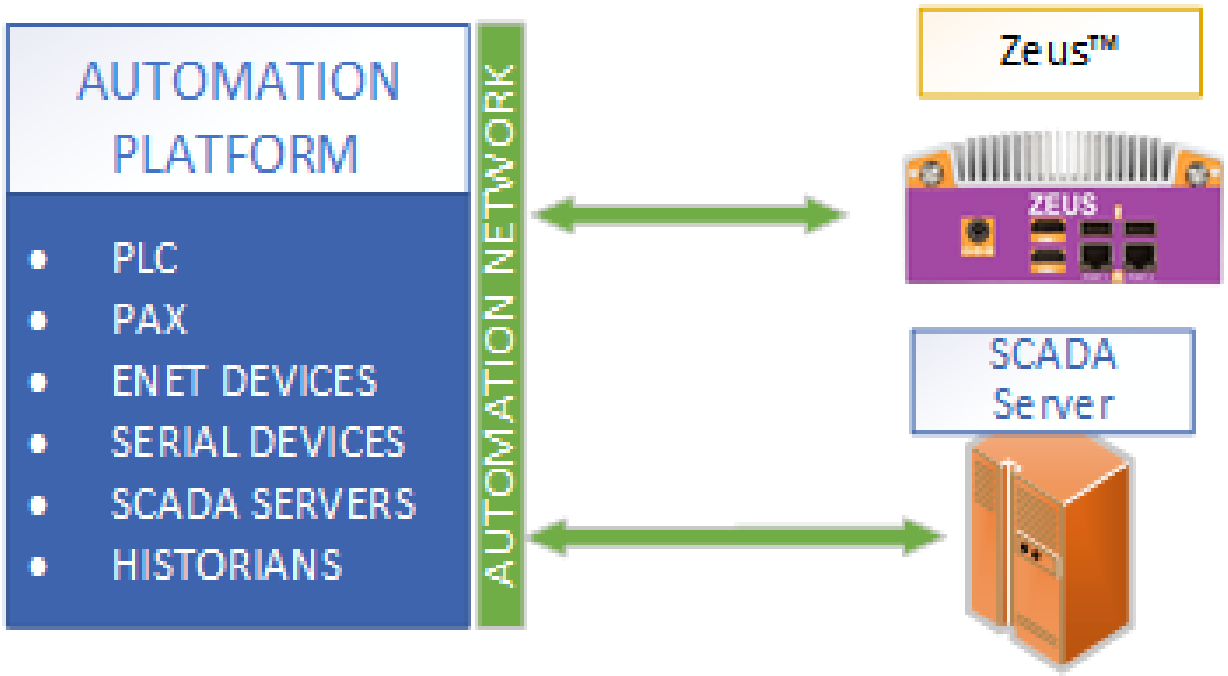
Cell Phones and Tablets



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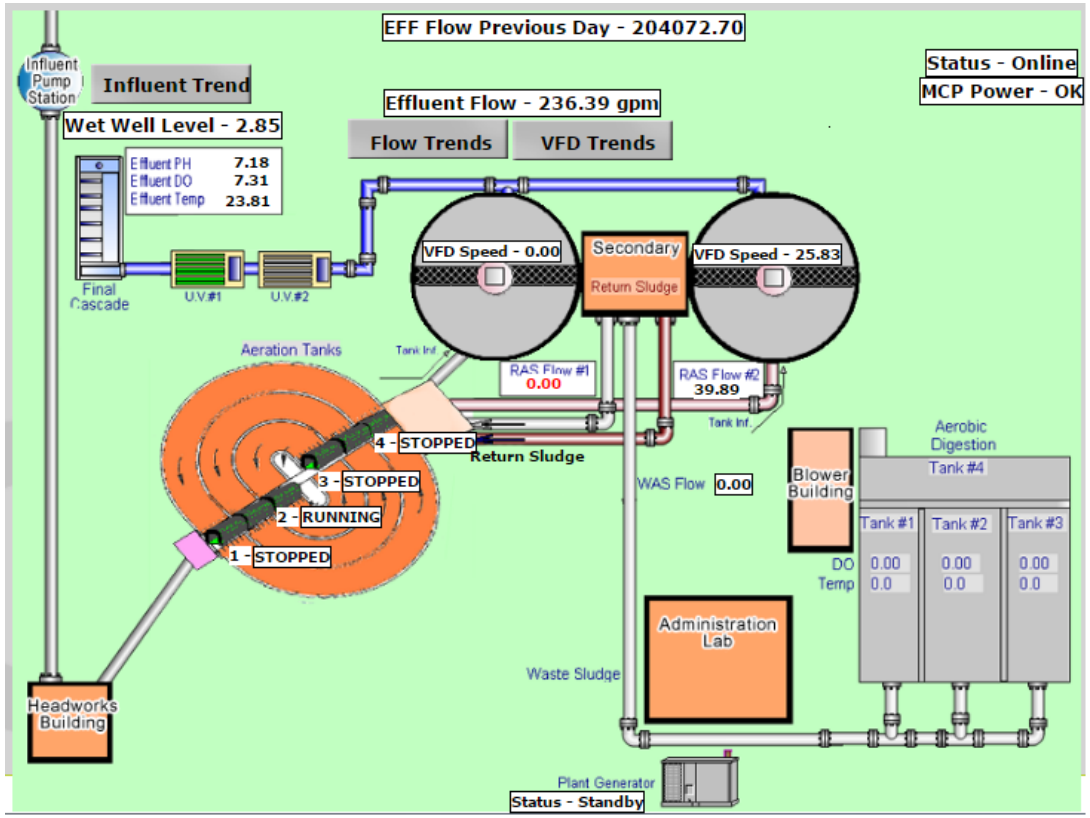
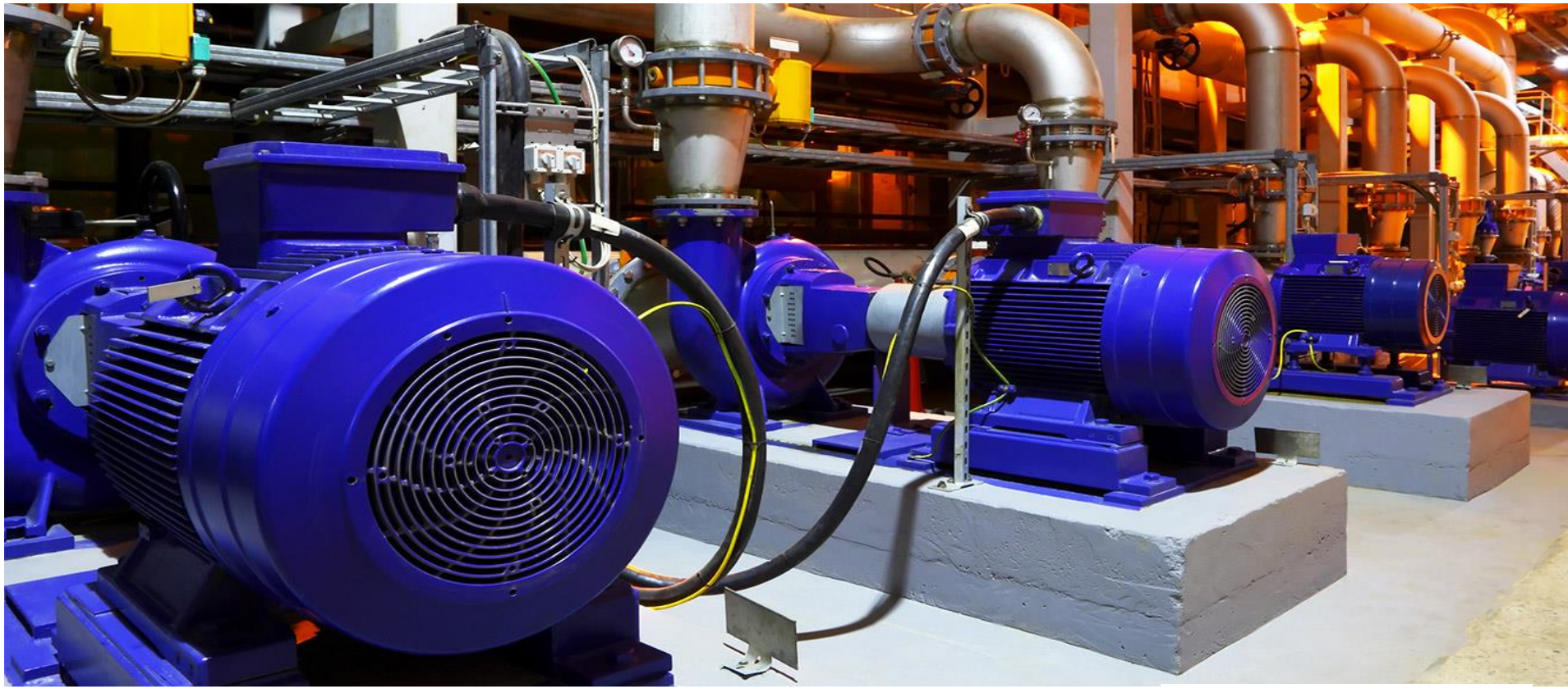
Virtual Touch Screen



Process Control Questions and Comments? Thank you!



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