



---

# Get More Value from Your VFD

# 1

## Why VFDs Are Essential Today

A VFD is a type of motor controller that can vary the frequency and voltage of induction and permanent magnet (PM) motors.

# Driving innovation in modern workplaces.

In a world where motors power critical systems across industries, variable frequency drives (VFDs) have become an essential component for success.

Although VFDs have been used for decades, today's models are incorporating the latest technologies that open a whole new world of possibilities. Modern VFDs are smarter, more compact, more powerful, more energy efficient, and have a wealth of advanced capabilities that organizations might not be taking advantage of.

This ebook will introduce you to some of those innovative capabilities, and, we hope, motivate you to seek out even more innovative and revolutionary ways to get more out of your VFDs than ever before.

## Why You Need VFDs in the First Place

Whether they're used in water/wastewater, aggregate/mining, manufacturing, oil & gas, or a range of other industries, VFDs can maximize productivity in high-performance environments and instances where you want to maximize energy efficiency.

VFDs have revolutionized industries by offering a range of capabilities that surpass the simple on-off operation of standard motor starters.

The main capabilities that make them so popular are:

- **Flexibility in speed control**—drives can be sped up or down incrementally as needed
- **Gradual ramp-up and ramp-down**—torque and power of a drive can be adjusted with soft acceleration and deceleration
- **Simple replacement** with little downtime and manual effort
- **Built-in automation/safety features**—if a fault in the motor occurs, the VFD will halt operations to prevent further damage



Source: Mordor Intelligence

## Benefits of using a VFD

The ability to dynamically vary the speed and torque of electric motors comes with a number of benefits. It allows organizations to:

- **Save on energy costs** and make systems more efficient
- **Improve working environments** by increasing and decreasing motor speed and torque as needed
- **Lower mechanical noise levels**—from fans and pumps, for instance
- **Extend equipment life** by reducing mechanical stress on machines
- **Decrease peak-demand prices** and reduce required motor size by using more exact motor speeds and torque

The reasons to use VFDs—and reap the rewards—are pretty clear. But now it's time to see how organizations are leveraging the special features of modern VFDs to raise the competitive bar and realize even greater benefits.



**“It is estimated electric motors in industrial applications consume approximately one-fourth of the world’s electrical energy. When these motors are incorporated with VFDs in centrifugal load service, their efficiency increases. With technological advancements in power electronics technology, VFD cost and size have decreased, while performance has improved.”**

Control Engineering

# 2

## Built-in PLCs

# Moving machine intelligence to the edge.

A PLC “is able to pull a large amount of data items that, together with the sensor data, give you a fuller picture of what’s going on with any given machine. It can monitor inputs and outputs to and from a machine, and can make logical decisions when necessary, based on programming.”

The Machine Builders’  
Guide to Remote  
Machine Monitoring

For decades, programmable logic controllers, or PLCs, have been a common component in many industries—especially those that use assembly lines or robotic devices, or involve activities that need a high degree of reliability, programming, or fault diagnosis.

What’s new these days is that many VFDs have built-in PLCs. Integration of the two devices reveals advanced capabilities that allow you to more easily automate sequence control and drive flexibility for a range of complex applications—right at the edge of operations. Built-in PLC capabilities allow you to pre-set automated functions and add a layer of customization for your unique applications. Plus, because the PLC is built right into the VFD, you eliminate the need for additional hardware, including sensors, transmitters, cabling, junction boxes, and so on.

## Finding New Uses for VFDs: 5 Important Questions to Ask

1 Where are the **bottlenecks** in your operations?

2 Where could more **precise motor control** make a difference?

3 Which processes **use the most energy**?

4 What manual tasks **Banner for Dialogue asks** are slowing down your processes?

5 What causes **the most unplanned downtime** in your organization?

# 1

## Advanced Capability No. 1

### Smart conveyor braking in poultry plant

Machinery is meant to make processes simpler, but in one small poultry plant, automated equipment was actually the cause of one of its biggest challenges.

The plant used automated conveyor belts to transfer freshly laid eggs right from the hens to the processing area. An automated egg counter tracked the eggs and delivered a final tally, which was critical to operations.

However, the hard starts and stops on the automated egg conveyor belt continually caused the eggs to roll back and forth and confuse the automatic counter. Inaccurate counts resulted in the need to do manual counts, which caused excess downtime and inefficient operations.

By controlling the conveyor belt with a VFD and its built-in PLC, the plant was able to overcome the difficulties. The VFD helped smooth out the belt stops and starts, and the PLC could slow down the belt as needed if eggs began to shift during the trip. Eggs no longer rolled all over the conveyor belt and the count was always accurate.

#### ADVANCED CAPABILITY

#### Benefits

- Reduced downtime** now that automated counts are accurate and there is no need to manually count eggs
- Increased confidence** in automated capabilities
- More efficient** operations overall



# 2

## Advanced Capability No. 2

### Plastic film tension control in printing plant

Keeping correct tension in a massive roll of plastic film can be the cause of emotional tension in plant workers. The roll's tension has a very small "sweet spot" as it is fed into the printing apparatus—if the roll is too slack or too tight by even a little bit, the film can jam the machine or rip. Both of those issues can cause undue downtime and result in a lot of manual technician effort.

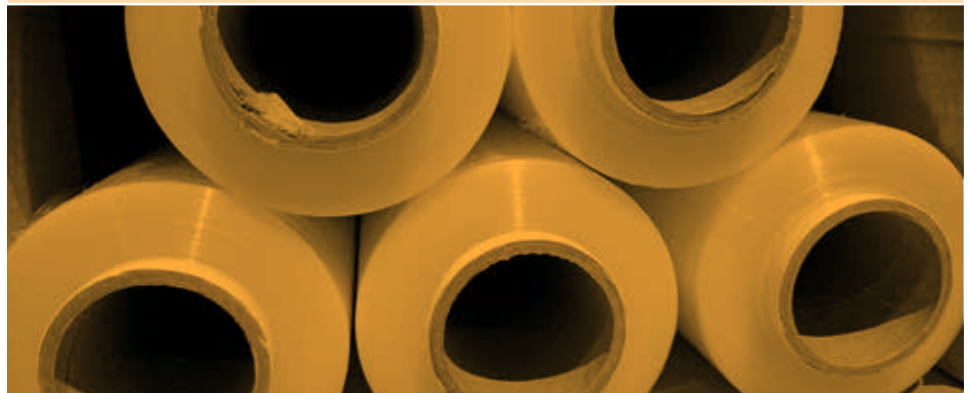
By using two VFDs with built-in PLC, each one controlling a motor at the end of a large roll of plastic film, the printing plant can avoid that downtime and extra effort.

The PLC on each VFD monitors the film tension on its end of the roll and compares that tension to the pre-set tension target. If tension on its end goes below or above the pre-set range, the PLC tells the VFD to adjust motor speed accordingly.

#### ADVANCED CAPABILITY

#### Benefits

- ✓ **Significantly reduced potential for downtime and waste of material** caused by film rips or breakage
- ✓ **More efficient operations**
- ✓ **Reduced need for manual oversight**





# 3

## Advanced Capability No. 3

### Pump anti-clogging at university wastewater treatment plant

When your sports team wins, it's always a cause for celebration. But victory traditions at one university wreaked havoc on wastewater treatment pumps.

After the winning game, students would go back to their dorms and flush stretchy socks and other fabrics down the toilet. That consistently caused the plumbing system to back up and put extreme stress on wastewater treatment pumps across campus.

Using VFDs with built-in PLC, the university was able to resolve much of the problem. Now when pump motors get overloaded, the PLC detects the stress and tells the VFD to slow down or even reverse the motors in an attempt to "clean" the pump automatically before the clog gets worse.

#### ADVANCED CAPABILITY

#### Benefits

- Automatic pump cleaning/anti-clogging**  
 helps greatly reduce downtime
- Less manual effort needed** to unclog  
 or repair pumps
- Lower repair/maintenance costs**

#### The Effect of "Flushable" Wipes on Wastewater Pumps

North American businesses and households spent an estimated \$2.5 billion on personal wipes in 2019. These wipes cause approximately

# \$441 Million

annually in additional operating costs at U.S. treatment plants. That averages out to about \$30,467 in extra costs per plant per year.



# 3

## Remote Monitoring

# Maintenance and more at a distance.

“According to the Vanson Bourne Research Study, roughly 82 percent of companies that have experienced unplanned downtime over the past three years, have experienced outages that lasted an average of four hours. The cost of downtime came with a price tag of an estimated two million dollars.”

Peter Brand,  
Oden Technologies

Not all VFDs are deployed in factory environments, or in close proximity to technicians and other workers. That’s why remote monitoring features, when integrated with VFDs, can deliver great benefits to businesses of all kinds.

The advanced capabilities of remotely monitoring VFDs and motors and gaining insight into potential issues are a huge plus. But the new features don’t only address monitoring. Some VFDs with remote monitoring also allow operators to perform actions on the VFD at a distance, such as viewing and setting VFD parameter lists, debugging programs, checking diagnostics, and more—right from their office PC or mobile device.

These capabilities help save a lot of time, which can translate into real money saved. They also can help organizations avoid unplanned downtime, which comes at great cost.

# 1

## Advanced Capability No. 1

### Multiple VFD management across large e-commerce fulfillment operation

Large e-commerce fulfillment operations require precise coordination and control—without those qualities, chaos can quickly ensue, which in turn can affect product delivery and, ultimately, customer satisfaction and loyalty.

The need for tight control is even greater at e-commerce fulfillment operations that have multiple warehouse locations spread across a large geographic area. Each warehouse has many conveyors controlled by multiple VFDs. Without a remote monitoring system, it would be impossible for one person to oversee and manage all the VFDs across all locations.

### 5 Benefits of Remote Monitoring in Industrial Environments

1

See into places you can't reach physically

2

Reduce the need for staff travel

3

Reduce the need for staff to enter hazardous areas

4

Improve operations through key performance indicator (KPI) presentation

5

React to issues more quickly

Using VFDs with remote monitoring capabilities, however, one operations manager could easily monitor and manage all warehouse VFDs and conveyors from a single dashboard in their office. The manager could stay aware of any complications and take immediate action to resolve issues without having to be on-site at the faulty component's location.

Not only does that allow technicians to address malfunctions quickly before they escalate, but it also allows the organization to keep operations efficient with less staff. Instead of having an operations manager at each location, one manager can oversee all locations without compromising productivity—a particular benefit in markets where budgets are shrinking and competition is increasing.

#### ADVANCED CAPABILITY

### Benefits

- Save time** by eliminating the need for time-consuming travel
- Save money** by reducing staffing needs through centralized management
- Reduce downtime** with the ability to take quick action when needed



In 2020, 76% of companies in the manufacturing industry worldwide cited preventive maintenance as their number one maintenance strategy.\* Remote monitoring can be a significant aid in identifying potential issues.

\* Plant Engineering, 2020

# 2

## Advanced Capability No. 2

### Oil & gas pump jack maintenance in remote locations

When remote oil and gas pumps go down, it can take hours to get them back up—especially when they’re located in extremely remote areas. Simply traveling to the pump can take half a day or more before a technician can assess the problem and make repairs. And woe to anyone who didn’t bring along the right tools or replacement parts.

By installing VFDs with remote monitoring capabilities, an oil and gas company can resolve those challenges with remote, anytime insight into pump jack conditions. A technician can stay abreast of any issues with the remote pump jacks and immediately see what the problem is when malfunction occurs in real time. Many issues can be fixed remotely through the monitoring software, such as debugging the program or resetting the drive. Other issues might still need a technician to travel to the site, but they’ll make the trip with confidence that it’s warranted.

“As companies seek to drive value through more reliable and digital-laden products, implementing remote monitoring will be increasingly mandatory to compete. Early adopters have already established an early advantage...”

Brant Henne, PTC

According to the Vanson Bourne Research Study, roughly 82 percent of companies that have experienced unplanned downtime over the past three years, have experienced outages that lasted an average of

# 4 hours.

The cost of downtime came with a price tag of an estimated two million dollars.

Peter Brand, Oden Technologies



#### ADVANCED CAPABILITY

### Benefits

- ✓ **Save time and effort** by eliminating the need for many trips to remote pump jacks
- ✓ **Save money** by reducing staffing needs through centralized management

# 4

## Networking

# Connecting drives for better precision.

“By 2025, the total number of consumer and industrial Internet of Things (IoT) connections in North America is forecast to grow to 5.4 billion. In 2019, the number of IoT connections in North America amounted to 2.8 billion connections.”

S. O’Dea, Statista

Many of today’s VFDs can be networked via Ethernet to other automation equipment, factory information management systems, or even other VFDs. The advanced capabilities of networked VFDs allow multiple drives to communicate with each other and stay in sync as needed. Organizations also gain access to a lot of helpful data, including condition alerts, device modes, and motor frequency feedback.

Some VFDs can be networked into a manufacturing execution system (MES) in order to both send and receive data. When connected to other automation equipment, these VFDs can form an information gateway between systems.

# 1

## Advanced Capability No. 1

### Hose operation in manufacturing plant

Energy efficiency is more important today than ever before. Organizations that can't control energy costs won't be able to stay competitive for very long. Networked VFDs can help organizations reduce energy requirements and save significantly on costs.

Consider a plant that manufactures pet food. It has a 300 horsepower motor and one large pump connected to 100 hoses. Sometimes, however, operations require just a few hoses to run at a time. With its current setup, the plant has to run the pump at full power regardless of how many hoses are operational. That wastes a lot of energy.

“The total installed base of Internet of Things (IoT) connected devices worldwide is projected to amount to 30.9 billion units by 2025, a sharp jump from the 13.8 billion units that are we expected in 2021.”

Lionel Sujay  
Vailshery, Statista

10%

Fans and pumps at are turned down just 10% can save up to 25% in energy costs.

25%  
savings

50%

In most systems, reducing its speed by 50% can cause a 75% drop in energy consumption.

75%  
drop

Source: Efficiency Vermont

A smart solution could be to replace the large motor with 10 smaller pumps that each control 10 hoses. With a network of 10 VFDs, each controlling a pump (and its 10 hoses), the plant could cut down on energy costs by powering on pumps only as needed. For instance, if 28 hoses were needed for a particular run, three VFDs would power on their pumps. The others would stay off, until a larger work order required more hoses. Another plus to this solution is that by networking the VFDs together, a technician could control them all easily.

#### ADVANCED CAPABILITY

### Benefits

- Significant energy savings**, thanks to eliminating the need to run one powerful motor for each run
- Less wear on equipment over time**, as each pump operates only when needed



“Networking [VFDs] allows the collection, storage and later review of a broader spectrum of data by multiple individuals for the purposes of troubleshooting problems, identifying potential issues before they occur, and enhancing delivery of service.”

John Gross,  
 CSE Magazine  
 Vailshery, Statista



# 2

## Advanced Capability No. 2

### Load sharing in pick-and-place operation at production facility

Today's production facilities live or die on ever-increasing speed and precision. While modern pick-and-place machinery helps keep these facilities on the razor-thin edge of success, networked VFDs can give them an even greater competitive edge.

Typically, a gantry used in pick-and-place operations has two separate motors to control lift and movement on multiple axes. These motors need to be in sync and move at the same speed when performing pick-and-place tasks to keep items level and aligned.

By using two networked VFDs to control those gantry motors, organizations can achieve greater stability and performance in production facilities. Each VFD stays aware of the other's position and movement, and can adjust its own movements based on that data to ensure items aren't dropped or damaged.

#### ADVANCED CAPABILITY

#### Benefits

- Reduced risk of dropping or damaging items being picked**, which results in less downtime and greater efficiency overall
- Improved worker safety** by reducing potential for pick-and-place accidents

**“Pick-and-place machines can handle a wide variety of parts and can theoretically handle 136,000 components per hour (cph). The fastest machines can perform 200,000 cph.”**

Jonathan Bara,  
Machine Design

# 3

## Advanced Capability No. 3

**Via wired or wireless networking connections, users can easily interact with VFDs to:**

Configure functions

Adjust control, operating and drive physics parameters

Upload/download settings

Monitor operation

Adjust tracking and tuning

Access advanced scope functions

Perform firmware downloads

Brian Sisler, Processing Magazine

## Droop looping in mining operation

Boring a tunnel through the earth is a complex and costly job. The stakes are high, and one misstep can sink an entire operation. Networked VFDs can head off disaster and ensure success.

In mining, a tunnel boring machine, or mole, undergoes extreme variations in stress across its entire cutter head, as it encounters materials of differing hardness throughout its operation. If one section of the cutter head hits a hard part of earth and the other section doesn't, it can create a stress imbalance that can result in motors overheating or being damaged.

By using multiple networked VFDs to control the motors of the mole, stress imbalances can quickly be resolved and prevent damage to a motor. Each VFD stays aware of the stress and workload of the other VFDs, and can speed up or down on the fly to alleviate potential malfunction. By slowing down, for instance, when another VFD is working extra hard, the networked VFDs conserve energy and reduce undue wear on machine parts until they move into an area with harder materials and need to speed up.

### ADVANCED CAPABILITY

#### Benefits

- Less potential for unnecessary strain on motors**
- Reduced risk of downtime due to overloaded motors**
- More efficient operations overall**

# 5

## How Mitsubishi Electric Can Help

# Deploying advanced technologies to keep you competitive.

Thanks to technology, today's VFDs have opened up a world of new possibilities. You can accomplish things you might never have imagined.

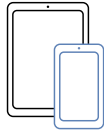
At Mitsubishi Electric, we can help you incorporate VFDs into your processes or discover how to do more with your Mitsubishi Electric VFDs to ensure you stay ahead of an ever-evolving marketplace.

### What makes our VFDs so special?



### Real Sensorless Vector Control

This feature allows more precise torque and speed response even at low speeds. Other companies might offer this capability on their larger drives, but we offer it even on our smallest drives.



## FR Configurator2

Included free with all drives, this app for iOS tablets and smartphones provides convenient commissioning, maintenance, troubleshooting, parameterization and monitoring support for our VFDs. It uses Ethernet instead of the more common Bluetooth technology for superior range and reliability in remote, device-based VFD management and control.



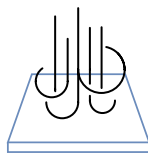
## Standard “Master Drive” Feature

With the ability to control up to five slave drives, Mitsubishi Electric VFDs deliver ultra-fast transfer of information between drives to keep them at simultaneous speeds in load sharing use cases. Our VFDs are easy to set up and network together.



**“The global industrial automation market size was valued at USD 168.81 billion in 2019 and is projected to reach USD 326.14 billion by 2027, exhibiting a CAGR of 8.9% during the forecast period.”**

Fortune Business Insights, August 2020



## Conformal Coating

Each printed circuit board (PCB) in our VFDs is conformal coated to protect drives in a wider variety of harsh operating environments—such as in the presence of corrosive gases, moisture, chemicals, etc. Mitsubishi Electric also offers an option to conformal coat each VFD’s bus bar, further protecting the device.



## An Environmental Alert System

Not only do our VFDs protect themselves with their conformal coating, the drives tell you when the environment could cause a problem for equipment—for instance, when corrosive gases are present.



## Soft Pulse Width Modulation (PWM) Technology

With soft PWM technology, our VFDs reduce the average power delivered by an electric signal. That means the drive can connect to the motor from a larger distance away, even up to 1000 feet, without the need of an output filter.

Mitsubishi Electric offers a comprehensive line of factory automation solutions for a broad range of factory automation applications. With industry-leading quality, performance and compatibility, these solutions are helping companies successfully automate factory operations and get on the path to Industry 4.0 and 5.0.

**Explore How Others Have Been Successful  
with Mitsubishi Electric Solutions**

**> Explore CASE STUDIES**

## Gain competitive advantage with:

- Built-in PLCs
- Remote monitoring
- Networking

Discover the advanced capabilities of our VFDs



> **Connect with Us**

## Mitsubishi Electric Europe B.V., Factory Automation, Sales Offices

**Germany**  
**Mitsubishi Electric Europe B.V.**  
Mitsubishi-Electric-Platz 1  
D-40882 Ratingen  
Phone: +49 (0)2102 / 486-0

**Czech Rep.**  
**Mitsubishi Electric Europe B.V.**  
Pekařská 621/7  
CZ-155 00 Praha 5  
Phone: (+) 420 734 402 587

**France**  
**Mitsubishi Electric Europe B.V.**  
25, Boulevard des Bouvets  
F-92741 Nanterre Cedex  
Phone: +33 (0)1 / 55 68 55 68

**Italy**  
**Mitsubishi Electric Europe B.V.**  
Viale Colleoni 7 Palazzo Sirio  
I-20864 Agrate Brianza (MB)  
Phone: +39 039 / 60 53 1

**Ireland**  
**Mitsubishi Electric Europe B.V.**  
Westgate Business Park, Ballymount  
IRL-Dublin 24  
Phone: +353 (0)1 4198800

**Netherlands**  
**Mitsubishi Electric Europe B.V.**  
Nijverheidsweg 23C  
NL-3641RP Mijdrecht  
Phone: +31 (0) 297 250 350

**Poland**  
**Mitsubishi Electric Europe B.V.**  
ul. Krakowska 48  
PL-32-083 Balice  
Phone: +48 (0) 12 347 65 00

**Russia**  
**Mitsubishi Electric (Russia) LLC**  
2 bld. 1, Letnikovskaya st.  
RU-115114 Moscow  
Phone: +7 495 / 721 2070

**Spain**  
**Mitsubishi Electric Europe B.V.**  
Carretera de Rubí 76-80 Apdo. 420  
E-08147 Sant Cugat del Vallés (Barcelona)  
Phone: +34 (0) 93 / 5653131

**Sweden**  
**Mitsubishi Electric Europe B.V. (Scandinavia)**  
Hedvig Möllers gata 6  
SE-223 55 Lund  
Phone: +46 (0) 8 625 10 00

**Turkey**  
**Mitsubishi Electric Turkey Elektrik Ürünleri A.Ş.**  
Şerifali Mahallesi Kale Sokak No:41  
TR-34775 Ümraniye-İSTANBUL  
Phone: +90 (216) 969 25 00

**UK**  
**Mitsubishi Electric Europe B.V.**  
Travellers Lane  
UK-Hatfield, Herts. AL10 8XB  
Phone: +44 (0)1707 / 28 87 80

## Mitsubishi Electric Europe B.V.

Factory Automation EMEA  
Mitsubishi-Electric-Platz 1  
D-40882 Ratingen Germany  
Tel.: +49(0)2102-4860  
NEWS-FA-EMEA@meg.mee.com  
<https://emea.mitsubishielectric.com/fa/contact>

Specifications subject to change. All trademarks and copyrights acknowledged.