LISTEN.
THINK.
SOLVE.®

VFD Control – New Technologies & Products

A Focus on Portfolio Expansion and Enhancements

Power Control Business
March 2024

Matt Smith, Power Technology Consultant

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www.rockwellautomation.com

Rockwell
Automation

PowerFlex 520 Family

PowerFlex 525

- 30 Hp
- Standard USB connectivity
- Comms: Embedded DSI + Single port EtherNet/IP
- Comms Options: Dual port EtherNet/IP with DLR, DeviceNet, Profibus
- Safety: Embedded Safe Torque Off SIL2/PLd
- Motor Control options: V/Hz, SVC, Economizer SVC, Closed Loop Velocity Vector, Permanent Magnet Motor
- Incremental Encoder Option
- AppView & CustomView Application Configuration
- CCW Programming Software

PowerFlex 523

- 30 Hp
- Standard USB connectivity
- Comms: Embedded DSI
- Comm Options: Dual port EtherNet/IP with DLR, DeviceNet, Profibus
- Motor Control options: V/Hz, SVC, Economizer SVC
- AppView & CustomView Application Configuration
- CCW Programming Software

PowerFlex 527

- Integrated Motion
- 30 Hp
- Communication: Embedded Dual Port Ethernet/IP
- Safety: Embedded Safe Torque Off SIL3/Ple for both hardwired and Integrated Network Safety
- Motor control Option: V/Hz, SVC, Closed Loop Velocity Vector, Permanent Magnet Motor*
- Incremental Encoder Option
- Removable terminal blocks
- Programmed via integrated motion instructions

PowerFlex 520 Series: Common Attributes

Innovative Design		Simplified Configuration	
• Modularity design • Common Power Module	• Smallest clearance requirement • Zero-stack • Extreme ambient temperatures	• Simplified programming • QuickView HIM	• Seamless integration into Logix with add-on profiles for Studio 5000

Armor PowerFlex

Bulletin 35E & 35S

expanding **human possibility**®

Armor PowerFlex

The Next Generation of On Machine Near Motor VFD

PowerFlex 525 motor **inside**

Extra Tough **IP66, Type 4/12**

Temp Range **-30'C to ~ 55'C**

Flexible Mounting Orientation

Reduced wiring &installation time with quick disconnect

Less time to install

Reduced commissioning & troubleshooting time with an integrated & common design

Local Motor **Disconnect**

Reduced cost with integrated safety & ADC

Cost Reduction*

Reduced engineering time through Premiere Integration with Studio 5000 &Logix

Faster to start up

Reduced staff training with a common hardware & software experience

Feed-through power distribution

* Compared to hardwired STO &third party commissioning within Logix &without ADC

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Armor PowerFlex Bulletin 35S

Integrated &Hardwired Safety **in ONE device**

Advanced Safety

STO, SS1, SLS, SLP, SDI, SBC

+

Hardwired STO,SS1(t)

ST0, SS1(t)

+

Safety I/O

2-dual channel Inputs

1-bipolar output
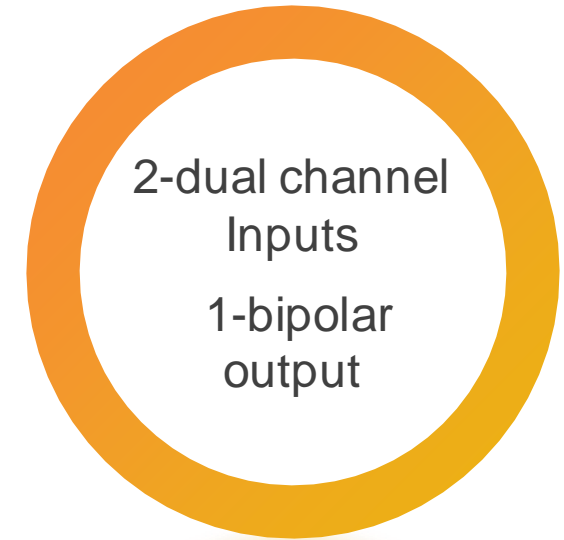
Minimum of **SIL CL 2, PLd** to a Maximum of **SIL CL 3, PLE, CAT4 safety** performance
(risk assessment defines the need)

ArmorConnect®
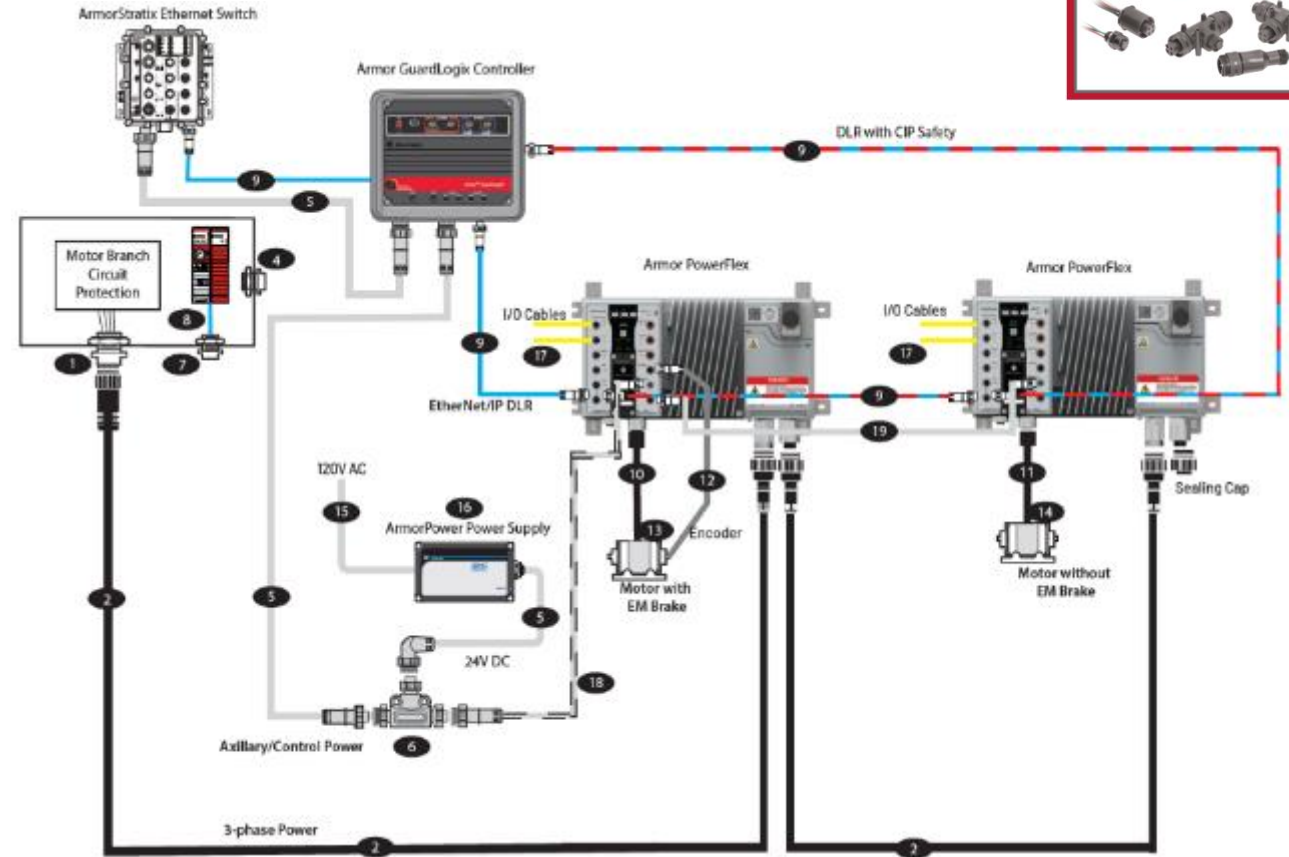## Total cabling solution for Armor PowerFlex

- ## ArmorConnect Portfolio

  Quick connection

  Reduced wiring mistakes

  Reduced installed costs

  Reduced installation time

  Improves mean-time-to-repair

Quick reference guides & tool help with selection

1. CAT5e Bulkhead Connector – Cat. No. 1585A-*
2. CAT5e Patchcord, – Cat. No. 1585D-*
3. CAT5e, RJ45 to RJ45 – Cat. No. 1585J-*
4. Three-Phase Power Receptacles – Cat. No. 280-M35F-*
5. Three-Phase Power Cable (M35) – Cat. No. 280-PWRM35*
6. ArmorBlock Guard I/O – Cat. No. 1732ES-IB8XOBV2
7. Three-Phase Power Tee – Cat. No. 280-T35

8. Control Power Recpetacles – Cat. No. 888N-*
9. Control/Auxiliary Power Cables – Cat. No. 889N-F4*
10. Control/Auxiliary Power Tees – Cat. No. 898N-43PB-N4KT
11. IO Cable between Safety I/O Module and ArmorStart – Cat. No. 889D-*
12. ArmorStart Auxiliary T-Port – Cat. No. 898N-543ES-NKF
13. Control Power Drop Cable – Cat. No. 889N-F65*
14. Three-Phase Power Cable (M22) – Cat. No. 280-PWRM22-*
15. Three-Phase Tee Reducing Drop – Cat. No. 280-RT35

6

PowerFlex 750 Architecture-class AC drives portfolio

PowerFlex 753 & 755
1…1800 Hp / 0.75…1400 kW

- Speed, Torque & Position Control
- XT Optional (Frame 8 & 9 Only)
- 6-pulse Drive
- **FORCE Technology**

PowerFlex 755TS
1…400 Hp / 0.75… 270 kW

- Speed, Torque & Position Control
- XT Optional
- CIP Security
- 6-Pulse Drive (S)
- **TotalFORCE Technology**

PowerFlex 755TL/TR
10…6000 Hp / 7.5…4500 kW

- Speed, Torque & Position Control
- XT Standard
- Liquid Cooled Option
- Active Front-End (**AFE**)
- Low Harmonic (L) & Regeneration (R)
- **TotalFORCE Technology**

PowerFlex 755TM
250…6000Hp/160…4500kW (AC)
70…4800 kW (DC)

- Speed, Torque & Position Control
- XT Standard
- Common Bus Drive System
  - Common Machine (M)
- **AFE** (w/ Regen) or 6-pulse supply (Option)
- Non-regen bus supply (Optional)
- **TotalFORCE Technology**
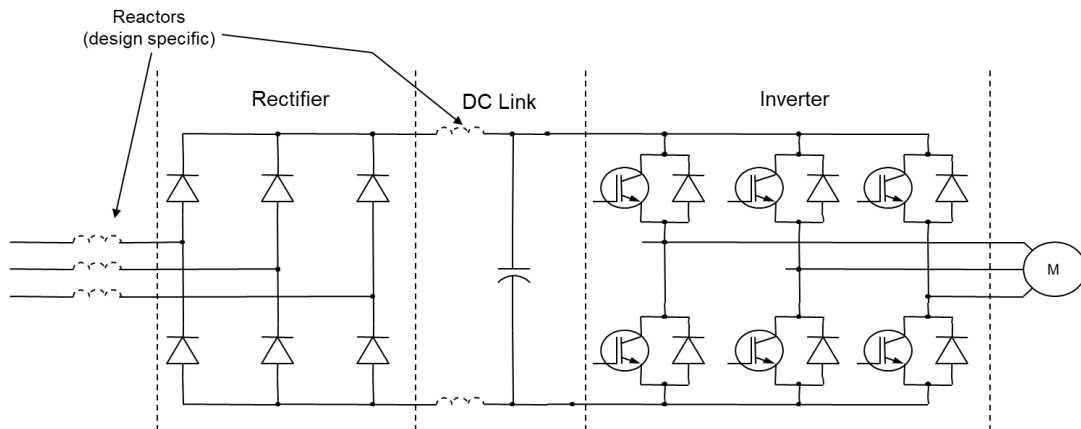
TotalFORCE® Technology

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Available Topologies on the TotalFORCE® Drives Family

Now we have 6-pulse and Active Front End (AFE) options available for our LV Drives
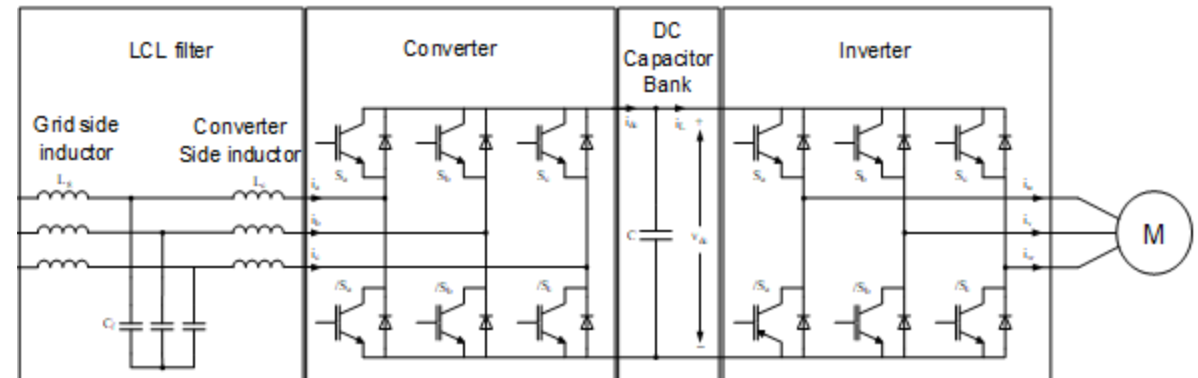
6-Pulse Drive

3 phase, six-pulse, rectifier bridge with either diodes or SCRs for front-end AC-DC power conversion
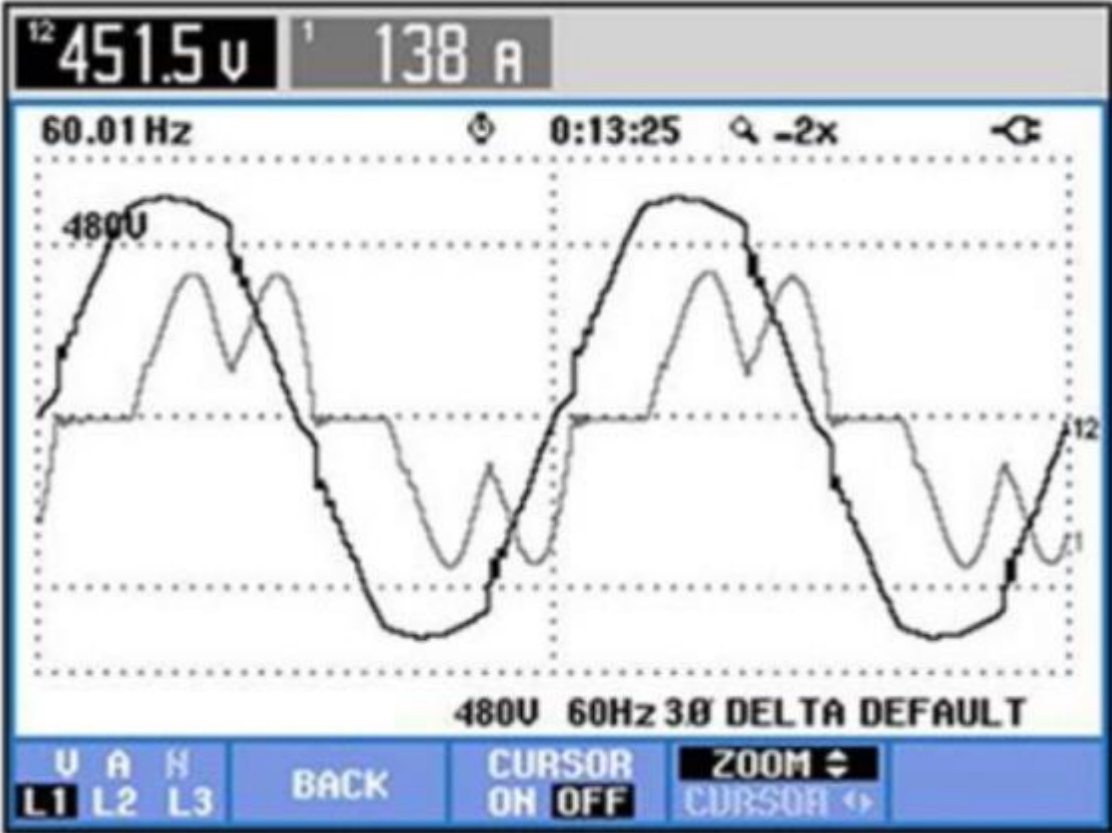

PowerFlex 755TS

AFE - Regeneration & Low Harmonic

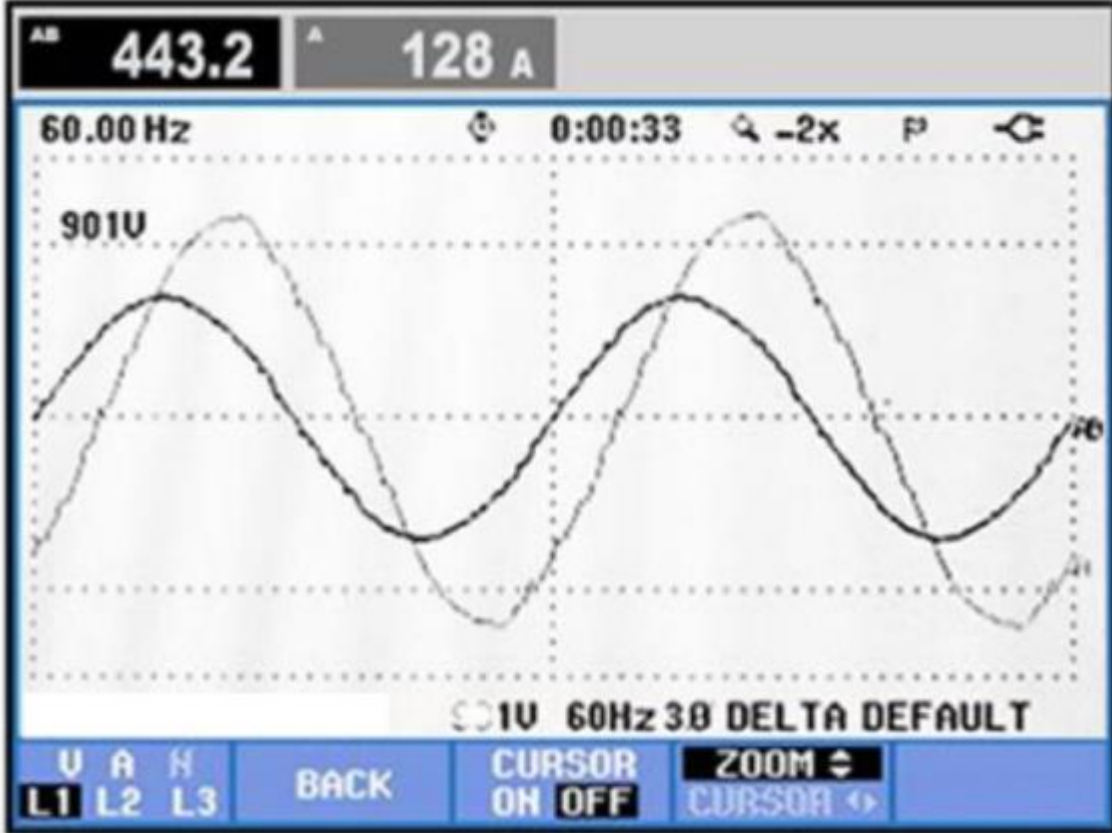3 phase, active rectifier IGBT based front-end AC-DC power conversion

PowerFlex 755TL/TR

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Harmonic Reduction

6 Pulse Drive

AFE

PowerFlex 750-Series with TotalFORCE® Technology

Adaptive Control in Flux Vector Control Mode

*Adaptive*Tuning

Helps increase machine reliability and performance

- Monitors drive performance characteristics and adapts if necessary
- Automatically suppresses potentially harmful resonance and vibration conditions
- Can be used to indicate machine wear out over time

*Load*Observer

Helps reduce startup time by reducing the effort needed for tuning

- Automatically monitors and compensates for load changes
- Compensates for normal machine wear
- Provides consistent dynamic behavior
- Requires Encoder Feedback

*Bus*Observer

Helps increase reliability by reducing the probability of resonance

- Only Available on AFE Drives
- Accounts for dynamic DC bus conditions
- Reduce startup time needed for tuning
- Automatically monitors and compensates for line changes

Patented drive analytics help increase performance and decrease commissioning time!

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TotalFORCE® Technology Predictive Maintenance

The right information at the right time to make the best decisions.

- Take a **proactive approach** to operation and maintenance with diagnostic data that **continuously monitors drive health** and compares the current performance to the application settings

- **Calculate** expected life of components based on actual operating conditions

- Develop an **effective maintenance plan**

- **Patented algorithms** project the remaining life span of drive components – such as fans, bus and LCL capacitors, IGBTs and relay contacts

- **Real-time data with clear meaning** leads to clear and **actionable** insights

- **Immediate notification** on issues that may compromise drive or motor health:

  - Blown fuses

  - Component runtime hours

  - Increasing temperatures out of normal operating range

TotalFORCE® Technology Predictive Maintenance

- PM parameters via CIP Objects for Ease of Use.

- Data available in Connected Components Workbench (CCW) and Studio 5000 Logix Designer Add-On Profile (AOP).

- Power Device Library v3.04
  - AOI/Faceplates Developed for drag/drop in Logix Controller programming and FTView ME/SE.

- Historian Compatible

PowerFlex 755T_2*

PowerFlex 755T_2

192.168.1.150 ℹ️ Connect ⌄

Overview
Parameters
Diagnostic Items
Faults / Alarms
Device Info
Wizards
Date / Time
Address
Predictive Maintenance

Predictive Maintenance

Location	Component Type		
All ⌄	All ⌄	Environmental Settings	Notification Settings

Heatsink Fan
Predicted Remaining Life: 8 Years 6 Months (74,177 Hours) Reset
Location: Converter (L0)
Catalog #: SK-RM-INVFAN1-F8
Remaining Life %

Heatsink Fan
Predicted Remaining Life: 10+ Years (151,066 Hours) Reset
Location: Inverter (M0)
Catalog #: SK-RM-INVFAN1-F8
Remaining Life %

Filter Capacitor
Predicted Remaining Life: 10+ Years (5,239,207 Hours) Reset
Location: LCL Filter (F0)
Catalog #: SK-RM-LCLCPn-F8M - See publication 750-TG100.
Remaining Life %

Bus Capacitor
Predicted Remaining Life: 10+ Years (649,732 Hours) Reset
Location: Converter (L0)
Catalog #: 20-750-MIn-xnnnxnnn - See publication 750-TD101
Remaining Life %

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Predictive Maintenance Extension – PowerFlex 755T fw v12.01
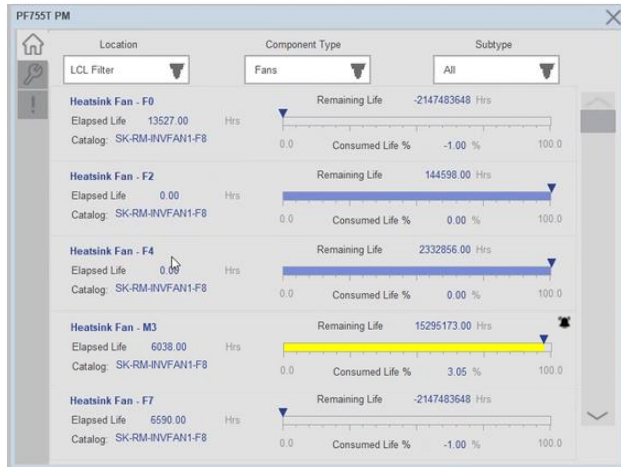
Power Device Library 3.04
Integrated power and energy monitoring for PowerFlex 755TL/R/S/M with firmware v11.01+

Home	Configuration	Fault Log

Displays all predictive maintenance parameters included temperatures, and elapsed and remaining life of components.

Filter on location, component type, and subtype.

Set remaining life threshold and enable/disable for each component type.

Monitored components: Insulated-gate bipolor transistors (IGBTs), Fans and blowers, DC bus capacitors, Circuit breaker, LCL capacitors , Filters (airflow health) , Temperature
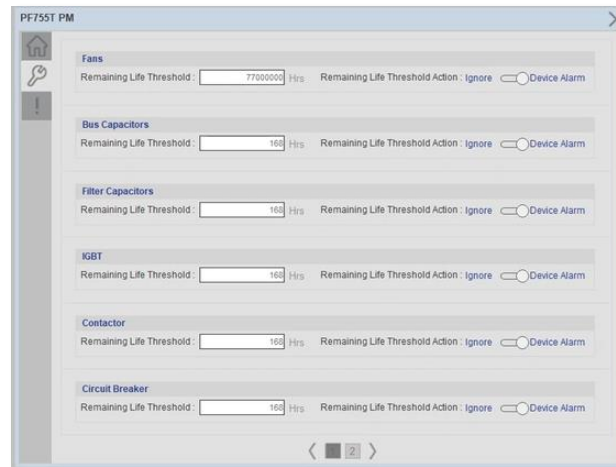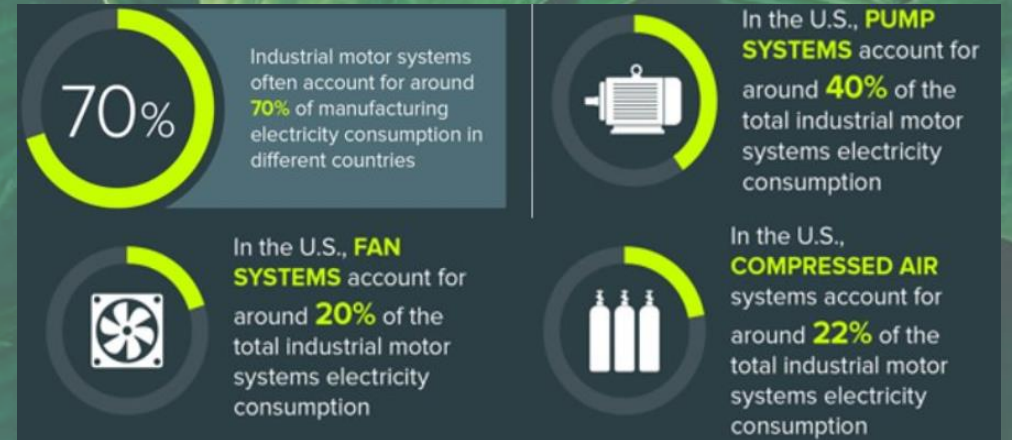
Maintains a log of faults that have occurred recently. Click on event for details including snapshots of the values at the time of the event.
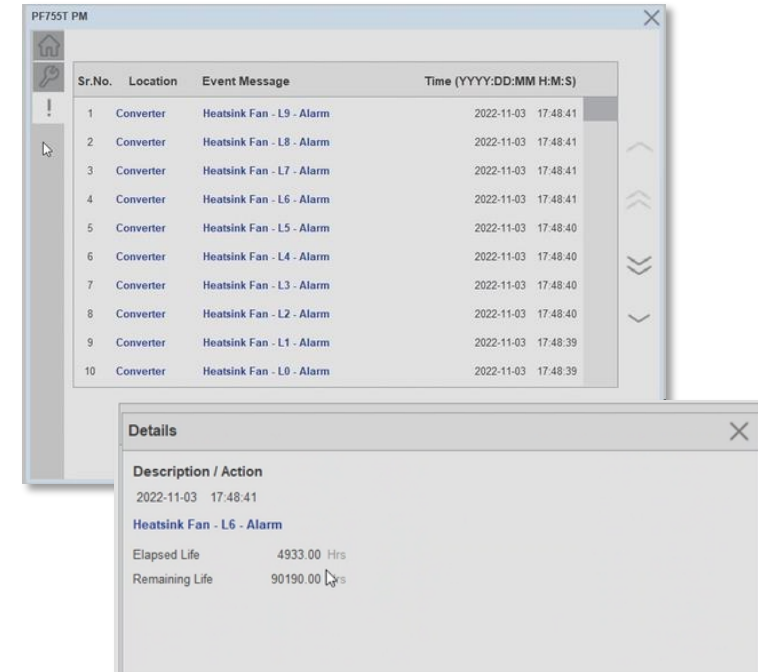
Energy savings

- PowerFlex drives are designed **with efficient internal components**

- Energy savings control modes for **efficient application operation**: energy efficient moves, energy pause and economizer mode

- PowerFlex 755TS drives **meet IEC 61800-9-2, IE2 EcoDesign directive**

- Better efficiency than most competitors

- **Improve efficiency** according to the application and environment that the drives are operating in to further save energy

Reducing the energy a VFD needs to control an application **creates a positive effect** on performance and lowers energy use and costs

70%
Industrial motor systems often account for around **70%** of manufacturing electricity consumption in different countries

In the U.S., **PUMP SYSTEMS** account for around **40%** of the total industrial motor systems electricity consumption

In the U.S., **FAN SYSTEMS** account for around **20%** of the total industrial motor systems electricity consumption

In the U.S., **COMPRESSED AIR** systems account for around **22%** of the total industrial motor systems electricity consumption

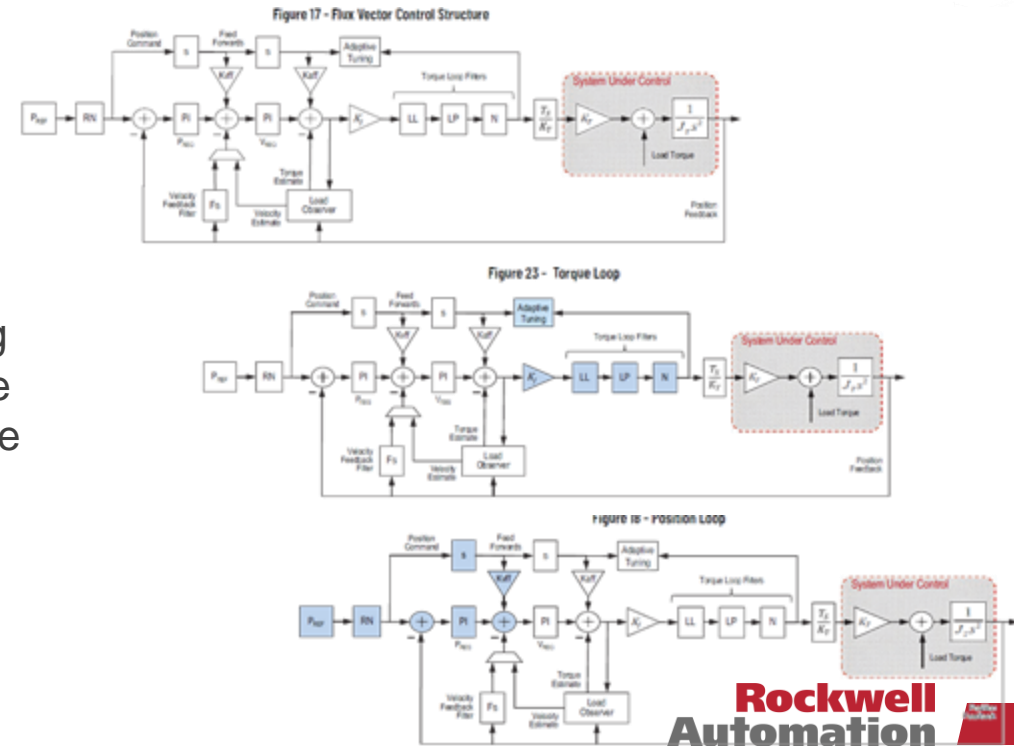Rockwell Automation

Rockwell Automation

Flexible, high-performance motor control - drive that does it all

Your new competitive advantage - TotalFORCE technology

PowerFlex 755T drives offer innovative features that you haven't seen from any other AC drives. TotalFORCE technology will help your application by accepting a motor agnostic control, increasing throughput and improving quality.

- **Motor agnostic control** - Flexible motor support in industry-leading footprint for complete drive solution, providing solutions for a variety of applications and motors

- **Increase application throughput** - With excellent tracking, the drives follow speed or torque commands very closely. They also effectively reject disturbances when loads change suddenly - to help keep the application running smoothly and increase output.

- **Improve the quality of end products** - As a result of rapid processing speed, the drives can provide very precise position, velocity and torque control to help improve the uniformity of end products. Plus, high torque accuracy helps maintain speed regulation in highly demanding tension control applications.


Figure 17 - Flux Vector Control Structure

Figure 23 - Torque Loop

Figure 18 - Position Loop

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PowerFlex 755T Drive Products

Communications

Industrial networks enable real-time visibility to optimize production, maintenance, and safety

- **Standard built-in dual Gigabit EtherNet/IP ports**
  - Supports linear, star and ring topologies with support for DLR
  - CIP Security Capable

- Options for additional industrial networks
  - DeviceNet *(20-750-DNET)*
  - ControlNet *(20-750-CNETC)*
  - ProfiNet *(20-750-PNET, 20-750-PNET2P)*
  - ProfiBus *(20-750-PBUS)*
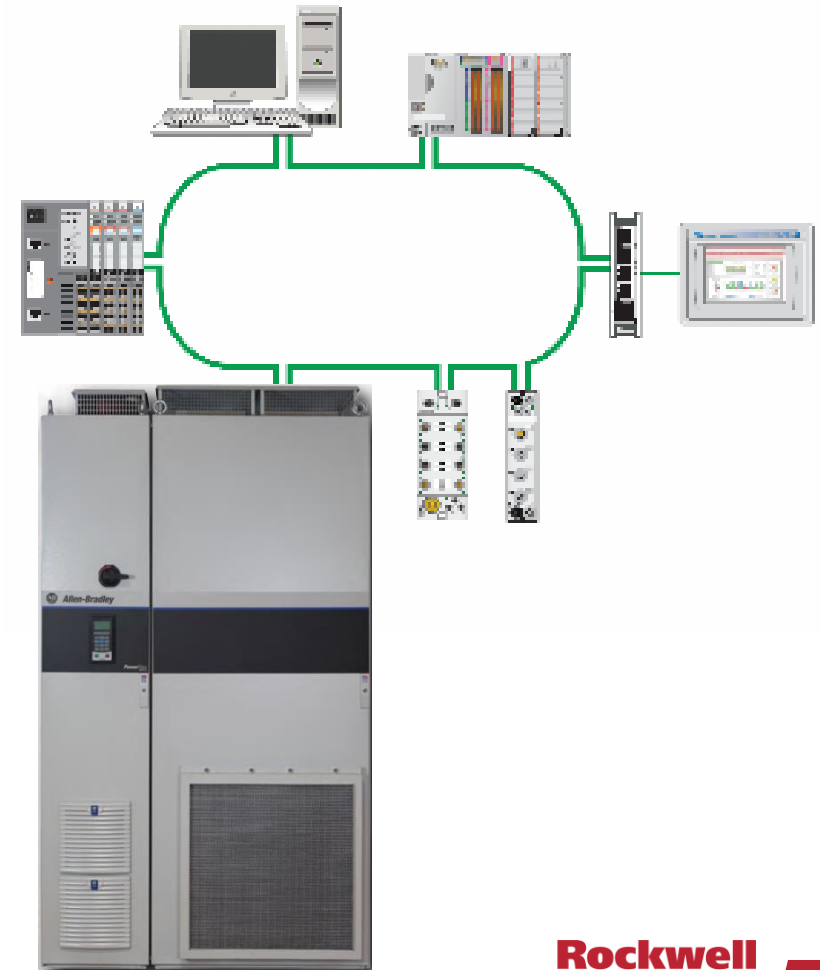
TLink Specifications

- 20-750-TLINK-XT

- Drive-to-Drive high-speed fiber optic communication

- Velocity or Torque followers use leader reference:

  - Trq Ref Out 10:2072

  - Trq Ref Selected 10:2076

  - Trq Ref Filt In 10:2080

  - Vref Ramped

- All drives synchronized within 6.25μS

- 2 parameters @ 125μS for up to 4 nodes

- Drives can be up to 50 m (164 ft) apart

- Compatible with PF755TM, PF755TR, and PF755TL V12+

Not compatible with existing SynchLink™ products

Control Loop Intervals

Master

Follower

aligning time base   synchronized
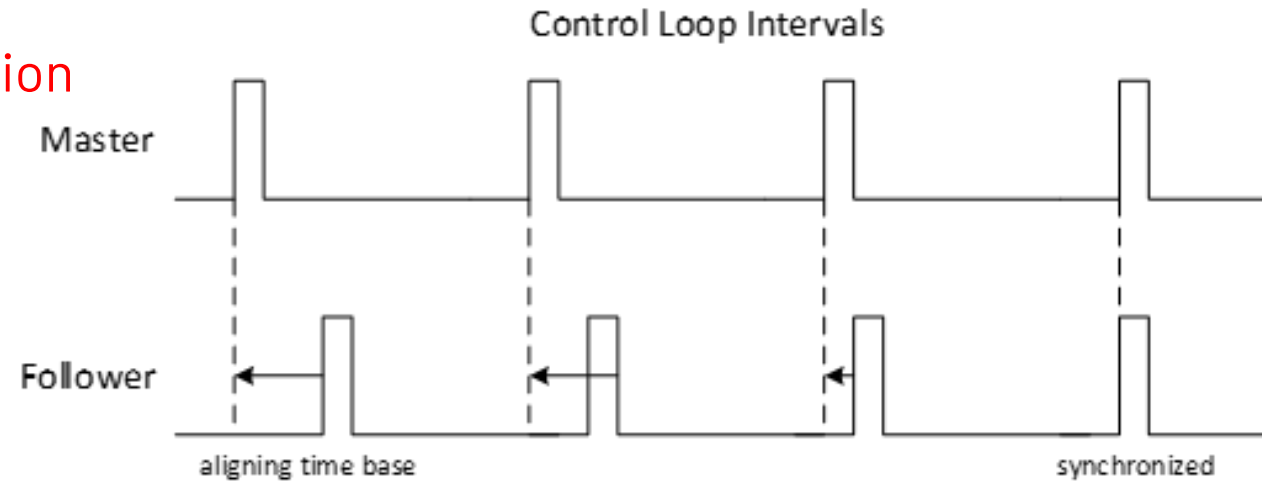
PowerFlex 755T TotalFORCE Torque Accuracy Module (TAM)

BENEFITS

Improved torque accuracy at all operating speeds.

Beneficial for applications that require torque setting or load sharing.

Better control of strip or web tension for winder and coiler applications.

➢ The TAM option board is functional in Flux Vector (FVC) motor control mode and recommended with Encoder Feedback.
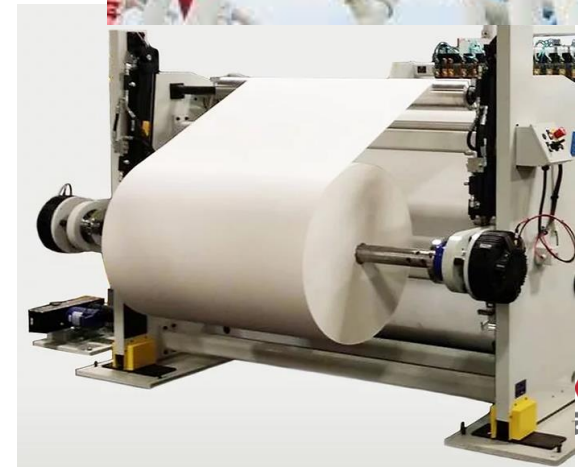
PowerFlex 755T Drive Products
Safety Supported

Safety options help protect personnel and assets while enabling increased application uptime

- **Network Safety**
  - Safe Torque Off *(20-750-S3)* – removes rotational power to the motor without shutting down the drive. SIL 3/PLe CAT 3
  - Safe Speed Monitor (20-750-S4) – allows access to parts of the application while there is limited motion. SIL3/PLe CAT 4
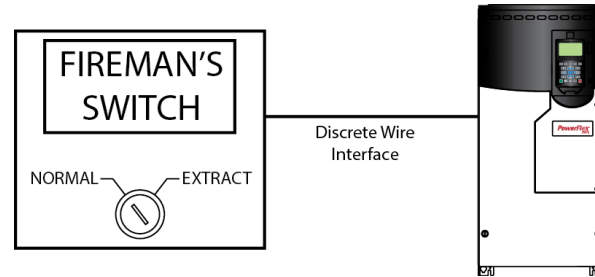
- **Hardwired Safety**
  - Safe Torque Off *(20-750-S)* – removes rotational power to the motor without shutting down the drive. SIL 3/PLe CAT 3
  - Safe Speed Monitor *(20-750-S1)* – allows access to parts of the application while there is limited motion. SIL 3/Ple CAT 4

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Emergency Override

- Some applications have emergency modes

- Consequences for stoppage

- Customer does not want drive to stop, even for faults

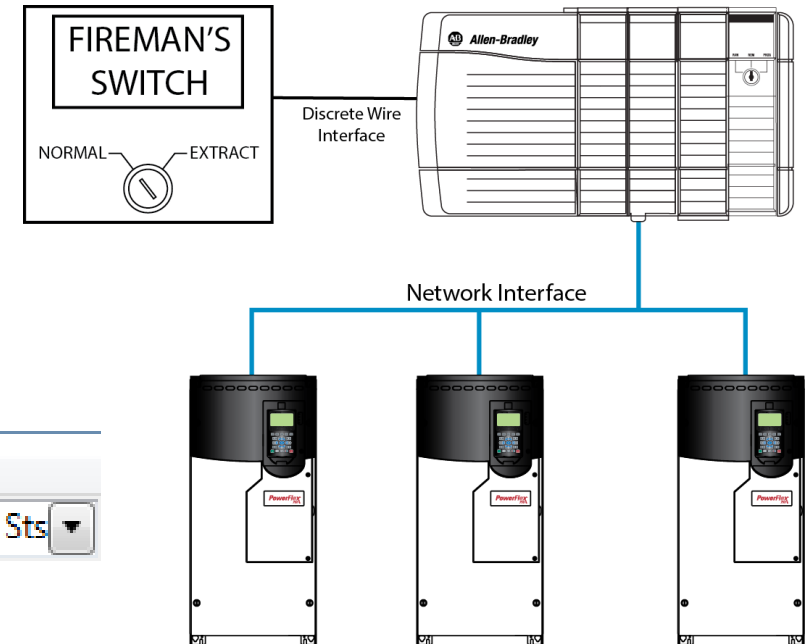- Customer will forego warranty to use the emergency mode
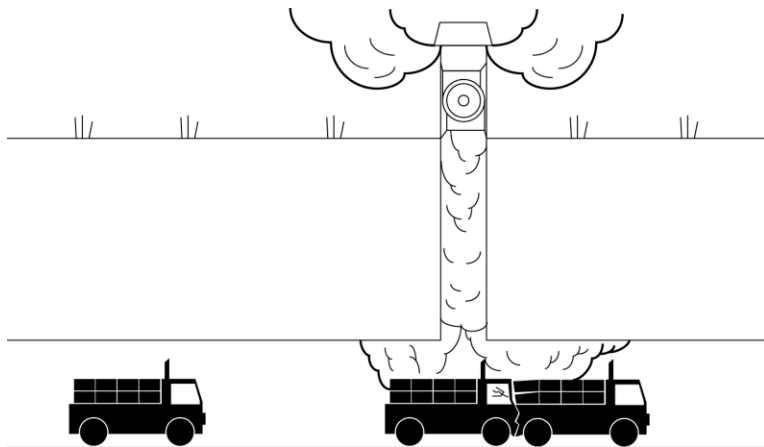
- Digital Input Function
  - Parameter 0:134 [DI EmergencyOVRD]

Port	#	Name	Value
0	134	DI EmergencyOVRD	Port 4: Dig In Sts ▼

- Network Connection (Bit 15 'Emerg OVRD' in Logic Command)

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PowerFlex 750-Series with TotalFORCE® Technology

Operate – Anti-sway Technology in Addition to Torque Proving

Automatically control sway in cranes without the need for auxiliary sensors, external controller or complex programming

- Helps prevent the "pendulum effect" of moving loads

- Built-in drive capability helps increase productivity and machine reliability
  - Decrease handling time by up to 2x
  - Prolongs the life of mechanical components

- Helps provide flexible and safe machine operation
  - Can be used with a manual or automatic operation mode
  - Helps provide a safe environment for personnel and assets
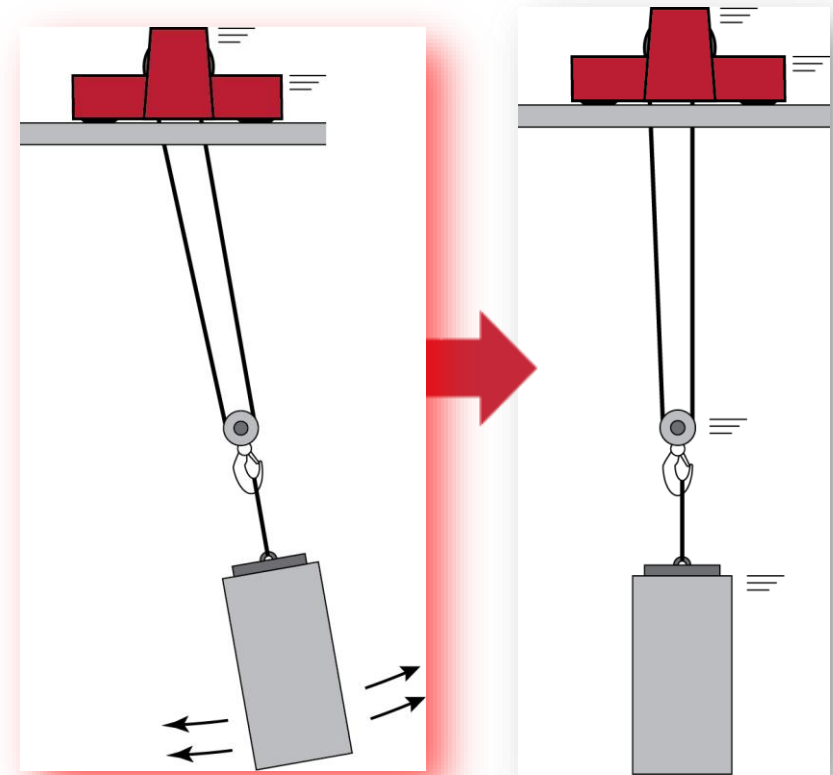
DeviceLogix™ provides built-in control capability for local application and supplementary supervisory control

- Enhanced productivity for standalone applications
  - Helps increase performance & reliability by processing logic locally (2 ms scan rate)
  - Powered through 3-phase input power or auxiliary 24V control power
  - Up to 500 instruction blocks can be configured to support industry application requirements
- Simple programming tool
  - Support for function block and ladder programming
  - Added **tag binding** capability for improved programming experience – create tags for any parameter in the drive
  - 16 standard instruction types available (ie: timer, counter, alarm, PID and so forth)
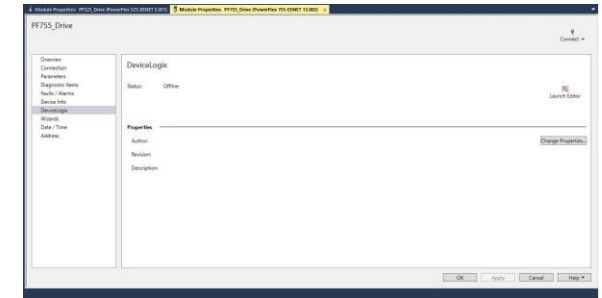

DeviceLogix™

DeviceLogix™ is a tool that can increase productivity!

PowerFlex 755T Drive Products

Programming

Simplified programming experience delivered through common tool set

- Dynamic Human Interface Module (HIM)
  - Full Numeric Keypad
  - Multiple Languages
- Connected Components Workbench™
  - Free software
- Studio 5000 Logix Designer®
  - Premier Integration
  - Automatic Device Configuration (ADC)
  - Compatible back to V20
    - *Note: V30 required with network safety option cards (20-750-S3 & 20-750-S4)*
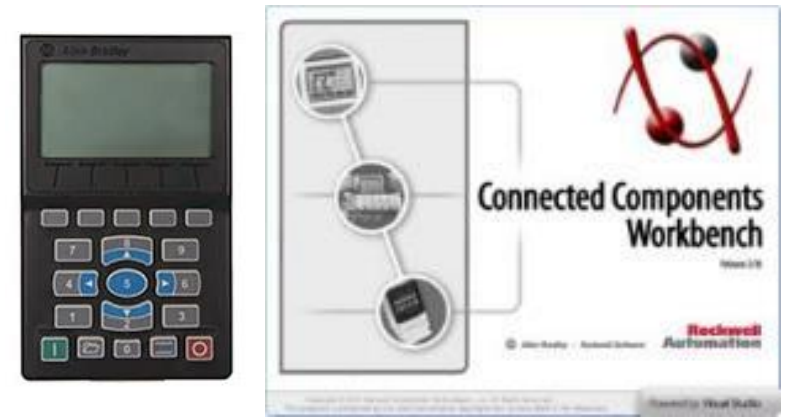
# PowerFlex® 755T Drives with XT - Corrosive Gas Protection

Corrosion in Industrial Electronics

- How much has it cost you already?

- What are you doing to reduce the risk of a corrosion-related drive issue?
- Your manufacturing environment can limit the life of electronic components. What if there was a new approach?

Corrosive environments are formed by:

- Presence of **Reactive Compounds** (Sulfides, Chlorides, etc).

- Both **Humidity** and **Heat** have an impact on rate and mechanisms of corrosion

- Electronics can be susceptible to corrosion throughout their life cycle:

  - Storage and transit, During commissioning

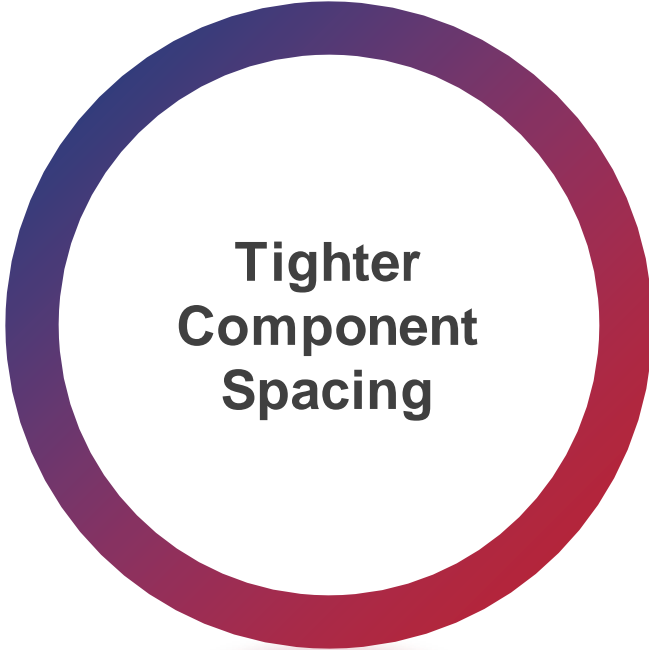 - Normal use in or near process

  - Maintenance activities

Reactive Compounds

Humidity

Heat

Corrosive Environment

Unplanned Downtime
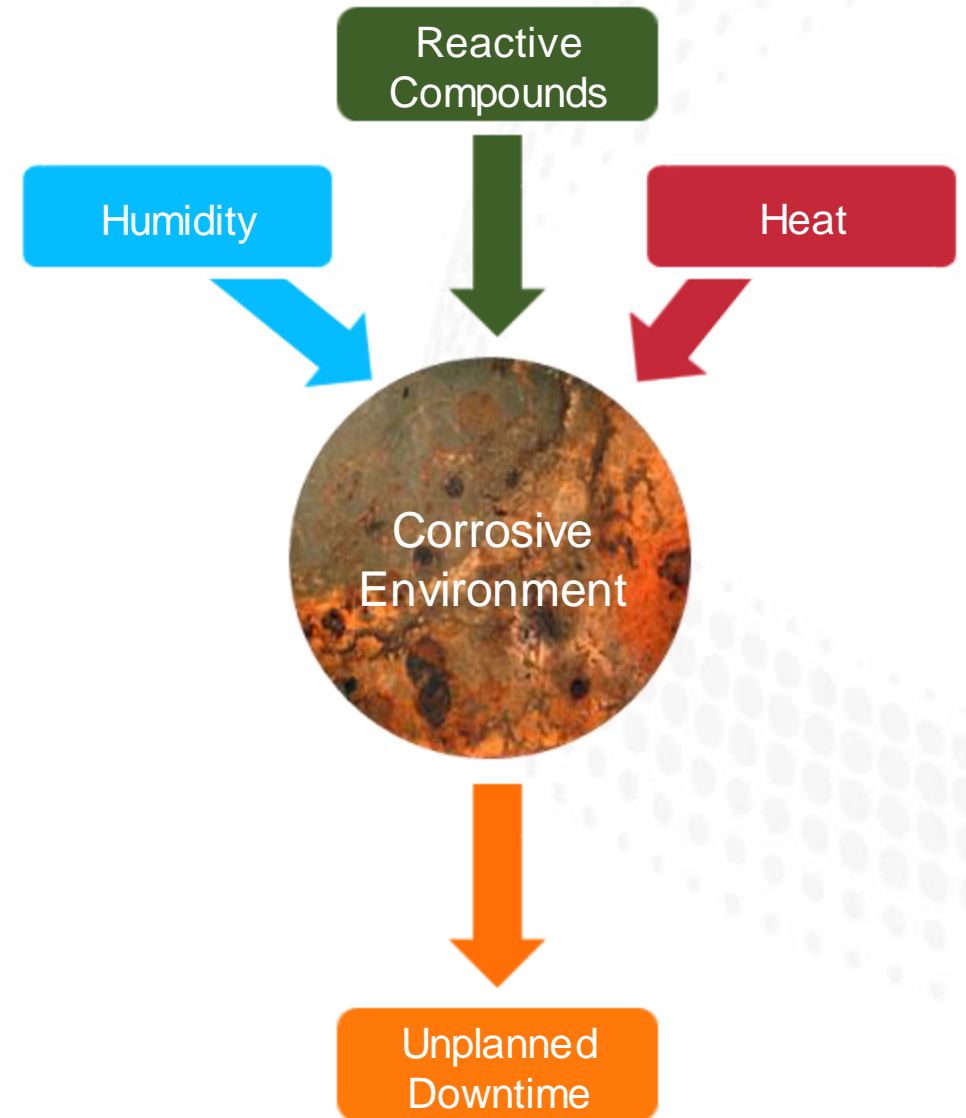
Why now?

Trends in electronic design are increasing awareness to long-standing corrosion challenges that may have previously been unknown.
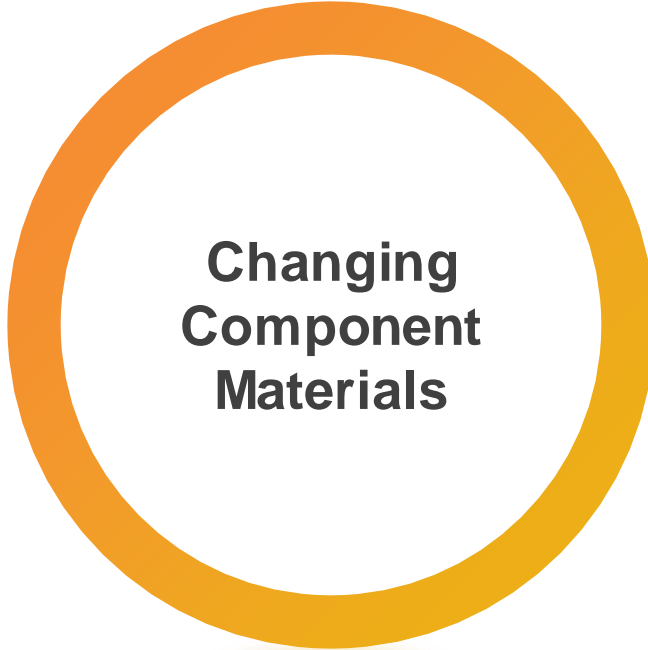
Demand for **smaller product footprint** and **sustainability initiatives** have resulted in:
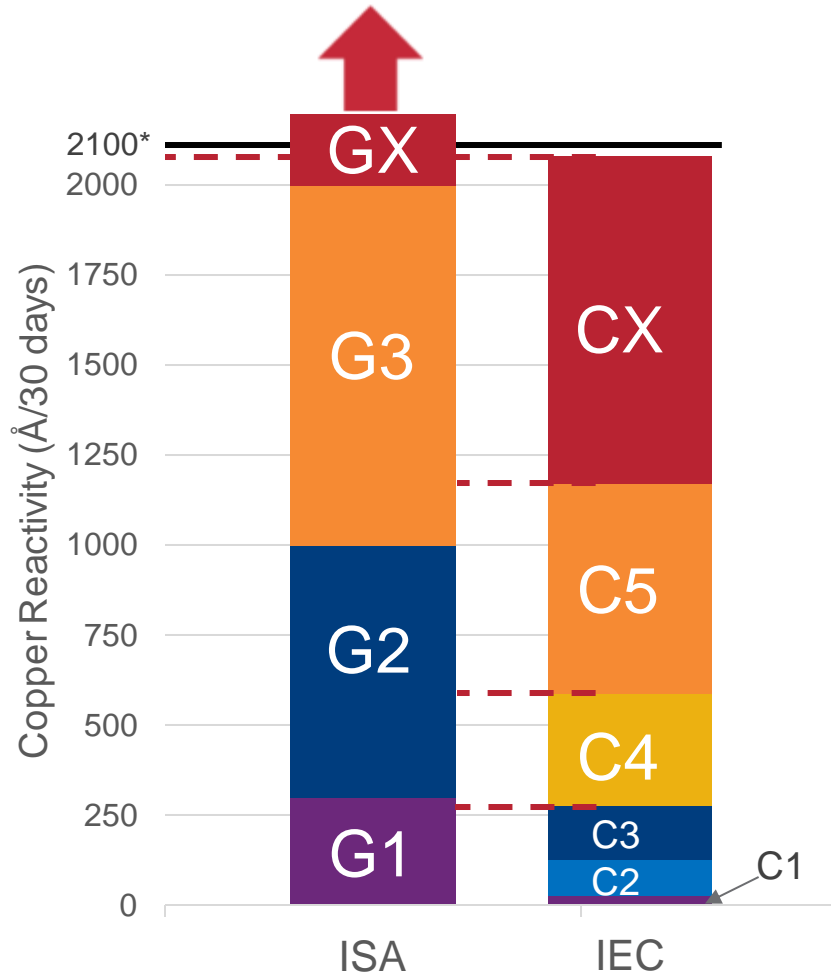
Smaller Components

Tighter Component Spacing

Changing Component Materials

Traditional approaches and solutions are now often not enough

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ISA & IEC Equivalency Using Copper Reactivity

Showing equivalency of IEC 60721-3-3 (2019) specification to ISA 71.04-2013

ISA 71.04-2013
Copper Reactivity
Å/30 days

IEC 60721-3-3 (V3, 2019)
Copper Reactivity
Å/30 days**

Rating	Corrosivity	LSL (≥)	USL (<)
G1	Mild	0	300
G2	Moderate	300	1000
G3	Harsh	1000	2000
GX*	Severe	2000	2100*

Rating	Corrosivity	LSL (>)	USL (≤)
C1	Very Low	0	21
C2	Low	21	125
C3	Medium	125	271
C4	High	271	583
C5	Very High	583	1167
CX	Extreme	1167	2083

How to quantify corrosion rate

Also called "reactivity"

Corrosion classification coupons

- Each coupon contains one strip of copper and silver

- Performed throughout facility

    - Inside enclosure

    - Outside enclosure

    - Store room

- Leave for 30 days then removed and sent in for analysis

- Report detailing corrosion rate observed and classification per ANSI/ISA 71.04-2013, Airborne Contaminants – Gas

- Multiple other methods including active electronic sensing is available
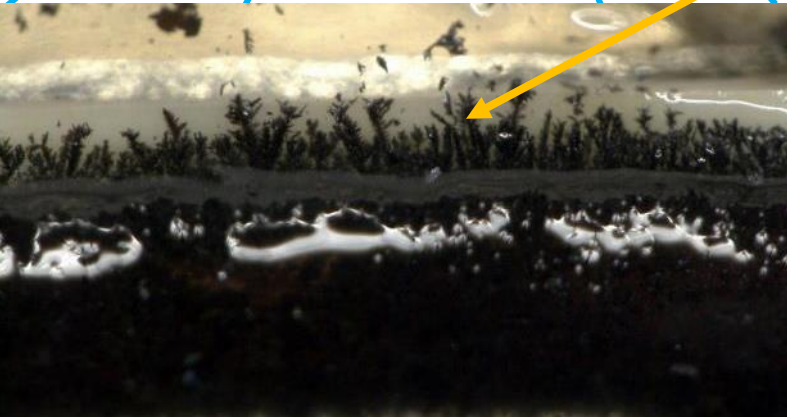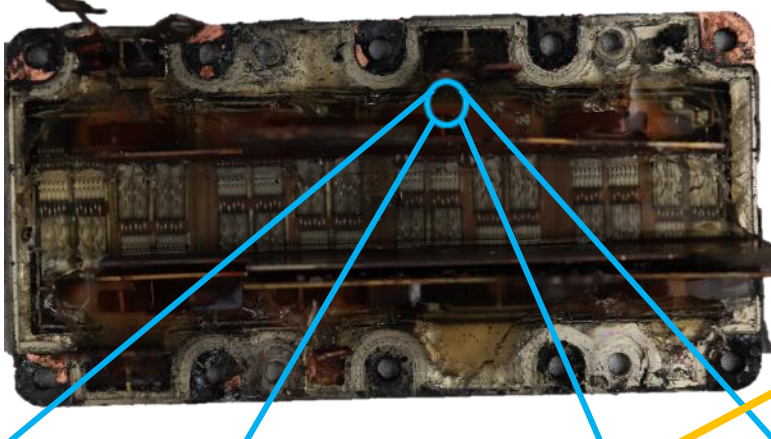
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Custom MFG chambers in Milwaukee Chemistry & Materials Lab

- Test chambers can be used for Method K accelerated testing
- Additional proprietary accelerated tests created based on studies of actual customer facilities
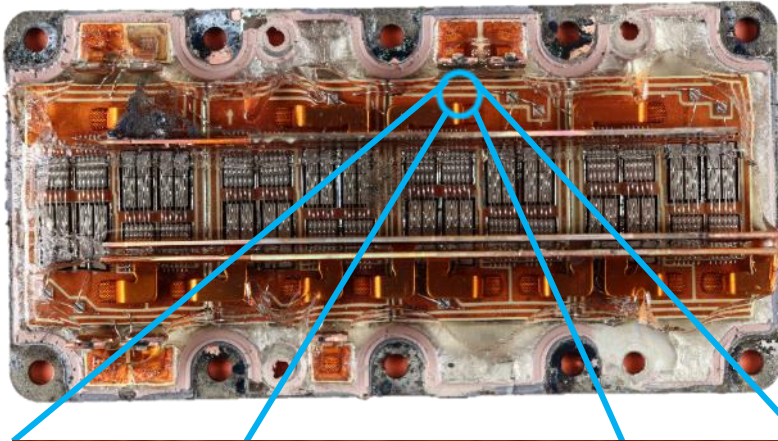
The Results

Standard IGBT

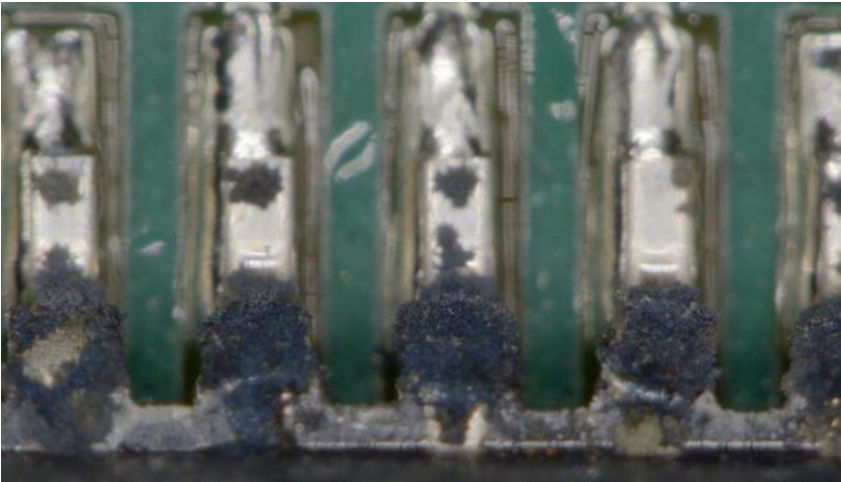**XT IGBT**

Dendrite growth between high-voltage conductors

Dendrite growth eliminated

Copper not darked

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Conformal coating – Standard versus enhanced

Components w/ palladium plated leads after 30 days in accelerated corrosion test

Standard coating
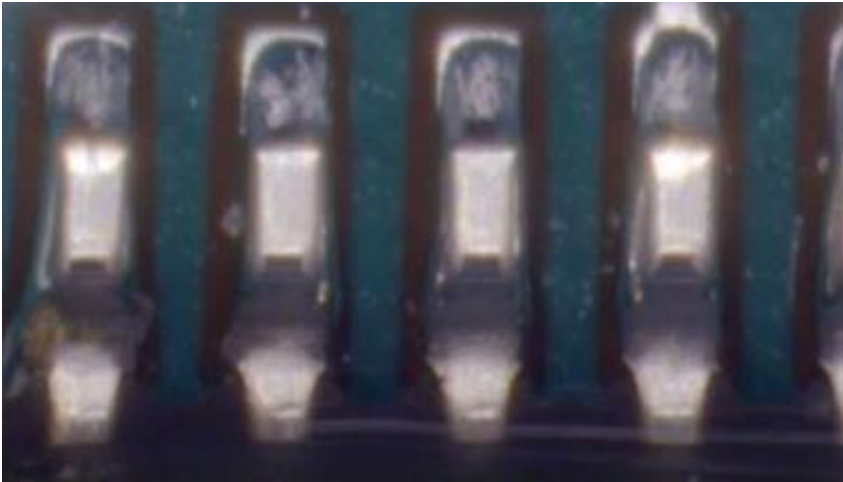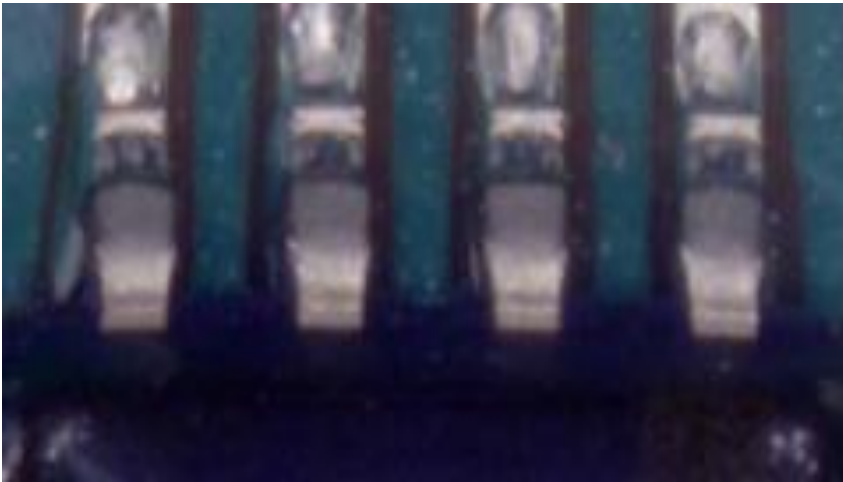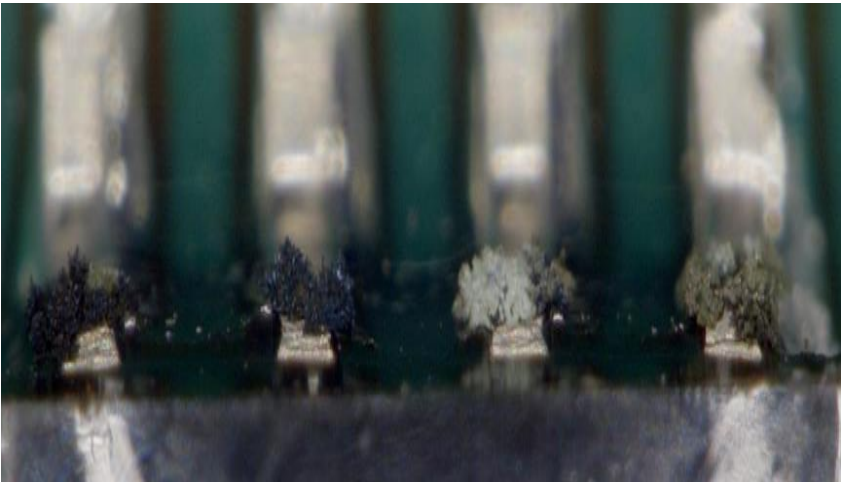
Enhanced coating

U25: Less corrosion using enhanced coating process

U46: Less corrosion using enhanced coating process

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Connector grease

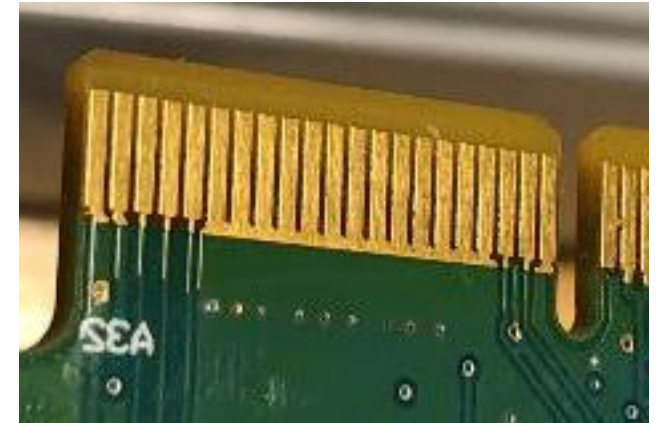- After test w/o grease applied

A @ J1

- Dielectric Grease

PST-576
NON-Silicone
Dielectric Grease
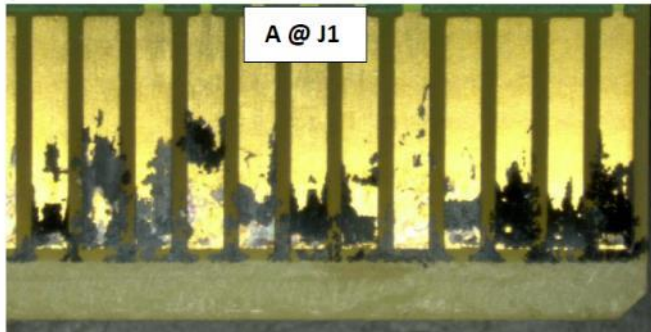
Test

- After test w/ grease applied

A32

- Connector grease helps limit the corrosive atmosphere from reaching the base metals and reduces risk of corrosion

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Solution: XT for Extreme Environments

Introducing additional protection against *GX level corrosive gas environments*

POWERFLEX 755TR

Standard offering on PowerFlex 755TL/TR/TM (Optional PF775TS)

Validated to operate in environments rated **GX** per ISA 71.03-2013 and **CX** per IEC 60721-3-3:2019

XT IGBTs

Enhanced conformal coating

Critical connection protection

Protected fans

Environment-resistant packaging

Plugs and Covers

Rockwell Automation

PowerFlex architecture-class AC drives portfolio w/ XT Features

Optional Frame 8 & 9

PowerFlex 753 & 755

1…1800 Hp / 0.75…1400 kW

- Speed, Torque & Position Control
- XT Option (Frame 8 & 9)
- 6-pulse Drive
- **FORCE Technology**

Optional

PowerFlex 755TS

1…400 Hp / 0.75… 270 kW

- Speed, Torque & Position Control
- XT Option
- CIP Security
- 6-Pulse Drive
- **TotalFORCE Technology**

PowerFlex 755TL/TR

10…6000 Hp / 7.5…4500 kW

- Speed, Torque & Position Control
- XT Standard
- Liquid Cooled Option
- Regeneration & Low Harmonic
- **TotalFORCE Technology**

PowerFlex 755TM

250…6000Hp/160…4500kW (AC)
70…4800 kW (DC)

- Speed, Torque & Position Control
- XT Standard
- Common Bus Drive System
- AFE or 6-pulse supply
- Non-regen bus supply
- **TotalFORCE Technology**

Rockwell Automation
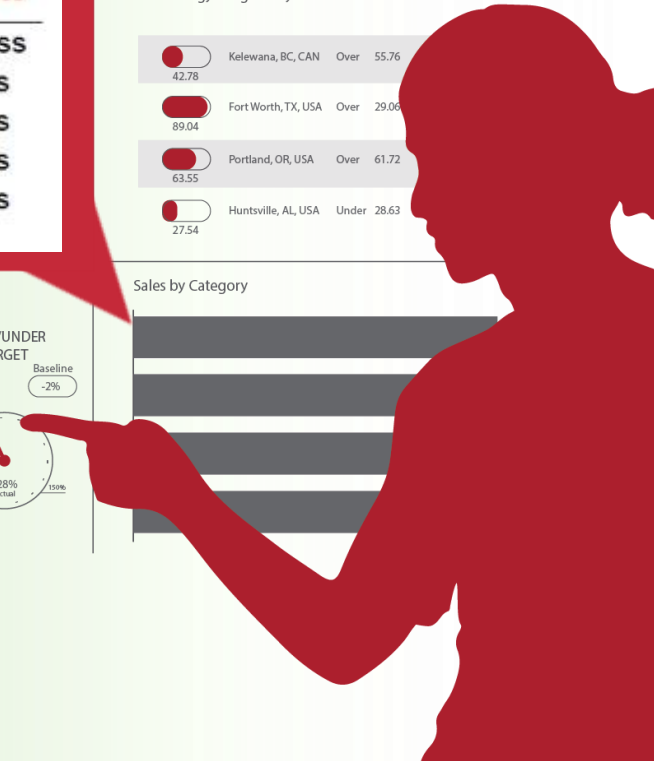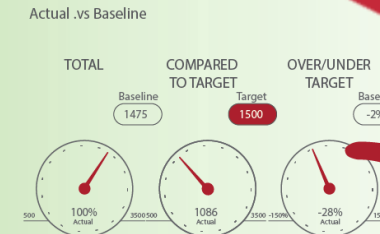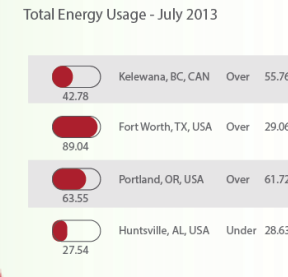
MAINTAIN

Simplified Maintenance Procedures
- Predictive analytics for maintenance notifies when critical components should be serviced
- Ease of maintenance for critical components
- Mismatch module detection and correction
- Automatic Device Configuration

Consistent Components and Processes
- Common spare parts and documentation
- Test Points for Meter easy meter connections
- Thumb Screws – No Tools need to change fans.
- Roll-in Power Modules (Wire Once Design)
- Converter/Inverter Interchangeable on AFEs
- Automatic Recognition of new Components.

20-750-MCART1

Typical Component Replacement Times for PowerFlex 755T Drives	
Roll-In Modules	10 minutes or less
Fans	5 minutes or less
Fuses	5 minutes or less
Circuit Board & Option Cards	5 minutes or less
Capacitors	5 minutes or less

Total Energy Usage - July 2013

Kelewana, BC, CAN	Over	55.76
42.78		
Fort Worth, TX, USA	Over	29.06
89.04		
Portland, OR, USA	Over	61.72
63.55		
Huntsville, AL, USA	Under	28.63
27.54		

Actual .vs Baseline

TOTAL	COMPARED TO TARGET	OVER/UNDER TARGET
Baseline 1475	Target 1500	Baseline -2%
100% Actual	1086 Actual	-28% Actual

Sales by Category

Rockwell Automation

Medium Voltage Drives Portfolio

POWERFLEX® 6000T
NON-REGEN, ALL PURPOSE DRIVES

Ideally suited for:

- Non-regen applications
- Long motor cable lengths (up to 6 miles – with filter)
- MTBF > 100,000hrs
- Voltage Source Drives

POWERFLEX® 7000
REGEN, SPECIAL PURPOSE DRIVES

Ideally suited for:

- Regenerative braking
- Extended motor cable lengths (up to 18 miles)
- MTBF > 100,000hrs
- Current Source Drives

2.3…11 kV (up to 680 A)

2.3…6.6 kV (up to 720 A)

TotalFORCE® Technology

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Thank you

www.rockwellautomation.com

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