ELECTRICAL ENGINEERING SPECIALISTS

INTELLIGENT MCC COST COMPARISON

A Case Study

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INTRODUCTION

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- Motor Control Centres (MCC) are widely used in industry to power low voltage motors.
  - Consist of combination motor starter circuits in a modular format.
  - Traditionally contained only electromechanical components with all connections hard wired.
- Modern industrial plants now rely heavily on plant automation to operate effectively.

THE INTELLIGENT MCC

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- MCCs can now incorporate advanced control and communications capability.
  - Intelligent devices that can do far more than simply switch a motor on or off.
  - Integrate directly with the plant control system.
- Higher level of capability, however hardware required is generally more expensive.
- Broad definition: Starter using intelligent motor protection relay (MPR).

MOTOR STARTER CIRCUITS

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- Many styles of motor starter circuits used on industrial plants.
  - Traditional hard wired starter circuits using remote chassis based PLC I/O.
  - Intelligent MCC using network connected motor protection relays (MPR).
  - Hybrid approaches incorporating distributed I/O modules within the MCC.

IS THERE ADDITIONAL COST?

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- Is it cost effective to specify an intelligent MCC design?
  - Are higher hardware costs offset by reduced cabling costs?
  - What size/type of motor starters should implement an intelligent MCC design?
  - What is the extra cost to buy an intelligent MCC?
  - Non economic benefits e.g. advanced protection capability, improved maintenance information?
- The short answer is…
  - It depends

TOTAL MCC COST

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- Total cost of an automated MCC includes:
  - MCC hardware (switchgear/motor starter circuits).
  - Control system hardware (PLC and I/O modules, communications hardware).
  - Interconnecting wiring .
- Total automation cost for different styles of MCC starter circuit.
- Compare cost difference between different starter circuits.
- Informed discussion about advantages and disadvantages of different MCC options.

TRADITIONAL MOTOR STARTER

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- Traditional hard wired motor starter:
  - Electromechanical components with all connections hard wired.
  - Individual hard wired connections to the Plant Control System to provide automation.
  - Requires interconnecting wiring between MCC and Plant Control System.

TRADITIONAL MOTOR STARTER

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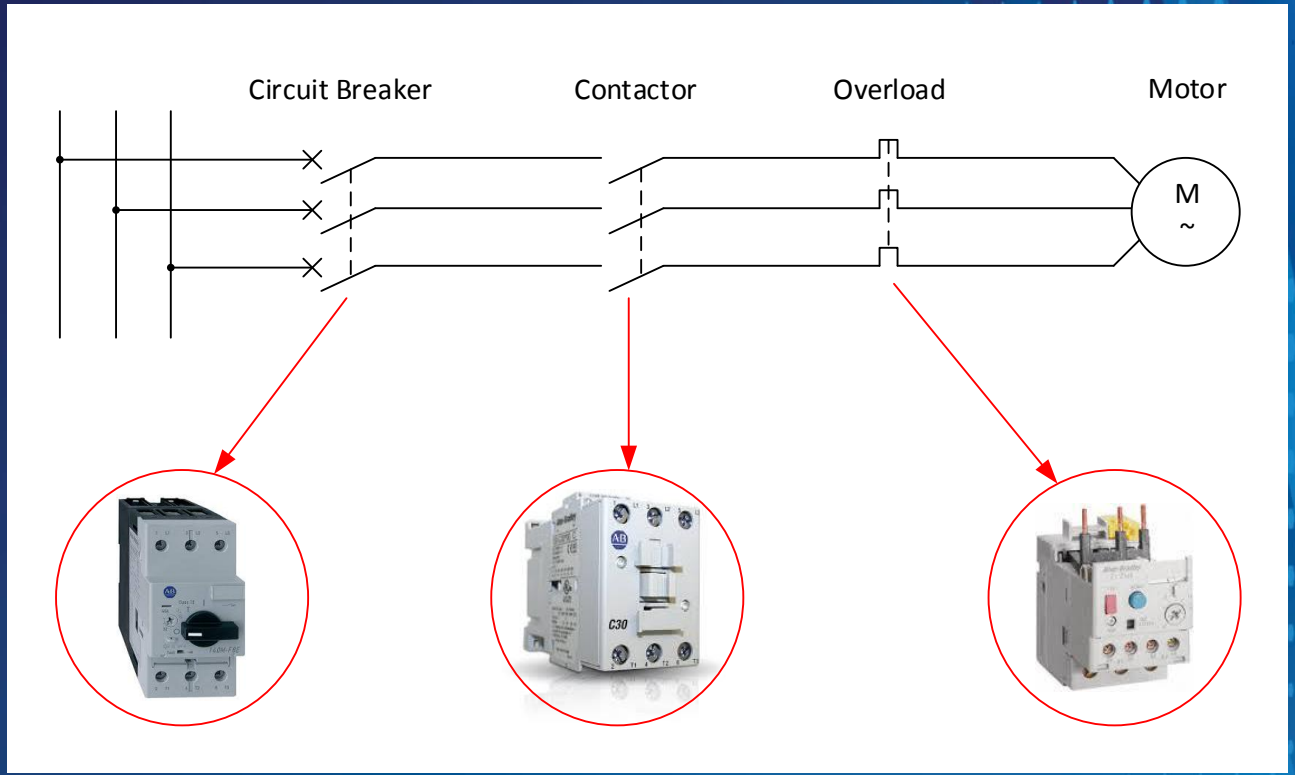
Simple representation of a traditional hard wired motor starter:



TRADITIONAL MOTOR STARTER

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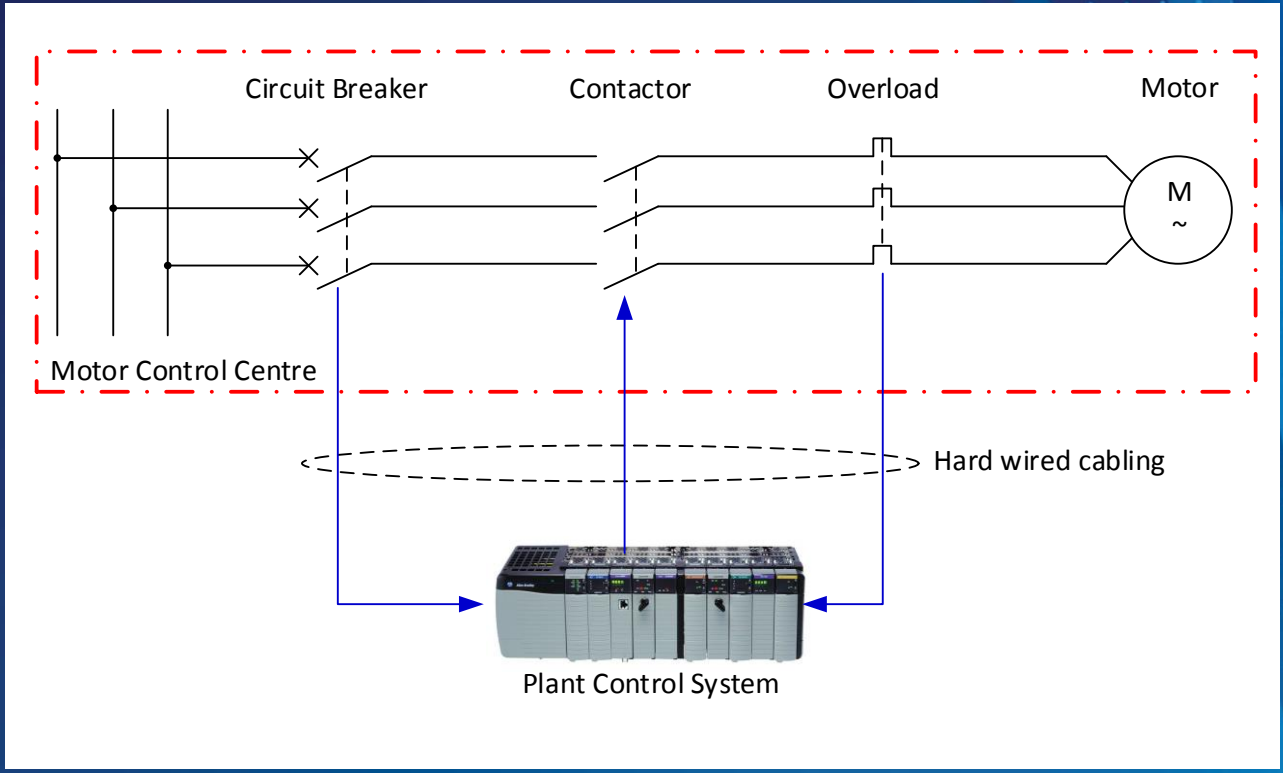
Hard wired connection to plant control system:



HYBRID MOTOR STARTER

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- Hybrid approach to motor starter circuit:
  - Similar MCC hardware to traditional motor starter.
  - Electromechanical components with all connections hard wired.
  - Distributed I/O for connection to the Plant Control System installed in MCC.
  - Network connection to Plant Control System.

HYBRID MOTOR STARTER

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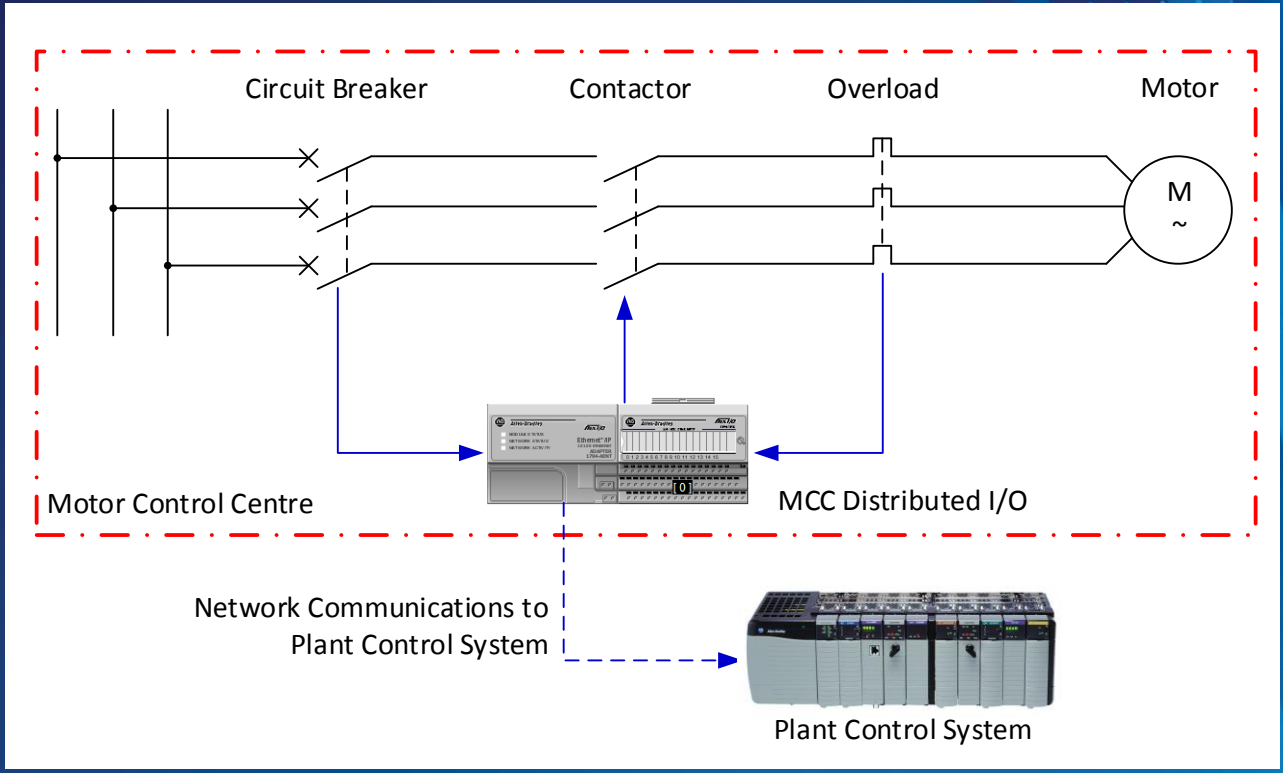
Distributed I/O connection to plant control system:



INTELLIGENT MOTOR STARTER

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- Intelligent motor starter circuit:
  - MPR controls motor operation.
  - Incorporates I/O for motor control signals.
  - Incorporates advanced protection features.
  - Network connection to Plant Control System.

INTELLIGENT MOTOR STARTER

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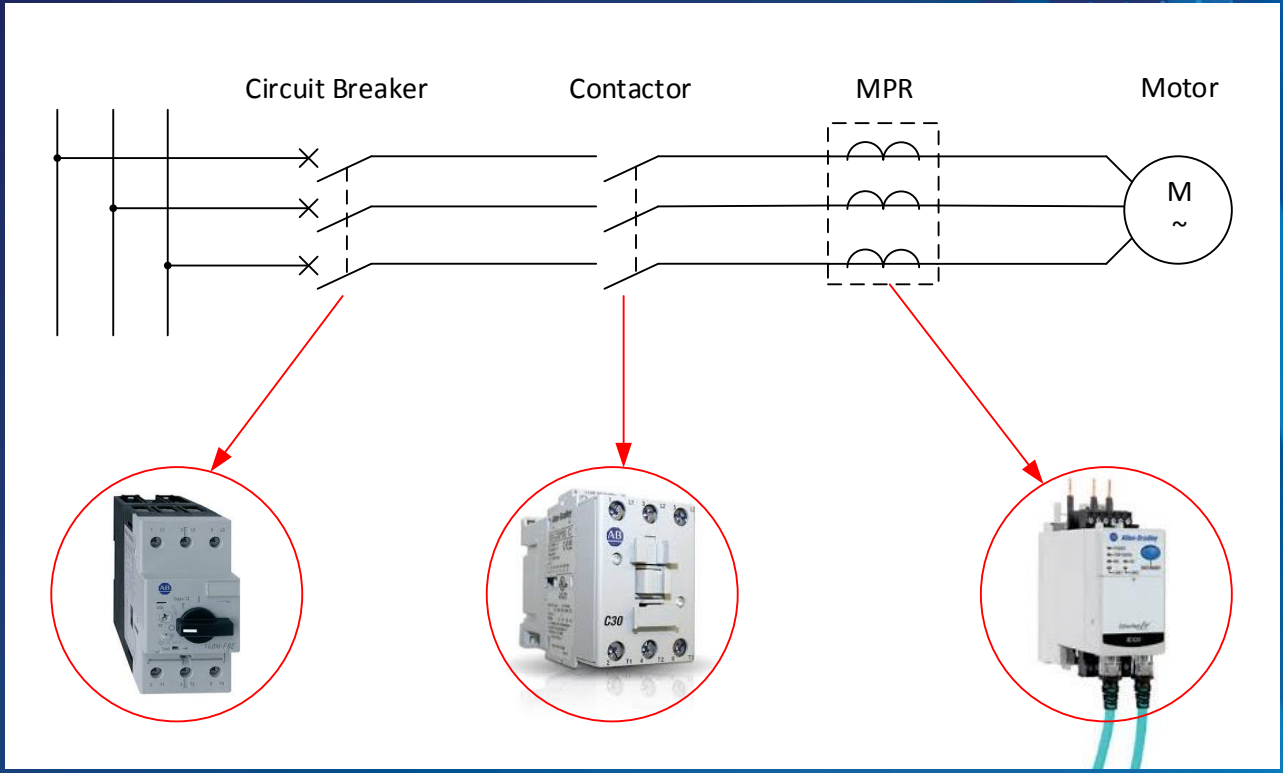
Simple representation of an intelligent motor starter:



INTELLIGENT MOTOR STARTER

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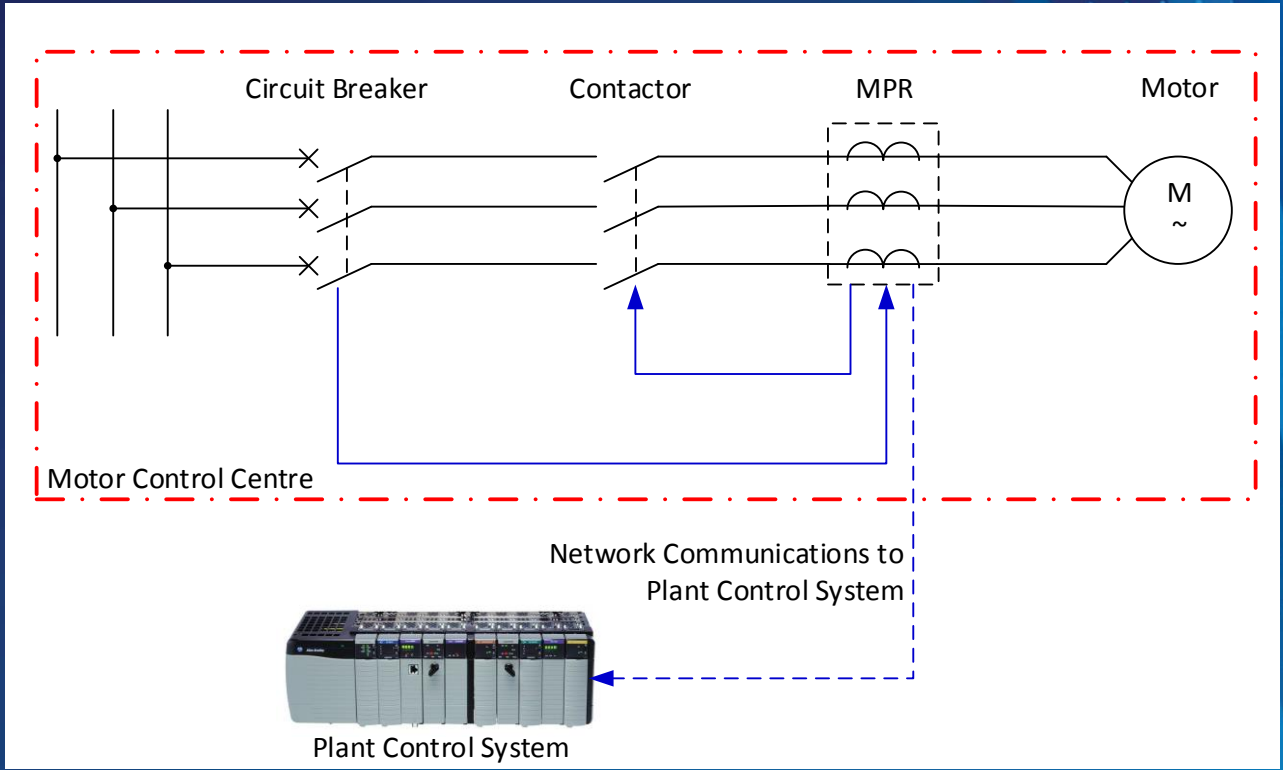
Network connection to plant control system:



COST COMPARISON PROCESS

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- Consider MCC hardware, control system hardware, cabling and installation costs.
- Traditional hard wired motor starter as base line for comparison.
- Determine the cost difference between individual starter circuits of different types.
- Consolidate control system hardware to determine cost per point.

COST COMPARISON PROCESS

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- Unit rates for supply and installation of cabling based on typical contractor installation rates.
- Typical integrator and trade pricing for hardware comparisons.
- Multiply cost differences to determine typical cost savings for a complete MCC.

STARTER CIRCUITS TO COMPARE

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- Starter circuits to compare:
  - Basic DOL motor starter (least complex)
  - Intermediate DOL motor starter (medium complexity)
  - Advanced DOL motor starter (most complex)
  - Typical variable speed drive

STARTER CIRCUIT OPTIONS

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- Starter circuit options to compare:
  1. Traditional hard wired starter circuit with I/O connections to a remote PLC
  2. Hybrid starter circuit with MCC mounted distributed I/O using network connection to a remote PLC
  3. Intelligent MCC with network connection from motor protection relays to a remote PLC

BASIC DOL MOTOR

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- Protection and control requirements for basic DOL motor starter (7.5kW):
  - Thermal overload protection
  - Auxiliary relays (4)
  - PLC digital inputs (5)
  - PLC digital outputs (1)

INTERMEDIATE DOL MOTOR

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- Protection and control requirements for intermediate DOL motor starter (22kW):
  - Thermal overload
  - Thermistor protection
  - Auxiliary relays (5)
  - PLC digital inputs (7)
  - PLC digital outputs (2)

ADVANCED DOL MOTOR

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- Protection and control requirements for advanced DOL motor starter (55kW):
  - Electronic overload protection
  - Thermistor protection
  - Current monitoring
  - Undercurrent protection
  - Auxiliary relays (5)
  - PLC digital inputs (8)
  - PLC digital outputs (2)
  - PLC analogue inputs (1)

VARIABLE SPEED DRIVE

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- Protection and control requirements for a typical variable speed drive:
  - Auxiliary relays (4)
  - PLC digital inputs (5)
  - PLC digital outputs (1)
  - PLC analogue inputs (1)
  - PLC analogue outputs (1)

ASSUMPTIONS

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- Hard wired PLC I/O – ControlLogix range, includes marshalling terminals and panel wiring.
- Distributed I/O – Flex IO range.
- Intelligent MPR – Allen-Bradley E300 range.
- Remote PLC chassis located approximately 30m away
- Hard wired control cabling using 1.5mm^2 multicore control cable.
- Comparison only evaluates differences in hardware between starter types.

ASSUMPTIONS

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- Comparison only evaluates hardware, equipment and labour, does not consider extra features of MPR.
- Apart from differences in protection and control, starter circuits are the same.
- E.g. all circuits use the same indication and control.
- PLC programming for each starter type assumed to be the same.
- Network connection for intelligent MPR – device level ring.
- Network connection for distributed I/O – one connection per tier.

BASIC DOL COMPARISON

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Scenario 1 - Basic DOL Motor Starter (7.5kW)					
Description	***Component***	***Make / Model***	***Qty***	***Sub Total***	***Cost Difference***
Option 1 Hard Wired	Thermal Overload Relay	S&S CT7N-23-C10	1	$ 124	**Baseline**
	Auxiliary Relays	Finder 55 Series & Base	4	$ 107	
	PLC Digital Inputs	ControlLogix 1756-IB32	5	$ 178	
	PLC Digital Outputs	ControlLogix 1756-OB32	1	$ 45	
	Control Cable (Cores)	1C 1.5mm^2 (Part of Multicore)	8	$ 716	
Option 2 Intelligent MPR	E300 Sensing Module	193ESMI30AC23	1	$ 191	**+$240**
	E300 Control Module	193EIO6324D	1	$ 534	
	E300 Communications Module	193ECMETR	1	$ 610	
	Auxiliary Relays	Finder 55 Series & Base	1	$ 27	
	Network Connection to PLC	Cat 6	1	$ 48	
Option 3 Distributed I/O	Thermal Overload Relay	S&S CT7N-23-C10	1	$ 124	**-$225**
	Auxiliary Relays	Finder 55 Series & Base	4	$ 107	
	PLC Digital Inputs	Flex I/O 1794-IB16	5	$ 215	
	PLC Digital Outputs	Flex I/O 1794-OB16	1	$ 52	
	Control Cable (Cores)	1C 1.5mm^2 (Panel Wiring)	8	$ 445	

BASIC DOL COMPARISON

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- Intelligent MPR option is $240/motor more than the hard wired option.
- Distributed I/O option is $225/motor less than hard wired option.
- Main factors affecting cost comparison:
  - Higher cost of E300 hardware
  - Higher cost of interconnecting wiring to remote PLC

INTERMEDIATE DOL COMPARISON

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Scenario 2 - Intermediate DOL Motor Starter (22kW)					
Description	***Component***	***Make / Model***	***Qty***	***Sub Total***	***Cost Difference***
Option 1 Hard Wired	Thermal Overload Relay	S&S CT7N-85-C75	1	$ 345.80	**Baseline**
	Thermistor Relay	S&S RT7-E2	1	$ 436.80	
	Auxiliary Relays	Finder 55 Series & Base	5	$ 133.95	
	PLC Digital Inputs	ControlLogix 1756-IB32	7	$ 249.58	
	PLC Digital Outputs	ControlLogix 1756-OB32	2	$ 90.03	
	Control Cable (Cores)	1C 1.5mm^2 (Part of Multicore)	10	$ 895.20	
Option 2 Intelligent MPR	E300 Sensing Module	193ESMIG60AC55	1	$ 381.50	**-$160**
	E300 Control Module	193-EIOGP4224D	1	$ 534.10	
	E300 Communications Module	193ECMETR	1	$ 610.40	
	E300 Expansion Module	193EXPDIO4224D	1	$ 390.60	
	Auxiliary Relays	Finder 55 Series & Base	1	$ 26.79	
	Network Connection to PLC	Cat 6	1	$ 47.58	
Option 3 Distributed I/O	Thermal Overload Relay	S&S CT7N-85-C75	1	$ 345.80	**-$270**
	Thermistor Relay	S&S RT7-E2	1	$ 436.80	
	Auxiliary Relays	Finder 55 Series & Base	5	$ 133.95	
	PLC Digital Inputs	Flex I/O 1794-IB16	7	$ 301.20	
	PLC Digital Outputs	Flex I/O 1794-OB16	2	$ 104.08	
	Control Cable (Cores)	1C 1.5mm^2 (Panel Wiring)	10	$ 556.24	

INTERMEDIATE DOL COMPARISON

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- Intelligent MPR option is $160/motor less than hard wired option.
- Distributed I/O option is $270/motor less than hard wired option.
- Main factors affecting cost comparison:
  - Higher cost of additional MCC hardware.
  - Higher cost of interconnecting wiring to remote PLC.

ADVANCED DOL COMPARISON

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Scenario 3 - Advanced DOL Motor Starter (55kW)					
Description	**Component**	**Make / Model**	**Qty**	**Sub Total**	**Cost Difference**
Option 1 Hard Wired	Electronic Overload Relay	S&S CEP7-EEHF	1	$ 902.72	**Baseline**
	Thermistor Relay	S&S RT7-E2	1	$ 436.80	
	Current Transducer	IME TT351030VDC	1	$ 495.04	
	Undercurrent Relay	Carlo Gavazzi DIB-02-C-D48-5A	1	$ 276.64	
	Auxiliary Relays	Finder 55 Series & Base	5	$ 133.95	
	PLC Digital Inputs	ControlLogix 1756-IB32	8	$ 285.23	
	PLC Digital Outputs	ControlLogix 1756-OB32	2	$ 90.03	
	PLC Analog Inputs	ControlLogix 1756-IF16	1	$ 127.04	
	Control Cable (Cores)	1C 1.5mm^2 (Part of Multicore)	13	$ 1,163.76	
Option 2 Intelligent MPR	E300 Sensing Module	193ESMVIG100AC97	1	$ 697.90	**-$1,310**
	E300 Control Module	193EIOGP4224D	1	$ 534.10	
	E300 Communications Module	193ECMETR	1	$ 610.40	
	E300 Expansion Module	193EXPDIO4224D	1	$ 390.60	
	E300 Expansion Power Supply	193-EXP-PS-DC	1	$ 293.30	
	Auxiliary Relays	Finder 55 Series & Base	1	$ 26.79	
	Network Connection to PLC	Cat 6	1	$ 47.58	
Option 3 Distributed I/O	Electronic Overload Relay	S&S CEP7-EEHF	1	$ 902.72	**-$320**
	Thermistor Relay	S&S RT7-E2	1	$ 436.80	
	Current Transducer	IME TT351030VDC	1	$ 495.04	
	Undercurrent Relay	Carlo Gavazzi DIB-02-C-D48-5A	1	$ 276.64	
	Auxiliary Relays	Finder 55 Series & Base	5	$ 133.95	
	PLC Digital Inputs	Flex I/O 1794-IB16	8	$ 344.23	
	PLC Digital Outputs	Flex I/O 1794-OB16	2	$ 104.08	
	PLC Analog Inputs	Flex I/O 1794-IE8	1	$ 173.91	
	Control Cable (Cores)	1C 1.5mm^2 (Panel Wiring)	13	$ 723.11	

ADVANCED DOL COMPARISON

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- Intelligent MPR option is $1,310/motor less than hard wired option.
- Distributed I/O option is $320/motor less than hard wired option.
- Main factors affecting cost comparison:
  - Additional protection capability of E300 relay.
  - Higher cost of additional MCC hardware.
  - Higher cost of interconnecting wiring to remote PLC.

VSD COMPARISON

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Scenario 4 - Typical Variable Speed Drive					
Description	***Component***	***Make / Model***	***Qty***	***Sub Total***	***Cost Difference***
Option 1 Hard Wired	Auxiliary Relays	Finder 55 Series & Base	4	$ 107.16	**Baseline**
	PLC Digital Inputs	ControlLogix 1756-IB32	5	$ 178.27	
	PLC Digital Outputs	ControlLogix 1756-OB32	1	$ 45.01	
	PLC Analog Inputs	ControlLogix 1756-IF16	1	$ 127.04	
	PLC Analog Outputs	ControlLogix 1756-OF8	1	$ 316.50	
	Control Cable (Cores)	1C 1.5mm^2 (Part of Multicore)	12	$ 1,074.24	
Option 2 Network Connection	PF753 Ethernet/IP Communications	20-750-ENETR	1	$ 482.30	**-$600**
	PF753 I/O Expansion Module	20-750-2262C-2R	1	$ 247.80	
	Auxiliary Relays	Finder 55 Series & Base	1	$ 26.79	
	Network Connection to PLC	Cat 6	1	$ 488.64	
Option 3 Distributed I/O	Auxiliary Relays	Finder 55 Series & Base	4	$ 107.16	**-$425**
	PLC Digital Inputs	Flex I/O 1794-IB16	5	$ 215.14	
	PLC Digital Outputs	Flex I/O 1794-OB16	1	$ 52.04	
	PLC Analog Inputs	Flex I/O 1794-IE8	1	$ 173.91	
	PLC Analog Outputs	Flex I/O 1794-OE12	1	$ 206.94	
	Control Cable (Cores)	1C 1.5mm^2 (Panel Wiring)	12	$ 667.49	

VSD COMPARISON

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- Intelligent MCC option is $600/motor less than hard wired option.
- Distributed I/O option is $425/motor less than hard wired option.
- Main factors affecting cost comparison:
  - Higher cost of additional analogue PLC I/O.
  - Higher cost of interconnecting wiring to remote PLC.

COMPARISON SUMMARY

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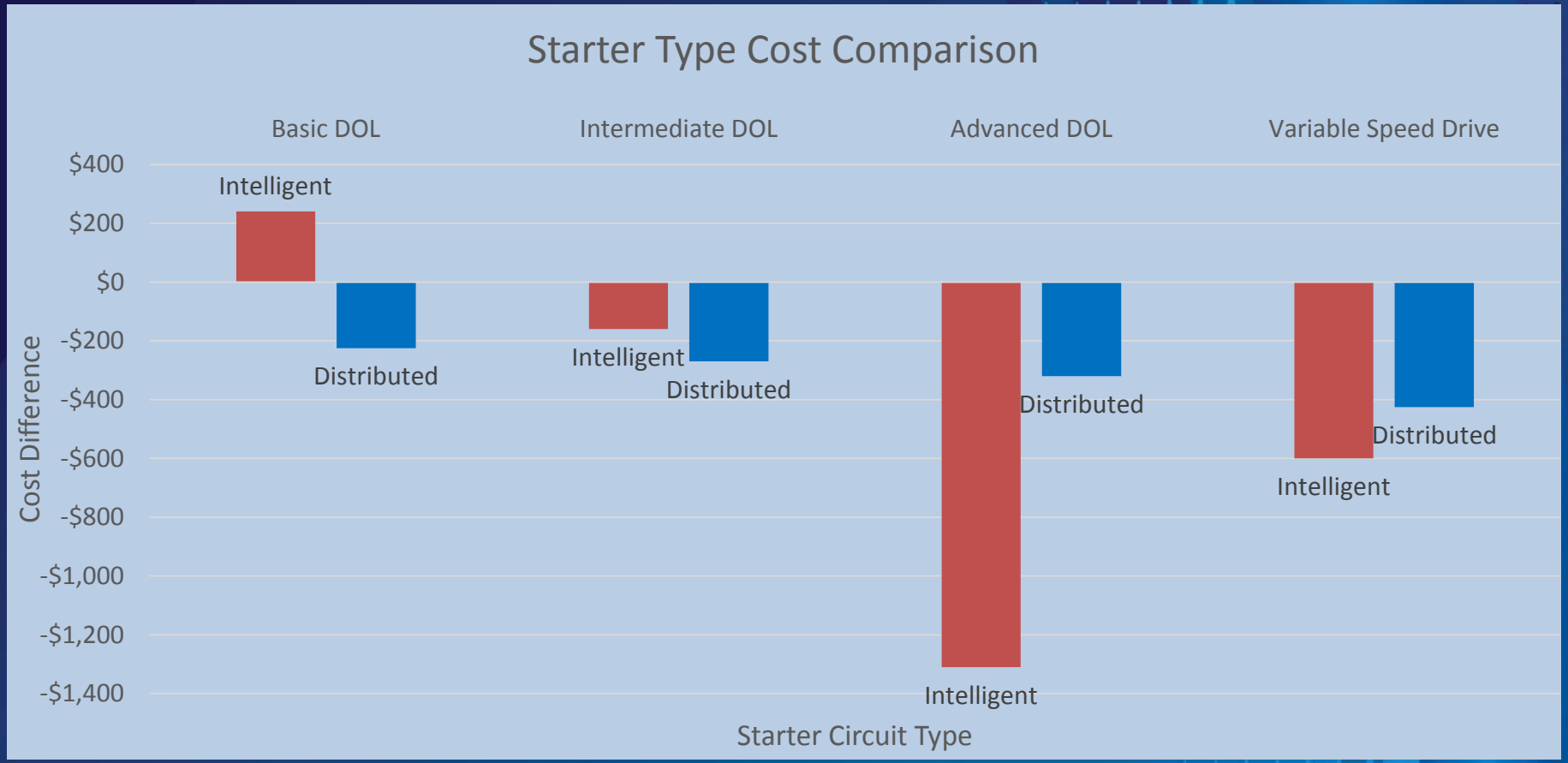

TOTAL MCC COMPARISON

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- Individual cost differences used to estimate cost difference for a complete MCC.
- Complete MCC cost comparison based on 30 motor starter circuits consisting of:
  - 13 basic DOL motors
  - 9 intermediate DOL motors
  - 3 advanced DOL motors
  - 5 variable speed drives

TOTAL MCC COMPARISON

ELECTRICAL ENGINEERING SPECIALISTS

Total MCC Cost Comparison (30 Drives)				
Description	***Component***	***Qty***	***Sub Total***	***Cost Difference***
Option 1 Hard Wired	Basic DOL Motor Starter	13	$ 15,224	**Baseline**
	Intermediate DOL Motor Starter	9	$ 19,362	
	Advanced DOL Motor Starter	3	$ 11,734	
	Variable Speed Drives	5	$ 9,241	
Option 2 Intelligent MCC	Basic DOL Motor Starter	13	$ 18,330	**-$5,280**
	Intermediate DOL Motor Starter	9	$ 17,919	
	Advanced DOL Motor Starter	3	$ 7,802	
	Variable Speed Drives	5	$ 6,228	
Option 3 Distributed I/O	Basic DOL Motor Starter	13	$ 12,270	**-$8,500**
	Intermediate DOL Motor Starter	9	$ 16,903	
	Advanced DOL Motor Starter	3	$ 10,771	
	Variable Speed Drives	5	$ 7,113	

IN CONCLUSION

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- Intelligent MCC cost varies depending on the complexity of the motor starter circuit.
- The more protection features required, the more cost effective an intelligent MCC is.
- Intelligent MCC cost is lower on average than a traditional hard wired MCC.
- Distributed I/O to automate a traditional hard wired MCC more cost effective than remote PLC I/O.

IN CONCLUSION

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- The cost of interconnecting cabling has a big impact on the comparative cost.
- Total cost difference between all three options is relatively small.
  - Intelligent MCC option is approx. 4% cheaper.
  - Distributed I/O option is approx. 6% cheaper.
- Careful consideration should be given to the overall architecture selected, not just MCC hardware costs.

QUESTIONS?

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