DEP SPECIFICATION

INTEGRATION OF MOTOR CONTROLS INTO BPCS

DEP 32.30.20.17-Gen.

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DESIGN AND ENGINEERING PRACTICE

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TABLE OF CONTENTS

1. INTRODUCTION 5
1.1 SCOPE 5
1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS 5
1.3 DEFINITIONS 5
1.4 CROSS-REFERENCES 9
1.5 COMMENTS ON THIS DEP 10
1.6 DUAL UNITS 10

2. GENERAL RESPONSIBILITIES 11
2.1 SCOPE 11

3. BASIC ARCHITECTURE LOW VOLTAGE PROCESS MOTORS 12
3.1 GENERAL 12

4. HARDWIRED CONTROLS 13
4.1 GENERAL 13
4.2 INTERFACE TO THE CONTROL SYSTEM 13

5. PROFIBUS CONTROL SYSTEM INTERFACE 14
5.1 GENERAL 14
5.2 USE OF PROFIBUS TECHNOLOGY 15
5.3 PROFIBUS TOPOLOGY 16
5.4 CONTROL IMPLEMENTATION 16
5.5 ELECTRICAL EQUIPMENT CONFIGURATION 17
5.6 VFD DRIVE CONFIGURATION 17
5.7 VERSION AND VARIETY MANAGEMENT OF PROFIBUS PRODUCTS 17
5.8 PROFIBUS CONFIGURATION TOOLS 18
5.9 PROFIBUS RISK ANALYSIS AND MANAGEMENT 18

6. DEVICENET CONTROL SYSTEM INTERFACE 19
6.1 GENERAL 19
6.2 DEVICENET CABLE AND WIRING REQUIREMENTS 19
6.3 USE OF DEVICENET TECHNOLOGY 20
6.4 DEVICENET NETWORK POWER SUPPLIES 21
6.5 DEVICENET TOPOLOGY 21
6.6 MOTOR OVERLOAD PROTECTION RELAY CONFIGURATION 23
6.7 VFD DRIVE CONFIGURATION 23
6.8 VFD CONFIGURED FAILURE MODES 24
6.9 VERSION AND VARIETY MANAGEMENT OF DEVICENET PRODUCTS 24
6.10 DEVICENET CONFIGURATION TOOLS 24
6.11 DEVICENET RISK ANALYSIS AND MANAGEMENT 25

7. MODBUS/TCP CONTROL SYSTEM INTERFACE 26
7.1 GENERAL 26
7.2 USE OF MODBUS/TCP TECHNOLOGY 26
7.3 MODBUS/TCP TOPOLOGY 26
7.4 CONTROL IMPLEMENTATION 27
7.5 ELECTRICAL EQUIPMENT CONFIGURATION 28
7.6 VERSION AND VARIETY MANAGEMENT OF MODBUS/TCP PRODUCTS 28
7.7 MODBUS/TCP CONFIGURATION TOOLS 29
7.8 MODBUS/TCP RISK ANALYSIS AND MANAGEMENT 29

8. ETHERNET/IP CONTROL SYSTEM INTERFACE 30
8.1 GENERAL 30
8.2 USE OF ETHERNET/IP TECHNOLOGY 30
8.3 ETHERNET/IP TOPOLOGY 31
8.4 CONTROL IMPLEMENTATION 31
8.5 ELECTRICAL EQUIPMENT CONFIGURATION 32
8.6 VERSION AND VARIETY MANAGEMENT OF ETHERNET/IP PRODUCTS 32
8.7 ETHERNET/IP CONFIGURATION TOOLS 33
8.8 ETHERNET/IP RISK ANALYSIS AND MANAGEMENT 33

Documents
Document Sharing Hub

Full document details: SHELL 32.30.20.17 0

9. DIAGNOSTIC INFORMATION 34

10. DOCUMENTATION 35
10.1 GENERAL 35
10.2 MANUFACTURER DOCUMENTATION 35

11. REFERENCES 37

APPENDICES

APPENDIX A EXAMPLE MOTOR CONTROLLERS USING DeviceNet 38

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Full document details: SHELL 32.30.20.17 0

1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the integration of motor control and electrical equipment into a BPCS (Basic Process Control System).

This DEP provides requirements for design and implementation of low voltage (600 volt or less) motor control integrated into a BPCS. It covers typical motor implementations in both upstream and downstream applications. Special applications or specialty motors will not be covered within this DEP due to the detailed engineering requirement for the specific application.

This DEP is not applicable to designs where the field hand/off/auto (or remote) switch is wired directly to the motor controller.

Where packaged equipment contains electric motors, then it may not be possible to follow this DEP; interfacing with these motors shall be determined on a case-by-case basis.

The air quality environment specifications (to ensure no corrosion of the electronic components) are beyond the scope of this DEP. The air quality shall be suitable for the electronic equipment being installed (may vary on a Manufacturer basis).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorized by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorized access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorized to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

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1.3.2 Specific definitions

Term	Definition
adapter	Provides connection between the device (e.g., drive, protection relay) and the DeviceNet network. An adapter is also known as a communications interface.
BPCS	Stands for Basic Process Control System. This generic name covers any control system architecture albeit based on a BPCS or a PLC platform. A BPCS does not include a Safety Instrumented System within the definition.
change-of-state communications	A device configured to produce change-of-state (COS) messages will produce data whenever the data changes or at a base heartbeat rate. This adjustable heartbeat rate provides a way for the consuming device to know that the data producer is still alive and active (when the device has no new data to report).
controller	A controller, also called programmable logic controller, is a solid-state control system that has a user-programmable memory for storage of instructions to implement specific functions such as I/O control, logic, timing, counting, report generation, communication, arithmetic, and data file manipulation. A controller consists of a central processor, input/output interface, and memory. See also Scanner.
cyclic communications	A device configured to produce a cyclic I/O message will produce its data at a precisely defined interval. This type of I/O messaging allows the user to configure the system to produce data at a rate appropriate for the application.
conformance testing	ODVA conformance testing is designed to validate that a product complies with relevant aspects of the ODVA specification. This includes the physical layer through to, and including, the application layer. Devices that have passed the ODVA DeviceNet conformance testing will have passed all the of the following tests (in one of ODVA's authorized test service providers): • Control and Information Protocol (CIP) Test; • DeviceNet Electronic Data Sheet (EDS) Test; • DeviceNet Physical Layer Test; and, • DeviceNet System Test. In addition, ODVA will also test and certify DeviceNet power supplies. This test verifies that the network power supplies provide the necessary voltage and currents, and operate as the specification requires under a variety of loading conditions.

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Term	Definition
DeviceNet network	A DeviceNet network uses a producer/consumer Controller Area Network (CAN) to connect devices (e.g., controllers, drives, protection relays). Both I/O and explicit messages can be transmitted over the network. A DeviceNet network can support a maximum of 64 devices where each device must have a unique address. As well, all devices must communicate at the same data rate (to avoid network problems). A DeviceNet network communicates on a cable which supplies both power (24 V DC) and communications to the devices. General information about DeviceNet and the DeviceNet specification are maintained by the Open DeviceNet Vendor Association (ODVA). ODVA is online at http://www.odva.org.
Electronic Data Sheet (EDS) files	EDS files are simple text files that are used by network configuration tools for DeviceNet to describe products so that you can easily commission them on a network. EDS files describe a product device type, revision, and configurable parameters.
EtherNet/IP	EtherNet/IP is an application layer protocol treating devices on the network as a series of "objects". EtherNet/IP is built on the Common Industrial Protocol (CIP), for access to objects from ControlNet and DeviceNet networks using the Ethernet physical layer network infrastructure.
GSD	General System Data is a file that contains general information about the slave device including communication of both cyclic data and cyclic diagnostic data. A GSD file is required by the network configuration software to configure the slave device on the PROFIBUS network.
Instrumented Protective Function (IPF)	A function comprising one or more sensors, a Logic Solver and one or more Final Elements whose purpose is to prevent or mitigate hazardous situations and that have SIL 1, SIL 2, SIL 3 or SIL 4. An IPF is intended to achieve or maintain a safe state for the process, in respect of a specific hazardous event. In IEC 61508 and IEC 61511 an IPF is referred to as a Safety Instrumented Function (SIF).
Instrumented Protective System (IPS)	The electromechanical, electronic and/or programmable electronic Logic Solver component of the Instrumented Protective Function, complete with input and output equipment. In IEC 61508 and IEC 61511 an IPS is referred to as a 'Logic Solver'.
Modbus/TCP	Is a Modbus variant used for communications of Modbus RTU (compact, binary representation of data) protocol over TCP/IP networks.

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Term	Definition
node address	A DeviceNet network can have as many as 64 devices connected to it. Each device on the network must have a unique node address between 0 and 63. Node address 63 is the default used by uncommissioned devices. Node addresses are sometimes called “MAC IDs.”
ODVA	Open DeviceNet Vendor Association (ODVA) **i**s an international association comprised of members from the world's leading automation companies.
polled communications	A slave configured for polled I/O will receive “output” data from the master device in a sequential order that is defined by the master’s scan list. The master’s polling rate is determined by the number of nodes in the scan list, the DeviceNet baud rate, the size of the messages, and the internal timing of the master device.
ProfiBus	PROcess FieldBUS is an open, digital industrial protocol designed to allow networking of a variety of devices, particularly in the fields of factory and process automation. IEC 61784-1: Communication network according communication profile family 3 (CPF3); incorporating application profiles and system integration aspects like interfaces and languages for engineering tools and HMI.
ProfiBus DP	Acronym for "PROFIBUS for Decentralized Peripherals". PROFIBUS DP is standardized within IEC 61158 and IEC 61784, communication profile families 3/1 and 3/2 The term "PROFIBUS DP" also is a synonym for the RS485 based deployments within factory
ProfiBus DP-Master Class 1	DPM1 is typically a PLC or BPCS communicating with other masters or slave devices for information/control. A DPM1 is a central controller which exchanges information with the decentralized stations (i.e. DP slaves) within a specified message cycle.
ProfiBus DP-Master Class 2	DPM2 is typically a PC or diagnostic device used for programming, configuration of the ProfiBus slave devices, or for diagnostics of the devices. DPM2 devices are programmers, configuration devices or operator panels. They are used during commissioning for configuration of the DP system or for operation and monitoring purposes which can be used to set device parameters via acyclical communication. A DPM2 need not be permanently connected to the bus system.
RS-485	Refers to the standard transfer technology for PROFIBUS that operates with a data transfer technology according to the RS-485 standard. PROFIBUS RS 485 is used for the data transfer with PROFIBUS DP. It allows high data transfer rates and is primarily used in factory automation.
scanner	A scanner is a separate module (of a multi-module controller) or a built-in component (of a single-module controller) that provides communication with adapters connected to a network.

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Term	Definition
SIS	Instrumented system used to implement one or more safety instrumented functions. A SIS is composed of any combination of sensor (s), logic solver(s), and final elements(s). [IEC 61511]. In summary, an SIS is a collection of IPFs (including sensors and final elements) that together protect a process unit or major piece of equipment.
Terminator	IEC 61158-2: A resistor connecting conductor pairs at both ends of a wire medium segment to prevent reflections from occurring at the ends of cables. Ideally it should be the wave impedance of the wire.

1.3.3 Abbreviations

Term	Definition
CIP	Common Industrial Protocol
DTM	Device Type Manager
EDS	Electronic Data Sheet
FAT	Factory Acceptance Test
FDT	Field Device Tool
GI	Global Infrastructure
GSD	General Station Description
HAZOP	Hazard and Operability Study
HOA	Hand-Off-Auto
IP	Internet Protocol
kbit/sec	Thousand bits per second
LOR	Local-Off-Remote
MAC	Media Access Control
Mbps	Megabits per second
MCC	Motor Control Centre
OLE	Object Linking and Embedding
OPC	OLE for Process Control
OSI	Open Systems Interconnection
PC	Personal Computer
PCAD	Process Control Access Domain
RCU	Remote Control Unit
SME	Subject Matter Expert
TOA	Test-Off-Auto
UPS	Uninterrupted Power Supply
VFD	Variable Speed Drive

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets ( ). Other documents referenced by this DEP are listed in (10).

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1.5 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal http://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

1.6 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

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2. GENERAL RESPONSIBILITIES

2.1 SCOPE

This DEP requires that the implementer is familiar with PROFIBUS DP, DeviceNet, Modbus/TCP, and EtherNet/IP technology and terminology, electrical symbology and terminology, and control system integration concepts.

Where the term Basic Process Control system (BPCS) is used, the reference is to a control system which may be based upon BPCS or Programmable Logic Controller (PLC) technology. In all cases for this document, the Safety Instrumented System (SIS) shall be considered separate from the BPCS definition.

If an EPC or Contractor is used for the implementation of this project, then a review shall be undertaken to allow the EPC/Contractor to demonstrate their knowledge of this technology and integration of said technology into their project plan and schedule.

If an operating site already has a motor control philosophy implementation, then local site standards shall also be considered. Selection and design of the motor control shall at all times ensure that safety is the top most priority. This includes consideration of field wiring (philosophy and wire colours), equipment selection, and colour selection for indication. The project shall work with the sites to determine the suitability of this Standard to the current project design.

The use of colours for the pilot lamp assemblies on the motor controller front panels shall be based upon existing site standards or regional project standards.

This Standard does not cover the design and implementation of ProfiBus or DeviceNet. It is recommended that external training courses be taken to allow the Contractor to obtain a comfort level of ProfiBus, DeviceNet, Modbus/TCP, and EtherNet/IP (and associated equipment).

This DEP will not recommend which technology to use for integration of Motor Control into the BPCS as this typically is dependent on the Supplier of the MCC equipment. This DEP provides direction on how best to implement the integration technology.

This initial release of the DEP direction for technologies is common with North American standards; however many of the concepts are valid for all projects. Future revision of this DEP will provide additional details of implementation consistent with IEC standards and Shell IMCS (Integrated Motor Control Systems) consistent with the benefits available from the global electrical equipment EFAs (Enterprise Framework Agreements).

DeviceNet™ is a trademarked technology. Within this DEP, wherever DeviceNet is used, it refers to DeviceNet™.

Profibus™ is a trademarked technology. Within this DEP, wherever Profibus is used, it refers to Profibus™.

Modbus/TCP™ is a trademarked technology. Within this DEP, wherever ModBus/TCP is used, it refers to ModBus/TCP™

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3. BASIC ARCHITECTURE LOW VOLTAGE PROCESS MOTORS

3.1 GENERAL

For low voltage motors controlled by the DCS System, there shall be design consistency (by application; by starter size) of the interface. Each low voltage motor shall have a HAND/OFF/AUTO (HOA) switch located in the field in close proximity to the motor. For process connected motors, the HOA shall be wired to the control system via 24 V digital wiring. The Hand and Auto positions shall be connected to the control system (two discrete inputs). The Off position shall be assumed when both Hand and Auto are off.

As an option to the HOA switch, either a TEST/OFF/AUTO (TOA) switch may be used or a LOCAL/OFF/REMOTE (LOR) switch can be used. In the TOA switch, the test position has a spring return back to the switch off position and in the LOR switch, the spring return is back to the remote position. The Principal shall confirm the project selection for the local switch taking into account existing site standards (if present). For the remainder of the DEP, HOA will be used regardless if a HOA or a TOA will be used for the project.

NOTE: Some sites/projects use different terms for the HOA or TOA such as Hand/Off/Remote (HOR), Local/Off/Remote (LOR), or Remote Control Unit (RCU). Any term can be used with this DEP as the importance is not in the nomenclature but ensuring compliance in the implementation.

The SIS shall provide (if required through a SIL analysis) a “permissive” digital output wired directly to the motor controller. This permissive shall be normally open (fail safe) and hence, energized for permissive to run. When this permissive is removed, power shall be removed from the motor contactor coil. Where there is no requirement for the SIS permissive, a jumper shall be installed across these terminals.

There shall be contacts for an Emergency Stop (E-Stop) wired to/within each motor controller. The E-Stop, as required through HAZOP and/or local code requirements (e.g., conveyer belt systems or where operators are at risk around electric motor-driven machinery), shall be wired directly from the motor controller to the E-Stop button located in the field. The E-Stop shall be of fail-safe design; that is, the circuit shall be completed for the motor logic (within the motor controller) to function. Where the E-Stop functionality is not required, a jumper shall be placed across the terminals in the motor controller. The E-Stop switch shall be of a design requiring manual local reset. Upon detection of the E-Stop permissive removed in the motor controller, the DCS shall remove the motor run permissive to the motor controller (to prevent auto-restart upon reset of the local E-Stop). Designs incorporating the E-Stop shall be approved by the Principal.

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4. HARDWIRED CONTROLS

4.1 GENERAL

Hardwired controls are the most simple of motor control implementation; however the ability to benefit from the smartness being provided in the electrical equipment (that is being paid for) is lost.

Each electrical device that is associated with control of motors/pumps is directly connected to the BPCS via digital and analogue signals. Where the current requirements exceed the capacity of the BPCS digital output channel, the user of interposing relays is required. All wiring used between the BPCS and the MCCs shall be rated for voltage and current requirements. The relays shall be factory installed, wired and tested before shipment.

Manufacturer standard supply of interposing relays shall be used – as agreed with the Shell Electrical Discipline.

For motor controllers, all shall be wired in the same manner – where a specific control is not required, a jumper shall be installed.

Each motor controller shall have terminals for a permissive from the safety system; again if the permissive is not required (as determined during the SIL Analysis), then a jumper shall be installed.

Where the current capacity of the IPS digital output channel is exceeded, an interposing relay shall be used; Manufacturer standard supply shall be used unless approved by the Principal. The relays shall be factory installed, wired and tested before shipment.

NOTE: There may be unique requirements for IPFs where feedback on the IPF permissive is required or higher level SIL requirement that justifies use of a SIL rated interposing relay. These are unique designs to be dealt with on a case by case basis with involvement of the Principal.

NOTE: This DEP does not discuss implementation of IPF permissives and resets; refer to DEP 32.80.10.10-Gen.

4.2 INTERFACE TO THE CONTROL SYSTEM

The BPCS will provide a digital output directly connected to the motor controller. The BPCS output will be normally de-energized (fail safe). When this digital output is energized (logic true), the BPCS motor start signal shall be enabled thereby providing a current path to the motor contactor coil.

There shall be (up to) one vertical section per line-up used for connection to/from the control system. All wiring from the individual motor controllers shall be to this vertical section and shall be factory wired. When the length of the line-up exceeds the shipping split length, the control wiring from the shipping splits shall be connected by factory-installed plugs suitable for the service. All wiring design to/from the motor controllers to this vertical section shall be provided at the time of order.

Note that there may be some motors (simple applications) that only have a local hand switch (only). The Principal shall identify which of these motors shall have the running status displayed in the BPCS.

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