Safety manual for Fisher™ FIELDVUE™ DVC6200 SIS Digital Valve Controller, Position Monitor, and LCP200 Local Control Panel

This supplement applies to

Instrument Level	SIS	
Device Type	130a	
Hardware Revision	2	
Firmware Revision	7	
Device Revision	1	3
DD Revision	7	1

1. Purpose

This safety manual provides information necessary to design, install, verify and maintain a Safety Instrumented Function (SIF) utilizing the Fisher DVC6200 SIS digital valve controller. The DVC6200 SIS can be installed with a local control panel (LCP200). This document must be thoroughly reviewed and implemented as part of the safety lifecycle. This information is necessary for meeting the IEC 61508 or IEC 61511 functional safety standards.

⚠ WARNING

This instruction manual supplement is not intended to be used as a stand-alone document. It must be used in conjunction with the following documents:
Fisher DVC6200 Series Quick Start Guide (D103556X012)
Fisher DVC6200 SIS Instruction Manual (D103557X012)
Fisher LCP200 Instruction Manual (D104296X012)

Failure to use this instruction manual supplement in conjunction with the above referenced documents could result in personal injury or property damage. If you have any questions regarding these instructions or need assistance in obtaining any of these documents, contact your Emerson sales office.

2. Description of the Device

The Fisher DVC6200 SIS digital valve controller is an instrument which delivers controlled pneumatic pressure to modulate a valve actuator in response to an electrical signal. An optional valve position monitor will either transmit a 4-20 mA signal in response to the actual valve travel or open and close a discrete limit switch based on a configurable trip point. An LCP200 can be used in conjunction with the DVC6200 SIS to locally open and close a safety shutdown valve as well as initiating a partial stroke test.

This safety manual applies to the DVC6200 SIS instrument with electronics hardware revision 2 (HW2) and firmware revision 4, 5, 6, and 7 with the following product options.

MODEL	CONSTRUCTION	OPTION							
		DETT	ETT	4-20 mA	24 VDC	Double-Acting Direct	Single-Acting Reverse	Single-Acting Direct	Position Monitor
DVC6200 SIS	Integral, Aluminum	✓	✓	✓	✓	✓	✓	✓	✓
DVC6200S SIS	Integral, Stainless Steel	✓	✓	✓	✓	✓	✓	✓	✓
DVC6205 SIS DVC6215	Remote Mount[1], Aluminum	✓	✓	✓	✓	✓	✓	✓	✓
APPLICATION									
	DETT	✓		✓	✓	✓	✓	✓	✓
	ETT		✓	✓		✓	✓	✓	✓
	4-20 mA	✓	✓	✓		✓	✓	✓	✓
	24 VDC	✓			✓	✓	✓	✓	✓

1. The Remote Mount construction is not available with the DVC6200 SIS High Cv option.

Accessories

LCP100/LCP200 Local Control Panel, HART Only

LC340 Line Conditioner, 24 VDC

3. Terms, Abbreviations, and Acronyms

β	Beta factor for common cause effects of failure
DD	Device Description, an electronic data file that describes specific features and functions of a device to be used by host applications.
DETT	De-energize to Trip
DTM	Device driver that provides a unified structure for accessing device parameters, configuring and operating the devices, and diagnosing problems.
DVC6200 SIS	Digital Valve Controller, product model designation for Safety Instrumented System applications
ESD	Emergency Shut Down
ETT	Energize to Trip
FIT	Failure In Time ($1x10^{-9}$ failures per hour)
FMEDA	Failure Mode Effect and Diagnostic Analysis
HART	Highway Addressable Remote Transducer, open protocol for digital communication superimposed over a direct current.
HCv1	Pneumatic booster with a Cv of 1.2 for double acting and both single direct and reverse acting. (Note: single-acting reverse certified for ETT applications only.)
HCv2	Pneumatic booster with a Cv of 3.2 for double acting and both single direct and reverse acting. (Note: single-acting reverse certified for ETT applications only.)
HCv3	Pneumatic booster with an exhaust Cv of 6.2 and a fill Cv of 3.2 for single direct acting.
HFT	Hardware Fault Tolerance
λ	Failure rate. λ_{DD}: dangerous detected; λ_{DU}: dangerous undetected; λ_{SD}: safe detected; λ_{SU}: safe undetected.
LC340	Line Conditioner; product model designation for a device that is inserted in the loop when the instrument (in Multidrop Mode) is powered with a low-impedance 24 V source, to enable HART® communications.
LCP100 LCP200	Local Control Panel; product model designation for a device that can be connected to a DVC6200 SIS instrument to enable manually-initiated functions.
Low Demand Mode	Mode of operation of a safety instrumented function where the demand interval is greater than twice the proof test interval.
Multidrop	Operating mode of the DVC6200 SIS where the instrument controls the current drawn to enable it to be powered with 24 VDC.
PFD_{AVG}	Average Probability of Failure on Demand
Point-to-Point	Operating mode of the DVC6200 SIS whereby the instrument is powered with 4-20 mA.
PVST	Partial Valve Stroke Test
Relay A	Pneumatic booster relay for double or single acting applications. Typical construction for double acting DETT applications.
Relay B	Pneumatic booster relay for single acting reverse applications. Typical construction for single acting ETT applications.
Relay C	Pneumatic booster relay for single acting direct applications. Typical construction for single acting DETT applications.
Safety	Freedom from unacceptable risk of harm.
Safety Function	Function of a device or combination of devices intended to be used within a Safety Instrumented System to reduce the probability of a specific hazardous event to an acceptable level.
SFF	Safe Failure Fraction
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SOV	Solenoid Operated Valve
Type A Element	"Non-Complex" element (using discrete components); for details see 7.4.4.1.2 of IEC 61508-2.
Type B Element	"Complex" element (using complex components such as micro controllers or programmable logic); for details see 7.4.4.1.3 of IEC 61508-2.

4. Related Literature

- Fisher DVC6200 Series Quick Start Guide (D103556X012)
- Fisher DVC6200 SIS Instruction Manual (D103557X012)
- 62.1:DVC6200 SIS, Fisher DVC6200 SIS Product Bulletin (D103555X012)
- HART Field Device Specification for Fisher DVC6200 SIS (D103638X012)
- Fisher LCP200 Local Control Panel Instruction Manual (D104296X012)
- 62.1:LCP200, Fisher LCP200 Local Control Panel Product Bulletin (D104313X012)
- IEC 61508: 2010 Functional safety of electrical/electronic/programmable electronic safety-related systems
- ANSI/ISA 84.00.01-2004 (IEC 61511 Mod.) Functional Safety – Safety Instrumented Systems for the Process Industry Sector
- Exida FMEDA Report for Fisher DVC6200 SIS, Position Monitor Applications - Report No. EFC 12/02-027 R001
- Exida FMEDA Report for Fisher DVC6200 SIS, DETT and ETT Applications - Report No. EFC 12-02-027 R004 V3 R0
- Exida FMEDA Report for Fisher DVC6200 SIS Digital Valve Controller with High Cv Option, ESD DETT applications - Report No. EFC 12/02-037 R002 V2 R3
- Exida FMEDA Report for Fisher DVC6200 SIS Digital Valve Controller with High Cv Option, ESD ETT applications - Report No. EFC 14/03-045 R001 V1 R5

5. General Requirements

⚠ WARNING

To ensure safe and proper functioning of equipment, users of this document must carefully read all instructions, warnings, and cautions in this safety manual and the Quick Start Guide.

- Refer to the Fisher DVC6200 SIS Quick Start Guide (D103556X012) for mounting and configuration.
- If a LCP200 is used, refer to the Fisher LCP200 instruction manual (D104296X012) for wiring configurations and mounting.
- Tools needed:

  DVC6200 SIS

  - Flat Head Screwdriver, 3 mm Thin Blade (wiring terminations)
  - Phillips Screwdriver
  - 3/8” Hex Key (terminal box conduit plug)
  - 6 mm Hex Key (module base screws)
  - 5 mm Hex Key (terminal box screw)
  - 2.5 mm Hex Key (I/P converter screws)
  - 1.5 mm Hex Key (terminal box cover screw)
  - 9/64” Hex Key (spool valve screws, HCv1)
  - 3 mm Hex Key (spool valve screws, HCv2 and HCv3)

  LCP200

  - Phillips Screwdriver (ground screw)
  - Flat Head Screwdriver, 3 mm Thin Blade (wiring terminations)
  - 10 mm Hex Key (cable entry plug)
  - 4 mm Hex Key (terminal cover screw)
  - 2.5 mm Hex Key (LED module screw, front panel screw)
  - Torque wrench capable of 2 - 2.5 N • m (18 - 22 lb • in) (terminal cover screw)
- Personnel performing maintenance and testing on the DVC6200 SIS and LCP200 shall be competent to do so.

6. Safety Instrumented System Design

When using the DVC6200 SIS digital valve controller or DVC6200 SIS with the LCP200 in a safety instrumented system, the following items must be reviewed and considered.

6.1 SIL Capability

6.2 Safety Function

6.3 Failure Rates

6.4 Application Limits

6.5 Environmental Limits

6.6 Application of the Switch Output for Diagnostic Annunciation

6.1. SIL Capability

- Systematic Integrity

  SIL 3 Capable— the digital valve controller has met manufacturer design process requirements of IEC 61508 Safety Integrity Level 3.

- Random Integrity

  - The digital valve controller is classified as a Type A device according to IEC 61508. The complete final element subsystem will need to be evaluated to determine the SFF. If the SFF of the subsystem is >90%, and the $PFD_{avg} < 10^{-3}$, the design can meet SIL 3 @ HFT=0.

  - The position monitor is classified as a Type B device according to IEC 61508. The complete final element subsystem will need to be evaluated to determine the SFF. If the SFF of the subsystem is >90%, and the $PFD_{avg} < 10^{-2}$, the design can meet SIL 2 @ HFT=0. If the SFF of the subsystem is between 60% and 90%, and the $PFD_{avg} < 10^{-1}$, the design can meet SIL 1 @ HFT=0.

  - The LCP200 is classified as a Type B device per IEC61508. If the SFF of the relay output state change subsystem is >90% and the $PFD_{avg} < 10^{-2,}$ the design can meet SIL2 @ HFT = 0. If the SFF of the subsystem is between 60% and 90%, and the $PFD_{avg} < 10^{-1}$, the design can meet SIL 1 @ HFT=0.

6.2. Safety Function

- **De-energize to Trip Application:** The application of the digital valve controller is limited for SIS to low demand mode. Table 1 describes the normal and safe states of DVC6200 SIS for a DETT configuration. The digital valve controller may be operated with one of the following control signals:
  - **0-24 VDC:** Normal operation is with a 24 VDC signal applied to the digital valve controller. A shut-down command is issued by interrupting the loop or taking the voltage signal to 1 VDC or less.
  - **4-20 mA:** Normal operation is with a 20 mA current loop signal to the digital valve controller. A shut-down command is issued by taking the current signal to 4 mA (nominal). If a loop-powered LCP100/LCP200 is attached, the shut-down command is issued by taking the current signal to 8 mA (nominal).

Table 1. Normal and Safe States for De-Energize to Trip (DETT) Application

Action	Output Type	Input Voltage or Current	Normal State	Safe State
Single	Direct	0 VDC or 4 mA		Port A < 1 psi
		24 VDC or 20 mA	Port A ≥ 95% of Supply	
	Reverse[(1)]	0 VDC or 4 mA		Output B ≥ Supply Pressure less 5 psi
		24 VDC or 20 mA	Port B < 1 psi	
Double	Direct	0 VDC or 4 mA		Port A pressure ≤ Port B pressure
		24 VDC or 20 mA	Port A ≥ 95% of Supply Port B < 1 psi	

1. DVC6200 SIS High Cv option is not certified for single-acting reverse DETT application.

- **Energize to Trip Application** (a less common application): The application of the digital valve controller is limited for SIS to low demand mode. Normal operation is with a 4 mA current loop signal to the digital valve controller. If a loop-powered LCP100/LCP200 is attached, normal operation is with an 8 mA (nominal) current loop signal to the digital valve controller. Table 2 describes the normal and safe states of DVC6200 SIS for an ETT configuration. A shut-down command is issued by taking the current signal to 20 mA (nominal).

Table 2. Normal and Safe States for Energize to Trip (ETT) Application

Action	Output Type	Input Current	Normal State	Safe State
Single	Reverse	4 mA	Port B ≥ 95% of Supply	
		20 mA		Port B < 1 psi
Double	Direct	4 mA	Port A < 1 psi Port B ≥ 95% of Supply	
		20 mA		Port A ≥ Port B pressure

- **Position Monitor Application:** The safety function of the position transmitter output is to transmit a 4-20 mA analog signal that represents valve position. The safety function of the limit switch output is to transmit a discrete signal that represents a user configurable threshold of valve position. Table 3 describes the normal and alarm states of the Position Monitor function of the DVC6200 SIS.

Table 3. Normal and Alarm States for the Position Monitor Application

Output Function	Normal State	Accuracy	Alarm State
4-20 mA Position Transmitter	Actual Valve Position	5%	>22.5 mA or <3.6 mA[1]
0/1A Limit Switch	CLOSED	5%	OPEN[2]

1. Configurable high or low. Values are per NAMUR NE43. Fail high when the instrument is powered.
2. On loss of loop circuit power, the limit switch will go to the open state.

- LCP200
    - The LCP200 will respond to a local TRIP button press with a change of state of the Trip relay output.
    - The LCP200 will respond to a local RESET button press with a change of state of the reset relay output.

6.3. Failure Rates

The failure rate data listed in tables 4, 5, 6, 8, 7, 9, and 10 is only valid for the 15-year useful lifetime of the DVC6200 SIS digital valve controller and the LCP200, when used. The failure rates will increase after this time period. Reliability calculations based on the data listed in the FMEDA report for mission times beyond the useful lifetime may yield results that are too optimistic, i.e. the calculated Safety Integrity Level will not be achieved. When used, the LCP100/LCP200 failure rates and the LC340 failure rates are to be added to the failure rates of the DVC6200 SIS. These failure rates assume that the self test shutdowns in the DVC6200 SIS are disabled. Consult the FMEDA report for a detailed list of the assumptions used in the analysis.

Table 4. Failure Rates for DVC6200 SIS with 0-24 VDC or 4-20 mA Control Signal, DETT

Failure Category	Failure Rate (in FIT)							SOV Test Config.
	DVC6200 SIS				Adders for LCP Loop or 24V External Power			
	Double Acting, Single Acting, Direct Acting		Single Acting, Reverse Acting		Non-Interfering		LC340	
	w/PVST Diagnostics	Normal	w/PVST Diagnostics	Normal	LCP100	LCP200		
Fail Safe Detected	182	0	182	-	-	-	-	62
Fail Safe Undetected	143	325	132	314	29	34	19	0
Fail Dangerous Detected	72	0	103	-	-	-	-	-
Fail Dangerous Undetected	44	117	52	155	1	2	-	-
No Effect	1,060	1,636	884	1,460	27	-	-	-
Annunciation Failure Detected	398	0	398	-	-	-	-	-
Annunciation Failure Undetected	177	0	177	-	-	-	-	62[1]

1. This number can be subtracted from the annunciated failure undetected number when the DVC6200 SIS is configured to perform a SOV test.

Table 5. Failure Rates for DVC6200 SIS High Cv Option with 0-24 VDC or 4-20 mA Control Signal, DETT

Failure Category	Failure Rate (in FIT)						
	DVC6200 SIS High Cv Option				Adders for LCP Loop or 24V External Power		
	Double Acting		Single Acting, Direct		Non-Interfering		LC340
	w/PVST Diagnostics	Normal	w/PVST Diagnostics	Normal	LCP100	LCP200	
Fail Safe Detected	641	0	637	0	-	-	-
Fail Safe Undetected	215	455	215	451	29	34	19
Fail Dangerous Detected	140	0	116	0	-	-	-
Fail Dangerous Undetected	38	178	35	151	1	2	-
No Effect	797	1380	828	1411	27	-	-
Annunciation Failure Detected	-	-	-	-	-	-	-
Annunciation Failure Undetected	-	-	-	-	-	-	-

Table 6. Failure Rates for DVC6200 SIS with 4-20 mA Control Signal, ETT

Failure Category	Failure Rate (in FIT)				SOV Test Config.
	DVC6200 SIS		Adders for LCP Loop or 24V External Power		
	w/PVST Diagnostics	Normal	Non-Interfering		
			LCP100	LCP200	
Fail Safe Detected	60	0	0	-	62
Fail Safe Undetected	104	164	28	34	0
Fail Dangerous Detected	261	0	0	-	-
Fail Dangerous Undetected	93	352	2	2	-
No Effect	939	1,547	27	-	-
Annunciation Failure Detected	425	0	0	-	-
Annunciation Failure Undetected	183	0	0	-	62(1)

1. This number can be subtracted from the annunciated failure undetected number when the DVC6200 SIS is configured to perform a SOV test.

Table 7. Failure Rates for DVC6200 SIS High Cv Option with 4-20 mA Control Signal, ETT

Failure Category	Failure Rate (in FIT)					
	DVC6200 SIS High Cv Option				Adders for LCP Loop or 24V External Power	
	Double Acting Single Acting, Direct		Single Acting, Reverse		Non-Interfering	
	w/PVST Diagnostics	Normal	w/PVST Diagnostics	Normal	LCP100	LCP200
Fail Safe Detected	514	0	512	0	0	-
Fail Safe Undetected	67	155	65	151	28	34
Fail Dangerous Detected	348	0	326	0	0	-
Fail Dangerous Undetected	93	441	91	417	2	2
No Effect	802	1418	830	1446	27	-
Annunciation Failure Detected	-	-	-	-	0	-
Annunciation Failure Undetected	-	-	-	-	0	-

Table 8. Failure Rates for DVC6200 SIS Position Monitor

Failure Category	Failure Rate (in FIT)	
	Position Transmitter or Limit Switch	
	End Mounted Rotary Linkage-Less, Non-Contact Feedback	All Other Mountings
Fail Safe Undetected	30	92
Fail Dangerous Detected		
Fail Detected (detected by internal diagnostics)(1)	160	203
Fail High (detected by logic solver)(1)	30	30
Fail Low (detected by logic solver)(1)	141	141
Fail Dangerous Undetected	31	96
No Effect	167	258
Annunciation Failure Undetected	5	5

1. If the system is not able to detect any or all of these failure categories, the corresponding Failure Rate(s) must be applied to the Fail Dangerous Undetected category.

Table 9. Failure Rates for LCP200

Failure Category	Failure Rate (in FIT)		
	LCP200 Trip and Reset Relay Output		
	24 VDC External Power	Loop Power	
		DETT	ETT
Fail Safe Undetected	31	31	31
Fail Safe Detected	15	17	15
Fail Dangerous Detected	153	136	148
Fail Dangerous Undetected	17	14	15
No Effect	1320	1338	1328
Annunciation Failure Detected	17	17	17
Annunciation Failure Undetected	8	9	9

Table 10. Failure Rates According to IEC 61508 in FIT

Application	Model	Device		λ_{SD}	λ_{SU}(1)	λ_{DD}	λ_{DU}	SFF(2)	DC(3)
De-Energize to Trip	DVC6200 SIS	Relay A Double, Single Acting, Relay C	w/PVST Diagnostics	581	143	72	44	-	62%
			Normal	0	325	0	116	-	-
		Relay B Single, Reverse Acting	w/PVST Diagnostics	581	124	103	52	-	66%
			Normal	0	306	0	155	-	-
		Adder for SOV Test Config.(4)		62	0	0	0	-	-
	DVC6200 SIS High Cv option	Single Acting, Direct	w/PVST Diagnostics	637	215	116	35	-	77%
			Normal	0	451	0	151	-	-
		Double Acting	w/PVST Diagnostics	641	215	140	38	-	79%
			Normal	0	455	0	178	-	-
	DVC6200 SIS / DVC6200 SIS High Cv option	Adder for LCP100		0	29	0	1	-	-
		Adder for LCP200 - Non-interfering		0	34	0	2	-	-
		Adder for LC340		0	19	0	0	-	-
Energize to Trip	DVC6200 SIS	w/PVST Diagnostics		485	104	261	93	-	74%
		Normal		0	164	0	352	-	-
		Adder for SOV Test Config.(4)		62	0	0	0	-	-
	DVC6200 SIS High Cv option	Double Acting, Single Acting, Direct	w/PVST Diagnostics	514	67	348	93	-	79%
			Normal	0	155	0	441	-	-
		Single Acting, Reverse	w/PVST Diagnostics	512	65	326	91	-	78%
			Normal	0	151	0	417	-	-
	DVC6200 SIS / DVC6200 SIS High Cv option	Adder for LCP100		0	28	0	2	-	-
		Adder for LCP200 - Non-interfering		0	34	0	2	-	-
Position Monitor	DVC6200 SIS	End Mounted Rotary Linkage-Less, Non-Contact Feedback		0	30	331	31	92.2%	91%
		All Other Mountings		0	92	374	96	82.9%	80%
LCP200		Trip and Reset relay, 24V external power		31	31	153	17	92.7%	90.0%
		Trip and Reset relay, Loop power, ETT		31	31	147	15	93.3%	90.7%
		Trip and Reset relay, Loop power, DETT		31	31	136	14	93.5%	90.7%

1. The No Effect failures are no longer included in the Safe Undetected failure category according to IEC 61508, ed2, 2010.
2. Safe Failure Fraction needs to be calculated on (sub)system level.
3. Diagnostic coverage (DC) is λ_{DD} / ($\lambda_{DD} + \lambda_{DU}$)
4. This number can be subtracted from the annunciated failure undetected number when the DVC6200 SIS is configured to perform a SOV test.

6.4. Application Limits

- Safety Instrumented Function design verification must be done for the entire collection of equipment used in the Safety Instrumented Function including the DVC6200 SIS digital valve controller and the LCP200 local control panel. The SIS must fulfill the requirements according to the Safety Integrity Level, especially the limitation of average Probability of Failure on Demand (PFDavg)
- In order to achieve the published failure rate and classification type for the 4-20 mA device, the hardware shutdown function must be enabled. See figure 1.
- The system's response time is dependent on the entire final element subsystem. The user must verify the system response time is less than the process safety time for each final element.
- The DVC6200 SIS digital valve controller fault reaction time is determined by the partial valve stroke test interval plus the mean time to repair.
- The DVC6200 SIS position monitor safety function has a fault reaction time of 30 seconds plus the mean time to repair.
- The position monitor with the remote mount construction is not safety certified.
- The LCP200 relay output changing state safety function has a fault reaction time of 180 seconds plus the mean time to repair.
- The valve actuation means must be of a type that automatically moves the valve to the safe state when the digital valve controller achieves the safe state. Valve stroke timing under these conditions may also need to be considered as part of the SIS design.
- When using the DVC6200 SIS in redundant applications, the owner-operator of the facility should institute common cause training and more detailed maintenance procedures specifically oriented toward common cause defense.
- An estimate for the common cause failure rate (β) as determined for the DVC6200 SIS used in a redundant configuration is 2% for DETT and ETT applications and 5% for Position Monitor applications.
- An estimate for the common cause failure rate (β) as determined for the LCP200 used in a redundant configuration is 5% for the relay output changing state.
- The digital valve controller safety function is intended for use in an independent SIF loop from the position transmitter or limit switch application. Common cause failures between the digital valve controller and position monitor were not considered as a part of the FMEDA analysis.
- The LCP200 is non-interfering to the DVC6200 SIS, meaning that it cannot adversely affect the safety function of the DVC6200 SIS.
- The supply pressure must not exceed 145 psig. The supply medium may be air or natural gas.

Air: Supply pressure must be clean, dry air that meets the requirements of ISA Standard 7.0.01.

Natural Gas: Natural Gas must be clean, dry, oil-free and noncorrosive.

A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended.

- Diagnostic annunciation is dependent on a HART communicating host device being connected to the DVC6200 SIS and being able to annunciate any problems encountered including the absence of a valid response from the DVC6200 SIS.

6.5. Environmental Limits

- Operating ambient temperature, refer to:
  - DVC6200 SIS Instruction Manual (D103557X012)
  - LCP200 Local Control Panel Instruction Manual (D104296X012)
- Humidity: tested per IEC 61514-2
- Electromagnetic Compatibility:
  - EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - General requirements
    - Immunity - Industrial locations per Table 2 of EN 61326-1
    - Emission – Class A, Group 1 per Table 4 of CISPR 11
  - To achieve the compatibility, the following installation practices shall be followed
    - Metal conduit shall be used to shield the AUX cable between DVC6200 SIS and LCP200. Ensure that the metal conduit has good contact with the enclosure of each equipment.
    - Both DVC6200SIS and LCP200 enclosures shall be grounded locally.
- Vibration: tested per ANSI/ISA S75.13.01 Section 5.3.5. If excessive vibration can be expected, special precautions shall be taken which may include, but are not limited to:
  - Ensuring the integrity of the instrument mounting to the actuator.
  - Ensuring the integrity of pneumatic connections.
  - Remote mounting the DVC6200 SIS on a pipestand or wall.
  - LCP200 pipe stand or wall mounted.

6.6. Application of the Switch Output for Diagnostic Annunciation

When using the Failure Rates “with PVST Diagnostics”, the system must be capable of monitoring the DVC6200 SIS for alert conditions. To monitor the diagnostic detection, configure the switch output to report an alert condition.

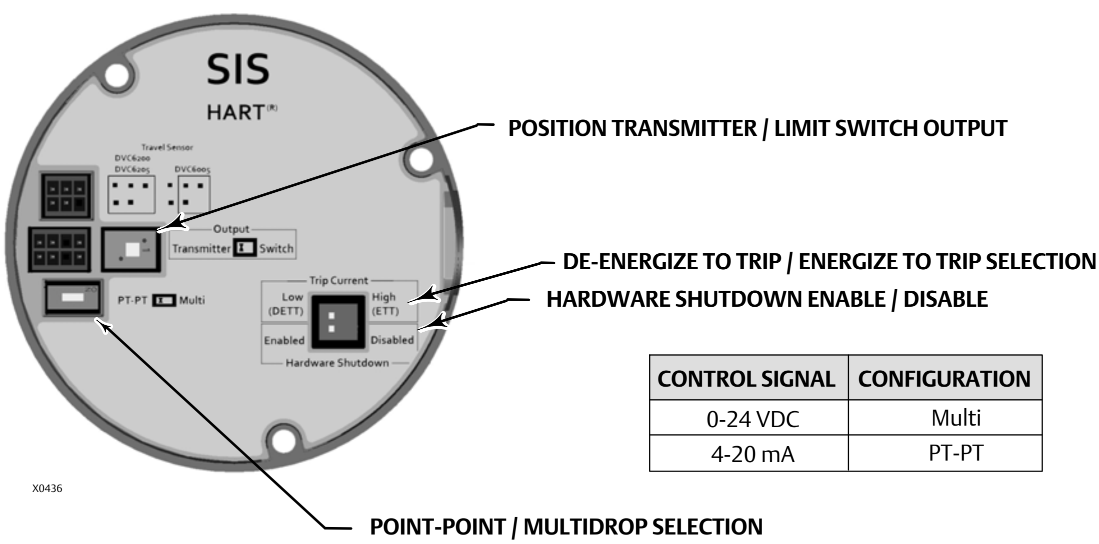
- ☐ Make sure that the electronics hardware is configured for the switch output. See figure 1.
- ☐ With a user interface tool, configure the switch output to report “SIS Diagnostic Credit” Table 11 lists the diagnostics that are included in the SIS Diagnostic Credit Alert.
- ☐ Configure the switch to close on detection of an alert.

7. Installation & Commissioning Guidelines

7.1. DVC6200 SIS DETT or ETT Safety Function

- ☐ Verify that the DVC6200 SIS is suitable for use in this Safety Instrumented Function. If a LCP200 is being used, verify it is also suitable for the Safety Instrumented Function.
- ☐ Verify that nameplate markings of all the equipment being installed are suitable for the hazardous location (if required).
- ☐ Verify appropriate connections to the logic solver are made by referring to the instruction and safety manual of the logic solver.
- ☐ For maximum availability and benefit of digital valve controller features, the unit must be properly configured and calibrated, the Instrument Mode set to In Service, End Point Pressure Control (EPPC) enabled, and the protection set to Config & Calib using the Instrument Setup > Change Protection menu. With protection set, calibration and other protected parameters cannot be changed, including the Instrument Mode. Figure 1 below identifies toggle switches on the main electronics board that are configured as determined by the safety function and system application.

Figure 1. Configuration Toggle Switches on the Main Electronics Board



CONTROL SIGNAL	CONFIGURATION
0-24 VDC	Multi
4-20 mA	PT-PT

- ☐ When operating with a 0-24 VDC control signal, the Hardware Shutdown circuit must be “Disabled” and an LC340 line conditioner is required to allow HART communication. An impedance boosting multiplexer (available from MTL, Pepperl+Fuchs / Elcon and others) may be used in place of the LC340. Refer to the documentation that comes with the product for installation instructions.
- ☐ An LCP100/LCP200 local control panel may be connected to the DVC6200 SIS to manually operate the final control element or run a PVST. Additionally, the LCP200 can change the state of the relay output when the trip or reset button is pressed. For details, see section 7.3 below. Both the LCP100 and LCP200 are non-interfering devices when used in DETT applications; the LCP200 is also non-interfering in ETT applications. The LCP200 has two safety functions available for use. Refer to table 4, 5, 6, 8, 7, 9, and 10 for failure rate adders when using the LCP100/LCP200. Refer to the documentation that comes with the product and LCP100/LCP200 instruction manual for installation and safety instructions.
- ☐ The safety function of the DVC6200 SIS within the final control element subsystem along with the overall SIS safety function must be tested after installation to ensure that it meets safety demand and applicable process safety time requirements.
- ☐ Solenoid Valve Test (not supported by DVC6200 SIS High Cv Option) - When a solenoid valve is installed in the pneumatic path between the digital valve controller pressure output and the actuator input, the digital valve controller can be configured to verify the operation of the solenoid valve. This applies to single-acting actuator applications only. The “unused” output port of the digital valve controller is tubed such that the pressure downstream of the solenoid valve is measured. When the solenoid valve is pulsed by the DVC6200 SIS, the digital valve controller senses the momentary pressure drop across the solenoid valve and records the data for performance evaluation.

  To do this, the OUT terminals in the digital valve controller are used in series with the solenoid valve and the Transmitter/Switch selection on the printed wiring board must be set to “Switch”. In addition the Output Terminal must be set to “Solenoid Valve Test”.

7.2. Position Monitor Safety Function

Note
The position monitor (transmitter or switch) with the remote mount construction is not safety certified.

- ☐ Verify that the DVC6200 SIS with position monitor is suitable for use in this Safety Instrumented Function.
- ☐ Verify that nameplate markings are suitable for the hazardous location (if required).
- ☐ Verify appropriate connections to the logic solver are made by referring to the instruction and safety manual of the logic solver.

☐ Ensure that the Output toggle switch (shown in figure 1) is set to the Transmitter position or Switch position, depending on the application.

☐ Ensure that the device configuration parameter for the function of the output terminal matches the Output toggle switch setting.

☐ For maximum availability and benefit of digital valve controller features, the unit must be properly configured and calibrated, the Instrument Mode set to In Service, and the protection set to Config & Calib using the Instrument Setup > Change Protection menu. With protection set, calibration and other protected parameters cannot be changed, including the Instrument Mode. Figure 1 identifies toggle switches on the main electronics board that are configured as determined by the safety function and system application.

☐ The sensor safety function of the position monitor along with the overall SIS safety function must be tested after installation to ensure that it meets safety demand and applicable process safety time requirements.

7.3. LCP200 Trip and Reset Relay Output Safety Function

☐ Verify that the LCP200 trip and reset relay output is suitable for use in this Safety Instrumented Function.

☐ Verify that nameplate markings are suitable for the hazardous location (if required).

☐ Verify appropriate connections to the logic solver are made by referring to the instruction and safety manual of the logic solver.

☐ To achieve electromagnetic compatibility, the following installation practices shall be followed.

- Metal conduit shall be used to shield the AUX cable between the DVC6200 SIS and LCP200. Ensure that the metal conduit has good contact with the enclosure of both equipment.
- Both DVC6200 SIS and LCP200 enclosures shall be grounded locally.

☐ Ensure that the logic solver has the appropriate logic for the desired action on the relay output change state.

☐ The trip and reset relay output safety function of the LCP200 along with the safety function of the shutdown valve must be tested after installation to ensure that it meets safety demand and applicable process safety time requirements.

8. Operation, Periodic Inspection, Test, and Repair

Periodic testing, consisting of proof tests and partial stroke testing, is an effective way to reduce the PFD_{avg} of the DVC6200 SIS instrument, LCP200 as well as the valve and actuator it is connected to. Results of periodic inspections and tests should be recorded and reviewed periodically.

Note

Any time the SIF needs to be disabled, such as to perform a proof test or to take corrective action, appropriate measures must be taken to ensure the safety of the process.

Note

To ensure corrective action, continuous improvement, and accurate reliability prediction, the user must also work with their local Emerson Automation Solutions service representative to see that all failures are reported.

8.1. Test Steps for the DVC6200 SIS, Position Monitor, and LCP200

Proof tests are full-stroke tests that are manually initiated. As part of the test, the capability of the SIF to achieve the defined safe state must be verified. The proof test interval must be established for the SIF based on the failure rates of all the elements within the function and the risk reduction requirements. The proof test interval has to be at least 2 times more frequent than the demand rate. This determination is a critical part of the design of the SIS. For the DVC6200 SIS with pneumatic relay a proof test will detect 77% (ETT) to 79% (DETT) of dangerous undetected failures not detected by the DVC6200 SIS automatic diagnostics. For High Cv option a proof test will detect 80% (ETT) to 81% (DETT, Single Acting Direct) or 83% (DETT, Double Acting) of dangerous undetected failures not detected by the DVC6200 SIS automatic diagnostics. A proof test includes the following steps:

- ☐ Read the digital valve controller alert record using a HART communicating device such as a Device Communicator, ValveLink software or a DD or DTM based host. Any active alert messages must be investigated and resolved.
- ☐ Bypass the final control element or take appropriate action to avoid a false trip.
- ☐ If used, bypass the safety function of the position monitor or take appropriate action to avoid a false trip.
- ☐ If applying “with PVST” failure rates, verify that the Instrument Mode is In Service, End Point Pressure Control (EPPC) is enabled, and that the instrument Protection is set to Config & Calib.
- ☐ Trip the DVC6200 SIS to its safe state by either de-energization (for DETT) or energization (for ETT).
- ☐ Observe that the actuator and valve move to its safe state within the required safety time through an instrument independent means (visual or other).

☐ If used, observe that the position transmitter reports the actual valve position to within 5% accuracy throughout the range of travel as required by the application through an instrument-independent means (visual or other).

☐ If used, observe that the limit switch is open through an instrument-independent means (visual or other).

☐ Restore the DVC6200 SIS to its normal state by either energization (for DETT) or de-energization (for ETT).

☐ Observe that the actuator and valve return to its normal state through an instrument-independent means (visual or other).

☐ If applying “with PVST” failure rates, ensure that EPPC is operational by noting that output pressure from the instrument goes to the Pressure Set Point after the Pressure Saturation Time has elapsed (default 45 seconds).

☐ If used, observe that the position transmitter reports the actual valve position to within 5% accuracy throughout the range of travel as required by the application through an instrument-independent means (visual or other).

☐ If used, observe that the limit switch is closed through an instrument-independent means (visual or other).

☐ Check air filters to ensure they are clean and operating properly.

☐ Inspect the unit for any loose screws or other incorrect mechanical condition.

☐ Record the test results and any failures in your company’s SIF inspection database.

☐ Remove the bypass and restore normal operation.

Partial stroke tests are designed to provide Diagnostic Coverage for many of the failure modes of the final control element without affecting the process under control. To take credit for the “with PVST” failure rates, the user must ensure that partial stroke tests are performed at least 10 times more frequently than the expected demand rate. A partial stroke test can be configured to be initiated by the following means:

- Schedule a partial stroke test to occur automatically on a time schedule (requires configuration).
- Press the “test” button on the LCP100/LCP200.
- Short the “aux” terminals on the DVC6200 SIS for 3 to 10 seconds (requires configuration).
- Initiate a partial stroke test using the Device Communicator, ValveLink software or a DD or DTM based host.

Should alarms, alerts, or failures be detected during operation, maintenance or periodic inspection and test, record the alarms, alerts, or failures, and immediately take corrective action. To ensure corrective action, continuous improvement, and accurate reliability prediction, the user must also work with their local Emerson Automation Solutions service representative to see that all failures are reported. Table 11 shows the diagnostics that are used to calculate the detected failure rates.

Table 11. Assumed Diagnostics for Determining Failure Rates Labeled “with PVST”

HART Command 48(1)	Alert Name	Description	Digital Valve Controller Action
Byte 0, Bit 7	Flash Integrity Failure	The flash ROM is corrupted.	Alert(2)
Byte 0, Bit 6	Minor Loop Sensor Alert(3)	The pneumatic relay position reading is out of the valid range.	Alert(2)
Byte 0, Bit 5	Reference Voltage Failure	The electronics has detected a problem with the internal voltage reading.	Alert(2)
Byte 0, Bit 4	Drive Current Failure	The I/P converter should be flowing current, but is not.	Alert(2)
Byte 0, Bit 3	Critical NVM Failure	Data is corrupted in the critical section of configuration memory.	Alert(2)
Byte 0, Bit 2	Temperature Sensor Failure	The temperature sensor is reporting a temperature <-60C or >100C.	Alert(2)
Byte 0, Bit 1	Pressure Sensor Failure	One or more pressure sensors is outside the expected operating range.	Alert(2)
Byte 0, Bit 0	Travel Sensor Failure	The travel sensor signal is outside the expected operating range.	Alert(2)
Byte 1, Bit 2	SIS Program Flow Failure	The firmware is not performing the expected series of calculations.	Alert(2)
Byte 2, Bit 7	SIS Hardware Failure	A demand has occurred, but the electronics hardware failed to take control of the I/P drive.	Alert(2)
Byte 2, Bit 6	Non-Critical NVM Alert	Data is corrupted in the non-critical section of configuration memory.	Alert
Byte 3, Bit 6	Valve Stuck (Fw 4, 5, & 6) PST Abnormal (Fw 7)	A PVST has failed.	Alert
Byte 3, Bit 4	End Point Pressure Deviation Alert	The instrument is in pressure control and the pressure is not tracking the set point within the configured deviation allowance.	Alert
Byte 4, Bit 3	Travel Deviation Alert	The valve travel is not tracking the set point within the configured deviation allowance.	Alert
Byte 4, Bit 0	Drive Signal Alert	The controller servo output is out of the normal operating range.	Alert
Byte 5, Bit 2	Output Circuit Error	The output circuit is not responding.	Alert
Byte 5, Bit 3	LCP Communications Error	LCP Communication failed due to electronics failure, broken connection or loss of power at the LCP	Alert
Device Status, Bit 2	Analog Input Saturated	The loop current reading is out of the normal operating range.	Alert

1. HART host must be configured to read these alerts and annunciate them.
2. This alert can be independently enabled to force the DVC6200 SIS output to the safe state (shutdown on alert - enabled).
3. Minor Loop Sensor Alert is not relevant for the DVC6200 SIS High Cv option.

Within table 11, the diagnostics detection time for the failures that can affect the safety function of the DVC6200 SIS instrument is 15 seconds.

The diagnostics detection time for all failures including the PVST is determined by the PVST interval which is configured by the user.

8.2. Test Steps for the Position Monitor

Proof tests are full-stroke tests that are manually initiated. As part of the test, the capability of the SIF to achieve the defined safe state must be verified. If the Position Monitor is used, the Safety Function must be verified. The proof test interval must be established for the SIF based on the failure rates of all the elements within the function and the risk reduction requirements. This determination is a critical part of the design of the SIS. A proof test will detect 88% of dangerous undetected failures not detected by the DVC6200 SIS automatic diagnostics. A proof test includes the following steps:

- Proof Test for the Position Transmitter
  - ☐ Bypass the safety function of the position transmitter or take appropriate action to avoid a false trip.
  - ☐ Using the Device Communicator, ValveLink software or a DD or DTM based host, verify that the DVC6200 SIS instrument mode is “In Service” and that the instrument protection is set to “Config & Calib.”
  - ☐ Inspect the feedback elements for any loose screws or other incorrect mechanical condition.
  - ☐ Change the valve position away from it’s current state by more than 5% throughout the range of travel as required by the application.
  - ☐ Observe that the position transmitter reports the actual valve position to within 5% accuracy throughout the tested range of travel through an instrument-independent means (visual or other).
  - ☐ Restore the valve to its normal state.
  - ☐ Observe that the position transmitter reports the actual valve position to within 5% accuracy through an instrument-independent means (visual or other).
  - ☐ Record the test results and any failures in your company’s SIF inspection database.
  - ☐ Remove the bypass and restore normal operation.
- Proof Test for the Limit Switch
  - ☐ Bypass the safety function of the limit switch or take appropriate action to avoid a false trip.
  - ☐ Using the Device Communicator, ValveLink software or a DD or DTM based host, verify that the DVC6200 SIS instrument mode is “In Service” and that the instrument protection is set to “Config & Calib.”
  - ☐ Inspect the feedback elements for any loose screws or other incorrect mechanical condition.
  - ☐ Change the valve position such that the limit switch trip point is exceeded.

- ☐ Observe that the limit switch changed to the open state within 5% of the trip point through an instrument-independent means (visual or other).
- ☐ Restore the valve to its normal state.
- ☐ Observe that the limit switch changed to the closed state within 5% of the trip point through an instrument-independent means (visual or other).
- ☐ Record the test results and any failures in your company's SIF inspection database.
- ☐ Remove the bypass and restore normal operation.

- Test Steps for the SOV Test

  Solenoid valve test is designed to detect a solenoid valve state change by monitoring the actuator pressure change. The solenoid valve test can be initiated as an independent test or as a test to be run before a PVST.

  - ☐ Configure the instrument to run a SOV test before a PVST.
  - ☐ Initiate an independent SOV test using an Emerson handheld communicator or ValveLink software. If predetermined thresholds are violated the SOV test is marked as abnormal and a PVST abnormal is flagged, if configured. An abnormal SOV test needs to be reviewed and corrective action initiated.

8.3. Test Steps for the Trip and Reset Relay Output

Proof tests are manually initiated to verify the ability of the SIF to achieve the defined safe state. If the relay output safety function is used, then they must be periodically verified. The proof test interval must be established for the SIF based on the failure rates of all the elements within the function and the risk reduction requirements. This determination is a critical part of the design of the SIS. A proof test includes the following steps:

- Proof Test for the relay output

  - ☐ Verify that either the green, red or yellow light are illuminated. If none of the lights are illuminated, then confirm that the LCP200 is communicating to the DVC6200 SIS.
  - ☐ Bypass the safety function of the trip relay output state change and take appropriate action to avoid a LCP initiated trip by the DVC6200 SIS.
  - ☐ Push the trip button and verify that the trip relay output changed state.
  - ☐ Bypass the safety function of the reset relay output state change and take appropriate action to avoid a LCP initiated reset by the DVC6200 SIS.
  - ☐ Push the reset button and verify that the reset relay output changed state.
  - ☐ Visually inspect the LCP200 for any damage or contamination.

□ Record the test results and any failures in your company's SIF inspection database.

□ Remove the bypass and restore normal operation.

8.4. Maintenance

- The effective time to repair the DVC6200 SIS is approximately 2 hours. This comprises of disassembly, repair, reassembly, and recalibration. This value can be used to determine the total mean time to restore (MTTR).

- Digital valve controller preventive maintenance consists, at a minimum, of replacing all critical elastomeric seals and diaphragms in the device and a visual inspection of moving components to verify satisfactory condition. The SIS Preventive Maintenance Kit includes all elastomeric seals and diaphragms and is available through your local Emerson sales office. Following maintenance, the digital valve controller must be calibrated per the Auto Travel Calibration or Manual Travel Calibration menu. After calibration, the digital valve controller functional safety must be validated.

- A conservative approach is taken in estimating the service interval for the digital valve controller in Safety Instrumented Systems. For SIS applications, preventive maintenance must be performed on the digital valve controller at eight to ten year intervals from the date of shipment. If the instrument is exposed to the upper or lower extremes of the environmental limits, the interval for preventative maintenance may need to be reduced.

- The effective time to repair the LCP200 is 1 hour.

- Preventive maintenance of the LCP200 involves replacing the elastomer O ring seals using the soft parts kit. The LEDs can be replaced by ordering the LCP replacement kit. The pushbuttons can be replaced using a front panel kit. The electronics can be replaced at a Fisher authorized service center.

- When the LCP200 safety function is utilized, preventive maintenance must be performed when the digital valve controller is being taken out for preventive maintenance or 8 to 10 years from the date of shipment of the device. If the instrument is exposed to the upper or lower extremes of the environmental limits, the interval for preventative maintenance may need to be reduced.

9. Decommissioning Guidelines

When decommissioning a DVC6200 SIS instrument, proper procedures must be followed. Decommissioning includes the following steps:

- ☐ Bypass the final control element or take appropriate action to avoid a false trip.
- ☐ Bypass the safety function of the position monitor or take appropriate action to avoid a false trip.
- ☐ Bypass the safety function of the LCP200 and take appropriate action to avoid a false trip or triggering any interlocks in the logic solver.
- ☐ Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before proceeding with any decommissioning procedures:
  - Always wear protective clothing, gloves, and eyewear to prevent personal injury or property damage.
  - Do not remove the actuator from the valve while the valve is still pressurized.
  - Isolate and disconnect any operating supply lines providing air pressure, electric power, or a control signal to the DVC6200 SIS. Be sure the actuator cannot suddenly open or close the valve.
  - Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve.
  - Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.
  - Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
  - Check with your process or safety engineer for any additional measures that must be taken to protect against process media.
- ☐ Disconnect the electrical wiring to and from the DVC6200 SIS instrument and the LCP200, if used.
- ☐ Disconnect the pneumatic tubing between the DVC6200 SIS instrument and actuator.
- ☐ Remove the DVC6200 SIS instrument, the LCP200 and the respective mounting parts and feedback elements from the actuator.

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