



BULLETIN 510



Pneumatic Machine Safeguarding Solutions



**Complete Your System with
ROSS CONTROLS® Safety-Related Products**

Where Does Your Safety System End?

A Complete Safety System should always include all of the components (both electrical and mechanical) – not just the electrical

SAFETY INFORMATION AND TRAINING

Fluid Power Safety for Machine Guarding Book (order A10264)



- Over 50 pages of information providing an overview of topics related to the safe application of fluid power in industrial applications
- Topics include Control Integrity, Control Categories, LOTO, Alternative LOTO, Risk Assessment, Risk Assessment as Related to Fluid Power, Clutch/Brake Controls for Mechanical Stamping Presses, Understanding the Function of Counterbalance on Mechanical Stamping Presses, and FAQ's

Fluid Power Safety Risk Locator Program

(electronic format, downloadable from the Safety Industry page at www.rosscontrols.com)

- Simply answer questions about your machine and the interactive program provides guidance to areas of possible safety concerns for closer examination

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Cautions - Standard ROSS cautions and warnings apply, available upon request or at www.rosscontrols.com.



ROSS CONTROLS and concern for Machine Safety: the two go hand-in-hand

ROSS has been designing and supplying the “industry standards” of safety products for pneumatic energy isolation (LOTO) and control reliable double valves for the metal-forming industry for clutch/brake applications and the general manufacturing sector for decades. Originally pioneered by ROSS before Federal and State Occupational Safety and Health Administrations (OSHA) existed, ROSS designed and supplied valves for energy isolation and mechanical press clutch/brake control valves that were later widely recognized as aids to companies for regulatory compliance in non-press applications. In most of the safety critical pneumatic valve applications in manufacturing today, ROSS has been there to help make jobs safer for workers, protect investments in machinery, and increase productivity.

Total Machine Safety Training Program



TOTAL MACHINE SAFETY™ ROSS CONTROLS

INTRODUCTION

Total Machine Safety is the first fully-integrated electrical and fluid power machine safeguarding training program.

A comprehensive approach to evaluating and designing safety controls systems is critical in the overall success of a safety program. An understanding of global safety standard requirements for lockout and machine guarding is critical to implementing safety systems that both protect employees and promote greater productivity. When safety is addressed in the machine design process, you begin to realize that safety is just another aspect of good business practices.

WHAT'S IN IT FOR YOU?

You will learn to:

- Understand the existing global safety standard landscape and future direction
- Assess and minimize risk when evaluating machines for safety
- Examine work environments and recognize potential problems
- Grasp the basics of electrical and fluid power safety components
- Manage productivity and uptime by taking a holistic approach to machine safety

WHAT DOES THE PROGRAM COVER?

This eight hour course is anchored on a fictional case study that addresses current safety standards, hazard & risk assessment, integration of safety devices, lockout/tagout, and pneumatic & electrical components.

Total Machine Safety will cover topics such as Standards, Risk Assessment requirements, Lockout/Energy Isolation, Electrical and Fluid Power Safety Devices and applications, and overall machine safeguarding requirements and solutions. This class will not cover detailed component specifications, detailed component selection, or specific detailed circuit design. It will, however, provide a broad basis and understanding of what is required from a design standpoint, how to implement a machine guarding process, and how to select the components that will most effectively provide a solution while avoiding common pitfalls.

Accredited for 0.8 CEUs by M-TEC (Michigan Technical Education Center).



Electrical



Pneumatic



Lockout/Tagout

Go to www.totalmachinesafety.com
for more information on scheduled seminars.
For additional information please contact ROSS.

Safety Product Data for SISTEMA Library Users

ROSS CONTROLS has available a safety product data library designed for use with the innovative new Safety Integrity Software Tool for the Evaluation of Machine Applications (SISTEMA).

Developed by the Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA, formerly know as the BGIA), SISTEMA is available to download for no charge at the IFA web site. This software tool is expected to prove invaluable to system designers because of its potential time savings and safety implications.

Besides having data suitable for use in this world-class system development tool, ROSS CONTROLS is conveniently providing free library data for a selection of its safety products. ROSS expects to expand the data offerings in the future.

Currently, data library for the following products is available: DM2® Series C, D and E -Cat-4 double valves, 5/2 CrossMirror® Series -Cat-4 double valves, SV27 Series Cat-2 & -3 double valves.

The ROSS DM2® Series safety products meet all global requirements for machine safety and are commonly used for exhausting the downstream air to help meet stop-time requirements in machine guarding applications.

ROSS safety valve customers will find convenience and increased system design accuracy with this free software tool and data library. It can enhance their overall safety program and offers a simple way to help ensure compliance with the EN ISO 13849-1:2006 standard.

To download a copy of ROSS' safety product data for the SISTEMA library, visit the
[Safety Industry page \(SISTEMA Library with ROSS' Safety Products\)](http://www.rosscontrols.com) at www.rosscontrols.com.

Lockout / Tagout

Pneumatic Energy Isolation for LOTO

L-O-X® Valves (Lockout and Exhaust)



Modular L-O-X®



Manual L-O-X®
Sizes 1/4 and 3/8



Manual L-O-X®
Sizes 3/8 thru 1 1/4



Manual L-O-X®
Sizes 1 1/2 and 2



Manual L-O-X® Size 3

- Fluorocarbon slipper seals for easy shifting, even after long periods of inactivity
- Easily identified by yellow body with red handle
- Integrated sensing port for pressure verification - see page 24 for verification accessories
- Lockable only in the OFF position
- Has a full size exhaust port (equal to or larger than supply)
- Simple push/pull of the large red handle provides positive direct manual operation



Modular L-O-X® Valves

Model Number*	Port Size		C _v	
	1, 2	3	1 to 2	2 to 3
Modular L-O-X® Sizes 1/4, 3/8, 1/2 and 3/4				
Y1523A2003	1/4	1/4	3.7	7.8
Y1523A3003	3/8	3/8	5.1	8.3
Y1523A4003	1/2	1/2	5.5	8.6
Y1523A5013	3/4	3/4	5.5	8.6
Manual L-O-X® Sizes 1/4 and 3/8				
Y1523D2002	1/4	3/8	1.84	1.79
Y1523D3012	3/8	3/8	2.67	2.64
Manual L-O-X® Sizes 3/8, 1/2, 3/4, 1 and 1 1/4				
Y1523C3002	3/8	3/4	4.74	3.57
Y1523C4002	1/2	3/4	7.10	4.00
Y1523C5012	3/4	3/4	8.26	4.10
Y1523C5002	3/4	1 1/4	13.12	8.98
Y1523C6002	1	1 1/4	16.56	9.52
Y1523C7012	1 1/4	1 1/4	19.25	9.74
Manual L-O-X® Sizes 1 1/2 and 2				
Y1523C8002	1 1/2	2	35.53	50.98
Y1523C9012	2	2	40.38	52.23
Manual L-O-X® Size 3				
Y3900A0829#	3	2 1/2	140.00	140.00
Y3900A0896##	3	2 1/2	140.00	140.00

* NPT port threads. For BSPP threads, insert "D" after "Y" to the model number, e.g., YD1523B3002.

#Manual Pilot. ##Solenoid Pilot.



Pneumatic Energy Isolation for LOTO

Stainless Steel L-O-X® Valves



- Corrosion-resistant 316 Stainless Steel construction
- Reliable Fluorocarbon seals withstand contaminant ingress
- Easily identified by unique shape
- Self-draining, washdown suitable design
- Trusted L-O-X® performance, lockable only in the OFF position
- Large exhaust port for rapid release of pressure
- Standard pressure sensing port with optional pressure switch or visual indicator
- Simple push/pull of the large handle provides direct manual operation

Model Number*	Port Size		C _v	
	1, 2	3	1 to 2	2 to 3
1523B2004	1/4	1/4	2.14	2.08
1523B3004	3/8	1/2	5.79	6.24
1523B4004	1/2	1/2	5.79	6.24
1523B5004	3/4	1	14.30	17.00
1523B6004	1	1	14.30	17.00
1523B8004	1½	2	39.00	45.00
1523B9004	2	2	39.00	45.00

* NPT port threads. For BSPP threads, add a "D" prefix to the model number, e.g., D1523B2004.



Stainless Steel L-O-X® Air Entry Combination

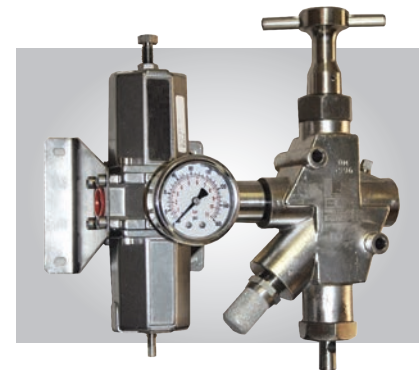
Lockout Valve with Integrated Filter/Regulator



- Block and bleed single action
- Corrosion-resistant 316 Stainless Steel construction
- Only lockable in the off position
- Has a full size exhaust port (equal to or larger than supply)
- Has a visible indicator of pressure release (verification port)
- Easy to operate (positive push/pull operation-detented)
- Filter and regulator consolidated into a single space-saving assembly
- Manual drain; automatic drain optional

Model Number*	Air Entry Type	Port Size		C _v		Dimensions (inches/mm)		
		1, 2	3	1 to 2	2 to 3	Length	Width	Depth
RCO10-13	FR	1/4	1/4	2.14	2.08	8.9 (226.1)	7.65 (194.4)	5.86 (149)
RCO11-13	FR	1/2	1/2	5.79	6.24	10.24 (260)	8.98 (228)	5.94 (151)
RCO12-13	FR	3/4	1	14.30	17	15.75 (400)	12.24 (311)	6.49 (165)
RCO13-13	FR	1	1	14.30	17	15.75 (400)	12.24 (311)	6.49 (165)

* NPT pressure port threads. For BSPP threads, consult ROSS.



Control Reliable Energy Isolation

- Stainless Steel Cabinet for:
- Wash-Down Applications • Caustic Environments



Will build to your specifications!

Manual energy isolation device (L-O-X®) located outside the cabinet is stainless steel and designed for wash-down applications, caustic environments. Stainless steel control cabinet includes filter/regulator and Category 4 DM²⁰ Series valve for air entry control. Control cabinet is built with slanted top to avoid pooling.



Modular L-O-X[®] Air Entry Combination

Lockout Valve with Integrated Filter/Regulator

- Filter and regulator consolidated into a single space-saving assembly
- Modular mounting for easy servicing
- Reverse flow, self-relieving piston-type regulator, or non-relieving
- Tamper-resistant pressure setting
- Has a visible indicator of pressure release (verification port)
- Only lockable in the off position
- Has a full size exhaust port (equal to or larger than supply)
- Easy to operate (positive push/pull operation-detented)
- Optional EEZ-ON[®] function available

HOW TO ORDER

MD3 53P B M C 2 A A 1

BOWL SIZE

- 53P - Plastic Bowl 5.1-oz (151-ml)
- 53M - Metal Bowl 6-oz (177-ml)

FILTER ELEMENT TYPE

- A - 40 µm bronze
- B - 5 µm polyethylene
- E - 5 µm bronze
- F - 20 µm bronze

BOWL DRAIN

- M - Manual Drain
- F - Float Drain
- E - Electronic Drain
- H - Automatic External Drain
- L - Less Drain Fitting (1/4 NPT female instead)

PIPE SIZE

- 2 - 1/4 NPTF
- 3 - 3/8 NPTF
- 4 - 1/2 NPTF
- B - 1/4 BSPP
- C - 3/8 BSPP
- D - 1/2 BSPP

ADJUSTMENT RANGE

- A - 0-200 psig (0-13.8 bar)
- B - 0-150 psig (0-10 bar)
- C - 0-100 psig (0-6.9 bar)
- D - 0-50 psig (0-3.4 bar)
- F - Reverse Flow 0-200 psig (0-13.8 bar)
- G - Reverse Flow 0-150 psig (0-10.3 bar)
- H - Reverse Flow 0-100 psig (0-6.9 bar)
- J - Reverse Flow 0-50 psig (0-3.4 bar)

ADD on Lockout - Optional

- 1 - L-O-X[®] on outlet side
- 2 - L-O-X[®] on the inlet side (must also choose Reverse Flow)
- 3 - L-O-X[®] with EEZ-ON[®] on outlet side
- 4 - L-O-X[®] with EEZ-ON[®] on inlet side (must also choose Reverse Flow)
- Blank - No L-O-X[®]

GAUGE

- A - No Gauge
- B - With Gauge 0-200 psig (0-13.8 bar)
- C - With Gauge 0-60 psig (0-4.1 bar)
- D - No Gauge, With Panel Mount Nut
- E - With Panel Mount Nut & Gauge 0-200 psig (0-13.8 bar)
- F - With Panel Mount Nut & Gauge 0-60 psig (0-4.1 bar)

Accessories not included with the product, consult ROSS.

Energy Isolation for Lockout/Tagout (LOTO)

L-O-X[®] Function (Lockout and Exhaust) with Combination Manual/Solenoid Operation



- Easily identified by red handle, lockable only in the OFF position
- Has a full size exhaust port (equal to or larger than supply)
- Simple push/pull of the large red handle accommodates reduced manual actuation forces and easy operation
- Integrated sensing port for pressure verification - see page 24 for verification accessories
- Solenoid-operated models for air dump function (Category 1). For Category 2 versions see page 12.



Combination Solenoid / Manual Model Number*	Port Size		C _v	
	1, 2	3	1 to 2	2 to 3
Y2773A2072**	1/4	1/2	2.5	3.1
Y2773A3072**	3/8	1/2	3.6	5.3
Y2773A4082**	1/2	1/2	3.3	5.3
Y2773A4072**	1/2	1	6.3	9.2
Y2773A5072**	3/4	1	7.7	11
Y2773A6082**	1	1	8.0	12
Y2773A6072**	1	1½	23	34
Y2773A7072**	1¼	1½	30	32
Y2773A8082**	1½	1½	30	31
Y2773A8072**	1½	2½	68	70
Y2773A9072**	2	2½	70	70
Y2773A9082**	2½	2½	70	71

* NPT port threads. For BSPP threads, insert letter "D" after "Y" in the model number, e.g. YD2773A2072.

** Specify voltage when ordering. Insert voltage code: "W" = 24 volts DC; "Z" = 110-120 volts AC, 50/60 Hz; e.g., Y2773A2072W, Y2773A2072Z.



Energy Isolation with Soft Start for LOTO

Combination L-O-X® Valve with EEZ-ON® Function

- Easily identified by blue handle
- Gradual re-application of pneumatic pressure prevents rapid equipment movement at startup
- Lockable only in the OFF position
- Has a full size exhaust port (equal to or larger than supply)
- Positive action (2 positions only)
- Simple push/pull of the large blue handle provides positive direct manual operation
- Integrated sensing port for pressure verification - see page 24 for verification accessories

Soft Start
Lockout / Tagout



Model Number*	Port Size		C _v	
	1, 2	3	1 to 2	2 to 3
Modular - Sizes 1/4, 3/8, 1/2 and 3/4				
Y1523A2103	1/4	1/4	3.7	7.8
Y1523A3103	3/8	3/8	5.1	8.3
Y1523A4103	1/2	1/2	5.5	8.6
Y1523A5113	3/4	3/4	3.6	8.1
Manual - Sizes 3/8 thru 1 1/4				
Y1523B3102	3/8	3/4	6.0	8.0
Y1523B4102	1/2	3/4	7.1	8.3
Y1523B5112	3/4	3/4	8.0	9.5
Y1523B5102	3/4	1 1/4	12.0	10.9
Y1523B6102	1	1 1/4	13.7	12.0
Y1523B7112	1 1/4	1 1/4	16.2	12.8

* NPT port threads. For BSPP threads, insert letter "D" after "Y" in the model number, e.g., YD1523A2103.

Combination L-O-X® Valve with EEZ-ON® Function with Manual or Manual /Solenoid Operation

- Easily identified by blue handle
- Gradual re-application of pneumatic pressure prevents rapid equipment movement at startup
- Lockable only in the OFF position
- Has a full size exhaust port (equal to or larger than supply)
- Simple push/pull of the large blue handle provides positive direct manual operation
- Integrated sensing port for pressure verification - see page 24 for verification accessories



Soft Start
Lockout / Tagout



Manual Model Number*	Combination Solenoid / Manual Model Number*	Port Size		C _v	
		1, 2	3	1 to 2	2 to 3
Y2783B2055	Y2773B2075**	1/4	1/2	2.5	3.1
Y2783B3055	Y2773B3075**	3/8	1/2	3.6	5.3
Y2783B4065	Y2773B4085**	1/2	1/2	3.3	5.3
Y2783B4055	Y2773B4075**	1/2	1	10.0	13.0
Y2783B5055	Y2773B4075**	3/4	1	12.0	15.0
Y2783B6065	Y2773B6085**	1	1	12.0	16.0
Y2783B6055	Y2773B6075**	1	1 1/2	23.0	34.0
Y2783B7055	Y2773B7075**	1 1/4	1 1/2	30.0	32.0
Y2783B8065	Y2773B8085**	1 1/2	1 1/2	30.0	31.0

* NPT port threads. For BSPP threads, insert letter "D" after "Y" in the model number, e.g., YD2773B2075.

** Specify voltage when ordering. Insert voltage code: "W" = 24 volts DC; "Z" = 110-120 volts AC, 50/60 Hz; e.g., Y2773B2075W, Y2773B2075Z.



Control Reliable Energy Isolation Double Valves



Air Dump / Release

- Rapid response time to minimize stopping time
- Status Indicator switch for valve condition (ready to run) feedback
- Highly contaminant tolerant poppet construction
- Sistema library data available, see page 3
- Wiring kits and accessories available, see page 25
- *Explosion proof solenoid pilot available, for more information consult ROSS*

Do not use in power press clutch/brake applications.



ISO 13849-1:2006
Category 4 PL e applications



DM¹ Series E Size 2 3/2 Double Valve with Dynamic Monitoring

- Self-contained dynamic monitoring system
- Line mounted

Model Number*	Port Size		C _v	
	1	2	1 to 2	2 to 3
DM1ENA20**31	1/4	1/2	1.34	2.43
DM1ENA21**31	3/8	1/2	1.92	2.43



DM² Series E Size 2 3/2 Double Valve with Dynamic Monitoring and Memory

- Dynamic memory of abnormal function retains lockout condition and this prevents unintentional reset with removal of air or electricity
- Self-contained dynamic monitoring system requires no additional valve monitoring controls
- Electrical reset valve
- Line mounted

Model Number*	Port Size		C _v	
	1	2	1 to 2	2 to 3
DM2ENA20**21	1/4	1/2	1.34	2.43
DM2ENA21**21	3/8	1/2	1.92	2.43



DM² Series C Sizes 4, 8, 12, 30 3/2 Double Valve with Dynamic Monitoring and Memory

- Dynamic memory of abnormal function retains lockout condition and this prevents unintentional reset with removal of air or electricity
- Self-contained dynamic monitoring system requires no additional valve monitoring controls
- Large exhaust capacity (2" port) if necessary
- Electrical reset valve
- Base mounted

Model Number*	Port Size		C _v	
	1	2	1 to 2	2 to 3
DM2CNA42**21	1/2	1/2	3	10
DM2CNA54**21	3/4	3/4	4.4	13
DM2CNA55**21	1	1	4.4	13
DM2CNA66**21	1	1	8.5	20
DM2CNA88**21	1½	2	22	64

* NPT port threads. For BSPP threads, replace "N" in the model number with a "D", e.g., DM1EDA20**31.

** Specify voltage when ordering. Insert voltage code: "A" = 24 volts DC, "B" = 110 volts AC, "C" = 220 volts AC, "D" = 12 volts DC, e.g., DM1ENA20A31, DM1ENA20B31.

M12 connectors available, consult ROSS.



Air Entry Package with Control Reliable Energy Isolation

- Pre-engineered panel-mounted design with air entry with: filter and regulator “FR”, or filter, regulator and lubricator “FRL”
 - Custom panel options available, consult ROSS
 - Wiring kits and accessories available, see page 25
 - *Explosion proof solenoid pilot available, for more information consult ROSS*
- Do not use in power press clutch/brake applications.**

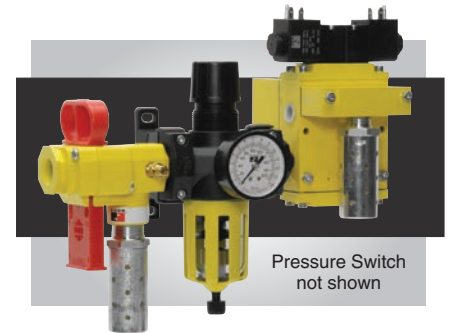


Electrical / Pneumatic Energy Isolation (LOTO)

Category 4 with Modular L-O-X® and DM¹ Series E

- Includes DM¹ Series E Double Valve with Monitoring

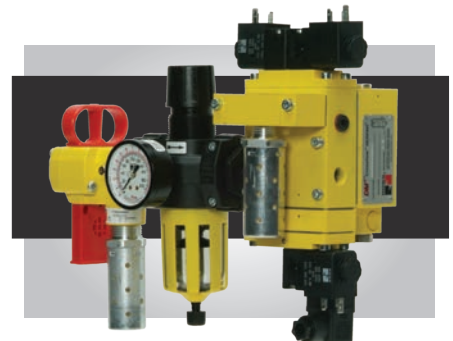
Model Number*	Air Entry Type	Port Size		C _v		Dimensions (inches/mm)		
		1	2	1 to 2	2 to 3	Length	Width	Depth
RC304-09**	FR	1/4	1/2	1.3	2.4	13.0 (330)	11.0 (279)	5.4 (135)
RC306-09**	FR	3/8	1/2	1.9	2.4	13.0 (330)	11.0 (279)	5.4 (135)
RC304L-09**	FRL	1/4	1/2	1.3	2.4	13.0 (330)	11.0 (279)	5.4 (135)
RC306L-09**	FRL	3/8	1/2	1.9	2.4	13.0 (330)	11.0 (279)	5.4 (135)



Category 4 with Modular L-O-X® and DM² Series E

- Includes DM² Series E Double Valve with Monitoring & Memory

Model Number*	Air Entry Type	Port Size		C _v		Dimensions (inches/mm)		
		1	2	1 to 2	2 to 3	Length	Width	Depth
RC404-09**	FR	1/4	1/2	1.3	2.4	13.0 (330)	11.7 (297)	5.4 (135)
RC406-09**	FR	3/8	1/2	1.9	2.4	13.0 (330)	11.7 (297)	5.4 (135)
RC404L-09**	FRL	1/4	1/2	1.3	2.4	13.0 (330)	11.7 (297)	5.4 (135)
RC406L-09**	FRL	3/8	1/2	1.9	2.4	13.0 (330)	11.7 (297)	5.4 (135)



Category 4 with Manual L-O-X® and DM² Series C

- Includes DM² Series C Double Valve with Monitoring & Memory

Model Number*	Air Entry Type	Port Size		C _v		Dimensions (inches/mm)		
		1	2	1 to 2	2 to 3	Length	Width	Depth
RC408-06**	FR	1/2	1/2	3	10	24.0 (610)	14.5 (369)	7.4 (187)
RC412-06**	FR	3/4	3/4	4.4	13	24.0 (610)	15.7 (399)	8.3 (211)
RC416-06**	FR	1	1	4.4	13	27.0 (686)	19.0 (483)	9.0 (229)
RC408L-06**	FRL	1/2	1/2	3	10	24.0 (610)	14.5 (369)	7.4 (187)
RC412L-06**	FRL	3/4	3/4	4.4	13	24.0 (610)	15.7 (399)	8.3 (211)
RC416L-06**	FRL	1	1	4.4	13	31.0 (788)	19.0 (483)	9.0 (229)



* NPT port threads.

** Specify voltage when ordering. Insert voltage code: “W” = 24 volts DC; “Z” = 110-120 volts AC, 50/60 Hz; e.g., RC404-09W, RC404-09Z. M12 connectors available, consult ROSS.

Control Reliable Energy Isolation Double Valves with Integrated Soft Start



Air Dump / Release



Category 4 Performance Level e
(certification pending)

U.S. Patent No. 6840258, 6840259
And Worldwide Patents Pending

- Rapid response time to minimize stopping time
 - Status Indicator switch for valve condition (ready to run) feedback
 - Highly contaminant tolerant poppet construction
 - Sistema library data pending
 - Wiring kits and accessories available, consult ROSS.
- Do not use in power press clutch/brake applications.**

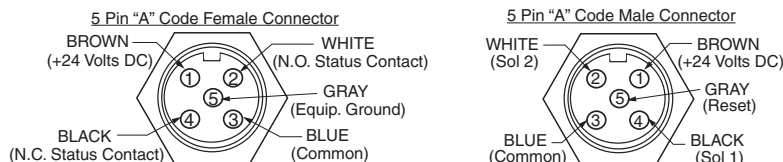
M DM²® Series C Sizes 8 3/2 Double Valve with Dynamic Monitoring and Memory

- Dynamic memory of abnormal function retains lockout condition and this prevents unintentional reset with removal of air or electricity
- Self-contained dynamic monitoring system requires no additional valve monitoring controls
- Electrical reset valve
- Base mounted

Model Number*	Transducer	Port Size		C _v	
		1	2	1 to 2	2 to 3
MDM2CNA55A21	With	3/4	3/4	3.7	8.5
MDM2CNA55A23	Without	3/4	3/4	3.7	8.5

* NPT port threads. For BSP threads, replace "N" in the model number with a "D", e.g., MDM2CDA55A21.

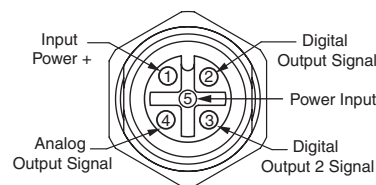
Valve Wiring



Digital Pressure Transducer

Model Number 1232H30

- Precision digital pressure transducer with 5 pin female connection
- Two PNP digital outputs which may be set individually, 4-20 mA analog output
 - Three operation modes: Easy, Window and Hysteresis
 - Selectable response times to eliminate output chattering
 - Powered by 12-24 volts DC
 - 6 pressure unit conversions
 - Lockable keypad
 - Fast zero reset



Wiring Kits

Kit Number 2431H77 M DM2C Wiring Kit - 5 meters (16.4 feet).
Includes two cords, and the cord grips.

Kit Number 2432H77 M DM2C Wiring Kit with Transducer - 5 meters (16.4 feet).
Includes three cords, and the cord grips.



Air Entry Package with Control Reliable Energy Isolation

Category 4 with Manual L-O-X® and M DM2® Series C Double Valve with Integrated Soft Start



Electrical / Pneumatic Energy Isolation (LOTO)

- Pre-engineered panel-mounted design with air entry with: filter and regulator “FR”, or filter, regulator and lubricator “FRL”
- Custom panel options available, consult ROSS
- Includes M DM2® Series C Double Valve with Monitoring & Memory:
 - a) Self-contained dynamic monitoring system requires no further valve monitoring controls,
 - b) Dynamic memory of abnormal function prevents unintentional reset with removal of air or electricity
- All necessary features for safety applications are included:
 - a) Electrical reset valve,
 - b) Status indicator switch for valve condition (ready to run) feedback

Do not use in power press clutch/brake applications.



HOW TO ORDER

(Choose your options (in red) to configure your valve assembly model number.)

	M	5	1	1	X	A	X	1	2	1	1	
PRODUCT												CABLE OPTIONS
PORT SIZE												1.....YES
1/2" NPT												X.....NO
3/4" NPT												
1/2" BSPP												DOWNSTREAM PS
3/4" BSPP												(includes 1/4" Extra Port)
												X.....None
												1.....586A86
LOCKOUT VALVE TYPE												EXTRA PORTS
Modular L-O-X®												(Downstream of M DM2®)
L-O-X®												X.....None
No L-O-X®												1.....1/4"
												2.....3/8"
												3.....1/2"
												4.....1/2"
FILTER-REGULATOR (0-125 psi with 0-200 gauge)												M DM2® VALVE
5 Micron, Manual Drain, Metal Bowl												1.....Without Transducer
5 Micron, Auto Drain, Metal Bowl												3.....With Transducer
None												
LUBRICATOR												EXTRA PORTS (Prior to MDM2® Exhaust Valve)
None												X.....None
Standard Fill												2.....1/4"
												3.....3/8"
												4.....1/2"
REVISION LEVEL												

Custom panel options available, consult ROSS.

3/2 Normally Closed Sensing Valve

Pressure Controlled or Solenoid Pilot Controlled



Air Dump / Release



- Senses internal position & state
- Electrical feedback via DPST switch (Double-Pole Single-Throw)
- Directly operated safety-rated force-guided positive-break status switch (DPST)
- Poppet construction for near zero leakage & dirt tolerance
- A diagnostic coverage (DC) of 90% can be obtained by monitoring the safety switch status
- Sistema library data available (see page 3)
- Wiring kits and accessories available, see page 25
- *Explosion proof solenoid pilot available, for more information consult ROSS*

Solenoid Pilot Controlled Model Number*	Pressure Controlled Model Number*	Port Size		C _v	
		1, 2	3	1 to 2	2 to 3
SV27NC305407PSAA**	SV27NC305405ASAA	1/2	1	6.3	9.2
SV27NC305507PSAA**	SV27NC305505ASAA	3/4	1	7.7	11
SV27NC305607PSAA**	SV27NC305605ASAA	1	1	8.0	12
SV27NC307607PSAA**	SV27NC307605ASAA	1	1½	23	34
SV27NC307707PSAA**	SV27NC307705ASAA	1¼	1½	30	32
SV27NC307807PSAA**	SV27NC307805ASAA	1½	1½	30	32
SV27NC309807PSAA**	SV27NC309805ASAA	1½	2½	68	70
SV27NC309907PSAA**	SV27NC309905ASAA	2	2½	70	70
SV27NC309957PSAA**	SV27NC309955ASAA	2½	2½	70	71

* NPT port threads. For BSPP threads, replace "N" in the model number with a "D", e.g., SV27DC305407PSAA1A.

** Specify voltage when ordering. Insert voltage code: "1A"=120 volts 60 Hz solenoids. "2A"=240 volts 60 Hz, "3A"=24 volts 60 Hz, "1D"=24 volts DC, e.g., SV27NC305407PSAA1A.



3/2 Normally Closed Sensing Valve with L-O-X®

Pressure Controlled or Solenoid Pilot Controlled

Air Dump / Release



- Senses internal position & state
- Electrical feedback via DPST switch (Double-Pole Single-Throw)
- Directly operated safety-rated force-guided positive-break status switch (DPST)
- Poppet construction for near zero leakage & dirt tolerance
- A diagnostic coverage (DC) of 99% can be obtained by monitoring the safety switch status
- Sistema library data available (see page 3)
- Wiring kits and accessories available, see page 25
- *Explosion proof solenoid pilot available, for more information consult ROSS*

Solenoid Pilot Controlled Model Number*	Pressure Controlled Model Number*	Port Size		C _v	
		1, 2	3	1 to 2	2 to 3
SV27NC3L5407PSAA**	SV27NC3L5405ASAA	1/2	1	6.3	9.2
SV27NC3L5507PSAA**	SV27NC3L5505ASAA	3/4	1	7.7	11
SV27NC3L5607PSAA**	SV27NC3L5605ASAA	1	1	8.0	12
SV27NC3L7607PSAA**	SV27NC3L7605ASAA	1	1½	23	34
SV27NC3L7707PSAA**	SV27NC3L7705ASAA	1¼	1½	30	32
SV27NC3L7807PSAA**	SV27NC3L7805ASAA	1½	1½	30	32

* NPT port threads. For BSPP threads, replace "N" in the model number with a "D", e.g., SV27NC3L5407PSAA1A.

** Specify voltage when ordering. Insert voltage code: "1A"=120 volts 60 Hz solenoids. "2A"=240 volts 60 Hz, "3A"=24 volts 60 Hz, "1D"=24 volts DC, e.g., SV27NC3L5407PSAA1A.



Air Entry Package with 3/2 Normally Closed Sensing Valve

Category 2 with Manual L-O-X[®] and SV27 Sensing Valve



Electrical /
Pneumatic Energy
Isolation (LOTO)



- Pre-engineered panel-mounted design with air entry with filter and regulator “FR”, or filter, regulator, and lubricator “FRL”
- Includes 3/2 Normally Closed Sensing Valve
- Wiring kits and accessories available, see page 25
- Custom panel options available, consult ROSS

Model Number*	Air Entry Type	Port Size		C _v		Dimensions (inches/mm)		
		1, 2	3	1 to 2	2 to 3	Length	Width	Depth
RC208-06**	FR	1/2	1/2	6.3	9.2	23.0 (585)	12.8 (326)	6.7 (171)
RC212-06**	FR	3/4	3/4	7.7	11	23.0 (585)	12.8 (326)	6.7 (171)
RC216-06**	FR	1	1	8.0	12	28.0 (712)	17.0 (432)	9.5 (242)
RC208L-06**	FRL	1/2	1/2	6.3	9.2	23.0 (585)	12.8 (326)	6.7 (171)
RC212L-06**	FRL	3/4	3/4	7.7	11	23.0 (585)	12.8 (326)	6.7 (171)
RC216L-06**	FRL	1	1	8.0	12	31.8 (808)	17.0 (432)	9.5 (242)

Category 2 with Modular L-O-X[®] and SV27 Sensing Valve



Electrical /
Pneumatic Energy
Isolation (LOTO)



- Pre-engineered panel-mounted design with air entry with filter and regulator “FR”, or filter, regulator, and lubricator “FRL”
- Includes 3/2 Normally Closed Sensing Valve
- Wiring kits and accessories available, see page 25
- Custom panel options available, consult ROSS

Model Number*	Air Entry Type	Port Size		C _v		Dimensions (inches/mm)		
		1, 2	3	1 to 2	2 to 3	Length	Width	Depth
RC208-09**	FR	1/2	1/2	6.3	9.2	14.80 (374.9)	12.45 (316.2)	6.60 (167.7)
RC208L-09**	FRL	1/2	1/2	6.3	9.2	14.80 (374.9)	12.45 (316.2)	6.60 (167.7)

* NPT port threads.

** Specify voltage when ordering. Insert voltage code: “W” = 24 volts DC; “Z” = 110-120 volts AC, 50/60 Hz; e.g., RC208-06W, RC208-06Z.
M12 connectors available, consult ROSS.

5/2 Pressure Return Double Valves - CROSSMIRROR® Series

Solenoid Pilot Controlled

- Self-contained dynamic monitoring system requires no additional valve monitoring controls
- Valve fault results in a lockout condition and prevents unintentional reset with removal of air or electricity
- Reset can be remote pneumatic signal or electrical solenoid
- Status indication switch (ready-to-run) to inform machine controller of valve condition
- Base mounted, stainless steel spool valve construction
- Manifordable for multi valve applications
- Sistema library data pending

Do not use in power press clutch/brake applications.

Meets Standards EN13736 and B11.2, Safety requirements for Pneumatic Cylinder Presses and other hazardous pneumatic cylinder applications.



Cylinder Return to Home Position



Category 4 Performance Level e (certification pending)

Valve and Base Assembly with Remote Reset

Model Number*	Port Size				C _v				Pressure Switch	Replacements*	
	1	2, 3, 4, 5	1-2	1-4	2-3	4-5	Valve No.	Base No.			
CM26PNA00**1X	1/4	1/4	0.8	0.5	0.5	1.1	Without	CM26PNA00**1X	Y1950D91		
CM26PNA00**11	1/4	1/4	0.8	0.6	0.5	1.1	With	CM26PXA0X**11	Y1950D91		
CM26PNA01**1X	3/8	3/8	0.8	0.6	0.5	1.1	Without	CM26PXA0X**11	Y1948D91		
CM26PNA01**11	3/8	3/8	0.8	0.6	0.5	1.1	With	CM26PXA0X**11	Y1948D91		

* Model number includes base supplied with NPT threads. For BSPP threads, replace "N" with a "D" in the model number, e.g., CM26PDA00A1X.

** Specify voltage when ordering. Insert voltage code: "A" = 24 volts DC; "B" = 110 volts AC, 50/60 Hz; e.g., CM26PNA00A1X, CM26PNA00B1X.



Cylinder Return to Home Position



Category 4 Performance Level e (certification pending)

Valve and Base Assembly with Solenoid Reset

Model Number*	Port Size				C _v				Pressure Switch	Replacements*	
	1	2, 3, 4, 5	1-2	1-4	2-3	4-5	Valve No.	Base No.			
CM26PNA00**2X	1/4	1/4	0.8	0.6	0.5	1.1	Without	CM26PXA0X**2X	Y1950D91		
CM26PNA00**21	1/4	1/4	0.8	0.6	0.5	1.1	With	CM26PXA0X**21	Y1950D91		
CM26PNA01**2X	3/8	3/8	0.8	0.6	0.5	1.1	Without	CM26PXA0X**2X	Y1948D91		
CM26PNA01**21	3/8	3/8	0.8	0.6	0.5	1.1	With	CM26PXA0X**21	Y1948D91		

* Model number includes base supplied with NPT threads. For BSPP threads, replace "N" with a "D" in the model number, e.g., CM26PDA00A1X.

** Specify voltage when ordering. Insert voltage code: "A" = 24 volts DC; "B" = 110 volts AC, 50/60 Hz; e.g., CM26PNA00A2X, CM26PNA00B2X.

APPLICATIONS:

- Two hand control EN574 Type III C
- Shearing equipment
- Pinch point applications
- Forming applications
- Cutting applications
- Clamping applications



Control Reliable 5/2 Double Valve - CROSSMIRROR® Series 77

Solenoid Pilot Controlled



- Self-contained dynamic monitoring system requires no additional valve monitoring controls
- Status indication switch (ready-to-run) to inform machine controller of valve condition; MUST be integrated into machine controls in order to prevent run signal until fault is cleared in valve
- Applications include small size pneumatic cylinder-operated presses, valve operators, and safety latches
- Base mounted, stainless steel spool valve construction
- Sistema library data available, see page 3
- *Explosion proof solenoid pilot available, for more information consult ROSS*

Cylinder Return to Home Position



Do not use in power press clutch/brake applications.

Meets Standards EN13736 and B11.2, Safety requirements for Pneumatic Cylinder Presses and other hazardous pneumatic cylinder applications.

Size 2

Model Number*	Port Size				C _v				Pressure Switch	Replacements*	
	1	2, 3, 4, 5	1-2	1-4	2-3	4-5	Valve No.	Base No.			
Y7776A3410**	1/2	3/8	2.0	1.6	1.6	2.8	Without	Y7776A3400**	Y996C91		
Y7776A3411**	1/2	3/8	2.0	1.6	1.6	2.8	With	Y7776A3401**	Y996C91		

Size 4

Y7776A4420**	3/4	1/2	3.2	3.4	2.7	7.2	Without	Y7776A4400**	Y1049C91
Y7776A4421**	3/4	1/2	3.2	3.4	2.7	7.2	With	Y7776A4401**	Y1049C91
Y7776A5410**	3/4	3/4	3.2	3.4	2.7	7.2	Without	Y7776A4400**	Y1153C91
Y7776A5411**	3/4	3/4	3.2	3.4	2.7	7.2	With	Y7776A4401**	Y1153C91

* Model number includes base supplied with NPT threads. For BSPP threads, order model or base with a "D" prefix, e.g., YD7776A3410, D996C91.

** Specify voltage when ordering. Insert voltage code: "W"=24 volts DC; "Z"=110-120 volts AC, 50/60 Hz; e.g., Y7776A3410W, Y7776A3410Z.



ISO 13849-1:2006 Category 4 PL e applications

Two-Hand Pressure Controlled



- Requires two inputs within 500 ms
- Self-contained dynamic monitoring system requires no additional valve monitoring controls
- Senses asynchronous inputs via status indicator switch
- Status indication switch available to be integrated with electrical safety control system where available
- Applications include small size pneumatic cylinder-operated presses, valve operators, and safety latches
- Base mounted, stainless steel spool valve construction
- Sistema library data available, see page 3

Cylinder Return to Home Position



Do not use in power press clutch/brake applications.

Size 2

Model Number*	Port Size				C _v				Pressure Switch	Replacements*	
	1	2, 3, 4, 5	1-2	1-4	2-3	4-5	Valve No.	Base No.			
Y7786A3410	1/2	3/8	2.0	1.6	1.6	2.8	Without	Y7786A3400	Y996C91		
Y7786A3411**	1/2	3/8	2.0	1.6	1.6	2.8	With	Y7786A3401**	Y996C91		

Size 4

Y7786A4420	3/4	1/2	3.2	3.4	2.7	7.2	Without	Y7786A4400	Y1049C91
Y7786A4421**	3/4	1/2	3.2	3.4	2.7	7.2	With	Y7786A4401**	Y1049C91
Y7786A5410	3/4	3/4	3.2	3.4	2.7	7.2	Without	Y7786A4400	Y1153C91
Y7786A5411**	3/4	3/4	3.2	3.4	2.7	7.2	With	Y7786A4401**	Y1153C91

* Model number includes base supplied with NPT threads. For BSPP threads, order model or base with a "D" prefix, e.g., YD786A3410, YD996C91.

** Specify voltage when ordering. Insert voltage code: "W"=24 volts DC; "Z"=110-120 volts AC, 50/60 Hz; e.g., Y7786A3411W, Y7786A3411Z.



ISO 13849-1:2006 Category 4 PL e applications

2/2 PO Check with Sensing

Pressure Controlled or Solenoid Pilot Controlled



- Poppet construction for near zero leakage & dirt tolerance
- Directly operated safety-rated force-guided positive-break status switch (DPST)
- Holds a vertical load in the event of loss of air pressure (and loss of electrical power with solenoid operated models)
- A diagnostic coverage (DC) of 90% **can** be obtained by monitoring the safety switch status
- Sistema library data available, see page 3
- Wiring kits and accessories available, see page 25
- *Explosion proof solenoid pilot available, for more information consult ROSS*

Load Holding



Solenoid Pilot Controlled Model Number*	Pressure Controlled Model Number*	Port Size 1, 2	C _v 1 to 2
SV27NC115408CSAA**	SV27NC115405ASAA	1/2	4.5
SV27NC115508CSAA**	SV27NC115505ASAA	3/4	8.3
SV27NC115608CSAA**	SV27NC115605ASAA	1	10.3
SV27NC117608CSAA**	SV27NC117605ASAA	1	20.2
SV27NC117708CSAA**	SV27NC117705ASAA	1¼	29.1
SV27NC117808CSAA**	SV27NC117805ASAA	1½	31.4

* NPT port threads. For BSPP threads, replace “N” in the model number with a “D”, e.g., SV27DC115408CSAA1A.

** Specify voltage when ordering. Insert voltage code: “1A” = 120 volts 60 Hz, “1D” = 24 volts DC; e.g., SV27NC115408CSAA1A.

Redundant 2/2 PO Check with Sensing

Pressure Controlled or Solenoid Pilot Controlled



- Poppet construction for near zero leakage & dirt tolerance
- Directly operated safety-rated force-guided positive-break status switch (DPST)
- Holds a vertical load in the event of loss of air pressure (and electrical power with solenoid operated models)
- A diagnostic coverage (DC) of 90% **can** be obtained by monitoring the safety switch status
- Sistema library data available, see page 3
- Wiring kits and accessories available, see page 25
- *Explosion proof solenoid pilot available, for more information consult ROSS*

Load Holding



Solenoid Pilot Controlled Model Number*	Pressure Controlled Model Number*	Port Size 1, 2	C _v 1 to 2
SV27NC555408CSAA**	SV27NC555405ASAA	1/2	4.5
SV27NC555508CSAA**	SV27NC555505ASAA	3/4	8.3
SV27NC555608CSAA**	SV27NC555605ASAA	1	10.3
SV27NC557608CSAA**	SV27NC557605ASAA	1	12.1
SV27NC557708CSAA**	SV27NC557705ASAA	1¼	18.7
SV27NC557808CSAA**	SV27NC557805ASAA	1½	22.3

* NPT port threads. For BSPP threads, replace “N” in the model number with a “D”, e.g., SV27DC555408CSAA**.

** Specify voltage when ordering. Insert voltage code: “1A” = 120 volts 60 Hz, “1D” = 24 volts DC; e.g., SV27NC555408CSAA1A.



Right-Angle PO Check Valves

Models with Threaded Banjo and Push-to-Connect Fitting

- Right angle design for easy positioning of pipe or tubing
- Threaded outlet ports available with NPT or G threads
- Inlet ports available with NPTF threaded or push-to-connect fittings
- Quick and easy installation
- Galvanized zinc plated brass body construction
- Lube or non-lube operation

Cylinder Position Holding

Models with Threaded Banjo

Port 12	Port Size		Valve Model Number	Avg. C _v		Tightening Torque Max. Ft-lb (Nm)
	Port 1 (female threads)	Port 2 (male threads)		1 to 2	2 to 1	
10-32 UNF	1/8	1/8	1958A1010	0.4	0.4	22.13 (30)
10-32 UNF	1/4	1/4	1958A2010	0.8	0.7	14.75 (20)
10-32 UNF	3/8	3/8	1958A3010	1.2	1.3	22.13 (30)
10-32 UNF	1/2	1/2	1958A4010	2.3	2.2	29.50 (40)
M5	G1/8	G1/4	D1958A1010	0.4	0.4	7.38 (10)
M5	G1/4	G1/4	D1958A2010	0.8	0.7	8.85 (12)
M5	G3/8	G3/8	D1958A3010	1.2	1.3	14.75 (20)
M5	G1/2	G1/2	D1958A4010	2.3	2.2	22.13 (30)



Optional Manual Override

Manual Trapped Pressure Relief Adapter

Model Number	Port 1	Port 2
1998A1015	5/32	10-32 Manual Operated Check
D1998A1010	M5	M5 Manual Operated Check

Adapter threads into the signal port.

Models with Push-to-Connect Fitting

Port 12	Port Size		Valve Model Number	Avg. C _v		Tightening Torque Max. Ft-lb (Nm)
	Port 1# (tube size)	Port 2** (thread size)		1 to 2	2 to 1	
10-32 UNF	5/32"	1/8	1958A1115	0.4	0.4	11.06 (15)
10-32 UNF	1/4"	1/8	1958A1120	0.4	0.4	11.06 (15)
10-32 UNF	1/4"	1/4	1958A2120	0.8	0.7	14.75 (20)
10-32 UNF	3/8"	1/4	1958A2130	0.8	0.7	14.75 (20)
10-32 UNF	3/8"	3/8	1958A3130	1.2	1.3	22.13 (30)
M5	4 mm	G1/8	D1958A1140	0.4	0.4	7.38 (10)
M5	6 mm	G1/8	D1958A1160	0.4	0.4	7.38 (10)
M5	8 mm	G1/8	D1958A1180	0.4	0.4	7.38 (10)
M5	6 mm	G1/4	D1958A2160	0.8	0.7	8.85 (12)
M5	8 mm	G1/4	D1958A2180	0.8	0.7	8.85 (12)
M5	10 mm	G1/4	D1958A2110	0.8	0.7	8.85 (12)
M5	8 mm	G3/8	D1958A3180	1.2	1.3	14.75 (20)
M5	10 mm	G3/8	D1958A3110	1.2	1.3	14.75 (20)

Port 1 tubing size in inches (") or millimeters (mm). ** Port 2 threads are male.

Optional Manual Override

Manual Trapped Pressure Relief Adapter

Model Number	Port 1	Port 2
1998A1015	5/32	10-32 Manual Operated Check
D1998A1010	M5	M5 Manual Operated Check

Adapter threads into the signal port.



Valve Illustrated with Manual Trapped Pressure Relief Adapter (Optional)

- Load Holding
- Cylinder Position Holding



PO Check Valves

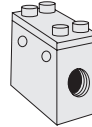
For Cylinder Position Holding And Load Holding with Trapped Pressure Release

- Available with automatic or manual trapped pressure release when pressure is removed from the Blowdown Signal Port (BP)
- Poppet construction for near zero leakage
- Applications include Air Holding and Cylinder Load Holding

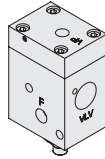
Load Holding



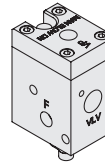
Type A Single PO Check Valve



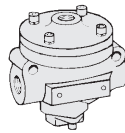
Type A Single PO Check Valve (Remote Trapped Pressure Relief)



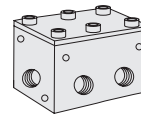
Type A Single PO Check Valve (Manual Trapped Pressure Relief)



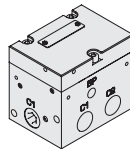
Type B Single PO Check Valve



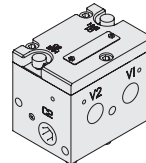
Type C Dual PO Check Valve



Type D Internal Pilot Dual PO Check Valve (Remote Trapped Pressure Relief)



Type D Internal Pilot Dual PO Check Valve (Manual Trapped Pressure Relief)



Cylinder Position Holding



Type E Solenoid Pilot Dual PO Check Valve

Pressure Controlled

Valve Type*	Port Size 1, 2	Model Number	Avg. C _v
A Single	1/4	2751A2908	2.2
	3/8	2751A3908	2.9
	1/2	2751A4915	3.2
A Remote	3/8	2751B3922	2.6
	1/2	2751B4922	2.8
	3/4	2751B5917	9.2
A Manual	3/8	2751A3920	2.6
	1/2	2751A4920	2.8
	3/4	2751A5919	9.2
B Single	1/4	2751A2903	2.3
	3/8	2751A3901	3.8
	1/2	2751A4902	4.0
	1/2	2751A4905	7.7
	3/4	2751A5903	9.0
	1	2751A6901	9.0
	1	2751B6490	24
	1 1/4	2751B7901	29
	1 1/2	2751B8920	29
	C Dual	3/8	2768C3900
1/2		2768C4900	3.2
3/4		2798C5900	8.5**
D Remote	1	2798A6900	8.5**
	3/8	2768D3901	2.9
	1/2	2768D4901	3.2
D Manual	3/4	2768C5901	8.5**
	1	2768A6901	8.5**
	3/8	2768D3904	2.9
D Manual	1/2	2768D4904	3.2
	3/4	2768D5904	8.5**
	1	2768A6904	8.5**

* NPT port threads. For BSPP threads, add a "D" prefix to the model number, e.g., D2751A2908.

**Effective C_v varies with load and pressure drop. Consult ROSS for specifics on your system.

Solenoid Pilot Controlled

Valve Type*	Port Size 1, 2	DIN Connector Model Number	3-Pin Mini Connector Model Number	3-Pin Mini Connector Model Number	24 volts DC 4-Pin Micro Connector Model Number	Avg. C _v
E	3/8	2778D3900	2778D3901	2778D3902	2778D3904	2.9
	1/2	2778D4900	2778D4901	2778D4902	2778D4904	3.2
	3/4	2778D5900	2778D5901	2778D5902	2778D5904	8.5**
	1	2778B6900	2778B6901	2778B6902	2778B6904	8.5**

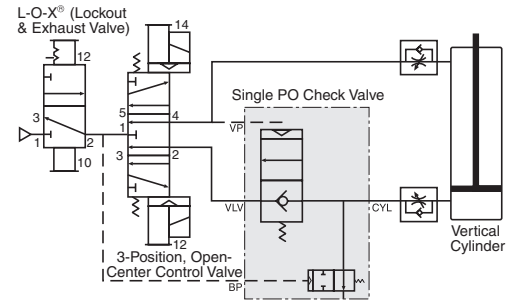
* NPT port threads. For BSPP threads, add a "D" prefix to the model number, e.g., D2778D3900.

**Effective C_v varies with load and pressure drop. Consult ROSS for specifics on your system.

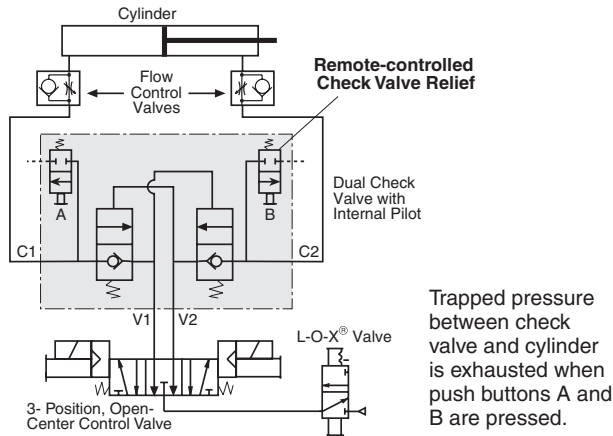
CIRCUIT FEATURES:

- Trapped pressure between check valve and cylinder is exhausted when the air supply at the Blowdown Signal Port (BP) is lost or locked-out
- Cylinder moves as long as the control valve solenoid is energized; use for continuous motion or jogging
- Cylinder remains stationary if neither control valve solenoid is energized, or if electrical signal is lost

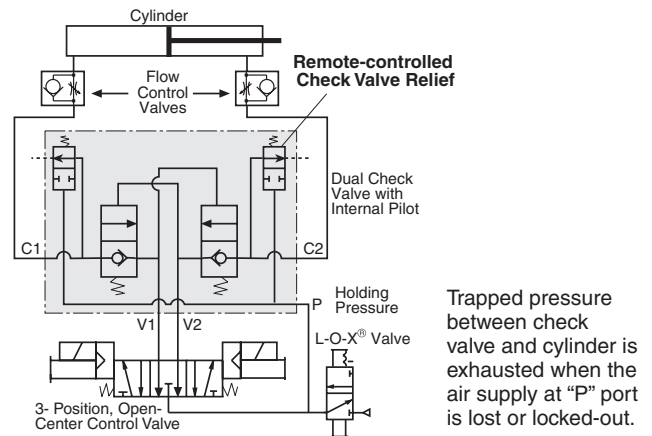
Single Pilot Operated Check Valve with Trapped Pressure Relief Application



Dual Pilot Operated Check Valve Manual Trapped Pressure Relief Application



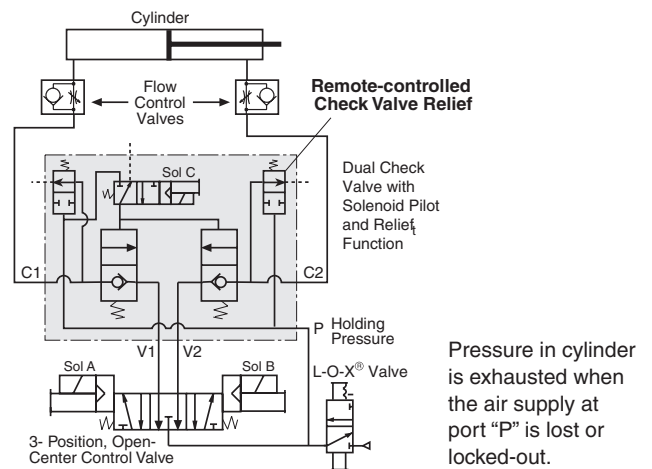
Dual Pilot Operated Check Valve Remote Trapped Pressure Relief Application



CIRCUIT FEATURES:

- To operate cylinder, simultaneously energize solenoids A and C or B and C
- Pilot supply and exhaust are independent of control valve
- Response time is not affected by exhaust restrictions of the control valve
- Cylinder remains stationary if neither control valve solenoid is energized, or if electrical signal is lost
- Pressure in cylinder is exhausted when the air supply at "P" port is lost or locked-out
- L-O-X® valve provides lockable shut-off of air supply, and exhausting of trapped downstream air

Dual Pilot Operated Check Valve Solenoid Pilot Controlled Application



IMPORTANT NOTES and CAUTIONS:

- Cylinder movement may occur when inlet pressure is lost. The cylinder's movement is slowed only by the restrictions of the flow control valves, and by the exhaust capacity of the check valve relief flow capacity
- For best response, flow control valves should be installed between the check valve and the cylinder
- Pressurizing the system after supply air has been off may cause rapid movement of the cylinder because cylinder air was exhausted while the supply air was off



Explosion-Proof Solenoid Pilot Poppet Valves for Line Mounting

Solenoid Pilot Controlled

2/2, 3/2 & 4/2 Normally Closed & Normally Open

Explosion-Proof

- Poppet construction for near zero leakage & high dirt tolerance
- Pilot can be rotated, giving the ability to change orientation
- Self-cleaning
- Wear compensating
- Repeatability throughout the life of the valve



2/2 Valve
Sizes 1/4 thru 2½



2/2 Valve
Sizes 1/4 thru 2½



4/2 Valve
Sizes 1/4 thru 1½

2/2 Normally Closed & Normally Open Valve

Valve Model Number*		Port Size 1, 2	C _v	
Normally Closed (NC)	Normally Open (NO)		NC	NO
2771B2002	2772B2002	1/4	2.3	2.3
2771B3002	2772B3002	3/8	3.8	3.3
2771B4012	2772B4012	1/2	4.0	3.5
2771B4002	2772B4002	1/2	7.7	6.5
2771B5002	2772B5002	3/4	9.0	7.3
2771B6012	2772B6012	1	9.0	7.9
2771B6002	2772B6002	1	24	21
2771B7002	2772B7002	1¼	29	20
2771B8012	2772B8012	1½	29	21
2771B8002	2772B8002	1½	49	49
2771B9002	2772B9002	2	57	57
2771B9012	2772B9012	2½	64	72

3/2 Normally Closed & Normally Open

Valve Model Number*		Port Size		C _v	
Normally Closed (NC)	Normally Open (NO)	1, 2	3	NC	NO
2773B2002	2774B2002	1/4	1/2	2.8	2.5
2773B3002	2774B3002	3/8	1/2	4.0	3.0
2773B4012	2774B4012	1/2	1/2	3.8	3.0
2773B4002	2774B4002	1/2	1	7.8	7.2
2773B5002	2774B5002	3/4	1	9.4	7.2
2773B6012	2774B6012	1	1	10	7.2
2773B6002	2774B6002	1	1½	29	21
2773B7002	2774B7002	1¼	1½	31	22
2773B8012	2774B8012	1½	1½	31	21
2773B8002	2774B8002	1½	2½	69	58
2773B9002	2774B9002	2	2½	70	60
2773B9012	2774B9012	2½	2½	71	55

4/2 Valve

Valve Model Number*	Port Sizes		Avg. C _v
	1, 2, 4	3	
2776B2002	1/4	1/2	2.5
2776B3002	3/8	1/2	3.6
2776B4012	1/2	1/2	3.7
2776B4002	1/2	1	6.9
2776B5002	3/4	1	8.2
2776B6012	1	1	8.9
2776B6002	1	1½	23
2776B7002	1¼	1½	24
2776B8012	1½	1½	25

* NPT port threads, for BSPP threads add a "D" prefix to the model number e.g., D2771B2002, D2773B2002, D2771B2002.
Standard voltages, 24 volts DC.

Explosion-Proof solenoid pilot valves for use in High Temperature and Low Temperature Service also available, consult ROSS.



EEZ-ON® Valves - Line Mounted

Pressure Controlled or Solenoid Pilot Controlled 3-Way Normally Closed EEZ-ON®

- Gradual re-application of pneumatic pressure prevents rapid equipment movement at startup
- Large exhaust port exceeds inlet size for rapid release of pressure
- Pressure sensing port allows installation of either the Pop-Up Indicator or Pressure Switch option to verify pressure is released
See pages 23 & 24 for accessories.

Solenoid Pilot Controlled Model Number*	Pressure Controlled Model Number*	Port Size		C _v	
		1, 2	3	1 to 2	2 to 3
2773B2037**	2783B2037	1/4	1/2	2.5	3.1
2773B3037**	2783B3037	3/8	1/2	3.6	5.3
2773B4047**	2783B4047	1/2	1/2	3.3	5.3
2773B4037**	2783B4037	1/2	1	10	13
2773B5037**	2783B5037	3/4	1	10	15
2783B6047**	2783B6047	1	1	12	16
2773B6037**	2783B6037	1	1½	23	34.2
2773B7037**	2783B7037	1¼	1½	30	32
2773B8047**	2783B8047	1½	1½	30	31

* NPT port threads. For BSPP threads, add a "D" prefix to the model number, e.g., D2773B2037.
** Specify voltage when ordering. Insert voltage code: "W" = 24 volts DC; "Z" = 110-120 volts AC, 50/60 Hz; e.g., 2773B2037W, 2773B2037Z.



EEZ-ON® Valves – Port Mounted

Right Angle Style 2-Way Normally Closed EEZ-ON®

- Gradual re-application of pneumatic pressure prevents rapid equipment movement at startup
- Right angle style mounts directly in cylinder ports
- Available with threaded ports or push-in-tubing ports
- Point of use Soft Start

Models with Threaded Banjo

Model Number	Port 1 (female)	Port 2 (male)	C _v 1 to 2
1969B2010*	1/4	1/4	1.2
1969B3010*	3/8	3/8	1.7
D1969B2010**	1/4	1/4	1.2
D1969B3010**	3/8	3/8	1.7

* NPT port threads. ** BSPP port threads.



Guarded Foot Pedal Valve

Protection from Accidental Actuation

- A direct acting 5-ports, 2 position Locking and Non-locking valve
- Conveniently allows hands free operation
- Simple installation
- Guard helps prevent inadvertent actuation
- Easy to operate with minimum maintenance required
- Convertible to a 3-way function

Model Description	Model Number	Port Size	Avg. C _v
Non-locking Foot Pedal	RM4F210-08G	1/4	0.5
Locking Foot Pedal	RM4F210-08LG	1/4	0.5



Minimize Hose Whip

Minimize Hose Whip



Protection from Broken Hose or Plastic Tubing

- Automatically reduces flow to minimize hose whip upon sensing a broken hose/tube
- For use with only non-corrosive, non-flammable, non-hazardous gases
- Simple installation; Reset by shutting off air supply
- Larger sizes available, consult ROSS.

Approximate Flow Before Shut-Off in CFM (Liters/Min.)

Pipe Size	Inlet Pressure					
	50 psi (3.4 Bar)	75 psi (5.1 Bar)	100 psi (6.9 Bar)	125 psi (8.6 Bar)	150 psi (10.3 Bar)	180 psi (12.4 Bar)
1/4	13 (368)	15 (424)	18 (509)	21 (594)	23 (651)	26 (736)
3/8	39 (1,104)	49 (1,387)	58 (1,642)	67 (1,897)	76 (2,152)	87 (2,463)
1/2	65 (1,840)	80 (2,265)	96 (2,718)	111 (3,143)	126 (3,568)	144 (4,077)
3/4	110 (3,114)	126 (3,567)	142 (4,020)	158 (4,474)	174 (4,927)	193 (5,465)
1	173 (4,898)	210 (5,946)	248 (7,022)	285 (8,070)	322 (9,118)	367 (10,392)

Model Number*	Port Size**
1969C2001	1/4 Male-Female
1969C3001	3/8 Male-Female
1969C4001	1/2 Male-Female
1969B2002	1/4 Female - Female
1969B3002	3/8 Female - Female
1969B4002	1/2 Female - Female
1969B5002	3/4 Female-Female
1969B6002	1 Female-Female

* NPT port threads. For BSPP threads, add a "D" prefix to the model number, e.g., D1969A2001.

** AIR-FUSE size should match actual hose inside-diameter size.



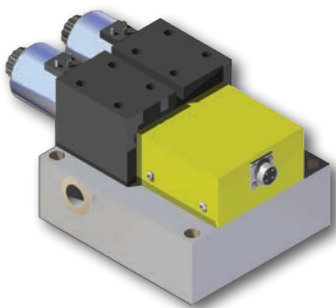
Safety Clamping Devices

ROSS CONTROLS specializes in pneumatic and hydraulic safety solutions. When needing rod locks, rod brakes or safety catchers ROSS will provide you the optimum solution for every application.

For information or technical assistance please call ROSS Technical Services in the U.S.A. at 1-888-TEK-ROSS(835-7677)

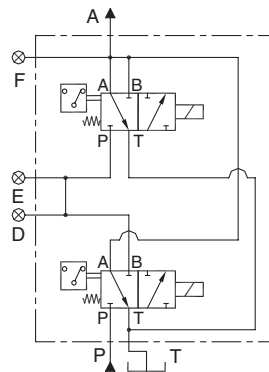
Control Reliable Hydraulic Double Valve

Size 12, 16 and 30



Ports:

Inlet: SAE #12, 16 and 30
 Outlet: SAE #12, 16 and 30
 Tank: SAE #12, 16 and 30



APPLICATIONS:

- Bending Machines
- Trimming Machines
- Cutting, Forming, Piercing Machines
- Special Purpose Hydraulic Applications

This valve package features redundant valve elements that allow series flow from the inlet to the outlet of the valve package and allows parallel flow from the outlet to tank. This configuration assures that if either valving element fails to operate as requested, inlet flow will be blocked and fluid from the outlet is directed to the tank. The shifting of each valving element is monitored by its own safety switch.

Solenoid Voltage: 12, 24, 48 volts DC; 115, 230 volts AC/60 Hz.
 Flow rate requirements, 30 GPM (114 LPM) to 150 GPM (568 LPM).

For information or technical assistance please call ROSS Technical Services in the U.S.A. at 1-888-TEK-ROSS(835-7677)



MUFFL-AIR® Silencers

- Reduces exhaust noise
- Diffuses exhausting air
- Back pressure, minimal
- Typical impact noise reduction is in the 20-25 dB range

Female Ported Models		
Part Number*	Port Size	C _v
5500A7001	1¼	37
5500A8001	1½	37
5500B9001	2	54
5500A9002	2½	65

Male Ported Models		
Part Number*	Port Size	C _v
5500A1003	1/8	2.0
5500A2003	1/4	2.7
5500A3013	3/8	3.2
5500A3003	3/8	4.9
5500A4003	1/2	5.9
5500A5013	3/4	5.9
5500A5003	3/4	13.5
5500A6003	1	16.7
5500A7013	1¼	17.4

Exhaust Noise Reduction



* NPT port threads. For BSPT threads, add a "D" prefix to the model number, e.g., D5500A7001.

Silencer Kits

- Reduces the Exponentially Perceived Noise (EPNdB)
- Improves equipment performance
- Impact noise reduction in the 35–40 dB range
- **Pressure Range:** 125 psig (8.6 bar) maximum
Kits include all plumbing required for installation.

DM¹ & DM²⁰ Series E

Valve Size	Threads	Type	Kit Number	Flow scfm
2	NPT		2323H77	256
2	BSPP		2328H77	256

DM²⁰ Series C

Valve Size	Threads	Type	Kit Number	Flow scfm
4	NPT		2324H77	800
8	NPT		2325H77	800
12	NPT		2326H77	2080
30	NPT		2327H77	7200
4	BSPP		2329H77	800
8	BSPP		2329H77	800
12	BSPP		2330H77	2080
30	BSPP		2331H77	7200

High-flow, high-reduction silencers for DM¹, DM²⁰ Series E & C double valves.

Exhaust Noise Reduction



Stainless Steel Silencers

- Constructed for corrosive situations
- For continuous heavy-duty use
- Recommended for air exhaust applications for pressures up to 125 psig (8.6 bar)
- 316 Stainless Steel sintered element silencers used to protect ports open to the atmosphere.
- Recommended for air exhaust applications for pressures up to 174 psig (12 bar)

Male Ported Models

Part Number*	Port Size	Material
5500A2004	1/4	Stainless Steel
5500A4004	1/2	Stainless Steel
5500A6004	1	Stainless Steel
5500A9004	2	Nickel Plated

Male Ported Models

Part Number*	Port Size	Material
5500A2005	1/4	Stainless Steel
5500A4005	1/2	Stainless Steel
5500A6005	1	Stainless Steel

* NPT port threads. For BSPT threads, add a "D" prefix to the model number, e.g., D5500A2004, D 5500A2005.

Exhaust Noise Reduction



Silencer/Reclassifiers

- Reduces exhaust noise at exhaust ports of valves
- Captures 90% of exhausted lubricants
- Use on air tools, valve with piped exhaust cylinder and air motor applications, or any system that requires air line lubrication
- Both a drain cock and a 1/8 tube fitting are supplied for the manual or constant draining of accumulated liquids
- Sound attenuation & back pressure data available, see FRL Catalog for more information

Part Number*	Port Size	C _v
5055B4009	1/2	5.4
5055B5009	3/4	7.4
5055B6009	1	7.4

* NPT port threads. For BSPP threads, add a "C" prefix to the model number, e.g., C5055B4009.

Exhaust Conditioning



- Pressure Release Verification
- Guarded Accidental Activation



Energy Release Verification Options

Pop-Up (Visual) Indicator or Pressure Switch (Electrical)



Pressure Release Verification

- May be installed on all L-O-X® valves and L-O-X® valves with EEZ-ON® function with pressure sensing port
- Provides a means to verify the release of downstream pressure to next obstruction
- Factory preset, 5 psi (0.3 bar) - falling

Model Number*	Inlet Port Size	Description
988A30	1/8	Pop-Up Indicator
586A86	1/8	Pressure Switch

* NPT port threads.



Pressure Release Verification

Redundant Downstream Feedback Switch

- May be installed downstream on all double valves
- Provides a redundant means to verify the release of downstream pressure to next obstruction
- Factory preset, 5 psi (0.3 bar) - falling

Model Number*	Inlet Port Size	Description
RC26-13	3/8	Feedback Switch

* NPT port threads.

Energy Release Verification Options for Stainless Steel L-O-X® Valves

Visual Indicator or Pressure Switch (Electrical)



Visual Indicator

- 316 Stainless Steel Body, Internals and Springs
- Nitrile Seal
- Visual Indicator Piston – acetal
- Visual Indicator Assembly – acetal with acrylic lens
- DPDT (Double-Pole Double-Throw) Pressure Switch, factory preset, 5 psi (0.3 bar) - falling



Pressure switch

Pressure Release Verification

Model Number*	Inlet Port Size	Description
1155H30	1/8	Visual Indicator
1162A30	1/8	Pressure Switch

* NPT port threads.



Guarded Accidental Activation

Multiple Lock-out Device Protection from Accidental Activation

For use with any ROSS model valve with L-O-X® capability.

Model Number 356A30



Pre-assembled Wiring Kits

DM¹ Series E Wiring Kits

Kit Model Number	Solenoid Connector Type	Length meters (feet)
2243H77	DIN	5 (16.4)
2244H77	DIN	10 (32.8)
2245H77	M12	5 (32.8)
2246H77	M12	10 (32.8)

These kits include 2 cables with either a DIN or M12 connector plus a cord grip for each. They are available in lengths of 5 or 10 meters. Separate kits are available for the Status Indicator.
(Note: Each cable has one connector.)

Status Indicator Kits

Include one cable with DIN connector and a cord grip.

Kit Model Number	Length meters (feet)
2247H77	5 (16.4)
2248H77	10 (32.8)

DM²® Series Wiring Kits

Kits include three cables for the solenoids and one cable for the status indicator. All cables come with a cord grip. Solenoid cables come with either DIN or M12 connectors. They are available in lengths of 5 or 10 meters.
(Note: Each cable has one connector.)

Kit Model Number	Solenoid Connector Type	Length meters (feet)
2283H77	DIN	5 (16.4)
2284H77	DIN	10 (32.8)
2288H77	M12	5 (32.8)
2289H77	M12	10 (32.8)

Wiring Kits with J-Box



A J-Box is a junction box with a 10-pin MINI connector for connecting to the user's control system and (4) 5-pin M12 ports for connecting to the 3 solenoids and the status indicator on the DM²® Series valve. The J-Box kits include the J-Box as described above and (4) 1-meter cables for connecting to the valve. These cables have a connector on each end. The status indicator cable and the (3) solenoid cables have an M12 connector on one end and a DIN connector on the other end (M12-DIN). Standard valves come with DIN type solenoid connections, but could be bought with M12 type connections as well. Therefore we also offer a kit that provides solenoid cables with an M12 connector on each end (M12-M12).

Kit Model Number*	Solenoid Connector Type	Length meters (feet)
2249H77	M12	1 (3.3)
2250H77	M12	1 (3.3)

*24 volts DC only.

10 PIN MINI Cable

These cables have a 10-pin MINI connector for connecting the J-Box kits above to the user's control system. Kits include one cable with connector and cord grip.
Cable conductors are 18-gauge wire.

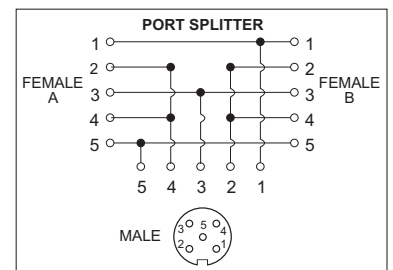
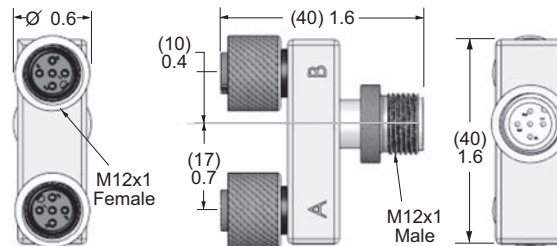
Kit Model Number	Length meters (feet)
2253H77	3.66 (12)
2254H77	6.1 (20)
2255H77	9.1(30)
2256H77	15.2 (50)

Outlet Port Pressure Monitoring Wiring Kit

Some customers prefer to monitor downstream pressure in addition to using the DM²® or DM¹ Series valve. A convenient way to do this is to install a pressure switch in the extra outlet port that is provided on the valve. The Outlet Port Pressure Monitoring kit can be used with one of the J-Box kits above to split one of the M12 ports on the J-Box so that a pressure switch can be wired in as well. These kits consist of one port splitter (a Tee with three M12 connectors) and one M12-DIN cable (1 meter).

The pressure switch is available separately - order part number 586A86.

Kit Model Number	Length meters (feet)
2251H77	1(3.3)



Series SV27 Sensing Valve Wiring Kits

These kits are available in lengths of 4 or 10 meters, with a cord grip for each cable. The kits for solenoid piloted SV27 models come with 2 cables; one with a 3-pin MINI connector for the solenoid and one with a 5-pin M12 (Micro) connector for the sensing switch. The kits for the air piloted models include only one cable with a 5-pin M12 connector for the sensing switch.
(Note: Each cable has one connector.)

Kit Model Number	Valve Type	Length meters (feet)	No. of Cables
2239H77	Solenoid Pilot	4 (13.1)	2
2240H77	Solenoid Pilot	10 (32.8)	2
2241H77	Air Pilot	4 (13.1)	1
2242H77	Air Pilot	10 (32.8)	1

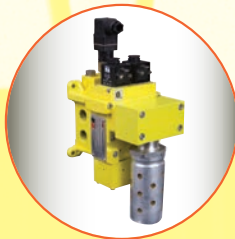
For Redundant SV27 (CAT 3) Pilot Operated Check valve order 2 kits.

ROSS Safety-related Solutions

ROSS has been manufacturing fluid power products since 1920. In 1954, ROSS patented the first double valve for the most demanding of safety applications: metal forming press clutch and brake control. Since that time, ROSS has patented several improved versions of the double valve and expanded its safety product offering. ROSS has become recognized as the premier supplier of high-quality pneumatic and hydraulic safety components for various applications in metal forming.

- Control-reliable solenoid operated pneumatic valves
- L-O-X® lockout and exhaust pneumatic energy isolation valves
- EEZ-ON® soft start pneumatic valves
- Pilot-operated pneumatic check valves with pressure release
- AIR-FUSE - Air hose blow-out protection

Critical Application Control-Reliable Double Valve



Critical Application 5-Way Solenoid Valve with Pressure Switch



Lockout Isolation & Visual Verification



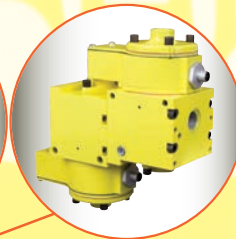
Safety Clamping Devices



Critical Application Control-Reliable Double Valve



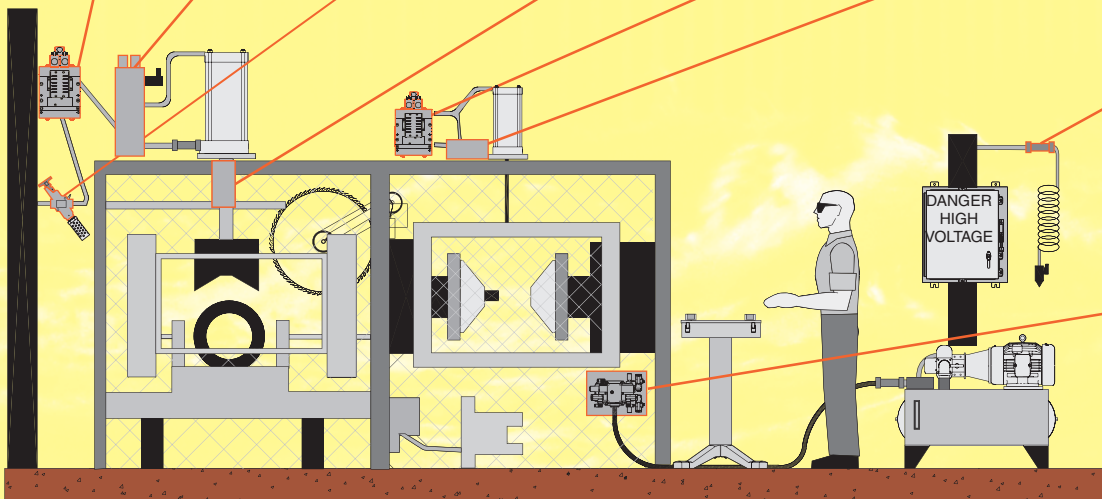
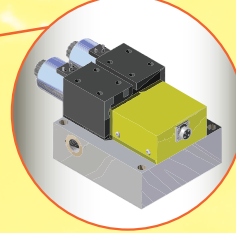
Load Holding SV27 PO Check with Sensing



Hose Failure Protection



Hydraulic Double Valve





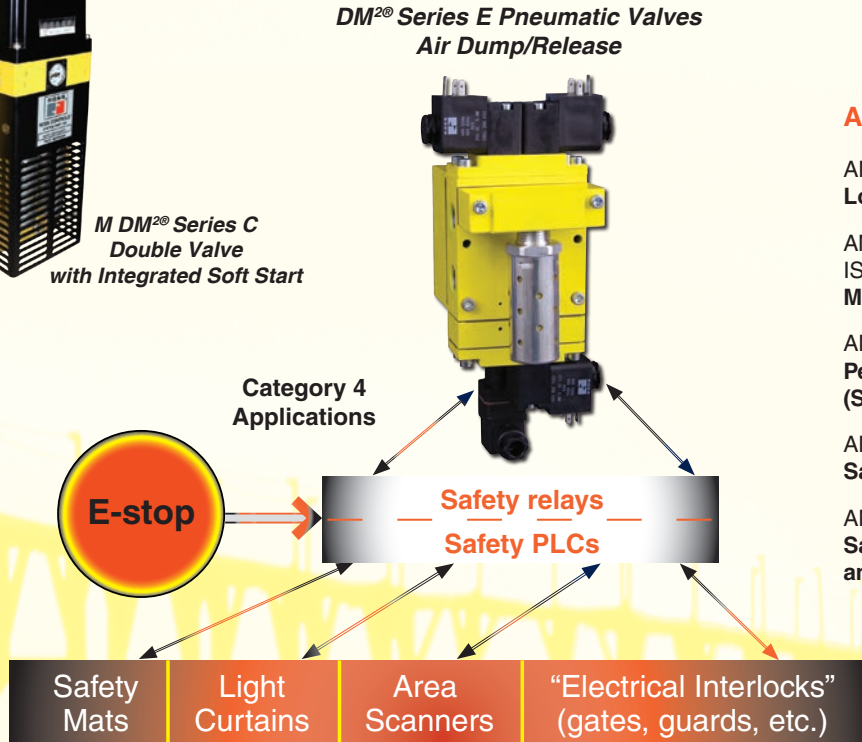
Pneumatic Solutions to Complete your Safety System

ROSS CONTROLS Helps You Address Machine Safeguarding Standards with Control Reliable, Energy Isolation Valves



M DM²⁰ Series C Double Valve with Integrated Soft Start

DM²⁰ Series E Pneumatic Valves Air Dump/Release



Applicable Safety-related Standards:

ANSI/ASSE Z244.1-2003 (R2008)
Lockout/Tagout Control of Hazardous Energy

ANSI B11.0-2010, RIA 15.06
ISO13849-1:2006
Machine Safeguarding

ANSI B11.19-2010
Performance Requirements for Safeguarding (Stop Time)

ANSI B11.TR6-2010
Safety Control Systems for Machine Tools

ANSI/PMMI B155.1-2011
Safety Requirements for Packaging Machinery and Packaging-Related Converting Machinery



Stainless Steel L-O-X[®] for Energy Isolation

Safety-related Pneumatics Products:

- Energy Isolation valves for Lockout
- Electrical / Pneumatic Energy Isolation (LOTO)
- Load-holding valves
- Soft start Lockout-Tagout
- Cylinder Return to Home Position
- Minimize Hose Whip
- Exhaust Noise Reduction
- Wash-Down Applications Cabinets



Pneumatic Lockout and Safety Exhaust Valve Cabinet for Wash-Down

E-mail: sales.info@rosscontrols.com

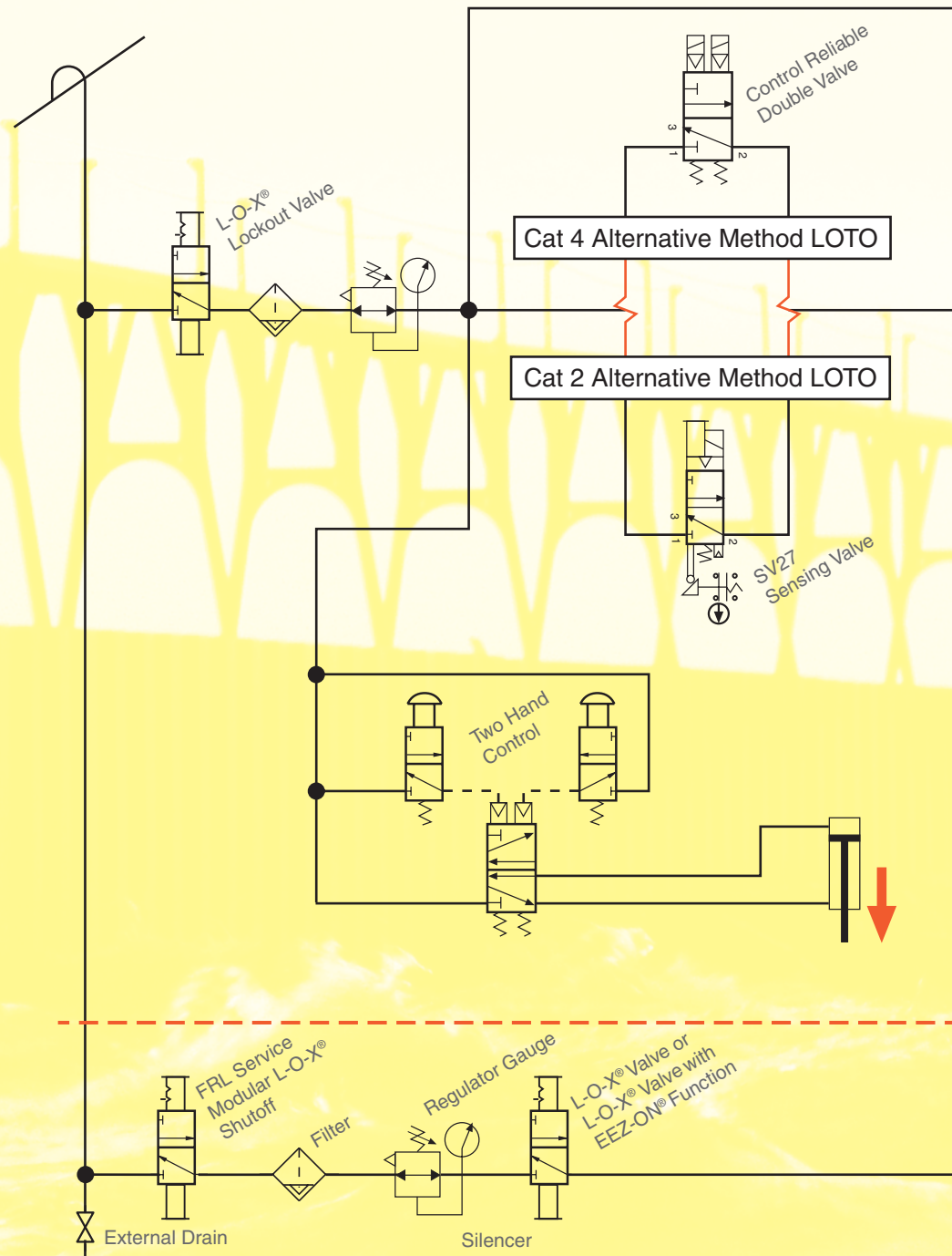
General Illustration - Safety-related Applications

ROSS Safety-related Applications

- * Cylinder hazard in 2 directions
- * Pinch points
- * Tooling or product damage
- * Single Point Lockout
- * Press clutch/brake
- * Counterbalance
- * Monitored power systems
- * Partial de-energization
- * Vertical loads
- * Cylinder hazard in one direction
- * Load holding
- * Cylinder hazard in 2 directions
- * Cylinder mid-stroke positioning
- * Two-hand control
- * Energy isolation
- * EEZ-ON[®] gradual pressure build-up
- * Noise reduction
- * 2-hand anti-tie-down machine start
- * Hose and/or fitting failure

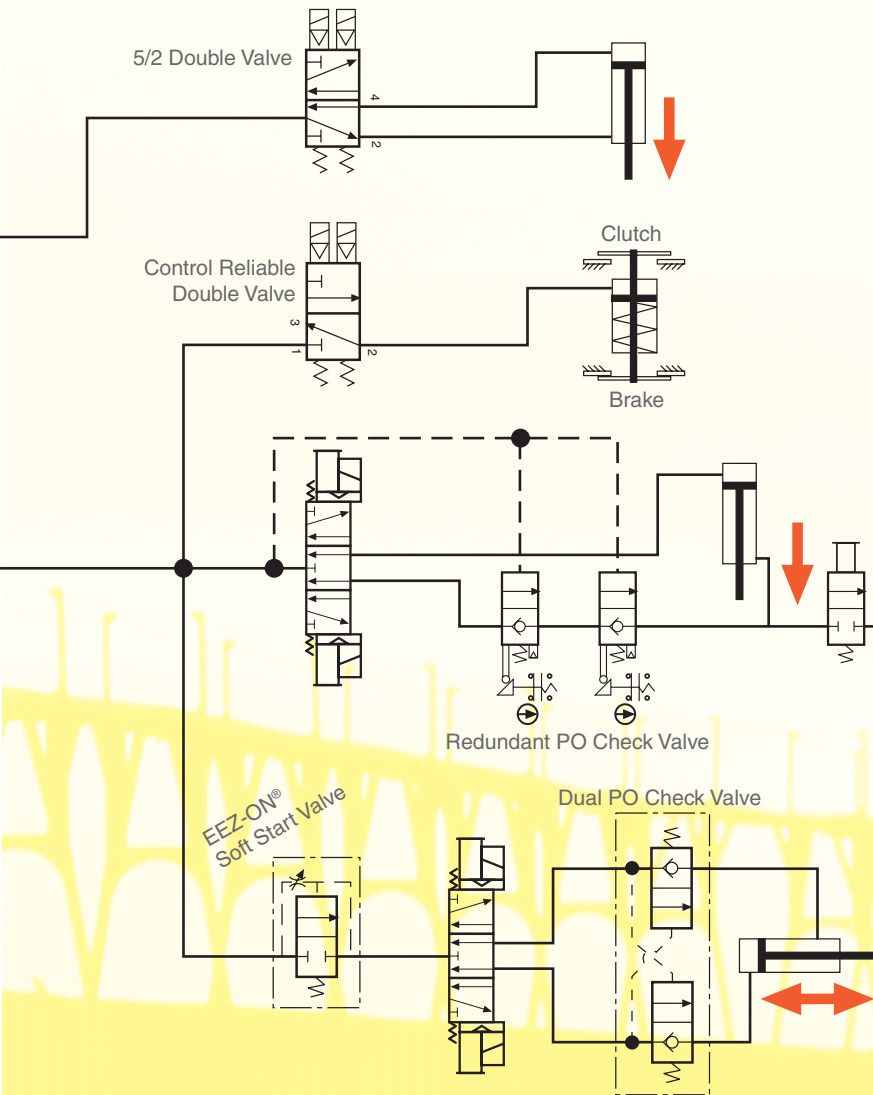
DISCLAIMER

These circuits are illustrative only and not intended to be used literally for your application. Each machine is unique and has individual characteristics that must be considered when designing a safety circuit. In addition, the referenced standards are not an exhaustive list. There may be many additional local, state, national, and international standards as well as machine function specific standards pertinent to your machine. This document is not a substitute for a complete risk assessment of a machine's hazards, professional circuit design or acquiring an in depth understanding of standards/regulations relevant to an application or machine.





General Illustration - Safety-related Applications



Various Safety-related Standards that Apply to Air Systems:

ANSI/ASSE Z244.1-2003 (R2008)
Lockout/Tagout Control of Hazardous Energy

OSHA 29 CFR 1910.147,
 ANSI B11.0-2010
 RIA 15.06
 ISO13849
Machine Safeguarding

ANSI/PMMI B155.1-2011
Safety Requirements for Packaging Machinery

ANSI B11.1
Safety Requirements for Mechanical Power Presses

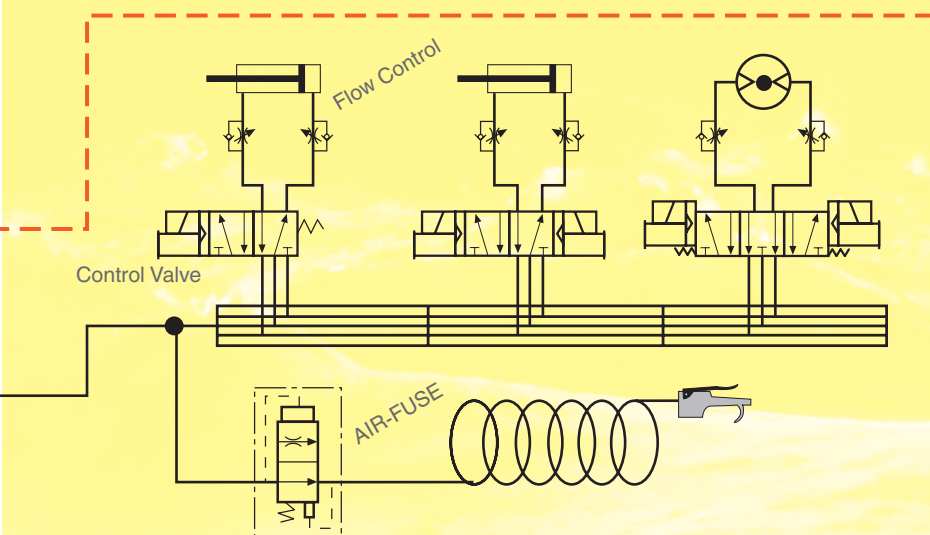
ANSI B11.2
Safety Requirements for Hydraulic Power Presses

ANSI B11.3
Safety Requirements for Power Press Brakes

ANSI B11.19-2010
Performance Requirements for Safeguarding (Stop Time)

ANSI B11.TR6-2010
Safety Control Systems for Machine Tools

OSHA 29 CFR 1910.211-219
Safeguarding Mechanical Power Presses



A Global Snapshot of Fluid Power and Safety

Valves enhance machine and worker safety

Critical-application safety valves are functionally redundant, self monitoring, and return to a safe position.

It is easy to say that “Safety is everyone’s goal”, but what is really meant by that? Sound workplace safety practices can reduce the risk of injury to not only machine operators but to other people such as maintenance technicians; it can also reduce the risk that there is accidental damage to machinery and other company assets, or harm to the environment. Common industry standards acknowledge that there is no such thing as zero risk, while nonetheless providing guidance to machine builders and operators regarding how to take steps to minimize risks. This is commonly referred to as machine safeguarding. Here’s a look at some key factors.

Control Integrity

The most important point in machine safeguarding is in evaluating the entire system and not just the electrical portion to minimize exposure to unnecessary risk. That’s because systems are rated based on the weakest link in the control chain.

Several standards (including ISO 13849-1:2006, ANSI/ASSE Z244.1-2003 (R2008) and ANSI/PMMI B155.1-2006) define the control system as including not only input, sensing, and interlock devices but also output devices such as pneumatic and hydraulic valves.

The function of a fluid control valve mimics that of an electrical-control relay and, therefore, is subject to the same rules for classifying safety integrity. Thus, properly specified machine safeguarding systems include provisions for pneumatic valves, including:

- Must be functionally redundant
- Must be monitored for faults (including diminished performance faults which may create the loss of redundancy), without depending on external machine controls or safety circuitry
- Must return to a safe position in the event of a loss of pressure or other such event
- Able to inhibit further operation upon detection of a fault condition until such condition is corrected
- Should have a dedicated, specific function-reset input and should prohibit the ability to perform a reset by simply removing or re-applying pneumatic or hydraulic power
- Must not automatically reset

Control reliability is generally considered safety Category-3 or -4 as defined in ISO 13849-1/ EN954-1 Standard for all types of circuits. This ISO standard regarding Category-3 states “a single fault in any of these parts does not lead to the loss of the safety function” and that “a fault shall be detected at or before the next demand upon the safety function.” According further to this ISO standard for Category-4, “an accumulation of undetected faults shall not lead to the loss of the safety function.”

Providing control reliability with fluid power is not quite the same as with electrical controls, however. For instance, plain redundancy in a safety circuit requires the equivalent function of four valve elements, not just two. Two of the four valve element handle the inlet function while the other two elements handle the stop function (energy release). Many self-designed systems risk having hidden, potential flaws, which can lead to unsafe conditions because they are unseen, unexpected and, therefore, excluded from design and safety reviews. A good example is the spool cross-over conditions or ghost positions of a valve, which are usually not shown on schematics.

Two general abnormal conditions can affect valve safety. The first is similar to an electrical-control fault, such as when a relay might be stuck in the open or closed position. The second abnormal condition is when a valve develops diminished performance, as when a valve becomes sticky or sluggish. In these cases the valve reaches the proper position, but slower shifting affects safe stopping distances or precise timing. The ANSI B11.19-2010 Standard mandates a monitoring system that detects these conditions for critical applications and the ANSI/PMMI B155.1-2010 Standard requires diminished performance monitoring if stopping time can be affected. An easy solution is to use a self-monitoring, Category-3 or -4 valve, designed to detect both conditions.

The use of double valves remained relatively unheard of for many years except in a few select industries, such as stamping presses, which first initiated control reliability requirements. Double valves provide dual internal functions (redundancy) so that an abnormal function of one side of the valve does not interfere with the overall normal operation. At the same time, the double valves sense abnormal operation on either side of the valve and then inhibit further operation until the problem has been corrected and the valve deliberately reset. This sensing and inhibiting function is commonly referred to as monitoring.

Two standard air valves, whether in parallel or in series, cannot perform the same safeguarding function as does a double valve critical function. By simply incorporating two standard air valves into the circuit, no provision is made to sense the abnormal operation of one side of the valve or, even more preferable, diminished performance such as slow shifting. In addition, there is no provision for inhibiting further operation of the circuit until the valve is repaired. If one valve actuates abnormally, the second one continues to function and redundancy is lost. The circuit doesn’t recognize lost redundancy nor would it halt operations as a warning that redundancy has been compromised. Then, if the second valve also actuates abnormally, there is no “back up” and control integrity no longer exists.

Double valves are appropriate for pneumatic and hydraulic equipment anytime reliability is an issue. Typical applications include E-stop, two-hand-control, light curtains, safety gates, pneumatic locking devices for safety gates, hydraulic brakes, air brakes, amusement rides, hoists, elevators, pinch-point applications, or any other application where control system integrity depends on valve operation.

Energy isolation

Lockout/tagout (LOTO) is another high-priority safety topic. Under standard LOTO, before a worker can enter a protected area of a machine, all energy must be dissipated and machine-status verified. The standards define the “de-energized” state as existing when all energy sources are disconnected from the machine and there are not any circuits containing residual stored energy. For fluid power, this requires a manually operated energy-isolation valve that must:

- Have a secure and tamper-resistant method of lock attachment
- Be located outside the protected area in an easily accessible location
- Have a method for employees to verify energy dissipation prior to entering the protected area
- Not be used in normal production
- Have a full-size exhaust port (ANSI/PMMI B155.1-2010, CSA Z142-02)
- Be positive acting (only two possible positions)
- Be easily identifiable
- Can only be locked in the off position



Alternative lockout

The ANSI/ASSE Z244.1-2003 (R2008) standard also addresses other lockout techniques, called alternative methods of controls. These systems can save costs and improve machine up time. But alternative methods controls only apply to routine, repetitive tasks that are integral to the production process and are based on risk assessment providing effective personal protection. The machine must still have a standard lockout system for repairs and other tasks.

Alternative methods of controls offer two time-saving advantages. First, it uses a single lock-point (a remote, low-voltage system) that simplifies and speeds lockout, and enhances safety by avoiding the chance of a point being missed. The operator need not travel all around the machine to access various points to lockout or unlock operations. These systems place electrical lockout switches, connected to the control system, at locations that require machine access, and incorporate appropriate safety valves for pneumatic and hydraulic lockout.

The second feature of alternative lockout systems is that not all energy needs to be removed. In fact, sometimes removing all the energy creates a more-hazardous condition. This can result in significant time and cost savings when systems contain large volumes of compressed air.

The standard is also useful for tasks that are not routine, repetitive, or integral to production, but require power for, say, troubleshooting a control circuit. The new standard recognizes that there is no such thing as zero risk, and that some risk is present in order to perform certain tasks. In this case, the standard requires that the control system and valve controlling the non-isolated energy be control-reliable, Category-3 or -4.

Risk reduction

There is no such thing as “zero risk”. Therefore, the standards require that you assess all possible risks, and determine what possible ways can be accomplished for most-effectively reducing those risks.

The best approach to risk assessment is as a team. One big change ANSI B11.0-2010 brought about is that both the machine manufacturer and user are responsible for performing the assessment for new and rebuilt machines. In the past, machine safety was considered the user’s responsibility.

Perhaps the most difficult part is defining the subjective words for the assessment. There are no precise answers, and even the standards differ. Users need to develop their own risk assessment program.

Many companies hold that there are two degrees of injury: minor and major. Minor injuries can be treated with a first aid kit, and anything requiring more extensive care is considered a major injury for risk assessment purposes.

When a company uses a risk matrix that leans toward the “better-to-be-safe” side, the first question is, of course, “Will it entail additional expense to eliminate a rare possibility?” But to error on the high side forces the assessment team to look more carefully at each hazard. Often, safety can pay back in machine up time, reduced employee absenteeism, saving the time and cost to investigate an accident, insurance savings, and other hidden costs involved with accidents. Safety is part of a company’s loss-prevention program.

Avoiding using the wrong category valve should be the primary concern when performing a risk assessment. For example, a circuit with a single valve that suffers a broken spring or a sticky spool would have a different fault result than a similar circuit employing a double valve experiencing a broken spring or sticky valve. ANSI B11.0-2010 sets the recommended minimum level of control integrity as follows.

Highest degree of risk reduction. Control systems having redundancy with continuous self-checking to ensure continuous performance.

High/intermediate risk reduction. Control systems having redundancy with self-checking upon startup.

Low/intermediate risk reduction. Control systems having redundancy that may be manually checked.

Lowest degree of risk reduction. Hydraulic or pneumatic devices and associated control system using single-channel configuration. Here are a few areas which are commonly considered during an assessment for safety and risk reduction in fluid power.

1. Hydraulic accumulator dump valves, which must be monitored or manually operated
2. Pilot operated check valves (PO checks), which are designed to hold a load in place and inherently trap pressure (which must be released during lockout procedures)
3. Use of 3-position all ports blocked valves, which trap pressure
4. Hazard created when a hose or tube fitting blows off
5. Sudden surge of compressed air being reapplied after LOTO, causing cylinders to move quickly and subjecting the machine to shock

For all of these, and more, a complete analysis of the circuit should be taken to uncover potential hazards, even though the hazards have never occurred in the past.

The standards say if it can happen, it must be considered.

To design a control reliable circuit, the engineer must be able to break the reliability chain into links. Each link must represent a control device that meets the control reliability specifications listed above. If the device does not meet all these criteria, it is not considered a control device but only a component for integration into a circuit, thus requiring additional components or requiring even a redesign to achieve control reliability.

Updating a system may not be difficult if the electrical controls are already control reliable. Because some valves have all of the monitoring logic built right in, there is no need to modify existing external control circuitry for valve monitoring. Simply replacing existing pneumatic or hydraulic valves with critical-application valves and properly wiring them into the existing system may easily bring the fluid controls into a control-reliable performance state.

So, the next time you design a circuit, remember that the ANSI, OSHA, ISO, and consensus standards apply to the entire control circuit from beginning to end and you will not break the chain.

Additional resources

ROSS Controls offers an expanded technical reference book, “Fluid Power Safety for Machine Guarding,” a “Risk Locator for Machinery with Pneumatic Power” CD-ROM, and a course in Fluid Power Safety. TOTAL MACHINE SAFETY. For more info, visit www.rosscontrols.com.

Design Standards and Certifications

ROSS valves for Safety-related applications are designed to meet many Global standards including the following:

CSA, Australian AS, EN, ISO, OSHA, ANSI, & CE

When required, ROSS products can be tested and certified by the following authorities:

UL, CSA, TUV, BG

Please visit www.rosscontrols.com for detailed technical information about any product contained in this brochure. Products containing the ROSS CONTROLS® safety logo are certified by ROSS to be engineered and designed for safety-related applications.





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ROSS CONTROLS

Troy, MI., U.S.A.

Telephone: + 1-248-764-1800

Fax: + 1-248-764-1850

In the United States:

Customer Service: 1-800-GET ROSS
(438-7677)

Technical Service: 1-888-TEK-ROSS
(835-7677)

www.rosscontrols.com



ROSS SOUTH AMERICA Ltda.

São Paulo, Brazil CEP 09725-020

Telephone: + 55-11-4335-2200

Fax: + 55-11-4335-3888

Email: vendas@ross-sulamerica.com.br

DIMAFLUID s.a.s.

Saint Ouen, France

Telephone: + 33-01-4945-6565

Fax: + 33-01-4945-6530

Email: dimafluid@dimafluid.com

www.dimafluid.com

ROSS EUROPA GmbH

Langen, Germany

Telephone: + 49-6103-7597-0

Fax: + 49-(0)6103-74694

Email: info@rosseuropa.com

www.rosseuropa.com

ROSS CONTROLS (CHINA) Ltd

Shanghai, China

Telephone: + 86-(0)21-6915-7951

Fax: + 86-21-6915-7960

Email: sales@rosscontrols.com.cn

www.rosscontrolschina.com

ROSS ASIA K.K.

Kanagawa, Japan

Telephone: + 81-427-78-7251

Fax: + 81-427-78-7256

www.rossasia.co.jp

ROSS UK Ltd.

Burntwood, United Kingdom

Tel: + 44-(0)154-367-1495

Email: sales@rossuk.co.uk

www.rossuk.co.uk

ROSS CONTROLS INDIA Pvt. Ltd.

Chennai, India

Telephone: + 91-44-2624-9040

Fax: + 91-44-2625-8730

Email: ross.chennai@rossindia.net

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