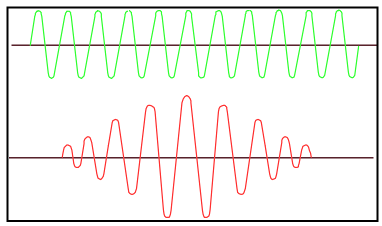
SPEC VS-01 June 98

Vibration and Seismic Shock Test Data for UE Pressure Switches



UNITED ELECTRIC CONTROLS
P.O. Box 9143 Watertown, MA 02472
Tel: 617-926-1000 Fax: 617-926-2568
www.ueonline.com

DESIGN PRINCIPLES AND THEIR RELATION TO SHOCK AND VIBRATION

Consideration of design features is important in switch selection when shock and/or vibration are present in the application. UE incorporates several design schemes to provide stability and reliability to its line of pressure switches. "Continuous motion" design is used with products which can be adjusted via a dial. "Force balance" design, on the other hand, is employed for products which do not require adjustment via a dial. "Belleville construction" is a feature of the Spectra 12 Series for superior resistance to shock and vibration via a negative rate snap acting washer.

Effects of shock and vibration
Shock and vibration can affect each design type differently, depending on the severity of these phenomena. As a result of vibration, switch 'chatter' can lead to premature failure of the microswitch contacts as well as causing undesired switch actuation ('false trip').

Minimizing the effects
The effects of shock and vibration can be minimized in several ways:

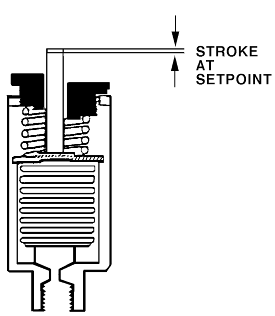
- mounting the pressure switch away from vibration
- mounting the switch perpendicular to the plane of vibration
- selecting a less sensitive switch model
- selecting a force-balance design or Belleville construction
- using vibration mounts

In cases of pulsation, a dampener, or snubber installed ahead of the pressure switch, may be desirable. Where shock conditions are present, shock mounts and flexible piping connections can eliminate 'false trips.'

Force Balance Design

Examples: Pressure versions of the 100, 117, 118, 119 Series and the J120

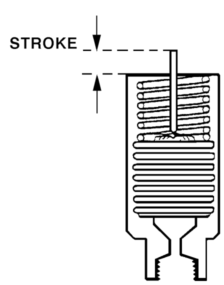
Plunger only moves around set point; total movement is typically 10-15% of continuous motion design. Adjustment changes loading on load spring.



Continuous Motion Design

Examples: Pressure versions of the 54, 105, 400 Series; H121,H122 and J21K

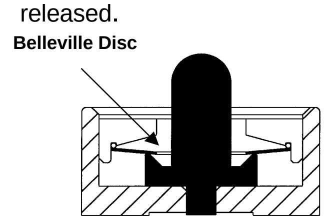
Plunger moves continuously in response to pressure change, from low end of the range to the high end. It is independent of set point. Setting adjustments raise/lower the switch position in relation to the plunger.

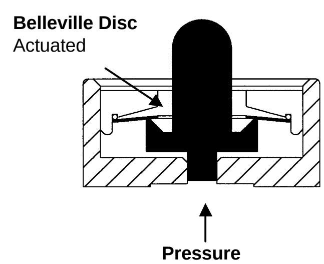


Negative Rate Belleville Spring Design

Example:
12 Series Pressure Switch

Belleville Spring "snaps over" when pressure is applied and "snaps back" when pressure is released.





All United Electric switches are subject to testing per ***MIL-STD-810***, a widely accepted seismic shock and vibration specification used in many projects and on rotating equipment such as pumps, compressors, turbines and dryers.

UE NON-BELLEVILLE PRODUCTS ARE TESTED TO:

Shock: Set point repeats after 15 g's, 10 millisecond duration
Vibration: Set point repeats after 2.5 g's, 5-500 Hertz

Special consideration in switch selection and/or installation should be taken to ensure optimum switch performance in applications involving severe vibration or shock. For example, a model with a less sensitive (higher deadband) range may be required, mounting away from vibration may be advisable, or selection of a unit with Belleville construction may be required.

GLOSSARY OF RELATED TERMS

- **Chatter** - Prolonged undesirable opening and closing of electric contacts, as on a relay or switch. Also known as contact chatter.
- **Frequency** - The number of repetitions of a complete sequence of values of a periodic function per unit variation of an independent variable
- **g force** - The natural force of gravitation; 1g = 32 ft/sec^2 = 9.8 m/sec^2
- **Hertz** - A unit of frequency used to quantify the number of cycles per second
- **Pulsation -** A brief surge or variation of a quantity whose value normally is constant; any vibration, beat or signal that is regular and rhythmic
- **Repeatability** - The exactness with which a unit duplicates its set point value after each successive cycle, within the same conditions
- **Set point shift -** a change in value of the predetermined set point or point at which a switch will operate
- **Shock** - A collision or sudden impact
- **Vibration** - A rapid linear motion of a particle or of an elastic solid about an equilibrium position

PERFORMANCE CHARACTERISTICS - Non-Belleville Units

The following test data provides performance characteristics on a variety of UE pressure switches under laboratory conditions. Vibration tests were conducted using a B&K vibration controller, set at 2.5 g's and cycled over the frequency range of 5 - 500 Hertz. Actual performance will vary with each application, due to the unique nature of specific equipment or processes. Shock tests were conducted on a Veripulse V35 Shock apparatus, to a minimum of 15 g's for a 10 millisecond duration.

Model & Range		*Set point (on rise)*	*Rise (PSI) (actual)*	*Set point shift*		*Set point repeatability specification*
				Gauge Pressure	*% of range (actual)*	
H100-173	Baseline Unit	45 PSI	45.0			± 1.00%
4 to 100 PSI	After Vibration		45.0	0.00 PSI	0.00%	
	After Shock		45.2	0.20 PSI	0.20%	
H100-184	Baseline Unit #1	35 PSI	35.0			± 1.50%
2 to 50 PSI	After Vibration		35.0	0.00 PSI	0.00%	
	After Shock		35.4	0.40 PSI	0.80%	
	Baseline Unit #2	35 PSI	35.0			± 1.50%
	After Vibration		35.0	0.00 PSI	0.00%	
	After Shock		35.0	0.00 PSI	0.00%	
H100-218	Baseline Unit #1	15 "Hg	15.0			± 1.00%
30"Hg to 0	After Vibration		14.8	-0.20 "Hg	-0.67%	
	After Shock		14.7	-0.30 "Hg	-1.00%	
	Baseline Unit #2	15 "Hg	15.0			± 1.00%
	After Vibration		14.5	-0.50 "Hg	-1.67%	
	After Shock		14.5	-0.50 "Hg	-1.67%	
H100-612	Baseline Unit #1	1000 PSI	1000.0			± 1.50%
125 to 3000 PSI	After Vibration		1000.0	10.00 PSI	0.33%	
	After Shock		1010.0	10.00 PSI	0.33%	
	Baseline Unit #2	1000 PSI	1000.0			± 1.50%
	After Vibration		1010.0	10.00 PSI	0.33%	
	After Shock		1010.0	10.00 PSI	0.33%	
H100-702	Baseline Unit #1	50 PSI	50.0			± 1.00%
3 to 100 PSI	After Vibration		50.0	0.00 PSI	0.00%	
	After Shock		50.0	0.00 PSI	0.00%	
	Baseline Unit #2	50 PSI	50.0			± 1.00%
	After Vibration		49.8	-0.25 PSI	-0.25%	
	After Shock		49.8	-0.25 PSI	-0.25%	
H117-191	Baseline Unit #1	44.8 PSI	44.8			± 1.50%
10 to 100 PSI	After Vibration		45.5	0.70 PSI	0.70%	
	After Shock		45.6	0.80 PSI	0.80%	
	Baseline Unit #2	45 PSI	45.0			± 1.50%
	After Vibration		45.0	0.00 PSI	0.00%	
	After Shock		45.0	0.00 PSI	0.00%	
H117-173	Baseline Unit	45 PSI	45.0			± 1.00%
4 to 100 PSI	After Vibration		45.3	0.30 PSI	0.30%	
	After Shock		45.1	0.10 PSI	0.10%	
H117-184	Baseline Unit	35 PSI	35.0			± 1.50%
2 to 50 PSI	After Vibration		35.0	0.00 PSI	0.00%	
	After Shock		35.0	0.00 PSI	0.00%	
J120-274	Baseline Unit #1	50 PSI	50.0			± 1.50%
6 to 300 PSI	After Vibration		50.5	0.50 PSI	0.17%	
	After Shock		50.2	0.20 PSI	0.07%	
	Baseline Unit #2	50 PSI	50.0			± 1.50%
	After Vibration		50.3	0.30 PSI	0.10%	
	After Shock		50.6	0.60 PSI	0.20%	

DESIGN PRINCIPLES - Belleville Technology

A Belleville spring is a small, conical washer that can transfer a relatively large force. When subjected to specific processing, it performs as a negative rate snap-acting device that "snaps over" when pressure is applied and "snaps back" when pressure is released. This "snap action" is fast, positive and non-linear. In comparison with conventional linear pressure sensors such as diaphragms, bellows, and pistons, the Belleville sensor has several inherent design advantages which make it extremely resistant to vibration. Since preloading of the electrical microswitch is not required, the possibility of contact "chatter" is virtually eliminated.

UE SPECTRA 12 PRODUCTS ARE TESTED TO:

Shock: 75 g's, 10 millisecond duration
Vibration: 15 g's, 10 - 2000 Hertz

PERFORMANCE CHARACTERISTICS - Belleville Technology

Shock Tests - Spectra 12

		Product 12SHSN 2A Range: 10 to 25 psi						**Product 12SHSN 2B Range: 15 to 45 psi**					
Spectra 12 Sample **2A** and **2B**					**Absolute Shift**						**Absolute Shift**		
		Rise	**Fall**	**Diff'l.**	**Rise**	**Fall**	**Diff'l.**	**Rise**	**Fall**	**Diff'l.**	**Rise**	**Fall**	**Diff'l.**
Initial setpoint		20.2	11.2	9.0	-	-	-	25.7	15.0	10.7	-	-	-
Vertical (Y-Axis)	**15 g's**	20.6	11.3	9.3	0.4	0.1	0.3	25.0	15.3	9.7	0.7	0.3	1.0
	75 g's	20.2	11.4	8.8	0	0.2	0.2	25.6	15.5	10.1	0.0	0.5	0.6
	100 g's	20.3	11.3	9.0	0.1	0.1	0	25.6	15.5	10.1	0.0	0.5	0.6
Horizontal (X-Axis)	**15 g's**	20.1	11.1	9.0	0.0	0.0	0	25.5	15.5	10.0	0.2	0.5	0.7
	75 g's	20.2	11.5	8.7	0	0.3	0.3	26.0	15.5	10.5	0.3	0.5	0.2
	100 g's	20.5	11.5	9.0	0.3	0.3	0	24.0	15.5	8.5	1.7	0.5	2.2

		Product: 12SHSN 3A Range: 10 - 25 psi						**Product: 12SHSN 3A Range: 15 - 45 psi**					
Spectra 12 Sample **3A**					**Absolute Shift**						**Absolute Shift**		
		Rise	**Fall**	**Diff'l.**	**Rise**	**Fall**	**Diff'l.**	**Rise**	**Fall**	**Diff'l.**	**Rise**	**Fall**	**Diff'l.**
Initial setpoint		9.4	4.6	4.8	-	-	-	13.8	10.2	3.6	-	-	-
Vertical (Y-Axis)	**15 g's**	9.0	4.8	4.2	0.4	0.2	0.6	14.0	10.4	3.6	0.2	0.2	0
	75 g's	9.2		4.4	0.2	0.2	0.4	14.3	10.7	3.6	0.5	0.5	0
	100 g's	9.4	4.8	4.6	0	0.2	0.2	14.0	10.4	3.6	0.2	0.2	0
Horizontal (X-Axis)	**15 g's**	9.1	4.7	4.4	0.3	0.1	0.4	14.3	10.7	3.6	0.5	0.5	0
	75 g's	9.0	4.7	4.3	0.4	0.1	0.5	14.2	10.7	3.5	0.4	0.5	0.1
	100 g's	9.3	4.7	4.6	0.0	0.1	0.2	14.0	10.5	3.5	0.2	0.3	0.1

All test values are in psi

SINE VIBRATION TEST - Spectra 12

Test Procedure

The submitted test units were subjected to a Sine Vibration Test in accordance with MIL-STD-810E, Method 514.4. Figure 514.4 - 40 modified to 2000Hz ±15g's input. The test was performed as follows.

The test specimens were subjected to sinusoidal vibration in each of three mutually perpendicular axes at the test levels listed below.

Frequency (Hz)	Amplitude
10 - 33	0.20 inches @ ± 2.0 g's
33 - 2000	0.036 inches @ ±15.0 g's

The frequency range of 10 to 2000 and return to 10 Hz was traversed logarithmically over a 20 minute period. The test units were subjected to the above test levels for a period of (2) two hours in each of the units three mutually perpendicular axes. The total test time was (6) hours.

Following each axis of test, the units were subjected to performance testing to identify any changes in operation. The units were also examined for evidence of physical damage. The test units were wired to a discontinuity monitor and monitored for electrical interruptions during the vibration testing. Following completion of the Sinusoidal Vibration Test, the specimens were examined for evidence of physical damage. No evidence of damage was detected after the completion of the test.