



Introduction

This document provides an overview of information related to the activation of ShockWatch impact indicators. Activation graphs/response curves and other auxiliary information are included.

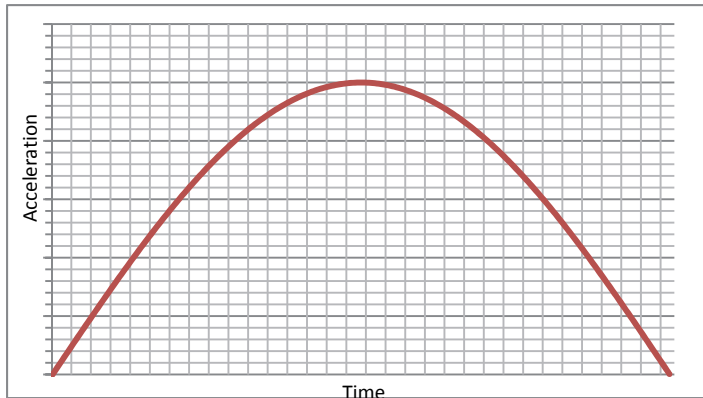
ShockWatch Impact Indicator Activation

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ShockWatch Impact Indicator Activation Overview

Two components comprise an impact – amplitude of acceleration (G) and duration of impact (msec). These components are illustrated in the graph below. The area under the curve represents the change in velocity (Δv).



ShockWatch impact indicator shock response curves are based on a half-sine shock pulse (shown above). A time, acceleration point on the half-sine curve can be correlated to the same point on the ShockWatch activation response curves.

The vertical axis of each ShockWatch impact indicator activation curve shows a linear scale and is titled "G" or "G-level." This value is the acceleration scale. A "G" is a multiple of the acceleration due to gravity (32.2ft/s^2 or 9.8m/s^2).

The horizontal axis of the graph shows a linear scale titled "t" and represents the time duration. The unit of measure for this scale is milliseconds.

The most critical thing to observe from the curve is that as duration decreases, acceleration increases. Each ShockWatch impact indicator has a minimum G-threshold that must be exceeded before it will activate. The minimum G-level for each ShockWatch impact indicator is the leftmost G-value on the curve (the G-value where the shock curve intersects the left acceleration scale). If this minimum G-value is not exceeded, regardless of the duration or the Δv , the device will not activate.

Response curves are measured with a drop system filtering at 3 kHz. Use of a different frequency filter will change the response curve.

If you have any questions or are unsure of how to interpret ShockWatch products, please contact ShockWatch or your local distributor for assistance.

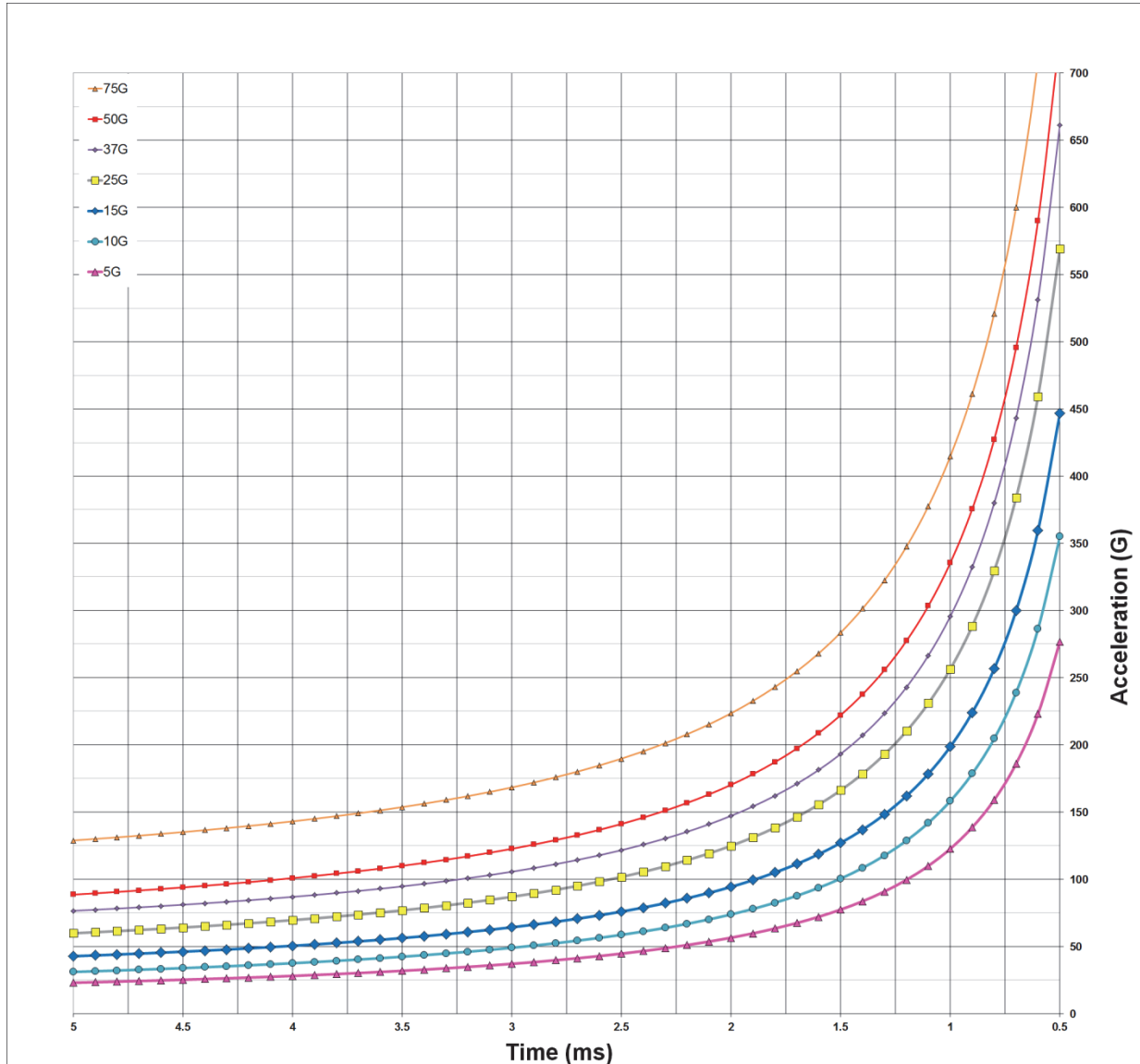
ShockWatch 2

ShockWatch 2 Activation Graphs - Response Curves

ShockWatch 2 G-Level vs. Duration (ms)

0.5 to 5ms

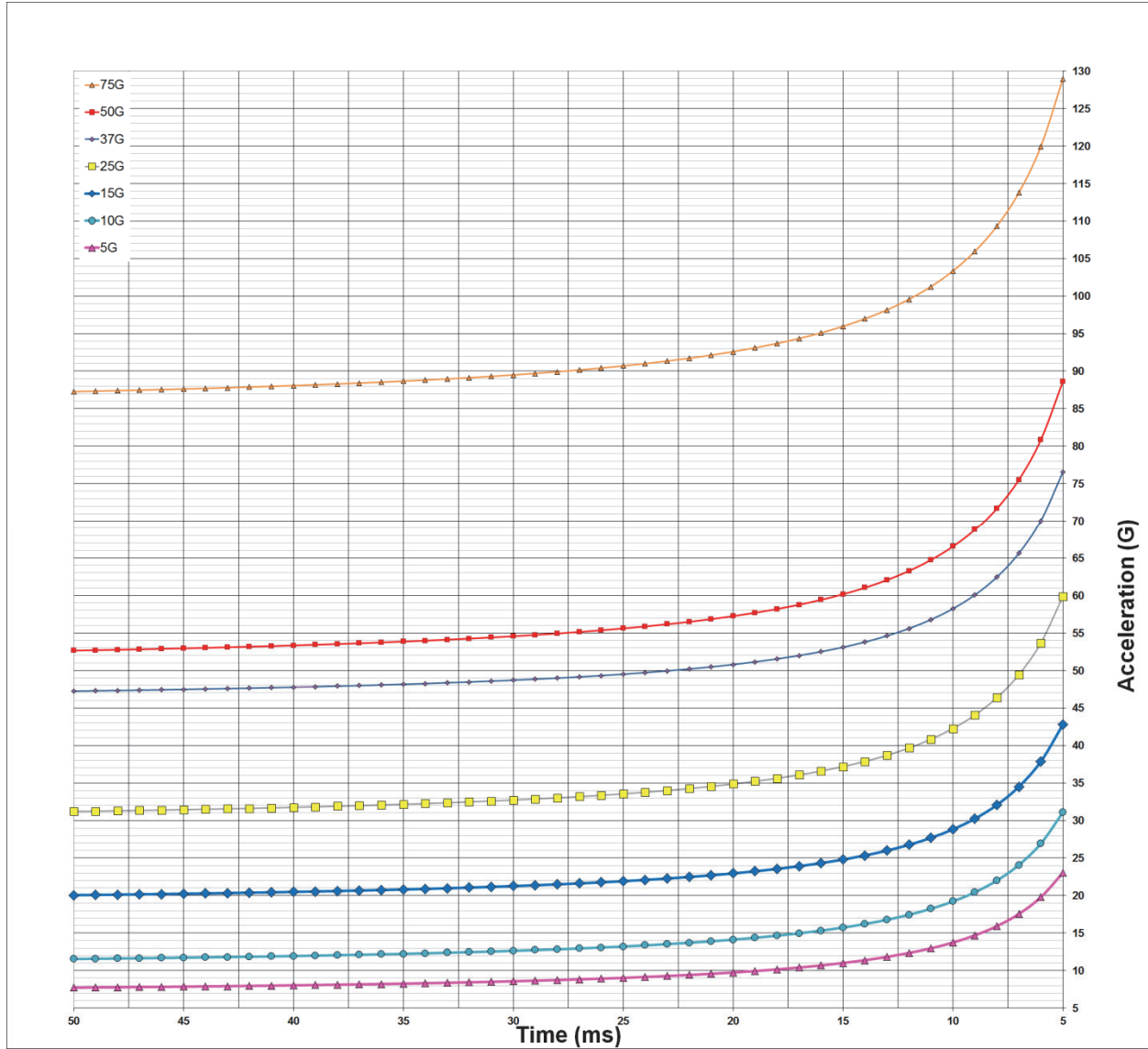
Activation Occurs +/- 15% of the Nominal Activation Value



ShockWatch 2 G-Level vs. Duration (ms)

5 to 50ms

Activation Occurs +/- 15% of the Nominal Activation Value





ShockWatch® Impact Indicator Activation

ShockWatch 2 Response Equations

All ShockWatch 2 impact indicator curves are based on the indicator being subjected to a flat drop. The ShockWatch 2's response generally follows the equations below:

Product	Equation
ShockWatch 2 – 5G	$G=(116/t^{1.22}) + 6.75$
ShockWatch 2 – 10G	$G=(148/t^{1.22}) + 10.3$
ShockWatch 2 – 15G	$G=(180/t^{1.25}) + 18.7$
ShockWatch 2 – 25G	$G=(227/t^{1.25}) + 29.5$
ShockWatch 2 – 37G	$G=(250/t^{1.3}) + 45.7$
ShockWatch 2 – 50G	$G=(285/t^{1.25}) + 50.5$
ShockWatch 2 – 75G	$G=(330/t^{1.25}) + 84.8$

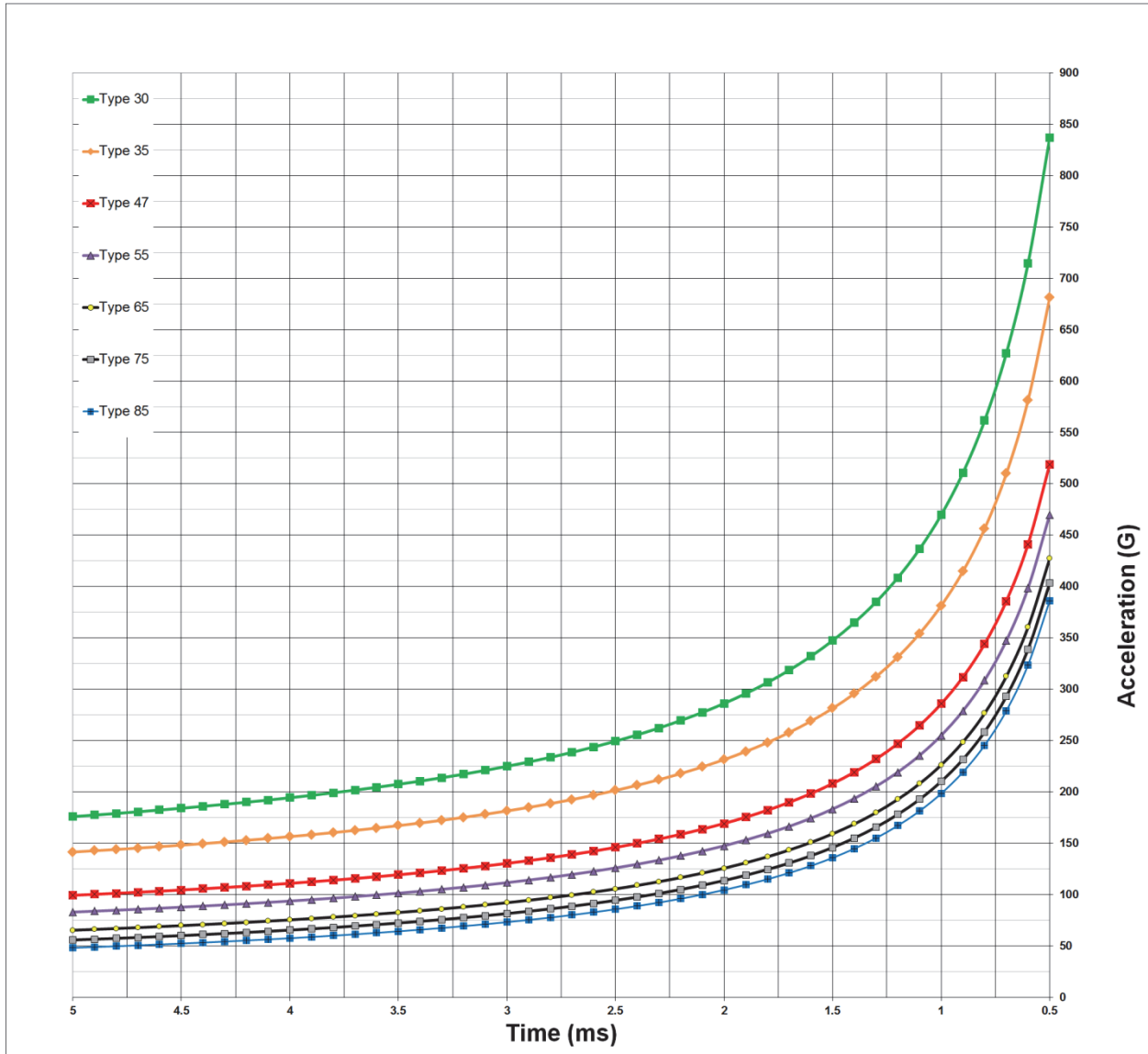
ShockWatch Label/Clip/Tube

ShockWatch Label/Clip/Tube Activation Graphs - Response Curves

Label/Clip/Tube G-Level vs. Duration (ms)

0.5 to 5ms

Activation Occurs +/- 15% of the Nominal Activation Value

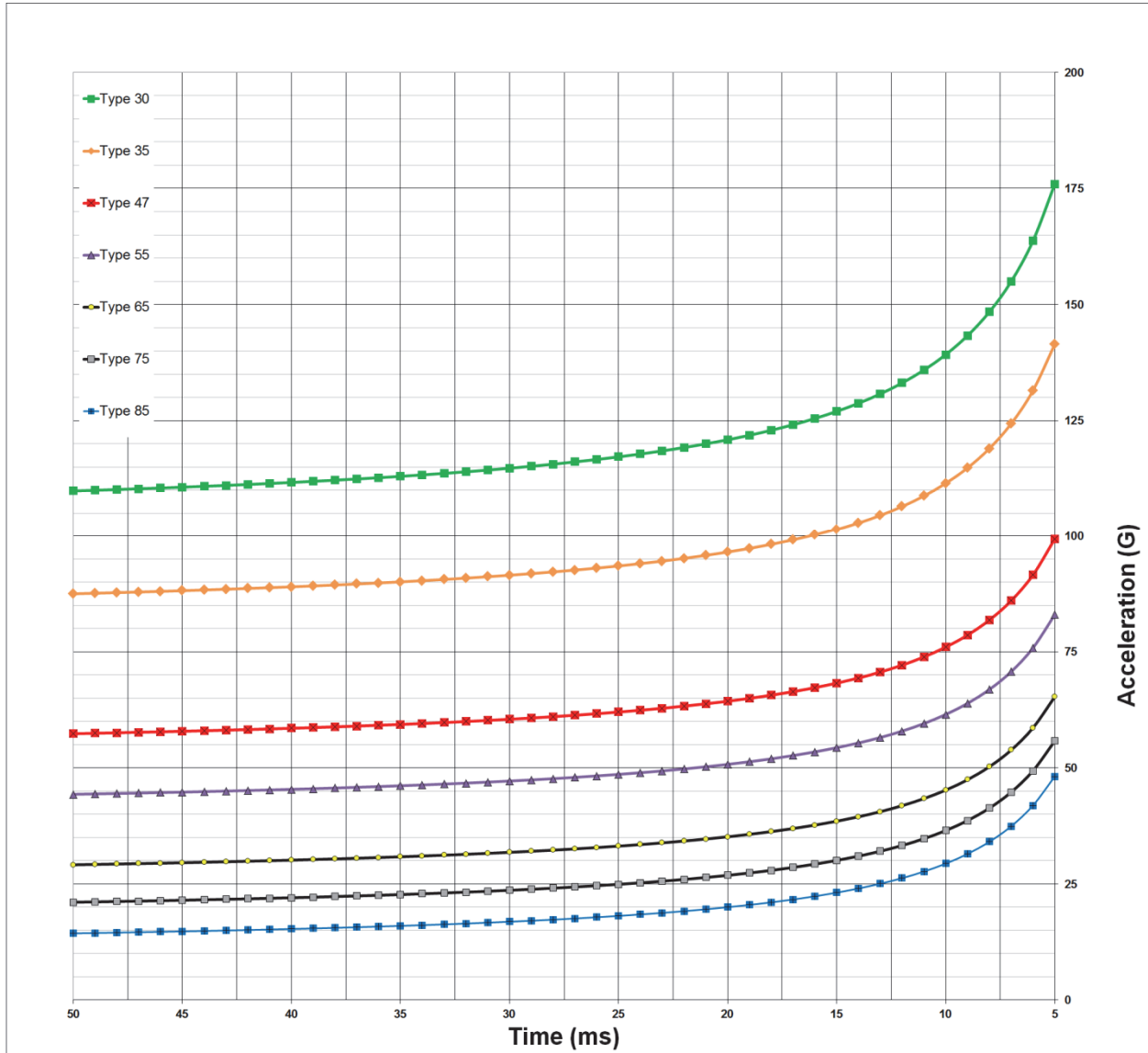


ShockWatch® Impact Indicator Activation

Label/Clip/Tube G-Level vs. Duration (ms)

5 to 50ms

Activation Occurs +/- 15% of the Nominal Activation Value



ShockWatch Label/Clip/Tube Response Equations

Activation curves for the ShockWatch Label, Clip, and Tube are based on the indicator receiving an impact at a 45° angle.

Product	Angle	Equation
Type 30 Label/Clip/Tube	45°	$G=367.2/t + 102.5$
Type 35 Label/Clip/Tube	45°	$G=299.8/t + 81.5$
Type 47 Label/Clip/Tube	45°	$G=233.1/t + 52.7$
Type 55 Label/Clip/Tube	45°	$G=215.0/t + 40$
Type 65 Label/Clip/Tube	45°	$G=201.1/t + 25.1$
Type 75 Label/Clip/Tube	45°	$G=193.0/t + 17.2$
Type 85 Label/Clip/Tube	45°	$G=187.8/t + 10.6$

The ShockWatch Label is most sensitive to impacts at a 45° angle; however, there is a slight deviation in the response of a ShockWatch Label to an impact at an angle of 90°. In most applications, this deviation is not relevant. However, there are some applications where precise impact values at specific angles are required.

The deviation in a ShockWatch indicator's response due to the change in angle generally follows this equation:

$$90^\circ \text{ acceleration (G) value} = 45^\circ \text{ acceleration (G) value} \div 0.7071$$

Knowing this characteristic of the ShockWatch Label can be a benefit. For instance, you may have a specific engineering application where you want an indicator that will react at a value that does not coincide specifically with one of the standard ShockWatch Label products. It is sometimes possible to simply change the orientation of the indicator to achieve the sensitivity required at a specific angle.

Note: The ShockWatch tube does not respond to impacts in the direction in which the red dye is housed.

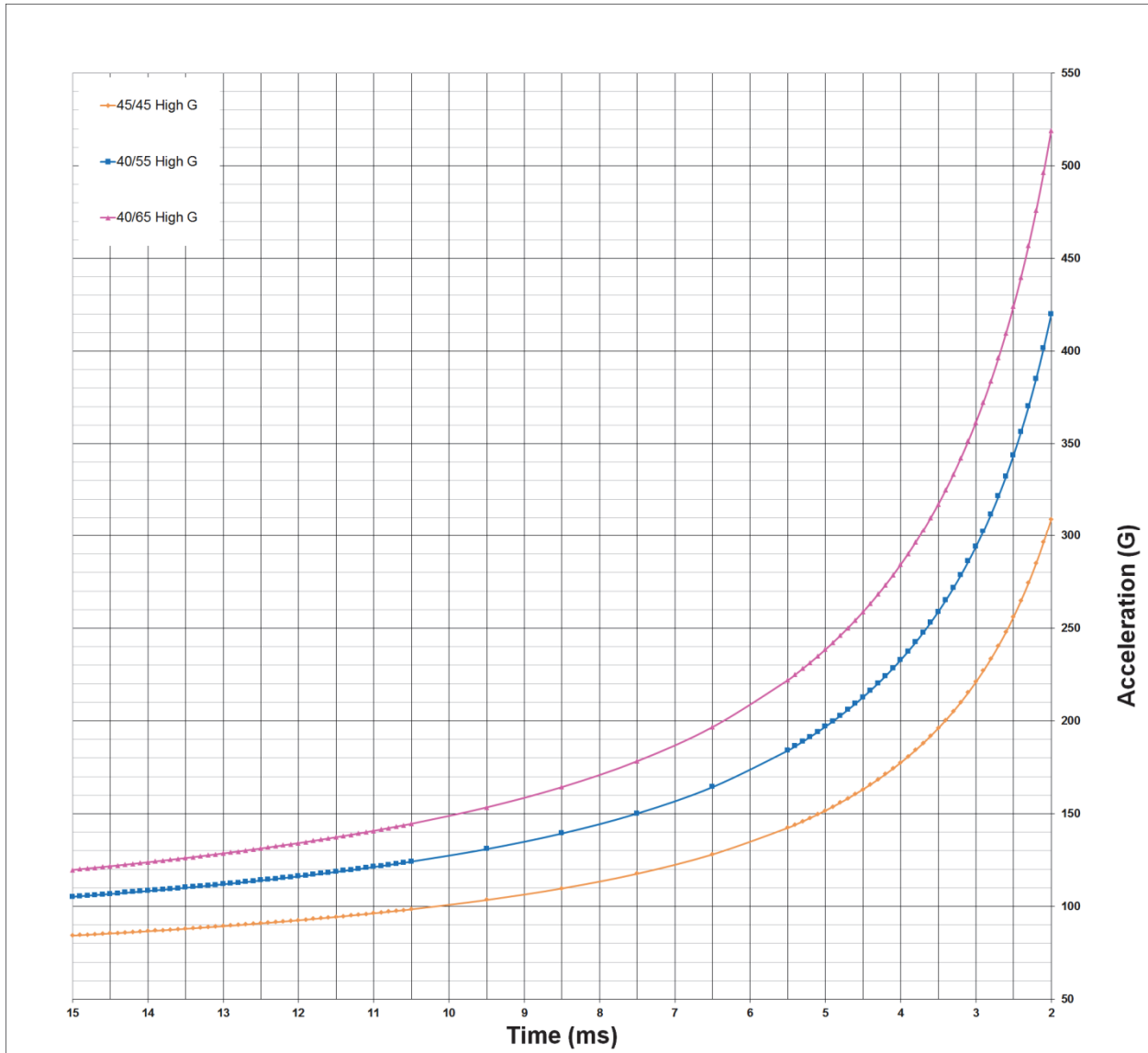
ShockWatch High G Clip/Tube

ShockWatch High G Clip/Tube Activation Graph - Response Curves

High G Clip/Tube G-Level vs. Duration (ms)

2 to 15ms

Activation Occurs +/- 15% of the Nominal Activation Value



ShockWatch High G Clip/Tube Response Equations

Activation curves for the ShockWatch Clip and Tube are based on the indicator receiving an impact at a 45° angle.

Product	Angle	Equation
Type 45/45 Clip/Tube	45°	$G=(526.77 / t^{-1.0389}) + 52.7$
Type 40/55 Clip/Tube	45°	$G=(750 / t^{-1.05}) + 65$
Type 40/65 Clip/Tube	45°	$G=(940/t^{-1.08}) + 65$

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ShockWatch MAG 2000

MAG 2000 Labeling Definitions

Each MAG 2000 is stamped with information that identifies the mounting orientation and the unit threshold setting when mounted according to that orientation.

Orientation definitions

A two-letter format is used to define the mounting orientation and configuration. The possible combinations are:

HH - Horizontal mount, horizontal configuration. For mounting on a horizontal surface, such as the top of a box. Configured to react to a horizontal impact at the activation value stamped on the device.

VH - Vertical mount, horizontal configuration. For mounting on a vertical surface, such as the side of a box. Configured to react to a horizontal impact at the activation value stamped on the device.

VV - Vertical mount, vertical configuration. For mounting on a vertical surface, such as the side of a box. Configured to react to a vertical impact at the activation value stamped on the device.

Device threshold setting

Each MAG 2000 is set to activate at the value stamped on the unit when mounted as per the suggested mounting orientation. Because the MAG 2000 can respond to very low acceleration values, the effect of gravity must be taken into consideration. Each MAG 2000 is set to compensate for the acceleration due to gravity when mounted as per the suggested mounting orientation.

The MAG 2000 will also respond to acceleration values not defined by its setting when the mounting orientation is changed. An example: for a MAG 2000 labeled as 5G HH, it would respond to 5G in the horizontal plane when mounted on a horizontal surface. If this device were mounted vertically, it would then have 1G of acceleration due to gravity working against it, thus its vertical activation would be the original 5G minus 1G and would net a 4G threshold. For this same device mounted vertically, its horizontal activation value would now be represented by the following equation:

$$\text{Horizontal response} = \sqrt{5^2 - 1^2} = 4.89G$$



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Another example uses the same vector math but yields a surprising answer. In an example of a 3G VH, by definition this device is set to activate at 3G in the horizontal direction when mounted to a vertical surface. With the vertical mounting, there is a constant 1G of acceleration due to gravity working against the device. To arrive at a 3G horizontal sensitivity the device must be set at a value that is actually higher than 3G. Here is the equation:

$$\text{Set value} = \sqrt{3^2 + 1^2} = 3.16G$$

If a 3G VH unit were mounted horizontally its horizontal response would be 3.16G, as derived in the equation above. Expanding from this concept, the same 3G VH device, when mounted vertically, would have a vertical response of 2.16G. This value is derived from the following equation:

$$\text{Vertical value} = \text{Horizontal value} - 1G \text{ (acceleration due to gravity)}$$

$$\text{Vertical value} = 2.16G = 3.16G - 1$$

Blocking guides

In some configurations, it is recommended that the MAG 2000 be fitted with guides that will block activation in certain directions. Guides that block vertical activation can be used in VH devices. The second example in the Device Threshold Setting section detailed that a 3G VH unit would respond to a 2.16G vertical acceleration. A guide could be installed in this example unit such that no vertical acceleration could activate the device. The use of a guide in this example would provide the user with assurance that any activation was specifically caused by a horizontal acceleration.

ShockWatch recommends using a guide in any VH unit that has a threshold setting of 2G or less.

ShockWatch MAG 2000 Activation Graph - Response Curves

MAG 2000 G-Level vs. Duration (ms)

0 to 50ms

Activation Occurs +/- 10% of the Nominal Activation Value

