Motorola MMA1201P Accelerometer Test Plan and Preliminary Test Results

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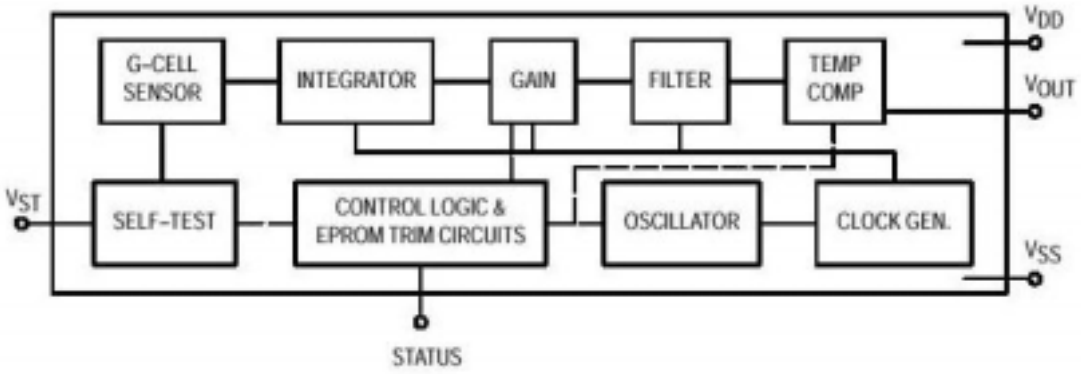
Part Description

Motorola MMA1201P is a single-axis, surface micromachined MEMS accelerometer rated for ±40 G and is packed in a plastic 16-lead DIP package. The operating temperature range is –40 °C to +85 °C with a storage temperature range of –40 °C to +105 °C. The part can sustain accelerations up to 2000 g from any axis while unpowered and powered accelerations up to 500 g.

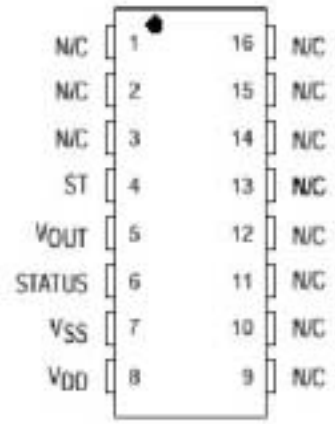
The main components of the MMA1201P consist of a surface micromachined capacitive sensing cell (g-cell) and a CMOS signal conditioning ASIC. The g-cell's mechanical structure is composed of three consecutive semiconductor plates, defining sensitivity along the Z-axis (orthogonal to flat plane of the chip). When the accelerometer system is subjected to accelerations with components parallel to the sensitive axis of the g-cell, the center plate moves relative to the outer stationary plates, causing two shifts in capacitance, one for each outer plate, proportional to the magnitude of force applied. The shifts in capacitance are then processed by the CMOS ASIC, which determines the acceleration of the system (using switched capacitor techniques), conditions and filters the signal, and returns a ratiometric high voltage output.

A fourth semiconductor plate located in the g-cell allows testing of the accelerometer mechanics and electronics. When this plate is properly biased, an electrostatic force causes the movable plate to displace, causing changes in capacitance that can be processed by the CMOS ASIC as an acceleration, returning an output voltage proportional to the test plate bias. A fault latch, which is linked to the self-test system, can deactivate the accelerometer in cases of insufficient supply voltage, clock frequency, or changes in EPROM parity to odd. A rising edge on the self-test input pin will reset the latch.

Functional Block Diagram



Pin Out Diagram



Pin No.	Pin Name	Description
1	—	Leave unconnected or connect to signal ground.
2 thru 3	—	No internal connection. Leave unconnected.
4	ST	Logic input pin to initiate self test.
5	V_{OUT}	Output voltage
6	Status	Logic output pin to indicate fault.
7	V_{SS}	Signal ground
8	V_{DD}	Supply voltage (5 V)
9 thru 13	Trim Pins	Used for factory trim. Leave unconnected.
14 thru 16	—	No internal connection. Leave unconnected.

Electrical Measurement Table

	Test Conditions	Min/Max Limits	Units
Output Voltage	VDD = 5V; T ≅ 21 °C; a = g_{Earth}	2.2 – 2.8	V
Supply Current	VDD = 5V; T ≅ 21 °C; a = g_{Earth}	4 – 6	mA
Sensitivity	a = g_{Earth} $\rightarrow$ 0 (rotate 90°)	47.5 – 52.5	mV/g
Status Output High	I_{LOAD} = 100 µA; Self-Test Logic High	> VDD - .8	V
Status Output Low	I_{LOAD} = -100 µA	< .4	V

Test Plan

I. Incoming Inspection
External examination, serialization, X-ray.

II. Thermal Cycling and Mechanical Shock
1. Low Range Thermal Cycle -40 to +105 °C (25 samples)
Electrical tests after 100, 200, 500, and 1000 cumulative cycles.

2. High Range Thermal Cycle -65 to +155 °C (25 samples)
Electrical tests after 30, 100, 200, 300, 500, 1000 cumulative cycles.

3. Mechanical Shocks 2000 g (20 samples)
Electrical tests after 30, 130, 430, 1430, 2500, 5000, 10000 cumulative shocks

III. Failure Analysis
All failed parts from cycling and shock tests sent to FA for inspection.

Preliminary Test Results

I. Thermal Cycles.

Test results are shown in Table 1 and in Figure 1.

Table 1. Temperature cycling results showing proportion of failures (%) out of 25 samples tested.

Number of Cycles	Temperature interval	
	-40 +105°C	-65 +155°C
0	0	0
30	0	8
100	0	20
300	4	96
1000	4	

II. Mechanical shock.

Test results are shown in Table 2.

Table 2. 2000 g Mechanical Shock Results. (25 samples).

Number of Shocks	Proportion of failures, %
0	0
30	0
130	16
430	20*
1430	20
2500	20
5000	20
10000	20

* One sample failed IDD high after 430 shocks, but then recovered after it was tapped several times, and showed normal IDD reading.

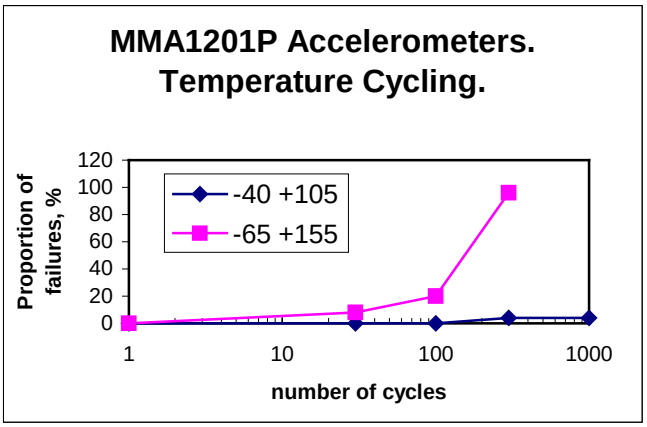


Figure 1.