ICS 49.035
CCS L 55

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 43939-2024

General test methods for servo circuits of quartz flexible accelerometers for space applications

宇航用石英挠性加速度计伺服电路通用测试方法

Issued on: April 25, 2024 **Implemented on: August 1, 2024**

Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC

Table of Contents

1 Scope

The document describes the methods for testing the parameters of the servo circuit of a quartz flexible accelerometer, called the circuit in the text.

It applies to the parameter testing of quartz flexible accelerometer servo circuits, and the servo circuits of other accelerometers may follow it by reference. The only normative reference is GB 50611-2010 on the antistatic design of electronic engineering works.

3 Terms and definitions

Eleven terms are defined. An accelerometer is the mechanical device that converts an acceleration quantity into a capacitance difference and that, together with the servo circuit, makes up an acceleration sensor; a note adds that the servo circuit has to be matched with an accelerometer for testing.

Quiescent current is the current flowing into the circuit under test through the supply terminal when the accelerometer is at 0g, g being the acceleration due to gravity, and no other input signal excitation is applied. Output noise voltage is the alternating voltage produced at the output terminal by the noise or interference of the circuit itself.

The +1g and the -1g output voltages are the direct voltage values measured across the sampling resistor at the circuit output with the accelerometer at +1g and at -1g. Output DC saturation voltage is the largest direct voltage the circuit can deliver, maximum output current the largest current it can deliver, and peak output voltage the largest undistorted alternating voltage it can deliver.

Resonance frequency is the frequency of the excitation signal that puts the circuit in resonance. Oscillation degree is the ratio of the gain at the resonance frequency point to the gain at low frequency, that is at the initial frequency. Bandwidth is the input signal frequency at which the gain has fallen by 3 dB relative to the gain at low frequency.

4 General requirements

Table 1 fixes the ports the circuit under test has to carry. It has four columns, serial number, port name, symbol and port definition, and eight rows.

The ports are: torquer low, ML, an output normally connected to the low end of the accelerometer torquer; torquer high, MH, an output normally connected to the high end; negative supply, Vee; positive supply, Vcc; ground, GND; self-test terminal, Tf, an input normally used for the Vsat measurement; differential capacitance sensing terminal 1, C1, an input normally connected to capacitor plate terminal 1 of the accelerometer; and differential capacitance sensing terminal 2, C2, an input normally connected to capacitor plate terminal 2.

The instruments and equipment used are a direct current power supply, a digital multimeter, an oscilloscope, a signal source and an accelerometer. They are to have been verified or calibrated and to be within the period of validity, with accuracy and precision meeting the test; their frequency range and measuring range are to suit the test; they are warmed up as their instructions require; during the test they are well earthed and electrostatic protection is applied, the antistatic performance of the test bench following GB 50611-2010; and the circuit test is made with an accelerometer connected, the accelerometer port definition being given in Figure 1.

The electrical test environment, unless otherwise specified, is an ambient temperature of -55 °C to +125 °C, an ambient pressure of 86 kPa to 106 kPa and an ambient humidity of 45 % RH to 65 % RH.

Operators are to be practised in the use of the instruments and equipment and clear about the test items and the criteria for reading the data, and they take electrostatic protection measures such as antistatic clothing, antistatic shoes and wrist straps.

5 Test methods

Each measurement is laid out in the same way: purpose, schematic diagram, test conditions and test procedure, with a precautions item where one is needed. The test conditions to be stated are the ambient temperature and the supply voltage value, and the later subclauses call up that same pair.

Quiescent current is measured with the circuit connected as in Figure 2, the load resistor being (1.00 +/- 0.05) kilohm, the accelerometer set to 0g, and the readings of the two ammeters taken as the quiescent current. The supply voltage is taken as the voltage at the terminal.

Output noise voltage is measured with the circuit connected as in Figure 3, the accelerometer at 0g, and the alternating voltage of the digital multimeter read as the result. The +1g and -1g output voltages use the same connection, with the accelerometer set to +1g and to -1g and the direct voltage of the multimeter read.

Output DC saturation voltage uses an electrical signal in place of a mechanical input: with the accelerometer at 0g, the signal source output is set in turn equal to Vcc and to Vee and the direct voltage of the multimeter is read. Maximum output current is measured on a load resistor of (200 +/- 10) ohm: the direct voltage is read with the signal source output set in turn to Vcc and Vee, and the current is obtained by dividing that voltage by the resistance of the load resistor.

Peak output voltage is measured with the accelerometer at 0g and a 200 Hz sine wave applied. The amplitude is adjusted while the output waveform is watched on the oscilloscope, and when the waveform reaches its largest undistorted amplitude the alternating voltage is read on the multimeter; the peak output voltage is then obtained from that reading by the equation given in the document.

Step response gives the overshoot and the number of oscillations. A 50 Hz square wave is applied with the accelerometer at 0g, the step response curve is taken from the oscilloscope, and the number of oscillations is read within plus or minus 5 % of the steady value. The overshoot is calculated from the steady value and the maximum value of the waveform.

Frequency characteristics give the oscillation degree, the resonance frequency and the bandwidth. A sine wave at 20 Hz is applied and the alternating voltage read; the frequency is then swept from 20 Hz to 2200 Hz and the largest alternating voltage read, the frequency at which it occurs being the resonance frequency and the ratio of the two voltages the oscillation degree. For the bandwidth the sweep is repeated and the frequency noted at which the alternating voltage has fallen to 0.707 times the value at 20 Hz, this being the bandwidth at -3 dB.

The irradiation test asks whether the circuit works in an irradiation environment and by how

much its parameters change after one. During irradiation the circuit is connected as in Figure 11 with a load resistor of (200 +/- 10) ohm and a capacitor of (56.0 +/- 5.6) pF, a sine wave of 400 Hz and 10 V peak to peak is applied and the output is observed on the oscilloscope; the conditions to be specified in the relevant documents are the irradiation environment test conditions and the supply voltage value. After irradiation the tests of 5.1 to 5.9 are repeated.

The precautions on irradiation fix the timing. The electrical parameter test items before and after irradiation follow the relevant provisions; the measurements before and after are made on the same test system with the same order of items and the same conditions; where the circuit is carried from the irradiation source to a remote test position and back, the ambient temperature is not to exceed the irradiation ambient temperature by more than 10 °C; the interval from the end of irradiation to the start of the electrical parameter test is not to exceed 1 h; the circuit is then held in dry ice at not higher than -60 °C with all its ports short-circuited for not more than 72 h, and its recovery from dry ice storage to room temperature testing takes not more than 30 min; and the interval between the end of one irradiation and the start of the next is not to exceed 2 h.