P&P LMC s.r.l.

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VIBRATION TESTS ON "IS 2" RACK SYSTEMS

RACK WITH VIBRATION DUMPERS

TEST REPORT

ON BEHALH OF: ABB SPA - ABB SACE DIVISION - MILANO

RT-AB-014/09-a rev. 00

Document of 25 pages

Written:	Michele Civera	03/03/2009
Verified and approved:	Alessandro Bonzi	05/03/2009

REVISIONS TRACK

Date	Version	Description of changes	Reference
March 2009	00	First issue	

The results are referred only to the tested items.

The quality system of P&P LMC fulfills the requirements of the ISO 9001 Standard for engineering services for structures and industrial products: qualification, experimental tests, numerical analyses, design and consultancy (CSQ Certificate No. 9175.ILMC – IQNet Certificate No. IT – 20582).

P&P LMC laboratory is qualified by RINA for the performance of Tests (3 – 12 – 13 – 17 – 20) listed in Annex IX of D.L. 299/2001 “Attuazione della direttiva 96/48/CE relativa all’interoperabilità del sistema ferroviario transeuropeo ad alta velocità” (Technical specification for interoperability relating to the infrastructure subsystem) (Qualification Certificate No. 05/2007 Rev. 0).

CONTENTS

1. GENERAL DATA

1.1. Customer

ABB S.p.A. – ABB SACE Division
Via Vittor Pisani, 16
20124 Milano (MI)
ITALIA

1.2. Unit under test

Vibration tests on a rack system IS-2 with vibration dumpers. The total mass of the equipment was about 400 kg.

1.3. Reference documents

1.3.1. Contract documents

a. Offer P&P LMC s.r.l No. OF-AB-017/09, dated February, 2 nd 2009.

b. Order ABB S.p.A. No. 4500496386/TP, dated February, 27 th 2009.

1.3.2. Documenti tecnici e normative

1. IEC 60068-2-6: Environmental testing - Part 2: Tests - Test Fc: Vibration (sinusoidal)
2. ISO 2041 Vibration and Shock – Vocabulary.

1.4. Test objective

The purpose of the tests was to demonstrate that, in the requested frequency range, vibration in two internal points are underd the threshold of 0,5 g when the excitation level at the base of the rack is 0,1 g.

1.5. Testing laboratory

P&P LMC Srl
Via Pastrengo, 9
24068 SERIATE (BG)
ITALY

1.6. Test date

February, 27 th 2009.

1.7. Responsibilities

Alessandro Bonzi, project leader – Michele Civera, test specialist.

1.8. Witnesses

Livio Corbetta	ABB S.p.A.
Ferrari	ABB S.p.A.

Litterini	ABB S.p.A.
AndreaTagliabue	ABB S.p.A.

2. TESTING PROCEDURES

2.1. General remarks

The tests consisted in:

- Vibration Response Investigation (VRI) tests in three different directions (X, Y, Z)

All the applied vibrations were monodirectional.

The in Z direction were performed on a vertical shaking table moved by an electro-dynamic shaker. For the other excitation directions, a horizontal shaking table was used. Excitation directions are shown in the photographs.

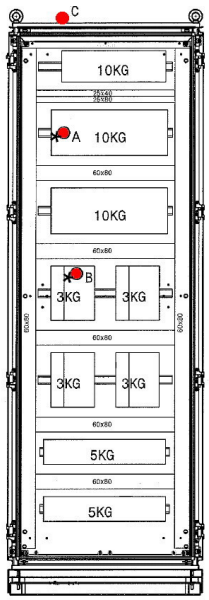
All the performed tests are listed in the tables of page 14.

2.2. Mounting techniques

For the tests the unit was fixed shaking table with No. 5 M12 screws with a tightening torque of 90 Nm.

2.3. Control and measuring positions

During the tests, for the motion control the signal of an accelerometer in the excitation direction (CP1) was used. Moreover, on the unit under test N.3 accelerometers were used to acquire the signal of the vibration in three characteristic points indicated by the customer (see figure and associated table).



Measuring positions	Accelerometer			Test Nr.
	Model	Serial number	Calibration document	
CP1: Control	353A	1374	SIT N. 178/S0037/09	All tests
MPA: position A	M353B18	71240	SIT N. 178/S0026/09	All tests
MPB: position B	M353B18	71238	SIT N. 178/S0025/09	All tests
MPC: position C	M353B18	71241	SIT N. 178/S0027/09	2 ÷ 3

2.4. Sine vibration tests

The specimen was subjected to sinusoidal scannings, with the following dynamic characteristics:

- Frequency range: 10-500 Hz;

- Peak acceleration: 0,1 g (g=9,81 m/s²);
- Sweep rate: 1 oct/min;
- Terst duration: 1 sweep for each axis;
- Excitation direction: X; Y; Z.

Signals from measuring accelerometers were processed to obtain the absolute response functions[1] of the control channel and the frequency transfer functions of the measuring channels on the unit.

3. MEASURING, EXCITATION AND DATA PROCESSING EQUIPMENT

3.1. Excitation equipment

Vibration tests in vertical direction were carried out using an electro-dynamic shaker manufactured by ELIN, type MZV 210 W 20 with the following characteristics:

- maximum sinusoidal dynamic force: 100 kN;
- moving element weight: 1000 N;
- frequency range: 0 ÷ 2000 Hz;
- max. displacement (peak to peak): 51 mm;
- max. velocity: 2000 mm/s;
- max. acceleration: 98 g.

Vibration tests in horizontal directions were carried out using a magnesium slip table (operated by the previously described ELIN shaker) with the following characteristics:

- maximum sinusoidal dynamic force: 100 kN;
- moving element weight: 3,4 kN;
- frequency range: 0 ÷ 500 Hz;
- max. displacement (peak to peak): 51 mm;
- max. velocity: 2000 mm/s;
- fixing surface: 1100 x 950 mm.

3.2. Measuring equipment

Accelerometers employed during all the tests were PCB 353 A and PCB 353 B18 monoaxial accelerometers with incorporated amplifiers.
The main characteristics of the accelerometers are listed below:

[1] The absolute response function is the phasor of the response signal, a complex number the magnitude of which is the amplitude of the first harmonic of the oscillation and the angle of which is the phase. The frequency response transfer function is the frequency dependent ratio of the motion-response phasor to the phasor of the excitation motion; this is a complex function and it is given graphically by curves showing the ratio of the first harmonic amplitude of the response signal to the first harmonic amplitude of the excitation signal and the relevant phase shift or phase angle versus the frequency.

PCB 353 A:

- Nominal sensitivity: 20 mV/g;
- Transverse sensitivity (max): < 5%;
- Frequency range: 1 ÷ 4000 Hz;
- Max. acceleration: 250 g;
- Resolution: 0,005 g;
- Weight: 0,10 N.

PCB M353 B18:

- Nominal sensitivity: 10 mV/g;
- Transverse sensitivity (max): < 5%;
- Frequency range: 1 ÷ 10000 Hz;
- Max. acceleration: 500 g;
- Resolution (rms): 0,005g;
- Weight: 0,02 N.

The frequency response of the whole measuring chain is flat, in the frequency range from 3 to 3000 Hz, with an accuracy of ± 5%.

Serial numbers of the employed accelerometers are listed in the above reported table. The instrumentation is submitted to a calibration program in accordance with internal procedures.

3.3. Data acquisition and processing instrumentation

During all the tests the shaker was controlled by a computer (the digital system LMS International) which is composed by an acquisition panel of 16 channels and by a PC. This control system generates the motion with the requested characteristics and feeds-back the shaker motion using the signal coming from the accelerometer chosen for the control.

Analogue signals coming from the accelerometers were amplified and conveyed to an analogue/digital converter, which sent the data to the disk storage of the aforementioned minicomputer for subsequent processing.

The block scheme of the excitation, acquisition and processing equipment is shown at page 13.

4. TEST RESULTS

Figures at pages 15 - 17 show the absolute response function relevant to the control accelerometer and the frequency transfer functions relevant to the measuring positions placed on the item obtained during the frequency response investigation test in Z direction (during this test measuring position C wasn't instrumented).

Figures at pages 18 - 21 show the absolute response function relevant to the control accelerometer and the frequency transfer functions relevant to the measuring positions placed on the item obtained during the frequency response investigation test in X direction (during this test measurement position MPC wasn't installed).

Figures at pages 22 - 25 show the absolute response function relevant to the control accelerometer and the frequency transfer functions relevant to the measuring positions placed on the item obtained during the frequency response investigation test in Y direction.

4.1. General remarks

At the end of the tests, at a visual inspection, no damages were detected on the tested equipments.

In all the measurement positions, we have transfer function module value under the threshold value fixed ad 5; due to this, for an excitation level of 0,1 g at the base of the rack, **the vibration level inside the rack is under the threshold of 0,5 g indicated in the "Test objective" paragraph. The test result is POSITIVE**.

The results of further checks on the unit are of CUSTOMER's responsibility.

LIST OF FIGURES

PHOTO DOCUMENTATION

Photo 1: Control position for vertical shaking table

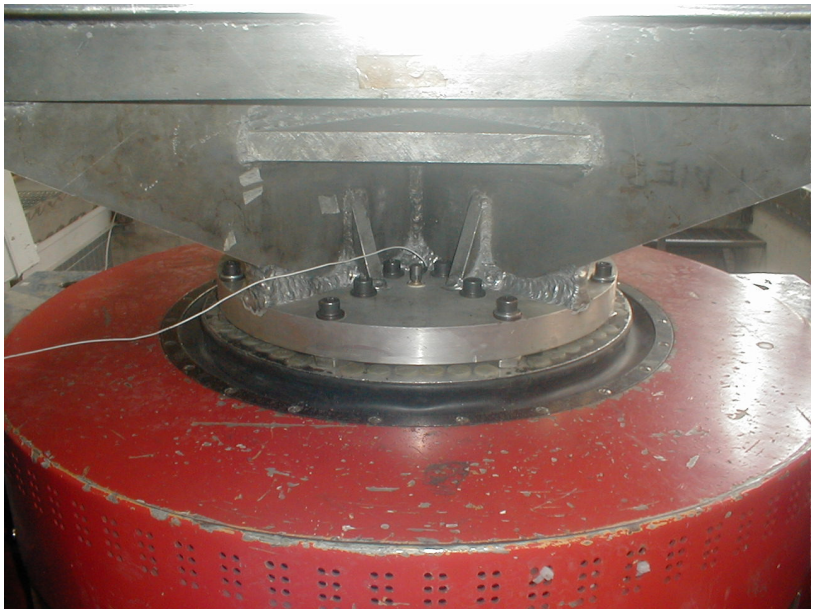


Photo 2: Control position for horizontal shaking table

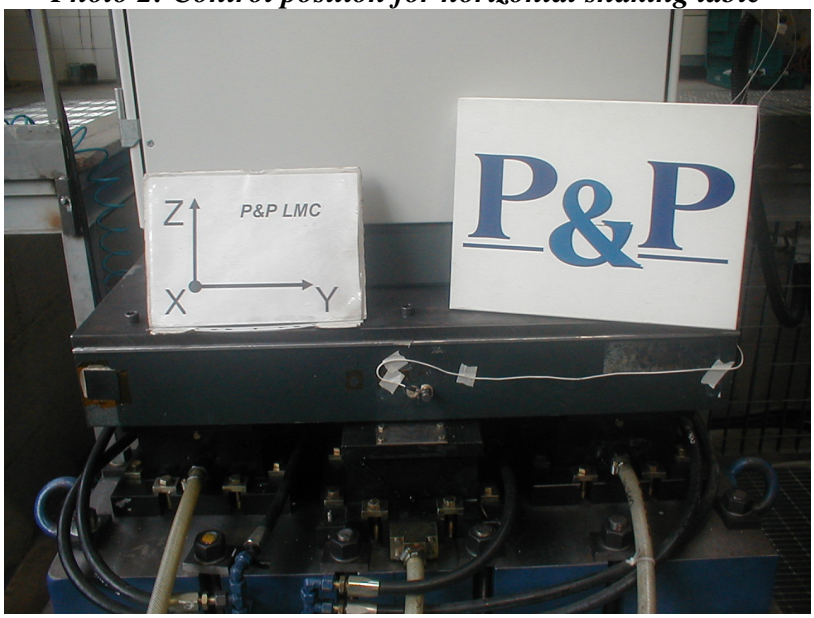


Photo 3: Measurement positions A and B

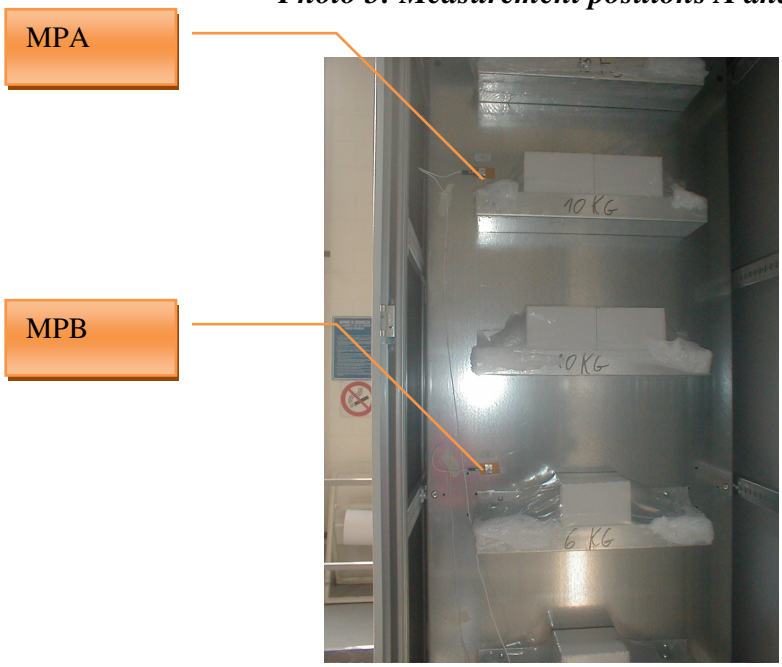


Photo 4: Measurement positions A and C

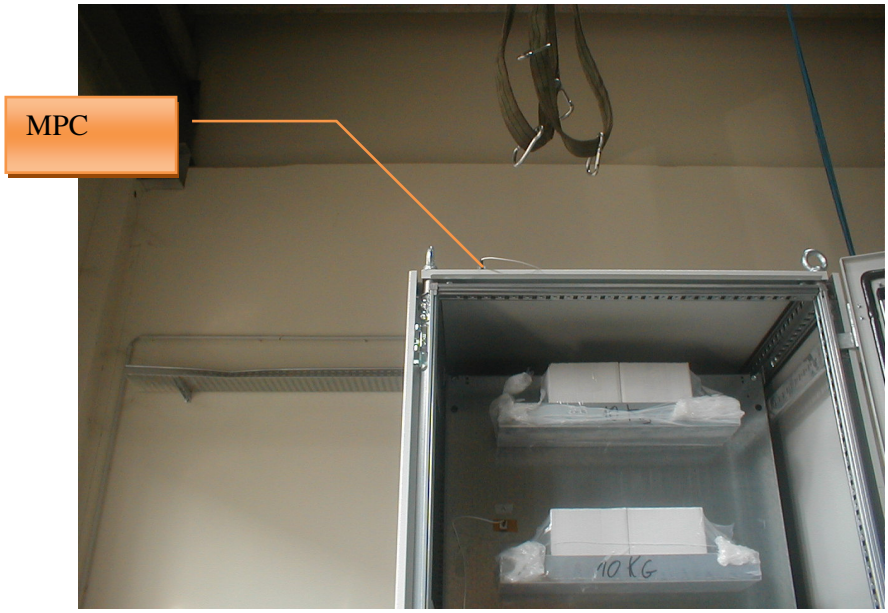
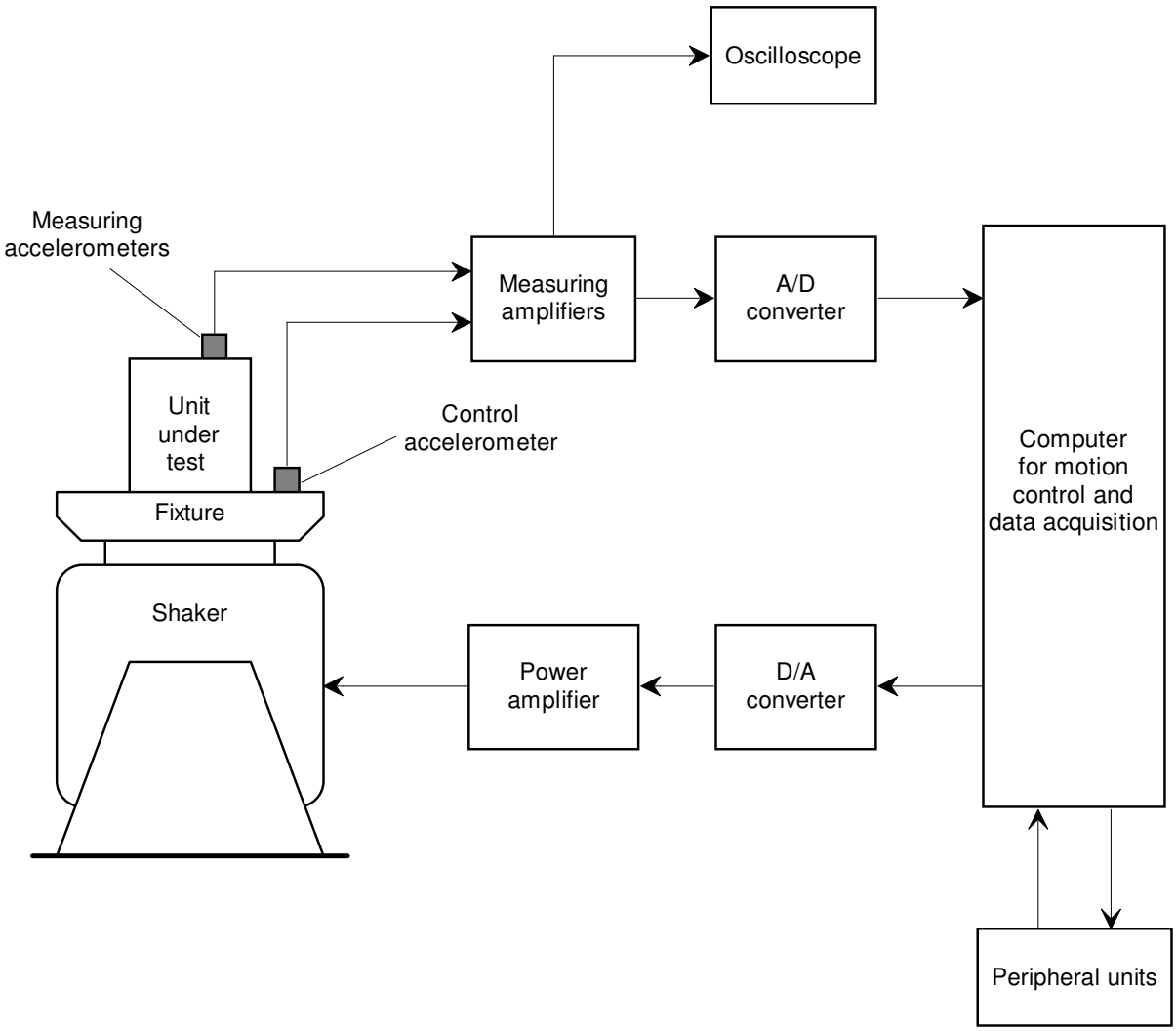


Photo5: Rack on vertical shaking table

Photo6: Rack on horizontal shaking table

BLOCK DIAGRAM RELEVANT TO THE DYNAMIC TESTS

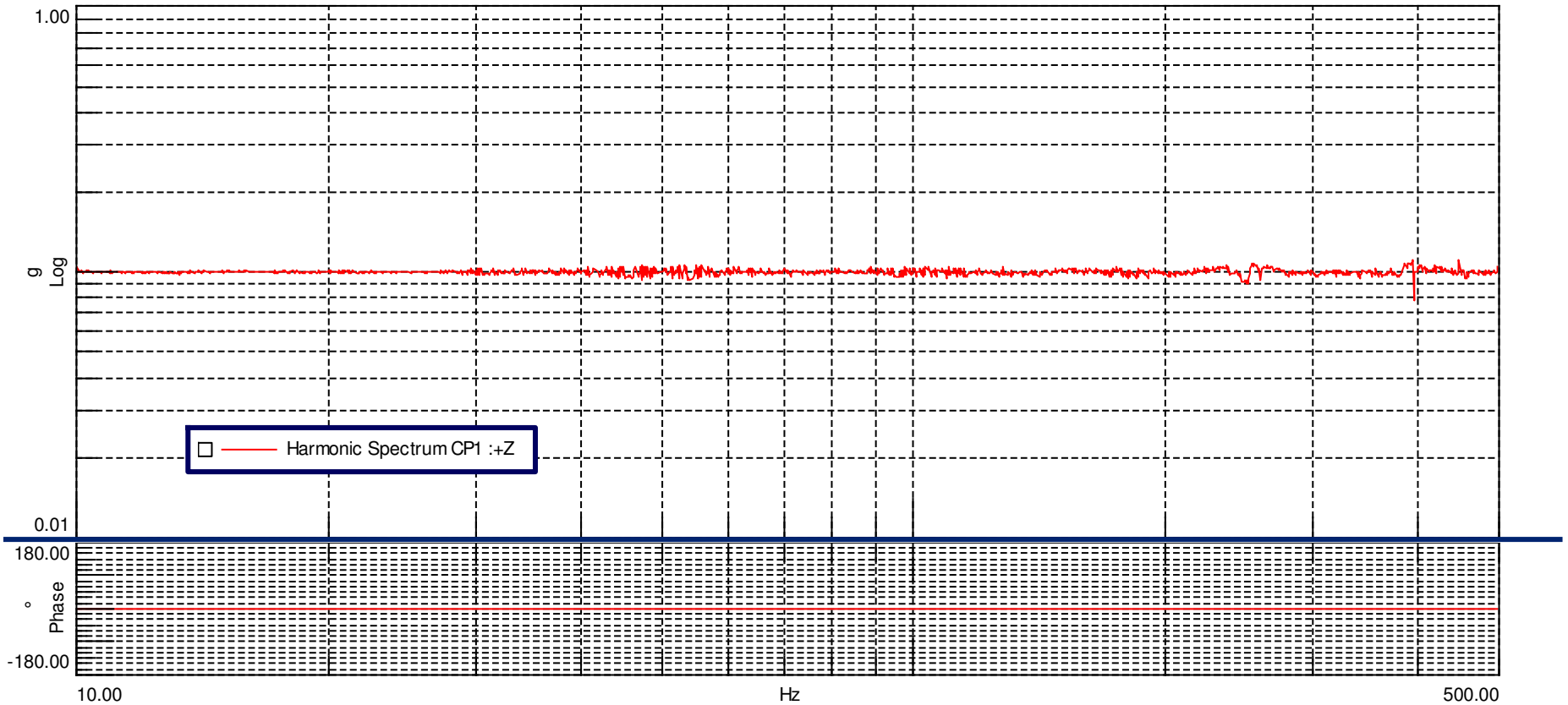


TEST LIST

N.	Test	Excitation axis	Test parameters	Duration	Pages
1	Insulated rack Sine test	Z	Frequency range: 10-500 Hz Acceleration: 0,1 g (g=9,81 m/s^2) Sweep rate: 1 oct/min	1 sweep	15 - 17
2	Insulated rack Sine test	X	Frequency range: 10-500 Hz Acceleration: 0,1 g (g=9,81 m/s^2) Sweep rate: 1 oct/min	1 sweep	18 - 21
3	Insulated rack Sine test	Y	Frequency range: 10-500 Hz Acceleration: 0,1 g (g=9,81 m/s^2) Sweep rate: 1 oct/min	1 sweep	22 - 25

Mechanical Test Laboratory – Sine Control

Project: AB01309	**Sweep done: 1**	**Control strategy: Average**
Section: Section1	**Sweep direction: Up**	**Reference id:**
Run: Sine_2	**Sweep mode: Log**	**Point id: Cp1**
Date: Thu Feb 26 2009 16:17:54	**Sweep rate: 1 Oct/min**	**Frequency resolution: Variable**



Mechanical Test Laboratory – Sine Control

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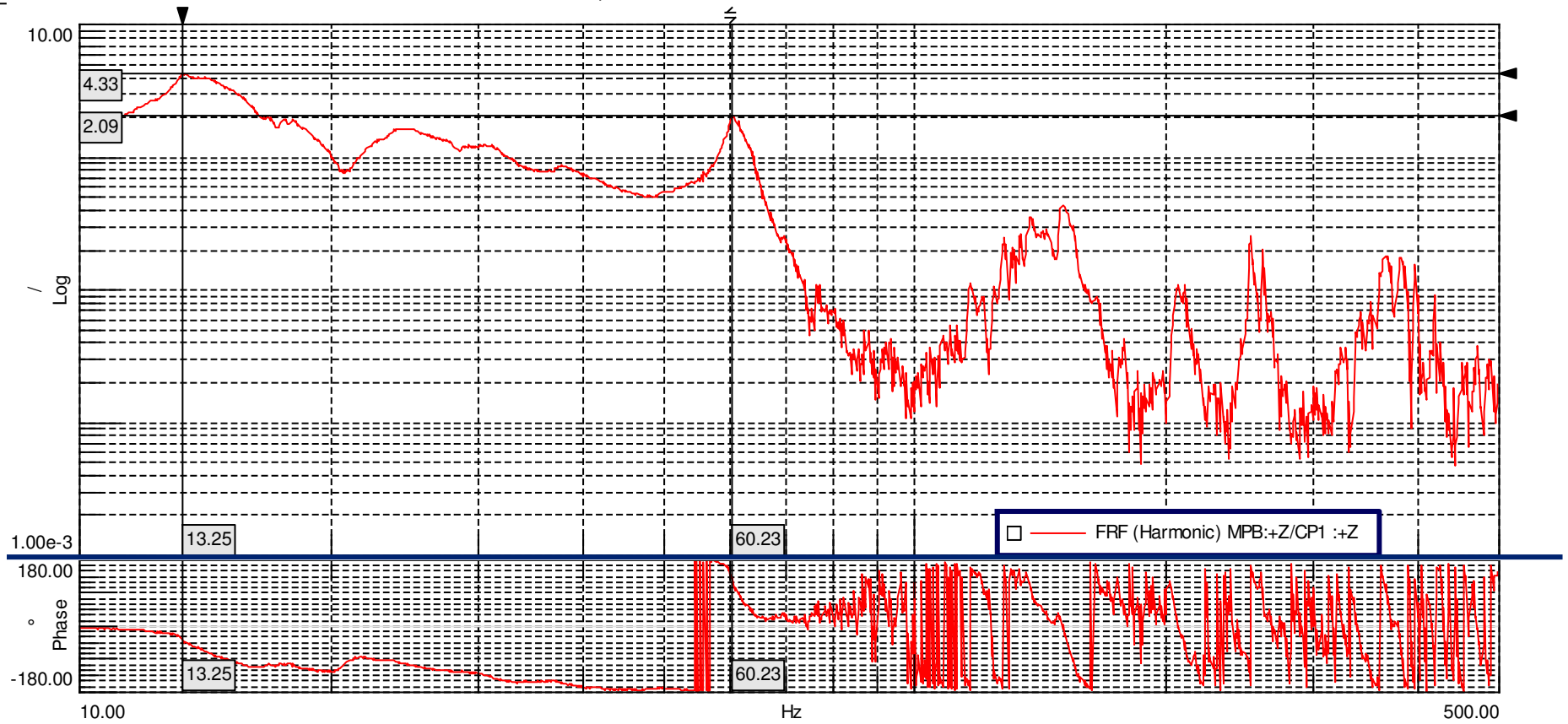

Mechanical Test Laboratory – Sine Control

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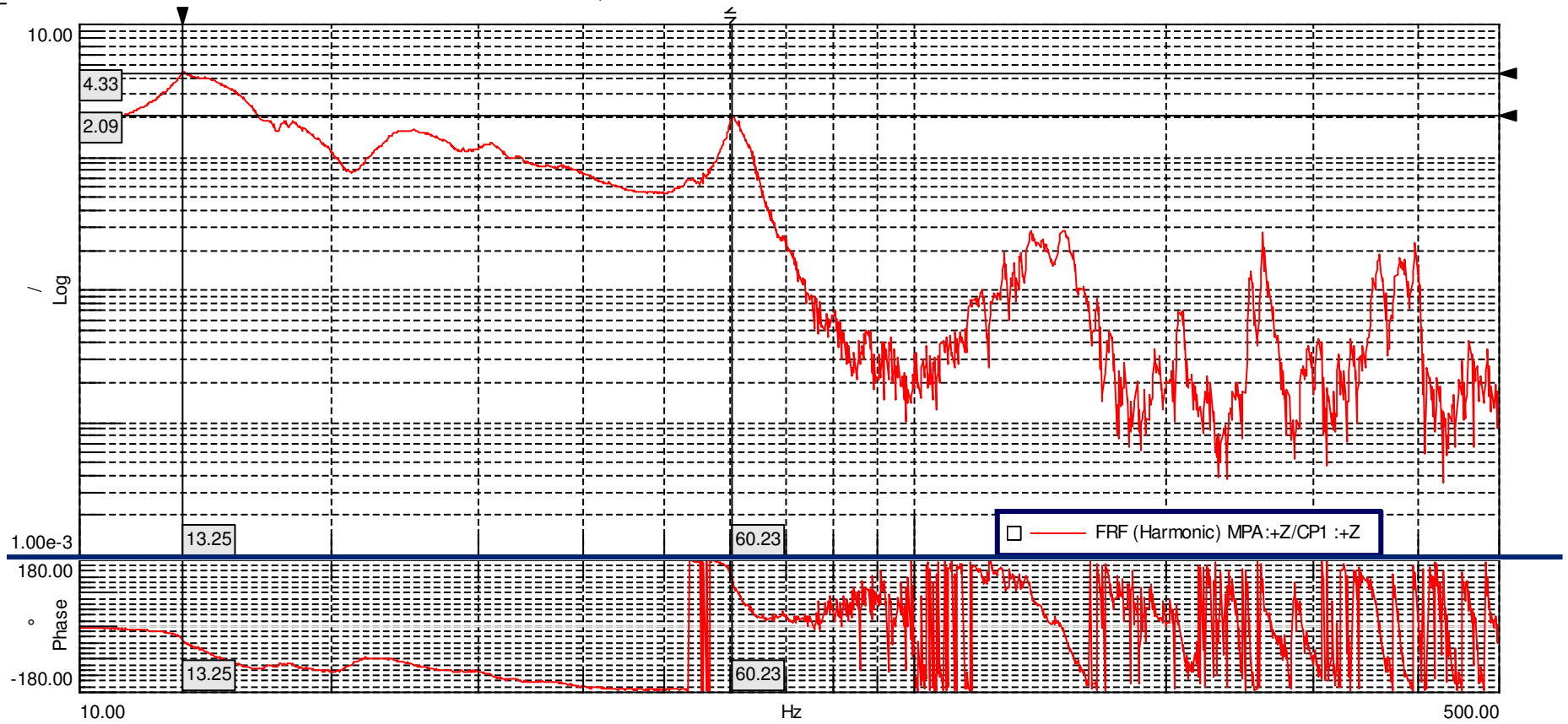

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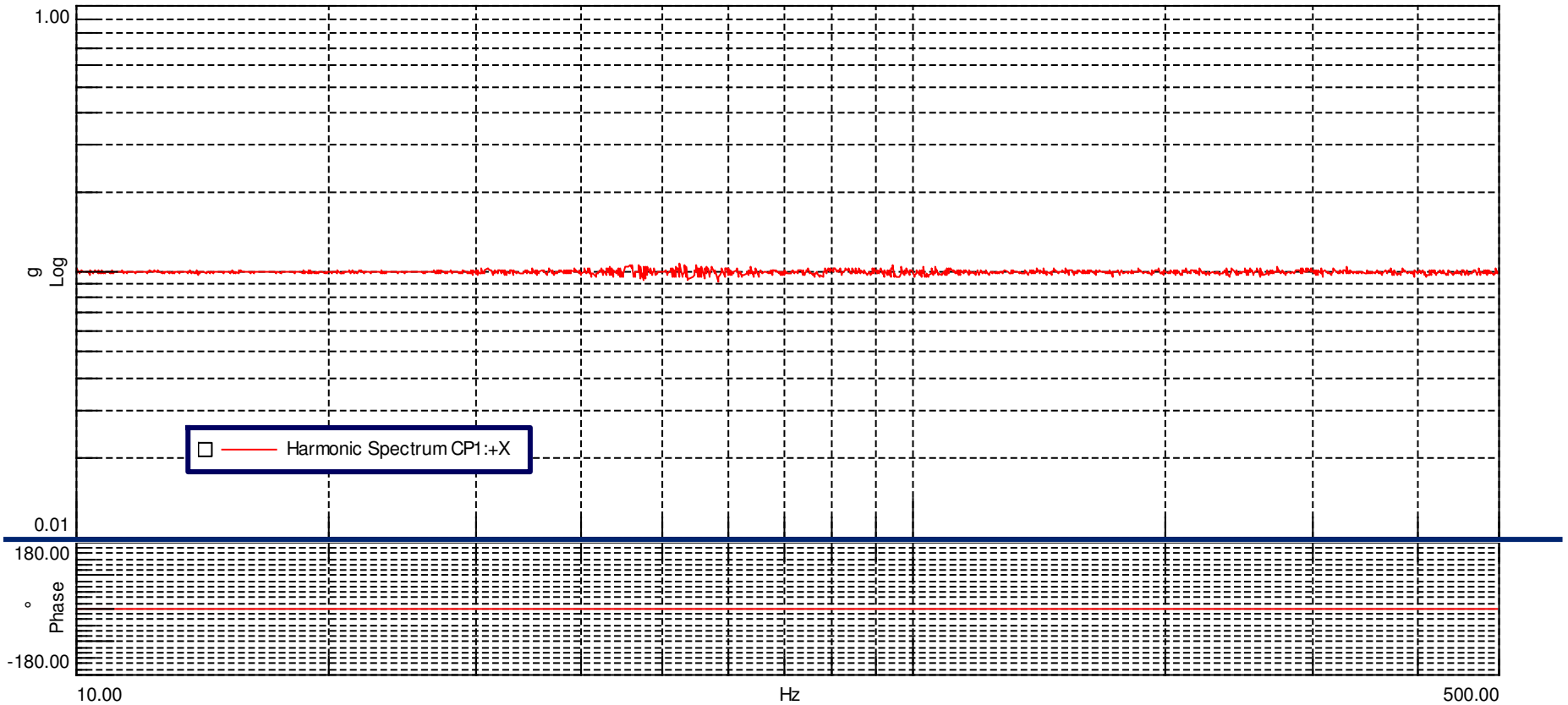

Mechanical Test Laboratory – Sine Control

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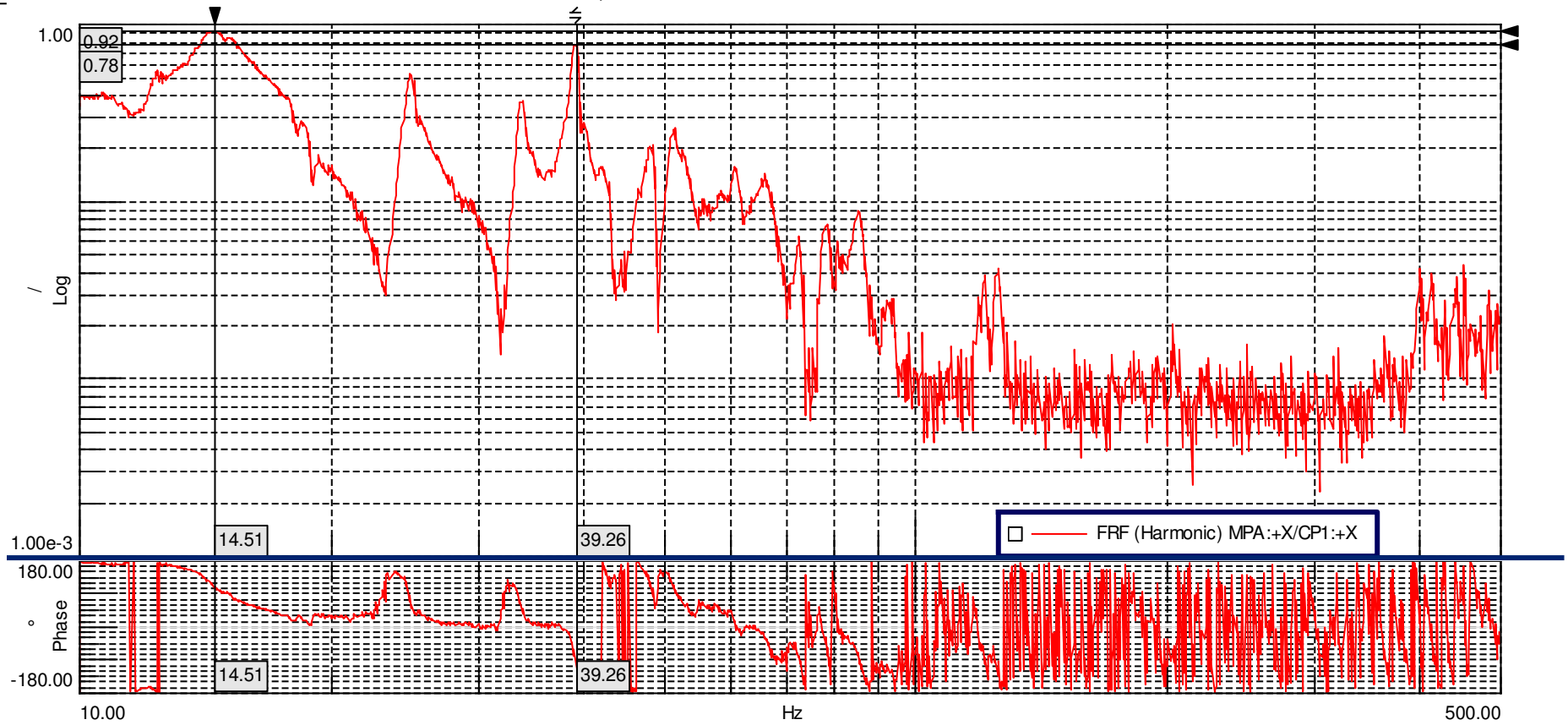

Mechanical Test Laboratory – Sine Control

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Section: Section1	**Sweep direction: Up**	**Reference id: CP1**
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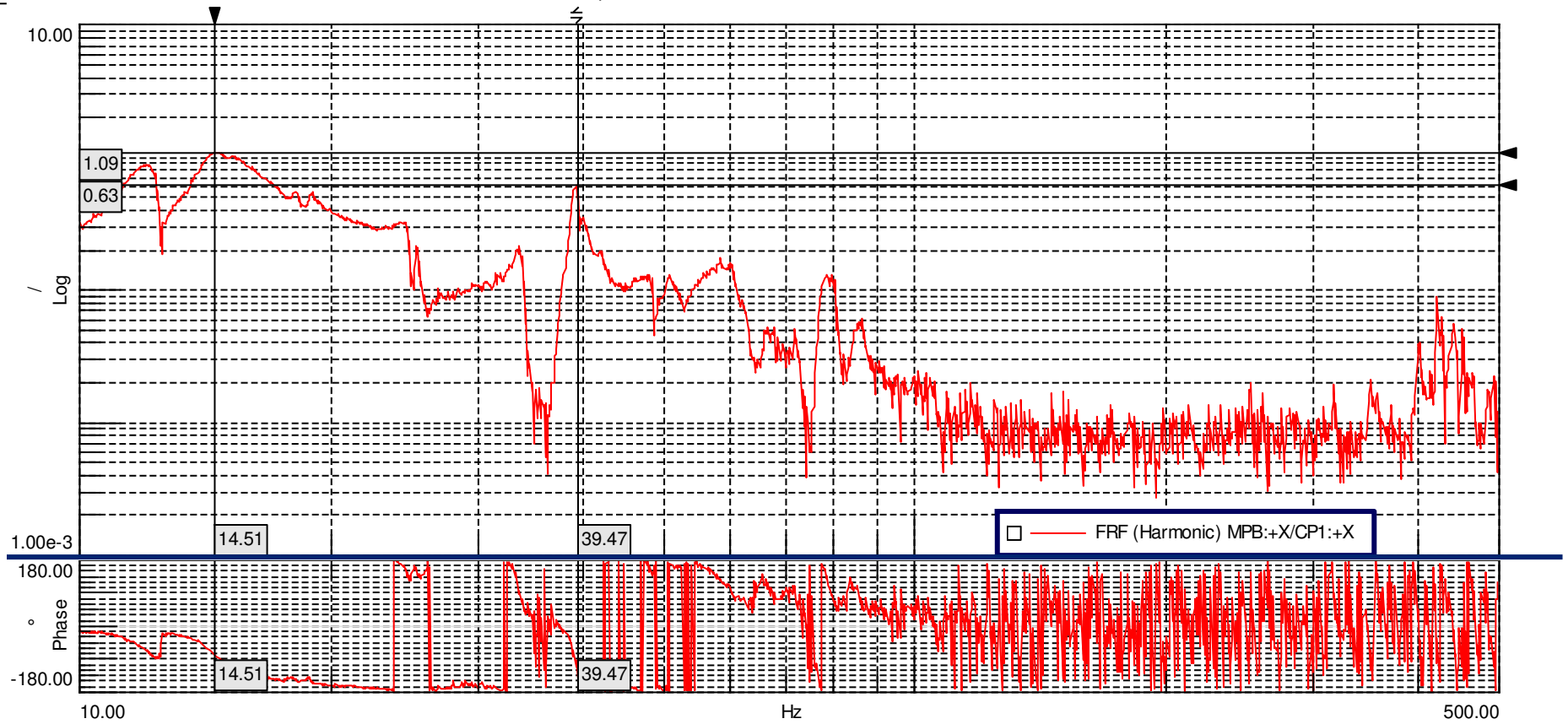

Mechanical Test Laboratory – Sine Control

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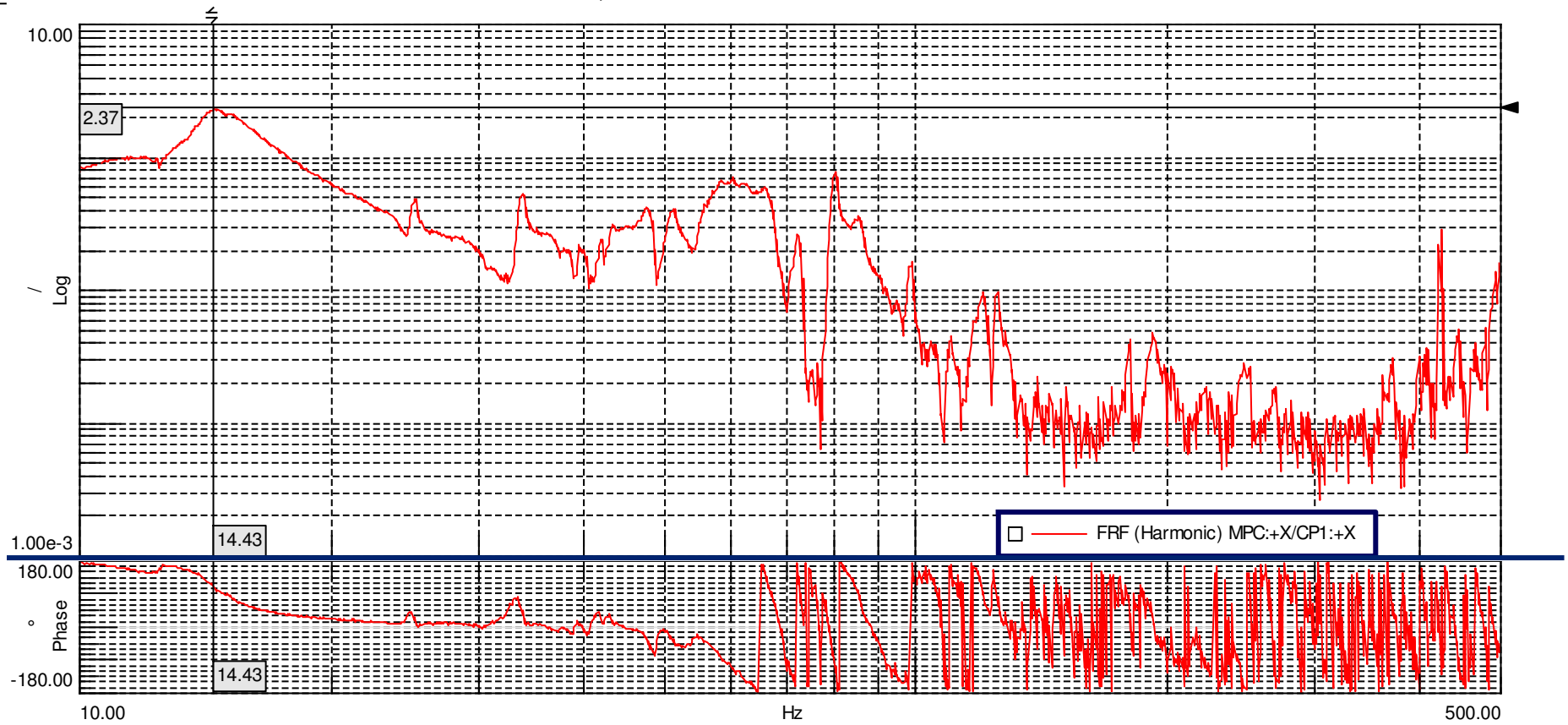

Mechanical Test Laboratory – Sine Control

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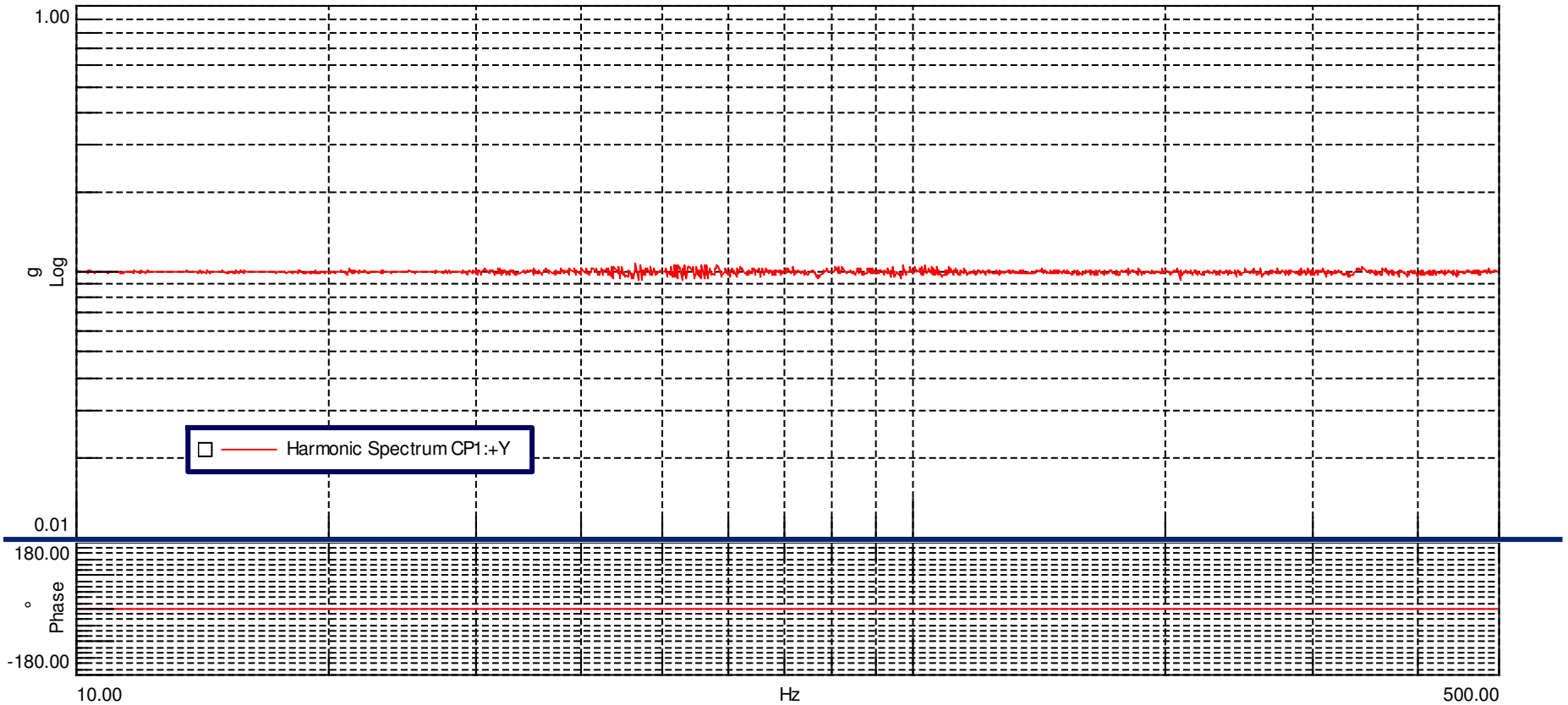

Mechanical Test Laboratory – Sine Control

Project: AB01309	**Sweep done: 1**	**Control strategy: Average**
Section: Section1	**Sweep direction: Up**	**Reference id: CP1**
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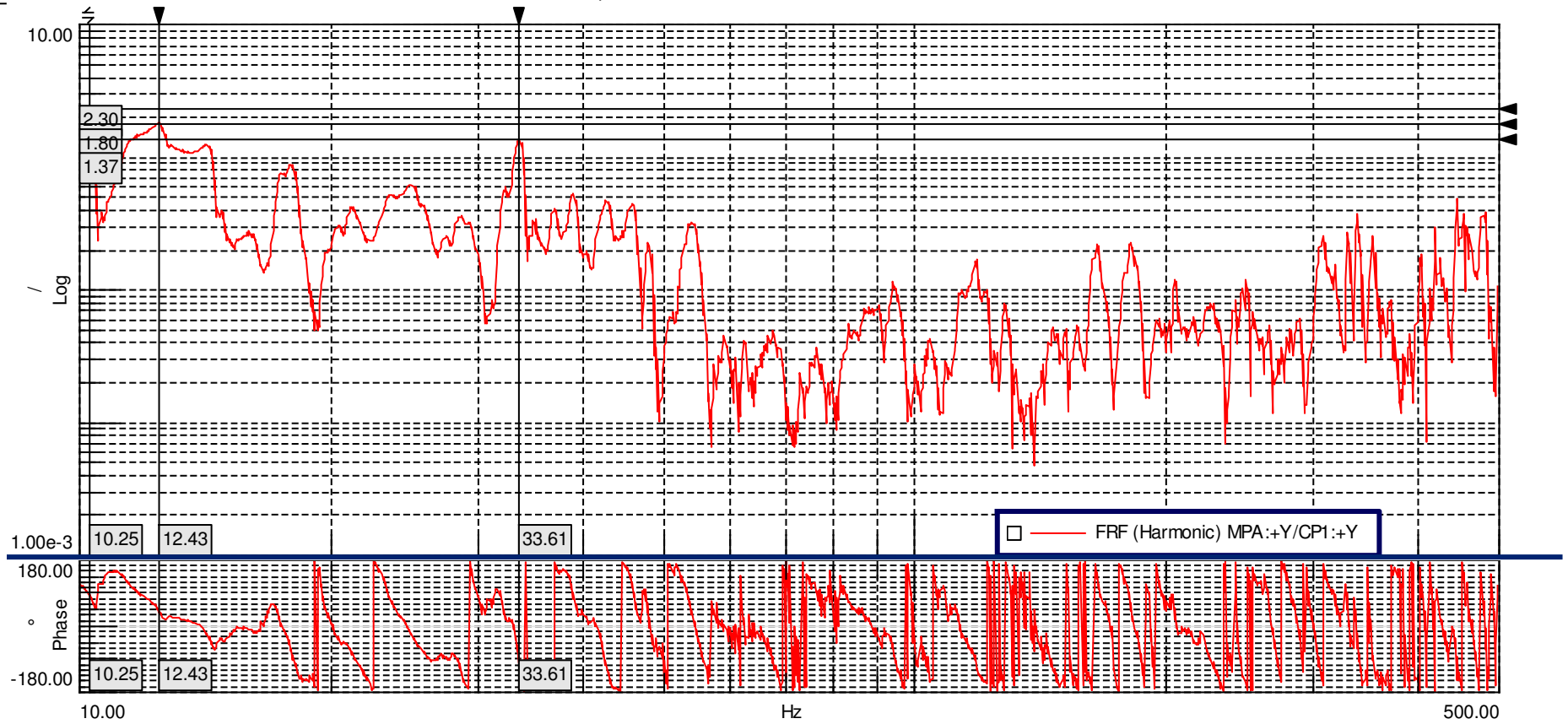

Mechanical Test Laboratory – Sine Control

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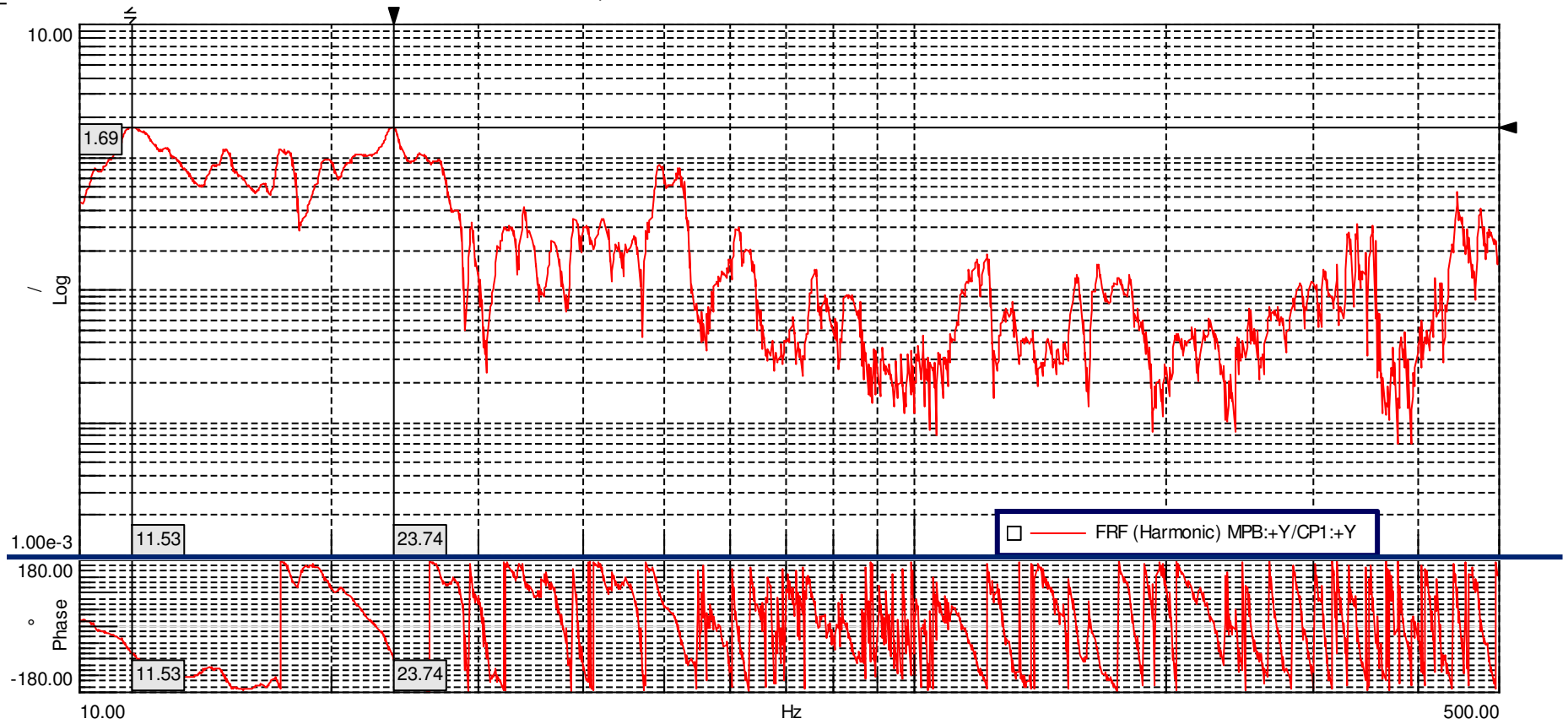

Mechanical Test Laboratory – Sine Control

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