APPENDIX B

Instrumentation Suite

May 16 2005

CH	SCU	CAB	S C	Name	Description	Location	Range		MODEL #	SERIAL #					
0	0	2	1	CTRSPKF1	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
1	1	1	2	CTRSPKF2	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
2	2	3	3	CTRSPKR1	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
3	3	4	4	CTRSPKR2	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
4	4	5		OUTSPKF1	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
5	5	6		OUTSPKF2	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
6	6	7		OUTSPKR1	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
7	7	8		OUTSPKR2	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain
8	8	9		CTRSPKTEMP	Thermocouple, Spoke	Center Rotor	32-1832F	Omega			0-5Vdc	5B47-K-04		0.002778	v/deg f
9	9	10		CTRRTRTEMPL	Temperature of Braking Surface, Infrared Sensor	Center Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f
10	10	11		CTRRTRTEMPR	Temperature of Braking Surface, Infrared Sensor	Center Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f
11	11	12		OUTRTRTEMPL	Temperature of Braking Surface, Infrared Sensor	Outer Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f
12	12	13		OUTRTRTEMPR	Temperature of Braking Surface, Infrared Sensor	Outer Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f
13	13	14		SPEED	Speed; sine from encoder	slip ring	+/-5v	michigan scientific			+/-5Vdc	5B41-02			
15	15			SPARE	spare							5B41-02			
14	14	15	5	AXLELAT	Lateral Acceleration, Axle Mounted	Axle	+/-200g	Silicon Design	2410-200	07133	+/-5Vdc	5B41-02		19.7	mV/G
16	0	1	6	LBOXLAT	Lateral Acceleration, Axle	Axle Box Left	+/-200g	Kistler	8786A200r	C196141	+/-2.5Vdc	5B41-02		9.57	mV/G
17	1	2	7	LBOXVERT	Vertical Acceleration, Axle	Axle Box Left	+/-500g	Kistler	8702B500	2009710	+/-2.5Vdc	5B41-02		10.25	mV/G
18	2	1	9	RBOXLAT	Lateral Acceleration, Axle	Axle Box Right	+/-200g	Silicon Design	2430-200	486	+/-5Vdc	5B41-02	x	50	mV/G
19	3	2	8	RBOXVERT	Vertical Acceleration, Axle	Axle Box Right	+/-200g	Silicon Design	2430-200	486	+/-5Vdc	5B41-02	z	50	mV/G
20	4	1	10	CTRCALPLAT	Lateral Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G
21	5	2	11	CTRCALPVERT	Vertical Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G
22	6	3	12	CTRCALPLONG	Longitudinal Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G
23	7	1		CTRCALALAT	Lateral Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0006	+/-5Vdc	5B41-02		50	mV/G
24	8	3		CTRCALAVERT	Vertical Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0006	+/-5Vdc	5B41-02		50	mV/G
25	9	2		CTRCALALONG	Longitudinal Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0006	+/-5Vdc	5B41-02		50	mV/G
26	10	1		OUTCALPLAT	Lateral Acceleration, Caliper, Near Pad	Outer Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G
27	11	2		OUTCALPVERT	Vertical Acceleration, Caliper, Near Pad	Outer Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G
28	12	3		OUTCALPLONG	Longitudinal Acceleration, Caliper, Near Pad	Outer Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G
29	13	30		PIPEPRESS	Brake Pipe Pressure		0-200 psi	Omega	px41c1-20(	148187	0-2.5V	5B41-07		0.012508	V/PSI
30	14	31		CYLPRESS	Brake Cylinder Pressure	Center Caliper	0-200 psi	Omega	px41c1-20(	148202	0-2.5V	5B41-07		0.0125	V/PSI
31	15	32		PARKPRESS	Brake Park Pressure	Center Caliper	0-200 psi	Omega	px41c1-20(	148201	0-2.5V	5B41-07		0.012498	V/PSI

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CH	SCU	CAB	S C	Name	Description	Location	Range		MODEL #	SERIAL #							inv N	shunt	
0	0	2	1	CTRSPKF1	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	uStrain max
1	1	1	2	CTRSPKF2	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	uStrain max
2	2	3	3	CTRSPKR1	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	uStrain max
3	3	4	4	CTRSPKR2	Strain Gage	Center Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	uStrain max
4	4	5		OUTSPKF1	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	
5	5	6		OUTSPKF2	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	
6	6	7		OUTSPKR1	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	
7	7	8		OUTSPKR2	Strain Gage	Outer Rotor					+/-5Vdc	5B38-02	gf=2.03	5911.33	uStrain			2955.682	
8	8	9		CTRDSKTEMP	Thermocouple, Spoke	Center Rotor	32-1832F	Omega			0-5Vdc	5B47-K-04		0.002778	v/deg f		360	1800	
9	9	10		CTRRTRTEMPL	Temperature of Braking Surface, Infrared Sensor	Center Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f		320	1600	
10	10	11		CTRRTRTEMPR	Temperature of Braking Surface, Infrared Sensor	Center Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f		320	1600	
11	11	12		OUTRTRTEMPL	Temperature of Braking Surface, Infrared Sensor	Outer Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f		320	1600	
12	12	13		OUTRTRTEMPR	Temperature of Braking Surface, Infrared Sensor	Outer Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f		320	1600	
13	13	14		SPEED	Speed; sine from encoder	slip ring	+/-5v	michigan scientific			+/-5Vdc	5B41-02							
15	15			SPARE	spare							5B41-02							
14	14	15	5	AXLELAT	Lateral Acceleration, Axle Mounted	Axle	+/-200g	Silicon Design	2410-200	07133	+/-5Vdc	5B41-02		19.7	mV/G		0.0508		
16	0	1	6	LBOXLAT	Lateral Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95259	+/-2.5Vdc	5B41-02		10	mV/G		0.1000		
17	1	2	7	LBOXVERT	Vertical Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95604	+/-2.5Vdc	5B41-02		10	mV/G		0.1000		
18	2	1	9	RBOXLAT	Lateral Acceleration, Axle	Axle Box Right	+/-200g	Silicon Design	2430-200	486	+/-5Vdc	5B41-02	x	50	mV/G		0.0200		
19	3	2	8	RBOXVERT	Vertical Acceleration, Axle	Axle Box Right	+/-200g	Silicon Design	2430-200	486	+/-5Vdc	5B41-02	z	50	mV/G		0.0200		
20	4	1	10	CTRCALPLAT	Lateral Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G		0.0200		
21	5	2	11	CTRCALPVERT	Vertical Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G		0.0200		
22	6	3	12	CTRCALPLONG	Longitudinal Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G		0.0200		
23	7	1		CTRCALALAT	Lateral Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0006	+/-5Vdc	5B41-02		50	mV/G		0.0200		
24	8	3		CTRCALAVERT	Vertical Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0006	+/-5Vdc	5B41-02		50	mV/G		0.0200		
25	9	2		CTRCALALONG	Longitudinal Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0006	+/-5Vdc	5B41-02		50	mV/G		0.0200		
26	10	1		OUTCALPLAT	Lateral Acceleration, Caliper, Near Pad	Outer Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G		0.0200		
27	11	2		OUTCALPVERT	Vertical Acceleration, Caliper, Near Pad	Outer Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G		0.0200		
28	12	3		OUTCALPLONG	Longitudinal Acceleration, Caliper, Near Pad	Outer Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G		0.0200		
29	13	30		PIPEPRESS	Brake Pipe Pressure		0-200 psi	Omega	px41c1-20(	148187	0-2.5V	5B41-07		0.012508	V/PSI		79.9464		
30	14	31		CYLPRESS	Brake Cylinder Pressure	Center Caliper	0-200 psi	Omega	px41c1-20(	148202	0-2.5V	5B41-07		0.0125	V/PSI		80.0000		
31	15	32		PARKPRESS	Brake Park Pressure	Center Caliper	0-200 psi	Omega	px41c1-20(	148201	0-2.5V	5B41-07		0.012498	V/PSI		80.0160		

* Note - channels 1 and 2 on SCU1 were swapped 5/14/2005 after the test run

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CH	SCU	File	CAB	S C	SLIP RING	mike data collec cable	HIGH SP	Name	Description	Location	Range		MODEL #	SERIAL #					
0	0	1	2	1	1			CTRSPK6F1	Strain Gage	Center Rotor R6					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
1	1	2	1	2	1			CTRSPK6F2	Strain Gage	Center Rotor R6					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
2	2	3	3	3	1	8	6	CTRSPK6R1	Strain Gage	Center Rotor R6					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
3	3	4	4	4	1		7	CTRSPK6R2	Strain Gage	Center Rotor R6					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
4	4	5			2	9	8	CTRSPK3R1	Strain Gage	Center Rotor R3					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
5	5	6			2		9	CTRSPK3R2	Strain Gage	Center Rotor R3					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
6	6	7			2	10	10	AXLECSPK6	Strain Gage	axle ; center Rot					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
7	7	8			2		11	AXLECSPK3	Strain Gage	axle ; center Rot					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
8	8	9			2	11	12	AXLEOSPK6	Strain Gage	Axle: 1/4					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
9	9	10			2		13	AXLEOSPK3	Strain Gage	Axle: 1/4					+/-5Vdc	5B38-02	gf=2.03	5911.330049	uStrain
10	10	11	9		1	12		CTRDSKTEMP	Thermocouple, Rotor	Center Rotor	32-1832F	Omega			0-5Vdc	5B47-K-04		0.002777778	v/deg f
11	11	12	10					CTRRTRTEMPL	Temperature of Braking Surface, Infrared Sensor	Center Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f
12	12	13	11					CTRRTRTEMPR	Temperature of Braking Surface, Infrared Sensor	Center Rotor	0-1600F	Omega			0-5Vdc	5B41-02		0.003125	v/deg f
13	13	14	14			4	14	SINE	Speed; sine from encoder	slip ring	+/-5v	michigan scientific			+/-5Vdc	5B41-02			
14	14	16	15	5		5	4	AXLELAT	Lateral Acceleration, Axle Mounted	Axle	+/-200g	Silicon Design	2410-200	07133	+/-5Vdc	5B41-02		19.7	mV/G
15	15							BAD								5B41-02			
16	0	17	1	6			1	LBOXLAT	Lateral Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95259	+/-2.5Vdc	5B41-02		10	mV/G
17	1	18	2	7			0	LBOXVERT	Vertical Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95604	+/-2.5Vdc	5B41-02		10	mV/G
18	2	19	1	9			3	RBOXLAT	Lateral Acceleration, Axle	Axle Box Right	+/-250g	PCB	J353B01	97687	+/-2.5Vdc	5B41-02		10	mV/G
19	3	20	2	8			2	RBOXVERT	Vertical Acceleration, Axle	Axle Box Right	+/-250g	PCB	J353B01	97688	+/-2.5Vdc	5B41-02		10	mV/G
20	4	21	1	10		14		CTRCALPLAT	Lateral Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G
21	5	22	2	11		13		CTRCALPVERT	Vertical Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G
22	6	23	3	12				CTRCALPLONG	Longitudinal Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Design	2440-100	0005	+/-5Vdc	5B41-02		50	mV/G
23	7	24	1					CTRCALALAT	Lateral Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G
24	8	25	3					CTRCALAVERT	Vertical Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G
25	9	26	2					CTRCALALONG	Longitudinal Acceleration, Caliper, Near Actuator	Center Caliper	+/-100g	Silicon Design	2440-100	0012	+/-5Vdc	5B41-02		50	mV/G
26	10	27				6	5	AXLELAT2	Lateral Acceleration, Axle Mounted	Axle	+/-500g	Dytran	3030b4	12361	+/-5Vdc	5B41-02		10.1	mV/G
27	11	28					15	SYNC	Synchronization signal	signal generator	+/-4V	0.5hz to 5Hz 5Secs tri			+/-5Vdc	5B41-02			volts
28	12	29				7		AXLELAT3	Lateral Acceleration, Axle Mounted	Axle	+/-500g	Endeveco	7264b-500		+/-5Vdc	5B41-02	10v ex	0.8	mV/G
29	13	30	30			15		PIPEPRESS	Brake Pipe Pressure		0-200 psi	Omega	px41c1-20(	148187	0-2.5V	5B41-07		0.012508375	V/PSI
30	14	31	31					CYLPRESS	Brake Cylinder Pressure	Center Caliper	0-200 psi	Omega	px41c1-20(	148202	0-2.5V	5B41-07		0.0125	V/PSI
31	15	32	32					PARKPRESS	Brake Park Pressure	Center Caliper	0-200 psi	Omega	px41c1-20(	148201	0-2.5V	5B41-07		0.0124975	V/PSI

CHANNEL 14 AND 15 ARE SWAPPED IN DATA FILE WITH CHANNEL 14 IS CALCULATED SPEED

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PIN1=NO OFFSET
PIN3=OFFSET

CH	SCU	VISHAY ECTRON	ORG CAB	CABLE	display	AXLE-SLIPRING	Name	Description	Location	Range		MODEL #	SERIAL #			JUMPERS SCU		
0	0	na	15		3-2	1-1	AXLELAT1-1	Lateral Acceleration, Axle Mounted	Axle	+/-200g	Silicon Des	2410-200	07133	+/-5Vdc	5B41-02	NO OFF	19.7	mV/G
1	1	na	x pl		3-3	1	TRFLLAT1	Lateral Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0026	+/-5Vdc	5B41-02	NO OFF	197.10	mV/G
2	2	na	z pu		3-3	1	TRFLVERT1	Vertical Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0026	+/-5Vdc	5B41-02	NO OFF	199.00	mV/G
3	3	na	y pr		3-3	1	TRFLLONG1	Longitudinal Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0026	+/-5Vdc	5B41-02	NO OFF	197.10	mV/G
4	4	na	x pr		4-3	1	BRMTLAT1	Lateral Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0028	+/-5Vdc	5B41-02	NO OFF	197.00	mV/G
5	5	na	z pu		4-3	1	BRMTVERT1	Vertical Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0028	+/-5Vdc	5B41-02	NO OFF	198.10	mV/G
6	6	na				1	SINE1	Speed; sine from encoder	slip ring 1	+/-10Vdc	michigan scientific			+/-10Vdc		NO	1	
7	7	na				2	SINE2	Speed; sine from encoder	slip ring 3	+/-10Vdc	michigan scientific			+/-10Vdc		NO	1	
8	8	na	y pf		4-3	1	BRMTLONG1	Longitudinal Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0028	+/-5Vdc	5B41-02	NO OFF	196.70	mV/G
9	9	na	1			1	CTRCALPLAT1	Lateral Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0005	+/-5Vdc	5B41-02	NO OFF	50	mV/G
10	10	na	2			1	CTRCALPVERT1	Vertical Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0005	+/-5Vdc	5B41-02	NO OFF	50	mV/G
11	11	na	3			1	CTRCALPLONG1	Longitudinal Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0005	+/-5Vdc	5B41-02	NO OFF	50	mV/G
12	12	na	31			1	CYLPRESS1	Brake Cylinder Pressure	Center Caliper	0-200 psi	Omega	px41c1-200g1	148202	0-2.5V	5B41-07	NO OFF	0.0125	V/PSI
13	13	na	9			1-1	CTRDSKTEMP1	Thermocouple, Rotor	Center Rotor	32-1832F	Omega			0-5Vdc	5B47-K-04	OFF	0.002778	v/deg f
14	14	na					SYNC	Synchronization signal	signal generator	+/-4V	0.5hz to 5Hz 5Secs tri			+/-5Vdc	5B41-02	NO	1	
15	15	na		AXLE2-14	1-2	2-4	AXLELAT2	Lateral Acceleration, Axle Mounted	Axle	+/-500g	VibraMetric	7002hg2k	0902	+/-5Vdc		NO	9.5	mV/G
16	0	na	x pl		1-3	2	TRFLLAT2	Lateral Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0027	+/-5Vdc	5B41-02	NO OFF	196.50	mV/G
17	1	na	z pu		1-3	2	TRFLVERT2	Vertical Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0027	+/-5Vdc	5B41-02	NO OFF	198.40	mV/G
18	2	na	y pr		1-3	2	TRFLLONG2	Longitudinal Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0027	+/-5Vdc	5B41-02	NO OFF	196.90	mV/G
19	3	na	x pr		2-3	2	BRMTLAT2	Lateral Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0029	+/-5Vdc	5B41-02	NO OFF	197.00	mV/G
20	4	na	z pu		2-3	2	BRMTVERT2	Vertical Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0029	+/-5Vdc	5B41-02	NO OFF	196.90	mV/G
21	5	na	y pf		2-3	2	BRMTLONG2	Longitudinal Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0029	+/-5Vdc	5B41-02	NO OFF	196.90	mV/G
22	6	na	1			2	CTRCALPLAT2	Lateral Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0012	+/-5Vdc	5B41-02	NO OFF	50	mV/G
23	7	na	2			2	CTRCALPVERT2	Vertical Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0012	+/-5Vdc	5B41-02	NO OFF	50	mV/G
24	8	na	3			2	CTRCALPLONG2	Longitudinal Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0012	+/-5Vdc	5B41-02	NO OFF	50	mV/G
25	9	na		AXLE2-15		2-4	CTRDSKTEMP2	Thermocouple, Rotor	Center Rotor	32-1832F	Omega			0-5Vdc	5B47-K-04	OFF	0.002778	v/deg f
26	10	na				2	CYLPRESS2	Brake Cylinder Pressure	Center Caliper	0-200 psi	Omega	px41c1-200g10t		0-2.5V	5B41-07	NO OFF	0.0125	V/PSI
27	11	1-1 1	2	AXLE1-1		1-1	CTRSPK6F1	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	5911.33	uStrain
28	12	1-2 2	1	AXLE1-2		1-1	CTRSPK6F2	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	5911.33	uStrain
29	13	1-3 3	3	AXLE1-3	1-1	1-1	CTRSPK6R1	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	5911.33	uStrain
30	14	1-4 4	4	AXLE1-4	1-1	1-1	CTRSPK6R2	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	5911.33	uStrain
31	15						BAD								5B41-02	NO		
32	0	1-5 5		AXLE1-5	1-1	1-2	CTRSPK3R1	Strain Gage	Center Rotor S3					+/-5Vdc	2120B	NO	5911.33	uStrain
33	1	1-6 6		AXLE1-6	1-1	1-2	CTRSPK3R2	Strain Gage	Center Rotor S3					+/-5Vdc	2120B	NO	5911.33	uStrain
34	2	2-1		AXLE1-7	2-1	1-2	AXLECSPK6	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	5911.33	uStrain
35	3	2-2		AXLE1-8	2-1	1-2	AXLECSPK3	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	5911.33	uStrain
36	4	2-3		AXLE1-9	2-1	1-2	AXLEOSPK6	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	5911.33	uStrain
37	5	2-4		AXLE1-10	2-1	1-2	AXLEOSPK3	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	5911.33	uStrain
38	6	2-5				1	AXLE1LLINK	Strain Gage	Center Caliper					+/-5Vdc	2120B	NO	5911.33	uStrain
39	7	2-6				1	AXLE1RLINK	Strain Gage	Center Caliper					+/-5Vdc	2120B	NO	5911.33	uStrain
40	8	3-1		AXLE2-1	3-1	2-3	CTR2SPK6R1	Strain Gage	Center Rotor S6 (SG1)					+/-5Vdc	2120B	NO	5911.33	uStrain
41	9	3-2		AXLE2-2	3-1	2-3	CTR2SPK6R2	Strain Gage	Center Rotor S6 (SG2)					+/-5Vdc	2120B	NO	5911.33	uStrain
42	10	3-3		AXLE2-3	3-1	2-3	CTR2SPK3R1	Strain Gage	Center Rotor S1 (SG3)					+/-5Vdc	2120B	NO	5911.33	uStrain
43	11	3-4		AXLE2-4	3-1	2-3	CTR2SPK3R2	Strain Gage	Center Rotor S1 (SG3a)					+/-5Vdc	2120B	NO	5911.33	uStrain
44	12	3-5		AXLE2-5		2-3	CTR2SPK6_4	Strain Gage	Center Rotor S4 (SG4)					+/-5Vdc	2120B	NO	5911.33	uStrain
45	13	3-6		AXLE2-6		2-3	CTR2SPK6_5	Strain Gage	Center Rotor S4 (SG5)					+/-5Vdc	2120B	NO	5911.33	uStrain
46	14	3-7		AXLE2-7		2-3	CTR2SPK4_6	Strain Gage	Center Rotor S4 (SG6)					+/-5Vdc	2120B	NO	5911.33	uStrain
47	15	4-1		AXLE2-8	4-1	2-4	AXLE2CSPK6	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	5911.33	uStrain
48	0	4-2		AXLE2-9	4-1	2-4	AXLE2CSPK3	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	5911.33	uStrain
49	1	4-3		AXLE2-12	4-1	2-4	AXLE2CSPK6+90	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	5911.33	uStrain
50	2	4-4		AXLE2-13	4-1	2-4	AXLE2CSPK6-90	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	5911.33	uStrain
51	3	4-5		AXLE2-10	4-1	2-4	AXLE2OSPK6	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	5911.33	uStrain
52	4	4-5		AXLE2-11	4-1	2-4	AXLE2OSPK3	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	5911.33	uStrain
53	5	4-6			3-2	1	LBOXLAT1	Lateral Acceleration, Axle	Axle Box Left	+/-100g	PCB	J353B01	95259	+/-2.5Vdc		NA	10	mV/G
54	6	na			4-2	1	LBOXVERT1	Vertical Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95604	+/-2.5Vdc		NA	10	mV/G
55	7	na			3-2	1	RBOXLAT1	Lateral Acceleration, Axle	Axle Box Right	+/-100g	PCB	J353B01	97687	+/-2.5Vdc		NA	10	mV/G
56	8	na			4-2	1	RBOXVERT1	Vertical Acceleration, Axle	Axle Box Right	+/-250g	PCB	J353B01	97688	+/-2.5Vdc		NA	10	mV/G

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PIN1=NO OFFSET
PIN3=OFFSET

CH	SCU	VISHAY ECTRON	ORG CAB	CABLE	display	AXLE-SLIPRING	Name	Description	Location	Range		MODEL #	SERIAL #		JUMPERS SCU	
57	9	na			1-2	2	LBOXLAT2	Lateral Acceleration, Axle	Axle Box Left	+/-100g	PCB	J353B31	97692	+/-2.5Vdc	NA	10 mV/G
58	10	na			2-2	2	LBOXVERT2	Vertical Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95603	+/-2.5Vdc	NA	10 mV/G
59	11	na			1-2	2	RBOXLAT2	Lateral Acceleration, Axle	Axle Box Right	+/-100g	PCB	J353B31	97690	+/-2.5Vdc	NA	10 mV/G
60	12	na			2-2	2	RBOXVERT2	Vertical Acceleration, Axle	Axle Box Right	+/-250g	PCB	J353B01	95258	+/-2.5Vdc	NA	10 mV/G
61	13	na			3-2	1-2	AXLELAT1-2	Lateral Acceleration, Axle Mounted	Axle	+/-500g	VibraMetric	7002hg2k	0867	+/-5Vdc	NA	9.9 mV/G
62	14	na			3-2	1-2	AXLELAT1-3	Lateral Acceleration, Axle Mounted	Axle	+/-500g	Endeveco	7264b-500		+/-5Vdc	NA	10 mV/G
63	15	na				1	AXLE1LLONG	Long Acc Axle		+/-100g	PCB	J353B31	97691	+/-2.5Vdc	NA	10 mV/G
****							SPEED1	CALCULATED SPEED FOR SINE1								

***ANY ADDITIONAL CALCULATED CHANNELS TO BE ADDED AFTER THE AD CHANNELS; THIS IS AND EXAMPLE

june 17 2005 Ver 25

PIN1=NO OFFSET
PIN3=OFFSET

CH	SCU	VISHAY ECTRON	ORG CAB	CABLE	display	AXLE-SLIPRING	Name	Description	Location	Range		MODEL #	SERIAL #			JUMPERS SCU	
0	0	na	15		3-2	1-1	AXLELAT1-1	Lateral Acceleration, Axle Mounted	Axle	+/-200g	Silicon Des	2410-200	07133	+/-5Vdc	5B41-02	NO OFF	19.7 mV/G
1	1	na	x pl		3-3	1	TRFLLAT1	Lateral Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0026	+/-5Vdc	5B41-02	NO OFF	197.10 mV/G
2	2	na	z pu		3-3	1	TRFLVERT1	Vertical Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0026	+/-5Vdc	5B41-02	NO OFF	199.00 mV/G
3	3	na	y pr		3-3	1	TRFLLONG1	Longitudinal Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0026	+/-5Vdc	5B41-02	NO OFF	197.10 mV/G
4	4	na	x pr		4-3	1	BRMTLAT1	Lateral Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0028	+/-5Vdc	5B41-02	NO OFF	197.00 mV/G
5	5	na	z pu		4-3	1	BRMTVERT1	Vertical Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0028	+/-5Vdc	5B41-02	NO OFF	198.10 mV/G
6	6	na				1	SINE1	Speed; sine from encoder	slip ring 1	+/-10Vdc	michigan scientific			+/-10Vdc		NO	1
7	7	na				2	SINE2	Speed; sine from encoder	slip ring 3	+/-10Vdc	michigan scientific			+/-10Vdc		NO	1
8	8	na	y pf		4-3	1	BRMTLONG1	Longitudinal Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0028	+/-5Vdc	5B41-02	NO OFF	196.70 mV/G
9	9	na	1			1	CTRCALPLAT1	Lateral Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0005	+/-5Vdc	5B41-02	NO OFF	50 mV/G
10	10	na	2			1	CTRCALPVERT1	Vertical Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0005	+/-5Vdc	5B41-02	NO OFF	50 mV/G
11	11	na	3			1	CTRCALPLONG1	Longitudinal Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0005	+/-5Vdc	5B41-02	NO OFF	50 mV/G
12	12	na	31			1	CYLPRESS1	Brake Cylinder Pressure	Center Caliper	0-200 psi	Omega	px41c1-200g10t	148202	0-2.5V	5B41-07	NO OFF	0.0125 V/PSI
13	13	na	9			1-1	CTRDSKTEMP1	Thermocouple, Rotor	Center Rotor	32-1832F	Omega			0-5Vdc	5B47-K-04	OFF	0.002778 v/deg f
14	14	na					SYNC	Synchronization signal	signal generatc	+/-4V	0.5hz to 5Hz 5Secs tri			+/-5Vdc	5B41-02	NO	1
15	15	na		AXLE2-14	1-2	2-4	AXLELAT2	Lateral Acceleration, Axle Mounted	Axle	+/-500g	VibraMetric	7002hg2k	0902	+/-5Vdc		NO	9.5 mV/G
16	0	na	x pl		1-3	2	TRFLLAT2	Lateral Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0027	+/-5Vdc	5B41-02	NO OFF	196.50 mV/G
17	1	na	z pu		1-3	2	TRFLVERT2	Vertical Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0027	+/-5Vdc	5B41-02	NO OFF	198.40 mV/G
18	2	na	y pr		1-3	2	TRFLLONG2	Longitudinal Acceleration, TRUCK FRAME LEFT		+/-25g	Silicon Des	2440-025	0027	+/-5Vdc	5B41-02	NO OFF	196.90 mV/G
19	3	na	x pr		2-3	2	BRMTLAT2	Lateral Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0029	+/-5Vdc	5B41-02	NO OFF	197.00 mV/G
20	4	na	z pu		2-3	2	BRMTVERT2	Vertical Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0029	+/-5Vdc	5B41-02	NO OFF	196.90 mV/G
21	5	na	y pf		2-3	2	BRMTLONG2	Longitudinal Acceleration, BRAKE MOUNTING TUBE		+/-25g	Silicon Des	2440-025	0029	+/-5Vdc	5B41-02	NO OFF	196.90 mV/G
22	6	na	1			2	CTRCALPLAT2	Lateral Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0012	+/-5Vdc	5B41-02	NO OFF	50 mV/G
23	7	na	2			2	CTRCALPVERT2	Vertical Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0012	+/-5Vdc	5B41-02	NO OFF	50 mV/G
24	8	na	3			2	CTRCALPLONG2	Longitudinal Acceleration, Caliper, Near Pad	Center Caliper	+/-100g	Silicon Des	2440-100	0012	+/-5Vdc	5B41-02	NO OFF	50 mV/G
25	9	na		AXLE2-15		2-4	CTRDSKTEMP2	Thermocouple, Rotor	Center Rotor	32-1832F	Omega			0-5Vdc	5B47-K-04	OFF	0.002778 v/deg f
26	10	na				2	CYLPRESS2	Brake Cylinder Pressure	Center Caliper	0-200 psi	Omega	px41c1-200g10t		0-2.5V	5B41-07	NO OFF	0.0125 V/PSI
27	11	1-1	2	AXLE1-1		1-1	CTRSPK6F1	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	4000 uStrain
28	12	1-2	1	AXLE1-2		1-1	CTRSPK6F2	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	4000 uStrain
29	13	1-7	3	AXLE1-3	1-1	1-1	CTRSPK6R1	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	4000 uStrain
30	14	1-8	4	AXLE1-4	1-1	1-1	CTRSPK6R2	Strain Gage	Center Rotor S6					+/-5Vdc	2120B	NO	4000 uStrain
31	15						BAD								5B41-02	NO	
32	0	1-5		AXLE1-5	1-1	1-2	CTRSPK3R1	Strain Gage	Center Rotor S3					+/-5Vdc	2120B	NO	4000 uStrain
33	1	1-6		AXLE1-6	1-1	1-2	CTRSPK3R2	Strain Gage	Center Rotor S3					+/-5Vdc	2120B	NO	4000 uStrain
34	2	2-1		AXLE1-7	2-1	1-2	AXLECSPK6	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	2000 uStrain
35	3	2-2		AXLE1-8	2-1	1-2	AXLECSPK3	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	2000 uStrain
36	4	2-3		AXLE1-9	2-1	1-2	AXLEOSPK6	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	2000 uStrain
37	5	2-4		AXLE1-10	2-1	1-2	AXLEOSPK3	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	2000 uStrain
38	6	2-5				1	AXLE1LLINK	Strain Gage	Center Caliper					+/-5Vdc	2120B	NO	3000 uStrain
39	7	2-6				1	AXLE1RLINK	Strain Gage	Center Caliper					+/-5Vdc	2120B	NO	3000 uStrain
40	8	3-1		AXLE2-1	3-1	2-3	CTR2SPK6R1	Strain Gage	Center Rotor S6 (SG1)					+/-5Vdc	2120B	NO	4000 uStrain
41	9	3-2		AXLE2-2	3-1	2-3	CTR2SPK6R2	Strain Gage	Center Rotor S6 (SG2)					+/-5Vdc	2120B	NO	4000 uStrain
42	10	3-3		AXLE2-3	3-1	2-3	CTR2SPK3R1	Strain Gage	Center Rotor S1 (SG3)					+/-5Vdc	2120B	NO	4000 uStrain
43	11	3-4		AXLE2-4	3-1	2-3	CTR2SPK3R2	Strain Gage	Center Rotor S1 (SG3a)					+/-5Vdc	2120B	NO	4000 uStrain
44	12	3-5		AXLE2-5		2-3	CTR2SPK6_4	Strain Gage	Center Rotor S4 (SG4)					+/-5Vdc	2120B	NO	4000 uStrain
45	13	3-6		AXLE2-6		2-3	CTR2SPK6_5	Strain Gage	Center Rotor S4 (SG5)					+/-5Vdc	2120B	NO	4000 uStrain
46	14	3-7		AXLE2-7		2-3	CTR2SPK4_6	Strain Gage	Center Rotor S4 (SG6)					+/-5Vdc	2120B	NO	4000 uStrain
47	15	4-1		AXLE2-8	4-1	2-4	AXLE2CSPK6	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	2000 uStrain
48	0	4-2		AXLE2-9	4-1	2-4	AXLE2CSPK3	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	2000 uStrain
49	1	4-3		AXLE2-12	4-1	2-4	AXLE2CSPK6+90	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	2000 uStrain
50	2	4-4		AXLE2-13	4-1	2-4	AXLE2CSPK6-90	Strain Gage	axle ; center Rot					+/-5Vdc	2120B	NO	2000 uStrain
51	3	4-5		AXLE2-10	4-1	2-4	AXLE2OSPK6	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	2000 uStrain
52	4	4-6		AXLE2-11	4-1	2-4	AXLE2OSPK3	Strain Gage	Axle: 1/4					+/-5Vdc	2120B	NO	2000 uStrain
53	5	na			3-2	1	LBOXLAT1	Lateral Acceleration, Axle	Axle Box Left	+/-100g	PCB	J353B01	95259	+/-2.5Vdc		NA	10 mV/G
54	6	na			4-2	1	LBOXVERT1	Vertical Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95604	+/-2.5Vdc		NA	10 mV/G
55	7	na			3-2	1	RBOXLAT1	Lateral Acceleration, Axle	Axle Box Right	+/-100g	PCB	J353B01	97687	+/-2.5Vdc		NA	10 mV/G
56	8	na			4-2	1	RBOXVERT1	Vertical Acceleration, Axle	Axle Box Right	+/-250g	PCB	J353B01	97688	+/-2.5Vdc		NA	10 mV/G

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PIN1=NO OFFSET
PIN3=OFFSET

CH	SCU	VISHAY ECTRON	ORG CAB	CABLE	display	AXLE-SLIPRING	Name	Description	Location	Range		MODEL #	SERIAL #		JUMPERS SCU	
57	9	na			1-2	2	LBOXLAT2	Lateral Acceleration, Axle	Axle Box Left	+/-100g	PCB	J353B31	97692	+/-2.5Vdc	NA	10 mV/G
58	10	na			2-2	2	LBOXVERT2	Vertical Acceleration, Axle	Axle Box Left	+/-250g	PCB	J353B01	95603	+/-2.5Vdc	NA	10 mV/G
59	11	na			1-2	2	RBOXLAT2	Lateral Acceleration, Axle	Axle Box Right	+/-100g	PCB	J353B31	97690	+/-2.5Vdc	NA	10 mV/G
60	12	na			2-2	2	RBOXVERT2	Vertical Acceleration, Axle	Axle Box Right	+/-250g	PCB	J353B01	95258	+/-2.5Vdc	NA	10 mV/G
61	13	na			3-2	1-2	AXLELAT1-2	Lateral Acceleration, Axle Mounted	Axle	+/-500g	VibraMetric	7002hg2k	0867	+/-5Vdc	NA	9.9 mV/G
62	14	na			3-2	1-2	AXLELAT1-3	Lateral Acceleration, Axle Mounted	Axle	+/-500g	Endeveco	7264b-500		+/-5Vdc	NA	10 mV/G
63	15	na				1	AXLE1LLONG	Long Acc Axle		+/-100g	PCB	J353B31	97691	+/-2.5Vdc	NA	10 mV/G
****							SPEED1	CALCULATED SPEED FOR SINE1								

***ANY ADDITIONAL CALCULATED CHANNELS TO BE ADDED AFTER THE AD CHANNELS; THIS IS AND EXAMPLE

CALIBRATION CERTIFICATES

AND SPECIFICATION SHEETS

FOR SENSORS USED

DURING ENSCO'S

ACELA BRAKE DISC TEST

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: **2430-200**

Part #: **153-00007-05** Doc. Rev. **D**

Mfg. Lot #: **9m095a**

Op. Number: **740**

Operator: **Jerry**

Serial #: **427**

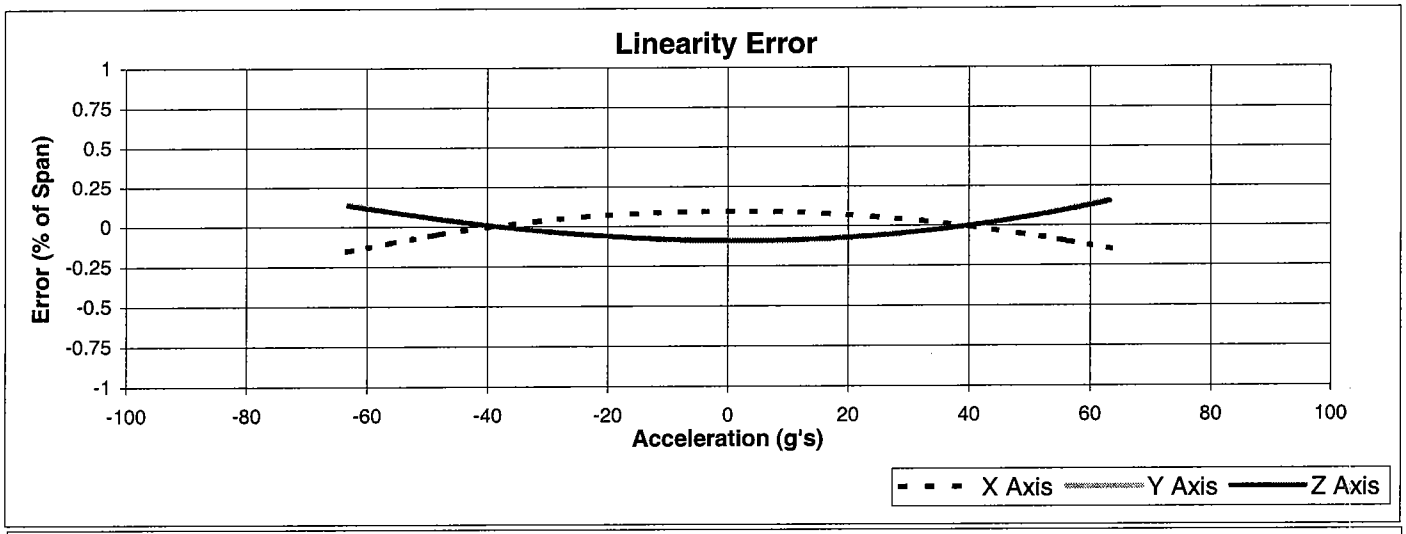
Calibration Date: **05/04/05**

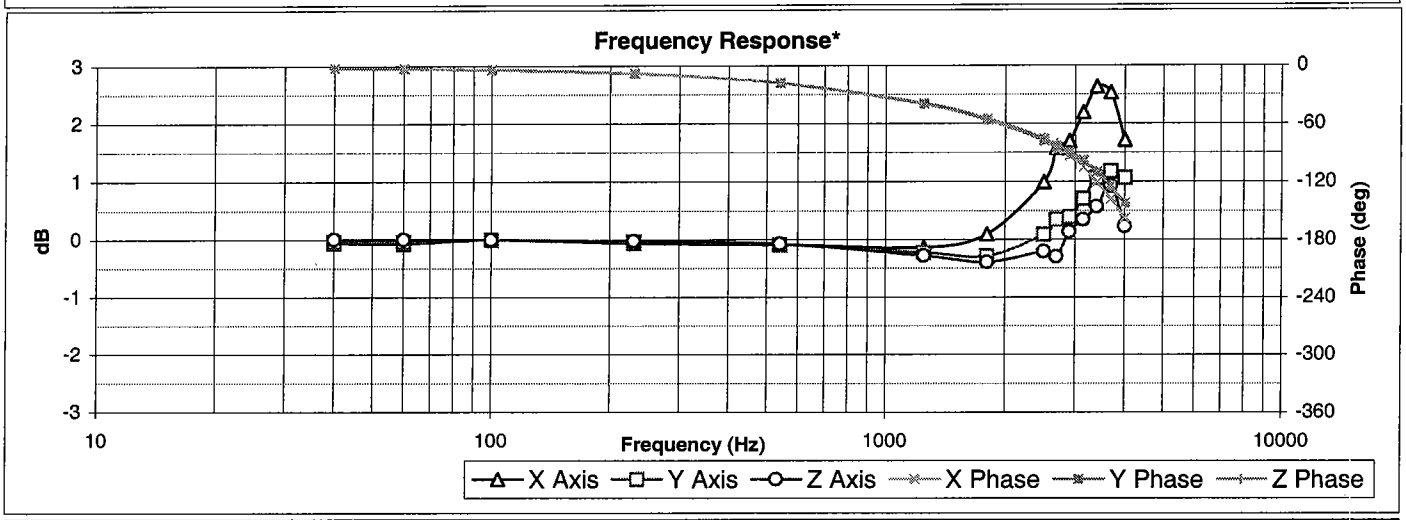
Supply Current: **26.3 mA**

Full Scale: **200 G**

Calibration Freq. **100 Hz**

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	33.0	19.0	12.0	mV DC
-1 G DC:	-17.0	-31.0	-38.0	mV DC
0 G Bias	8.0	-6.0	-13.0	mV DC
Scale Factor	25.00	24.90	25.20	mV/G
Sensor ID	62663	62661	62665	





Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out - X	-0.06	-0.06	0.00	-0.06	-0.09	-0.14	0.09	0.99	1.58	1.70	2.19	2.63	2.53	1.72
Phase (deg)	-2.1	-2.6	-4.0	-7.9	-17.9	-40.1	-56.4	-78.5	-87.4	-93.6	-105.5	-120.4	-137.9	-157.5
Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out - Y	-0.03	-0.03	0.00	-0.03	-0.09	-0.22	-0.29	0.09	0.35	0.39	0.71	1.07	1.18	1.07
Phase (deg)	-2.0	-2.5	-3.8	-7.7	-17.5	-39.1	-55.2	-75.8	-83.6	-88.9	-98.2	-109.9	-124.0	-141.9
Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out - Z	0.00	0.01	0.00	-0.02	-0.07	-0.28	-0.39	-0.21	-0.30	0.14	0.34	0.57	0.93	0.23
Phase (deg)	-2.1	-2.6	-3.9	-7.9	-18.0	-40.3	-56.7	-77.5	-81.2	-91.7	-99.9	-110.4	-125.9	-142.6

* Reference Frequency is 100 Hz

** 14.142 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90157

Final Status:

Pass:

website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE PAGE 2

Model: 2430-200 **Part #:** 153-00007-05 **Full Scale:** 200 G

Serial #: 427 **Op. Number:** 740 **Calibration Date:** 05/04/05

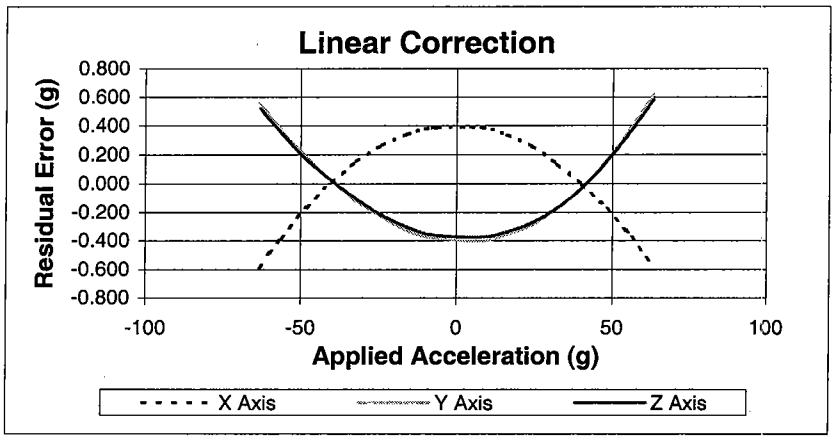
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

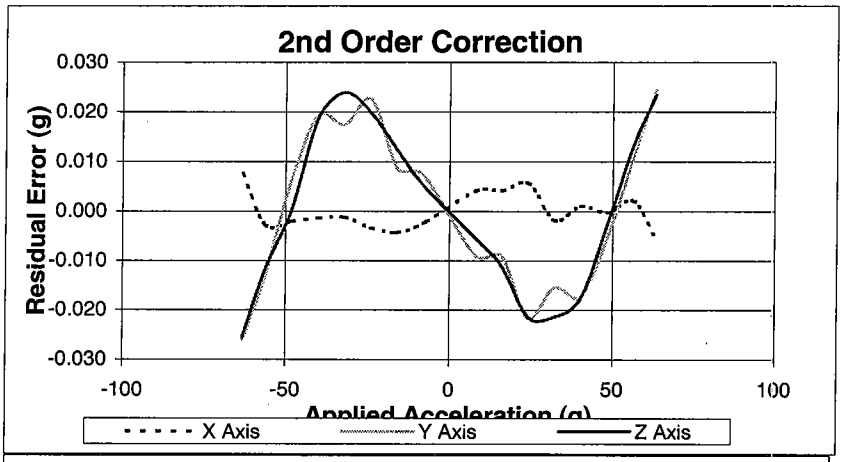
	X-Axis	Y-Axis	Z-Axis
b	-4.292E-01	3.593E-01	5.426E-01
a	4.004E+01	4.011E+01	3.973E+01
RMS Error	3.288E-01	3.319E-01	3.121E-01



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

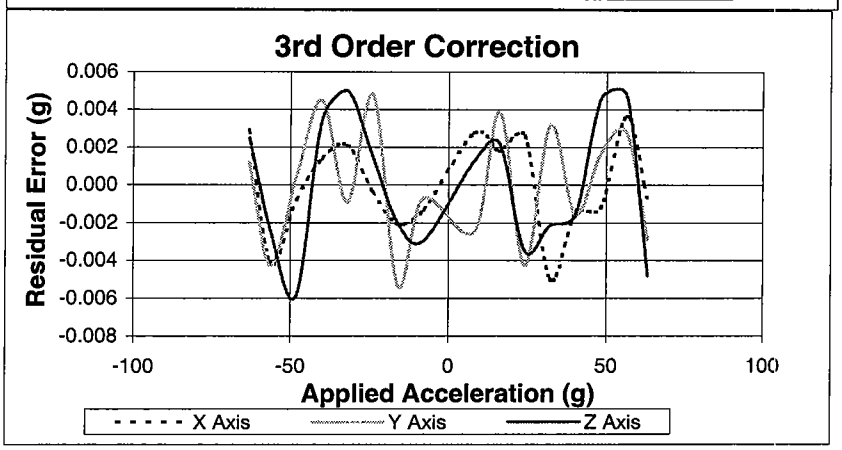
	X-Axis	Y-Axis	Z-Axis
b	-8.298E-01	7.634E-01	9.225E-01
a_1	4.004E+01	4.011E+01	3.973E+01
a_2	3.944E-01	-3.999E-01	-3.687E-01
RMS Error	3.677E-03	1.606E-02	1.658E-02



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	-8.298E-01	7.633E-01	9.226E-01
a_1	4.003E+01	4.015E+01	3.976E+01
a_2	3.944E-01	-3.996E-01	-3.688E-01
a_3	3.746E-03	-2.203E-02	-2.206E-02
RMS Error	2.491E-03	3.204E-03	3.456E-03



website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: **2430-200**

Part #: **153-00007-05** Doc. Rev. **D**

Mfg. Lot #: **0m063a**

Serial #: **486**

Full Scale: **200 G**

Op. Number: **740**

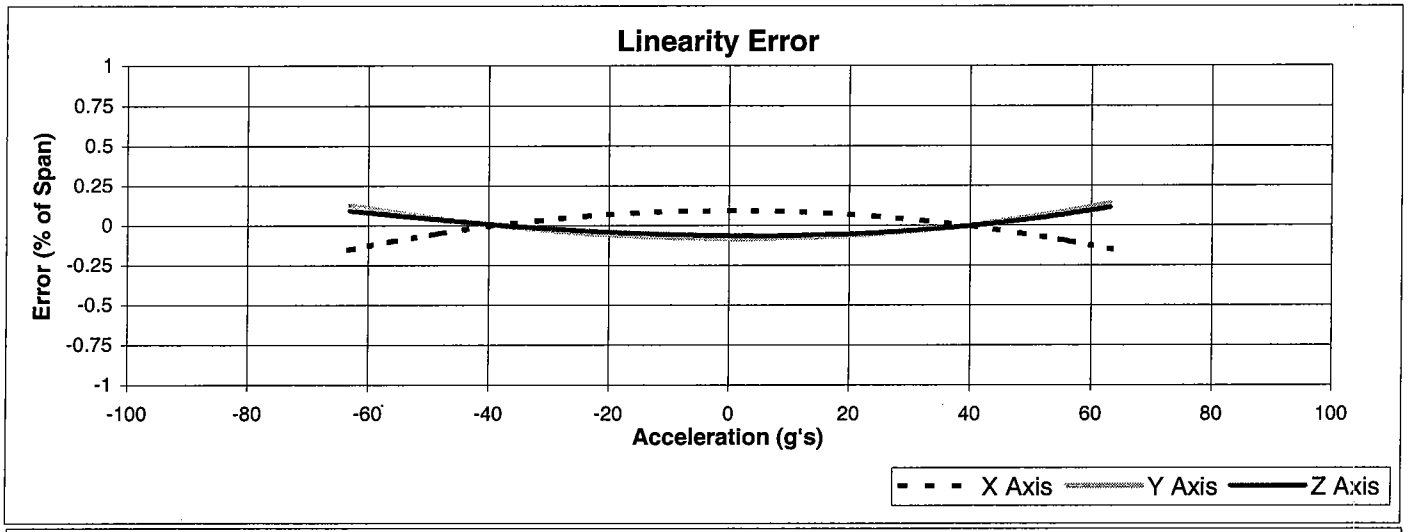
Operator: **Jerry**

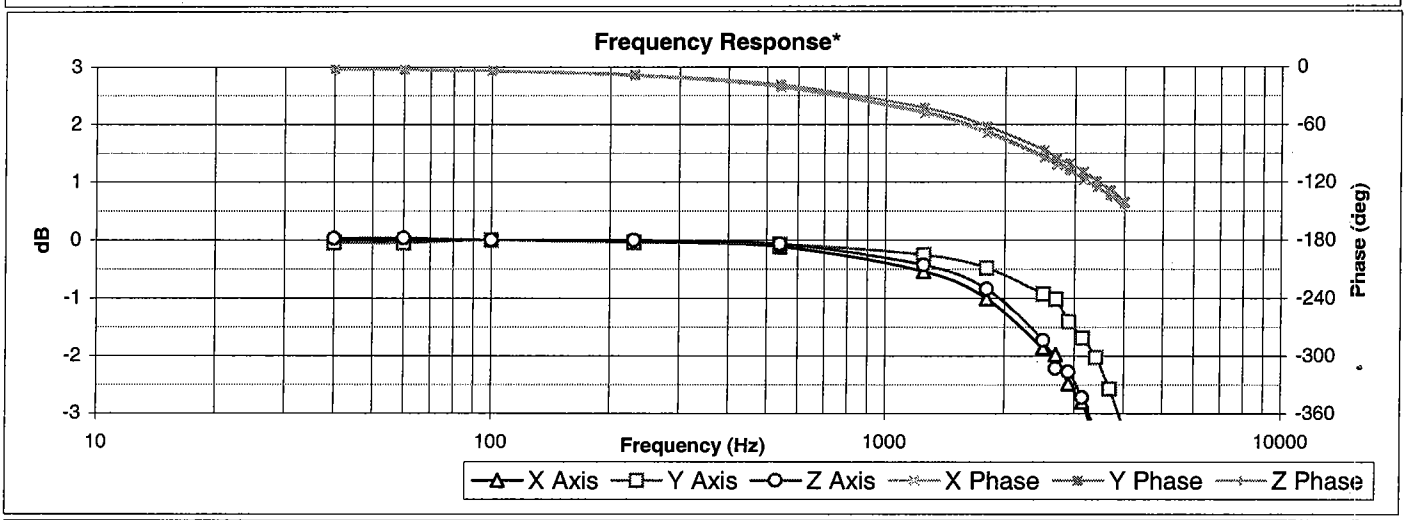
Calibration Date: **05/04/05**

Supply Current: **26.5 mA**

Calibration Freq. **100 Hz**

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	51.0	-14.0	14.0	mV DC
-1 G DC:	2.0	-63.0	-36.0	mV DC
0 G Bias	26.0	-39.0	-11.0	mV DC
Scale Factor	24.50	24.50	24.80	mV/G
Sensor ID	71916	71877	71896	





Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out - X	-0.03	-0.03	0.00	-0.04	-0.11	-0.54	-1.01	-1.85	-1.97	-2.48	-2.79	-3.47	-4.08	-4.58
Phase (deg)	-2.3	-2.9	-4.5	-9.3	-21.3	-48.5	-69.3	-94.5	-102.2	-107.5	-117.5	-125.4	-133.8	-142.5
Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out - Y	-0.05	-0.04	0.00	-0.04	-0.07	-0.25	-0.48	-0.92	-1.01	-1.40	-1.69	-2.02	-2.57	-3.25
Phase (deg)	-2.1	-2.7	-4.1	-8.1	-18.6	-42.5	-62.0	-86.7	-96.0	-100.6	-109.4	-119.0	-128.5	-140.1
Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out - Z	0.03	0.03	0.00	-0.01	-0.06	-0.42	-0.84	-1.73	-2.21	-2.27	-2.72	-3.30	-3.85	-4.70
Phase (deg)	-2.2	-2.8	-4.2	-8.9	-20.4	-46.9	-67.3	-92.7	-97.5	-107.7	-115.9	-124.7	-134.7	-145.7

* Reference Frequency is 100 Hz

** 14.142 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90157

Final Status:

Pass:

website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE PAGE 2

Model: 2430-200 **Part #:** 153-00007-05 **Full Scale:** 200 G

Serial #: 486 **Op. Number:** 740 **Calibration Date:** 05/04/05

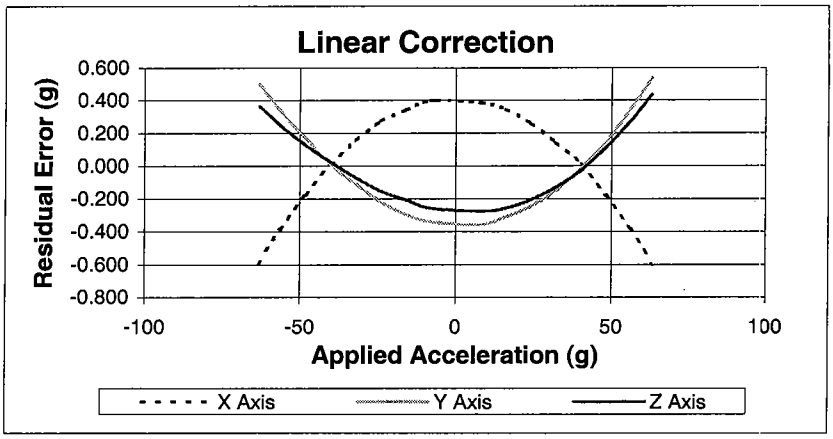
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

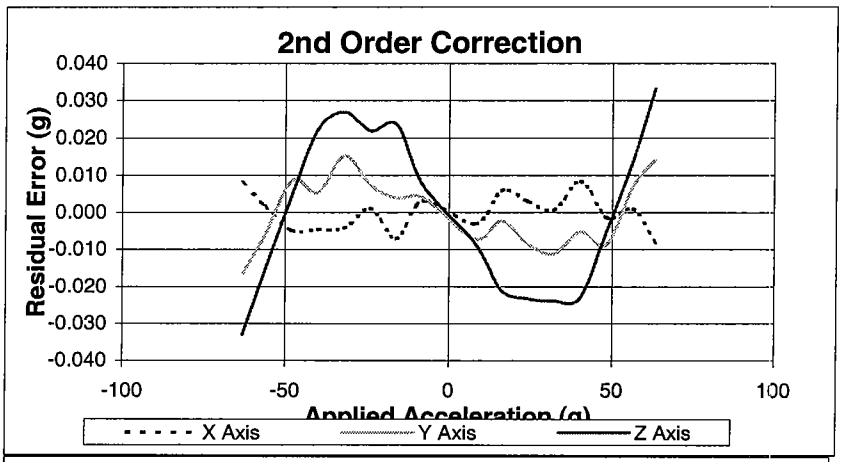
	X-Axis	Y-Axis	Z-Axis
b	-1.094E+00	1.677E+00	4.792E-01
a	4.078E+01	4.079E+01	4.024E+01
RMS Error	3.350E-01	2.948E-01	2.273E-01



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

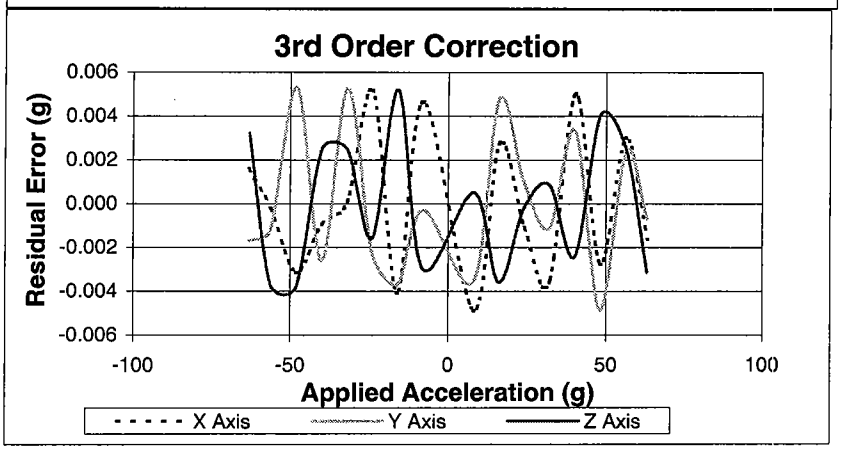
	X-Axis	Y-Axis	Z-Axis
b	-1.503E+00	2.035E+00	7.549E-01
a_1	4.077E+01	4.077E+01	4.024E+01
a_2	4.174E-01	-3.684E-01	-2.750E-01
RMS Error	4.895E-03	9.119E-03	2.111E-02



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	-1.502E+00	2.036E+00	7.551E-01
a_1	4.076E+01	4.079E+01	4.029E+01
a_2	4.172E-01	-3.695E-01	-2.753E-01
a_3	5.374E-03	-1.261E-02	-2.958E-02
RMS Error	3.246E-03	3.215E-03	2.981E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: **2430-100**

Part #: **153-00007-04** Doc. Rev. **D**

Mfg. Lot #: **4m286a**

Serial #: **677**

Full Scale: **100 G**

Op. Number: **740**

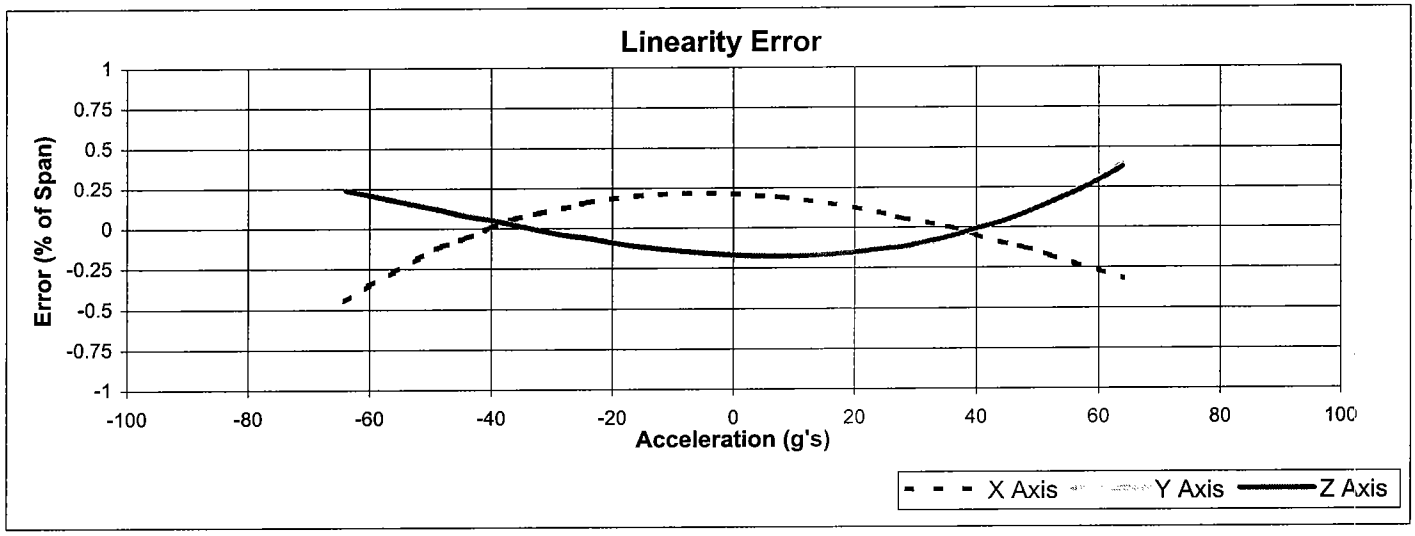
Operator: **joe**

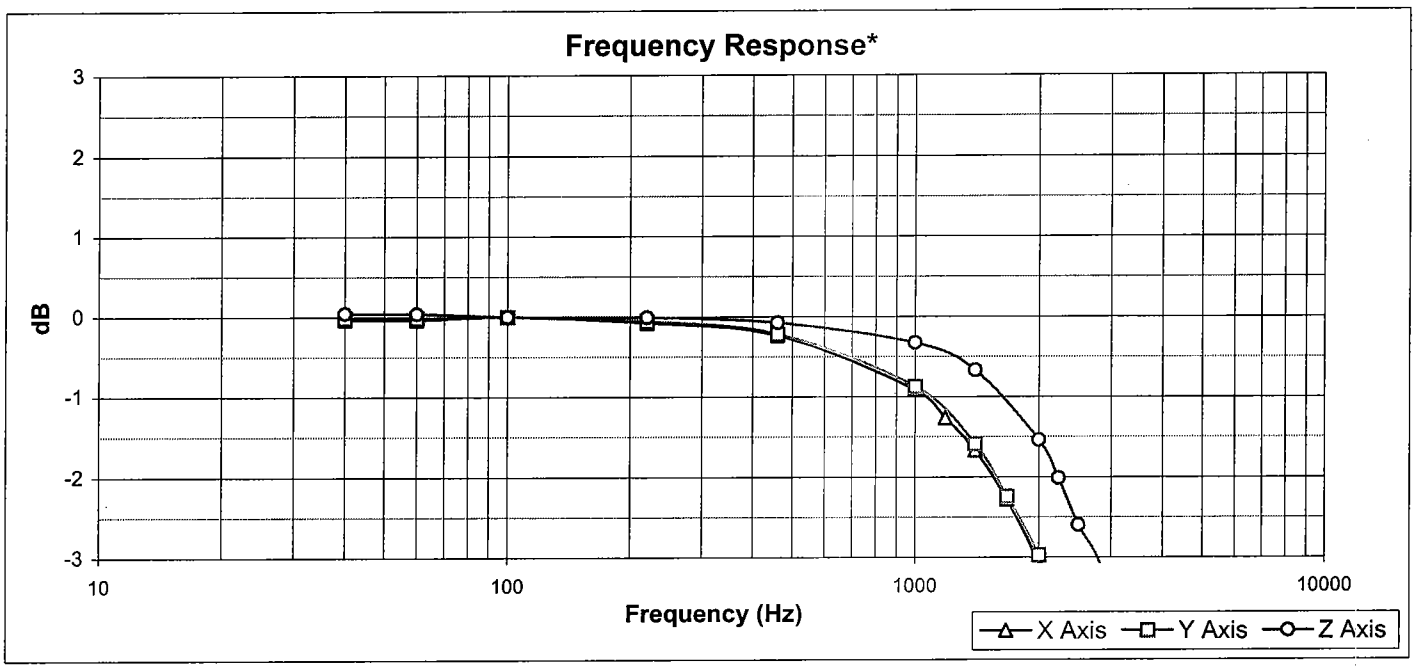
Calibration Date: **10/27/04**

Supply Current: **27.1 mA**

Calibration Freq. **100 Hz**

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	60.0	28.0	34.0	mV DC
-1 G DC:	-37.0	-71.0	-65.0	mV DC
0 G Bias	11.0	-22.0	-15.0	mV DC
Scale Factor	49.00	48.80	49.50	mV/G
Sensor ID	168393	168419	168381	





Freq. (Hz)**	40	60	100	220	460	1000	1185	1400	1675	2000	2235	2500	3200	4000
dB Out - X	-0.033	-0.037	0	-0.076	-0.234	-0.913	-1.263	-1.668	-2.28	-3.065	-3.663	-4.307	-6.239	-8.599
dB Out - Y	-0.019	-0.018	0	-0.062	-0.22	-0.873	-1.592	-2.24	-2.974	-3.721	-4.435	-5.481	-6.422	-8.841
dB Out - Z	0.041	0.039	0	-0.009	-0.076	-0.332	-0.671	-1.542	-2.015	-2.6	-3.106	-4.287	-5.304	-6.656

* Reference Frequency is 100 Hz

** 14.142 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90157

Final Status:

Pass:

website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE PAGE 2

Model: 2430-100 **Part #:** 153-00007-04 **Full Scale:** 100 G

Serial #: 677 **Op. Number:** 740 **Calibration Date:** 10/27/04

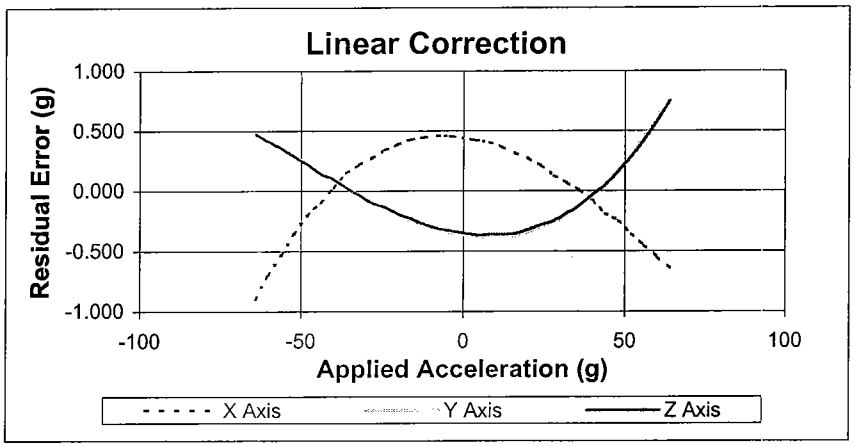
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

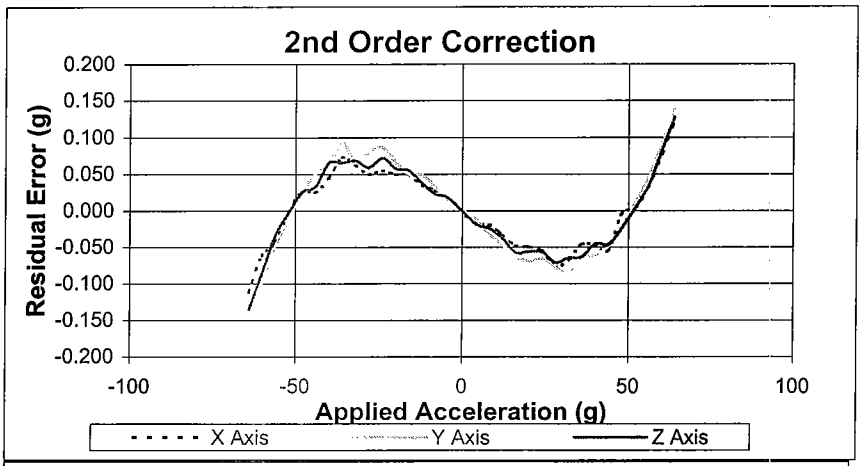
	X-Axis	Y-Axis	Z-Axis
b	-3.957E-01	4.729E-01	3.922E-01
a	2.042E+01	2.049E+01	2.020E+01
RMS Error	3.879E-01	3.262E-01	3.099E-01



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

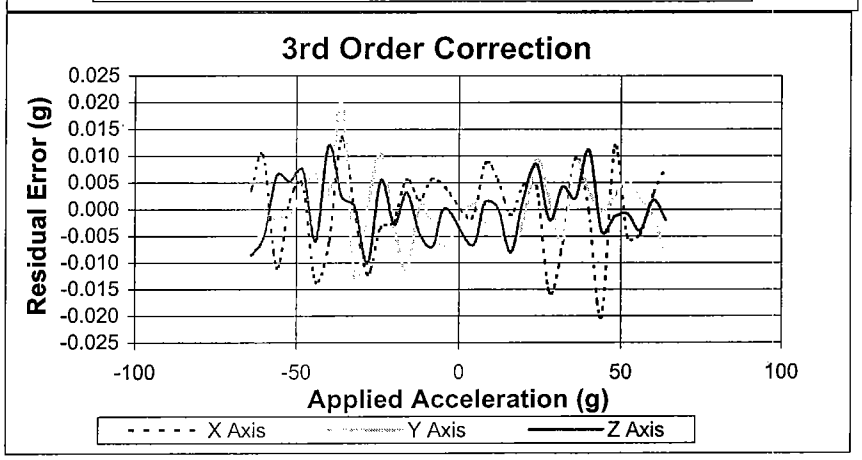
	X-Axis	Y-Axis	Z-Axis
b	-8.401E-01	8.417E-01	7.437E-01
a_1	2.042E+01	2.049E+01	2.020E+01
a_2	1.237E-01	-1.035E-01	-9.580E-02
RMS Error	5.376E-02	6.824E-02	5.959E-02



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	-8.396E-01	8.418E-01	7.436E-01
a_1	2.049E+01	2.057E+01	2.027E+01
a_2	1.233E-01	-1.033E-01	-9.560E-02
a_3	-1.025E-02	-1.328E-02	-1.108E-02
RMS Error	8.126E-03	6.561E-03	5.613E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: **2430-100**

Part #: **153-00007-04** Doc. Rev. **D**

Mfg. Lot #: **4m286a**

Serial #: **678**

Full Scale: **100 G**

Op. Number: **740**

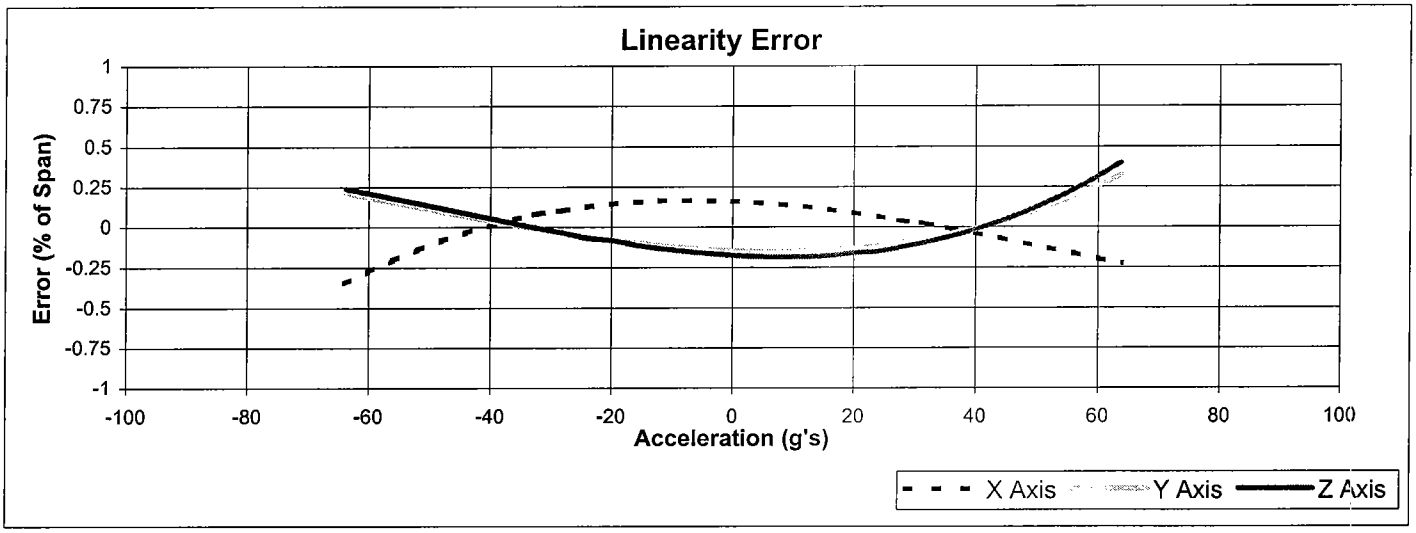
Operator: **joe**

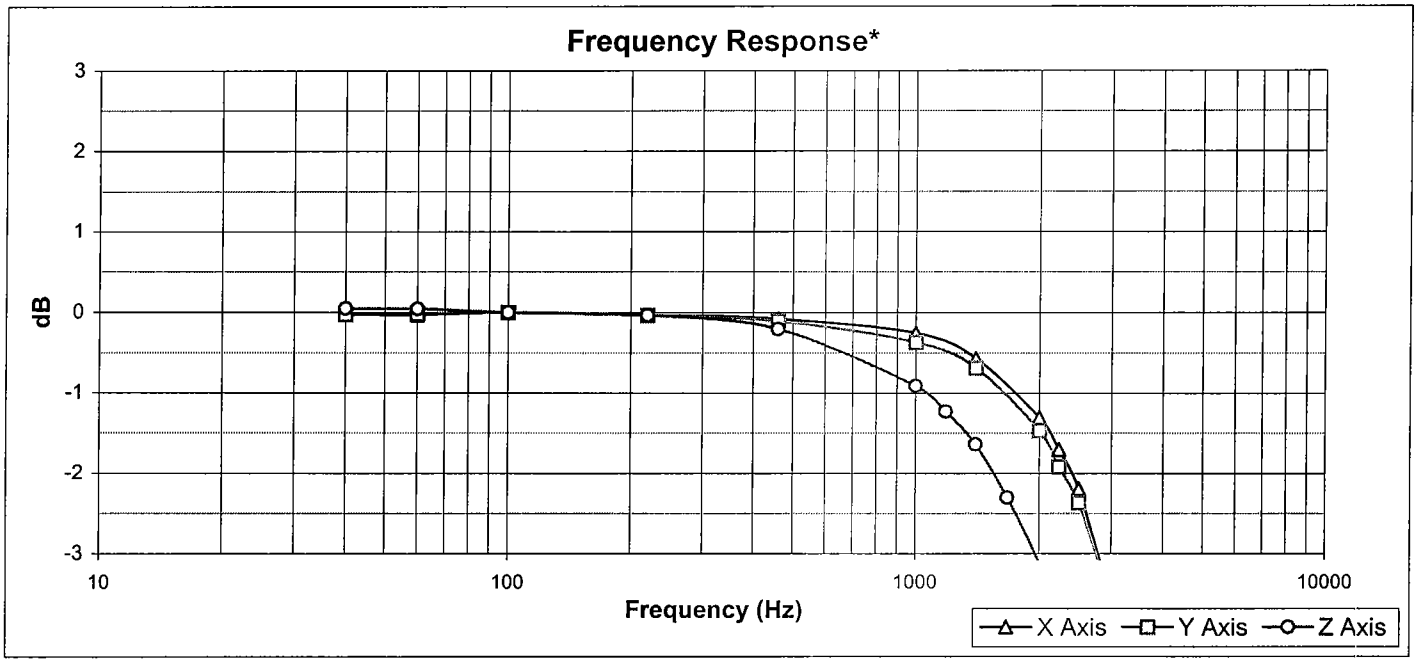
Calibration Date: **10/27/04**

Supply Current: **27.2 mA**

Calibration Freq. **100 Hz**

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	28.0	50.0	38.0	mV DC
-1 G DC:	-70.0	-49.0	-61.0	mV DC
0 G Bias	-21.0	0.0	-12.0	mV DC
Scale Factor	49.30	49.10	49.80	mV/G
Sensor ID	168386	168379	168394	





Freq. (Hz)**	40	60	100	220	460	1000	1400	2000	2235	2500	2830	3200	3575	4000
dB Out - X	-0.026	-0.029	0	-0.037	-0.081	-0.256	-0.569	-1.305	-1.701	-2.191	-3.118	-3.941	-5.058	-6.043
dB Out - Y	-0.025	-0.023	0	-0.036	-0.107	-0.37	-0.686	-1.465	-1.918	-2.367	-3.157	-3.777	-4.749	-5.922
dB Out - Z	0.047	0.043	0	-0.036	-0.209	-0.908	-1.228	-1.638	-2.303	-3.107	-3.757	-4.5	-6.27	-8.522

* Reference Frequency is 100 Hz

** 14.142 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90157

Final Status:

Pass:

website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE PAGE 2

Model: 2430-100 **Part #:** 153-00007-04 **Full Scale:** 100 G

Serial #: 678 **Op. Number:** 740 **Calibration Date:** 10/27/04

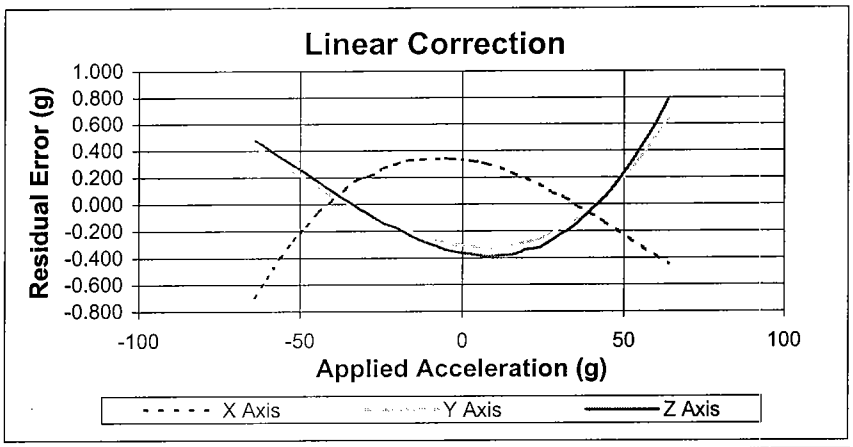
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

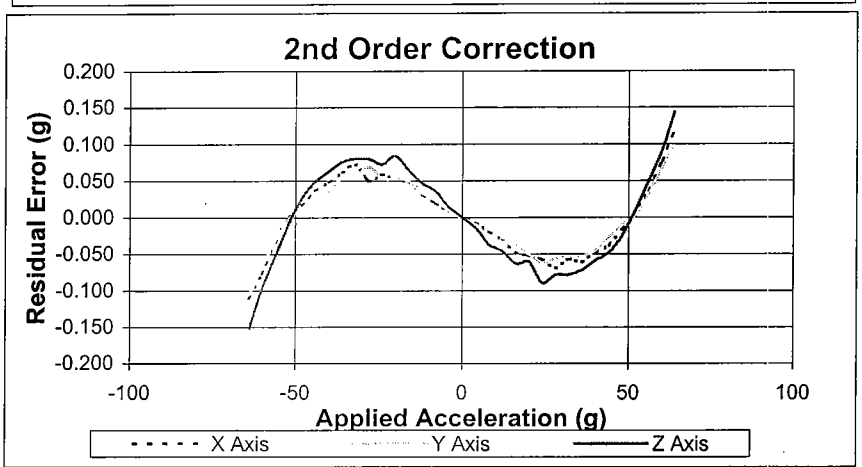
	X-Axis	Y-Axis	Z-Axis
b	2.794E-01	1.073E-01	3.344E-01
a	2.026E+01	2.038E+01	2.009E+01
RMS Error	2.914E-01	2.723E-01	3.237E-01



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

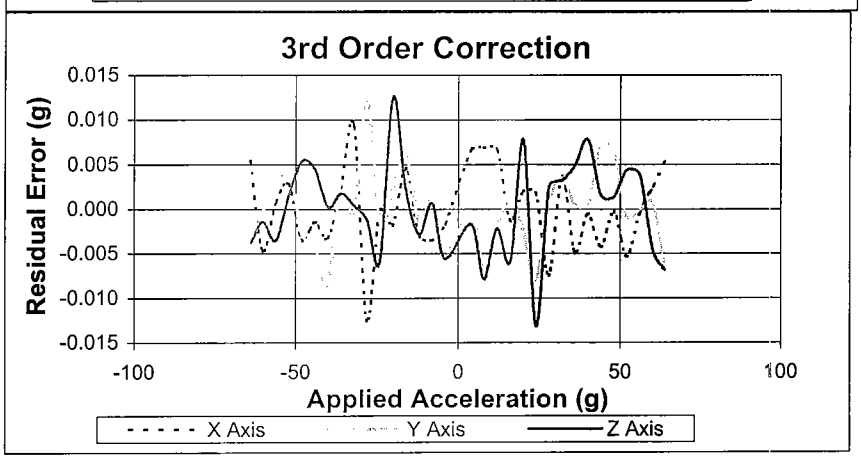
	X-Axis	Y-Axis	Z-Axis
b	-5.187E-02	4.176E-01	7.000E-01
a_1	2.027E+01	2.039E+01	2.009E+01
a_2	9.077E-02	-8.609E-02	-9.859E-02
RMS Error	5.347E-02	4.879E-02	6.990E-02



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	-4.972E-02	4.168E-01	6.996E-01
a_1	2.033E+01	2.045E+01	2.018E+01
a_2	8.964E-02	-8.563E-02	-9.822E-02
a_3	-1.004E-02	-9.369E-03	-1.285E-02
RMS Error	4.684E-03	4.446E-03	5.206E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Mfg Lot #: **5m031a** Model: **2210-200** Part #: **153-00001-05** Doc. Rev. **D**

Op. Number: **135**

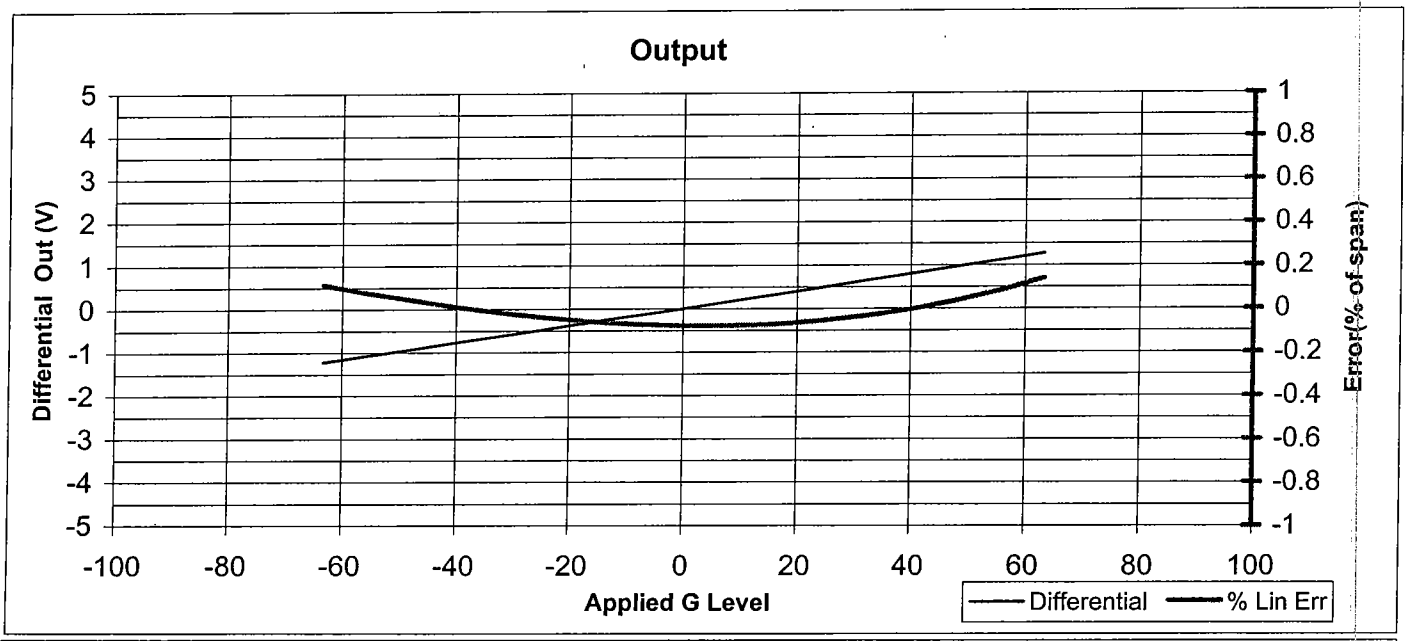
Serial #: **7132** Operator: **ch** +1 G DC: **33 mV DC**

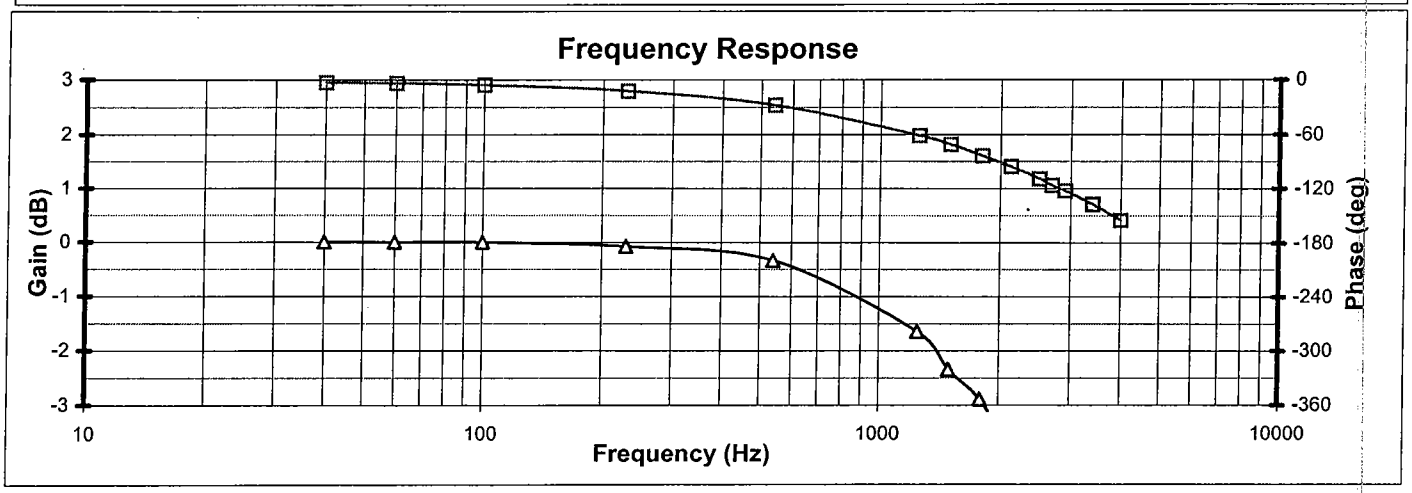
Calibration Date: **02/28/05** -1 G DC: **-6 mV DC**

Full Scale: **200 g** Calibration Freq.: **100 Hz** 0 G Bias **14 mV DC**

Sensor ID **133344** Scale Factor **19.7 mV/G**

Supply Current: **7.9 mA**





Freq. (Hz)**	40	60	100	230	540	1250	1500	1800	2120	2500	2690	2900	3400	4000
dB Out	0.01	0.00	0.00	-0.08	-0.34	-1.64	-2.34	-2.89	-3.75	-4.77	-5.12	-6.16	-7.53	-9.33
SF mV/g	20	20	20	19	19	16	15	14	13	11	11	10	8	7
Phase (deg)	-3	-4	-6	-12	-28	-61	-71	-83	-95	-109	-116	-122	-137	-155

* Reference Frequency is 100 Hz

** 14.142 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90157

Final Status:

Pass:

website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE PAGE 2

Model: 2210-200 **Part #:** 153-00001-05 **Full Scale:** 200 G

Serial #: 7132 **Op. Number:** 135 **Calibration Date:** 02/28/05

Room Temperature Correction Factors:

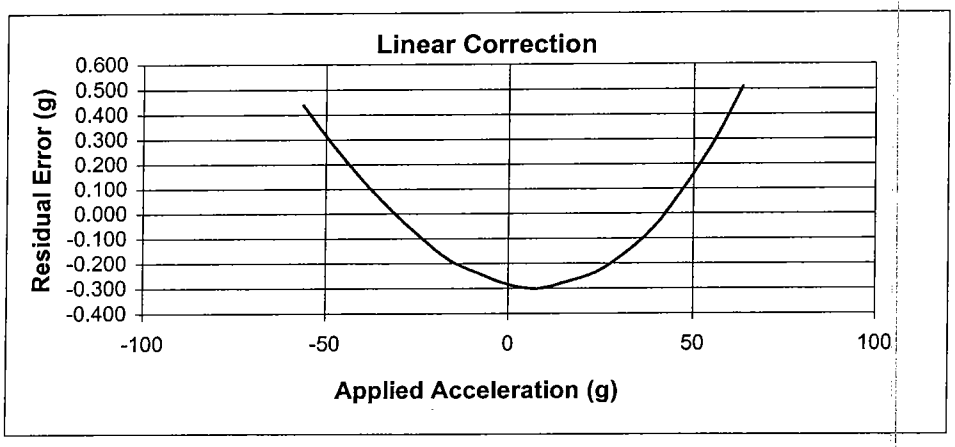
Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

b	-6.050E-01
a	5.078E+01

RMS Error 2.603E-01

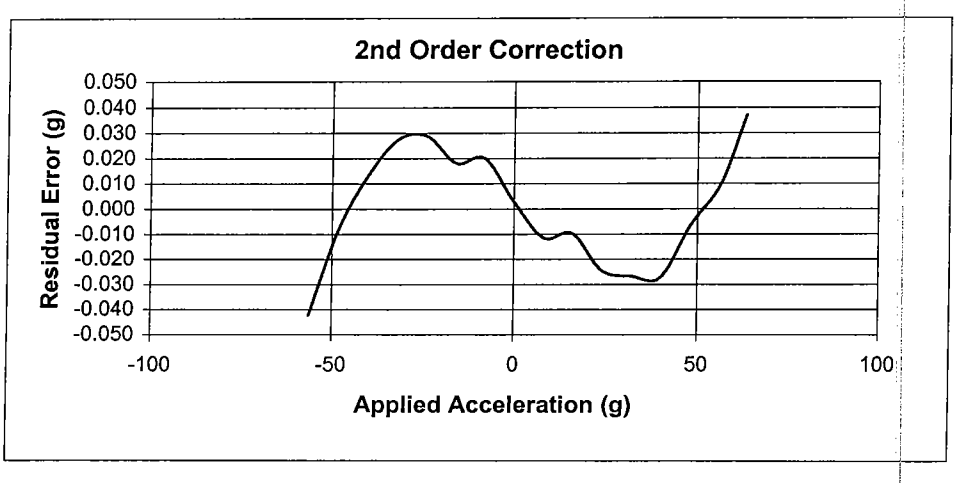


2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

b	-3.178E-01
a_1	5.089E+01
a_2	-5.531E-01

RMS Error 2.253E-02

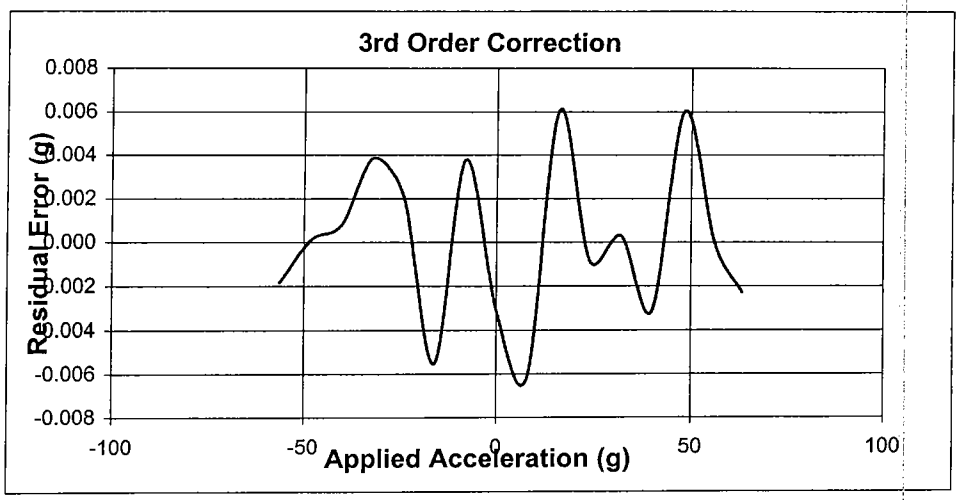


3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

b	-3.241E-01
a_1	5.096E+01
a_2	-5.321E-01
a_3	-7.606E-02

RMS Error 3.572E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Mfg Lot #: **5m031a** Model: **2210-200** Part #: **153-00001-05** Doc. Rev. **D**

Op. Number: **135**

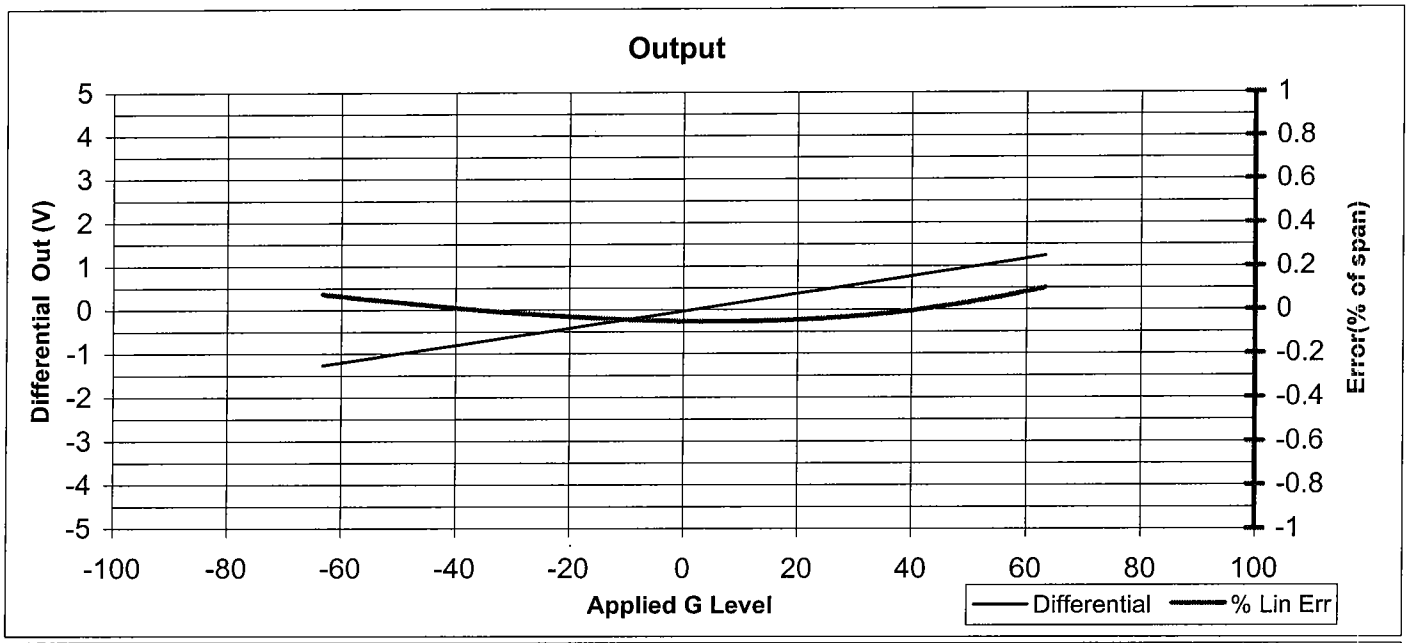
Serial #: **7133** Operator: **ch** +1 G DC: **-4 mV DC**

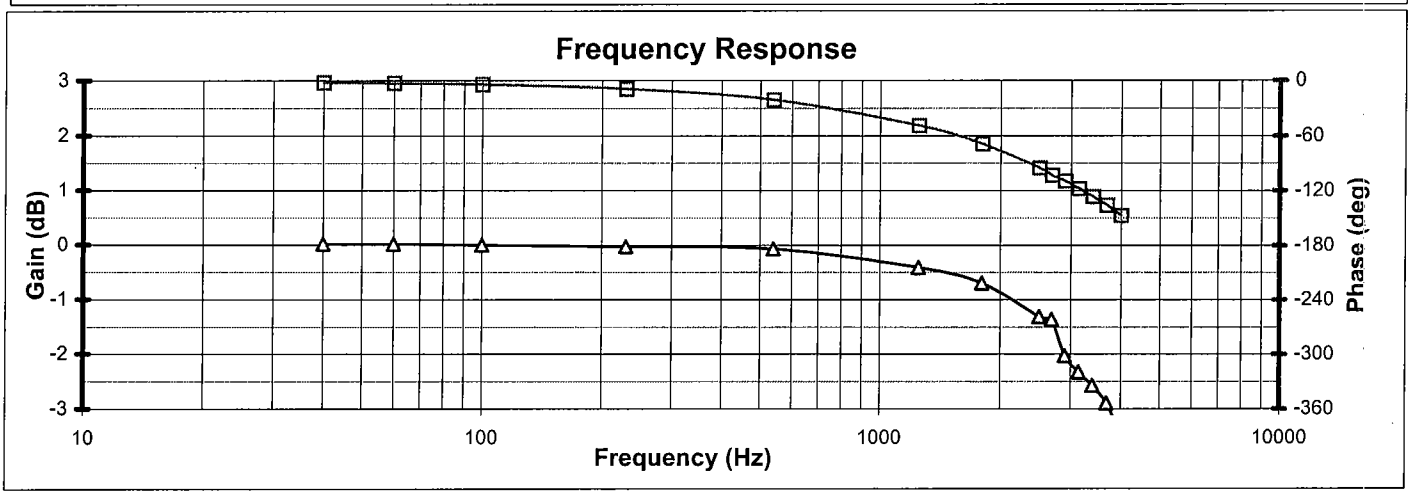
Calibration Date: **02/28/05** -1 G DC: **-45 mV DC**

Full Scale: **200 g** Calibration Freq.: **100 Hz** 0 G Bias **-25 mV DC**

Sensor ID **127946** Scale Factor **19.7 mV/G**

Supply Current: **7.0 mA**





Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out	0.02	0.02	0.00	-0.03	-0.07	-0.42	-0.70	-1.31	-1.36	-2.03	-2.33	-2.57	-2.90	-3.44
SF mV/g	20	20	20	20	19	19	18	17	17	16	15	15	14	13
Phase (deg)	-2	-3	-4	-9	-21	-49	-69	-95	-103	-109	-118	-126	-136	-147

* Reference Frequency is 100 Hz

** 14.142 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90157

Final Status:

Pass:

website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

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CALIBRATION CERTIFICATE PAGE 2

Model: 2210-200 **Part #:** 153-00001-05 **Full Scale:** 200 G

Serial #: 7133 **Op. Number:** 135 **Calibration Date:** 02/28/05

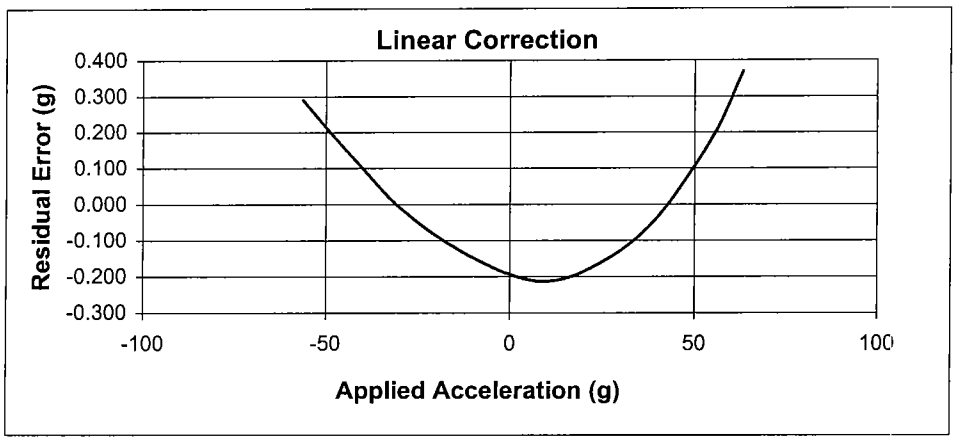
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

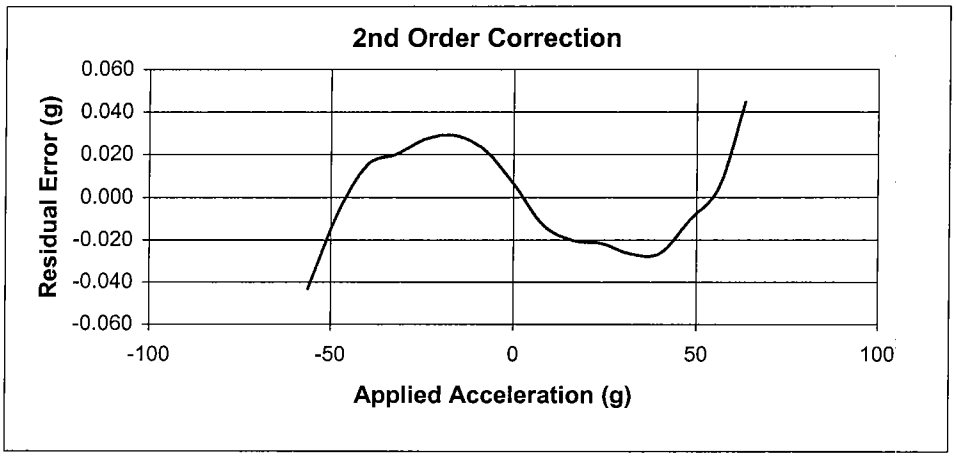
b	1.298E+00
a	5.073E+01
RMS Error	1.812E-01



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

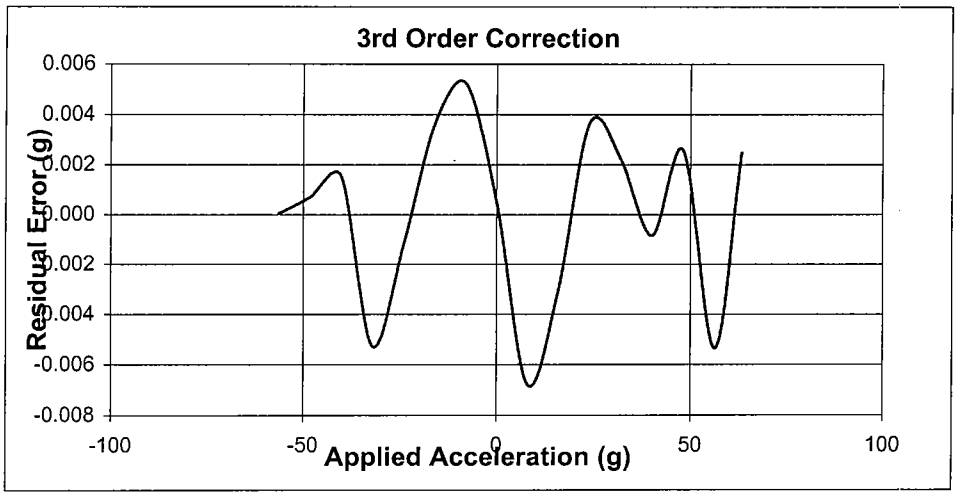
b	1.500E+00
a_1	5.078E+01
a_2	-3.826E-01
RMS Error	2.403E-02



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

b	1.496E+00
a_1	5.085E+01
a_2	-3.700E-01
a_3	-8.126E-02
RMS Error	3.427E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Mfg Lot #: **5m031a** Model: **2210-200** Part #: **153-00001-05** Doc. Rev. **D**

Op. Number: **135**

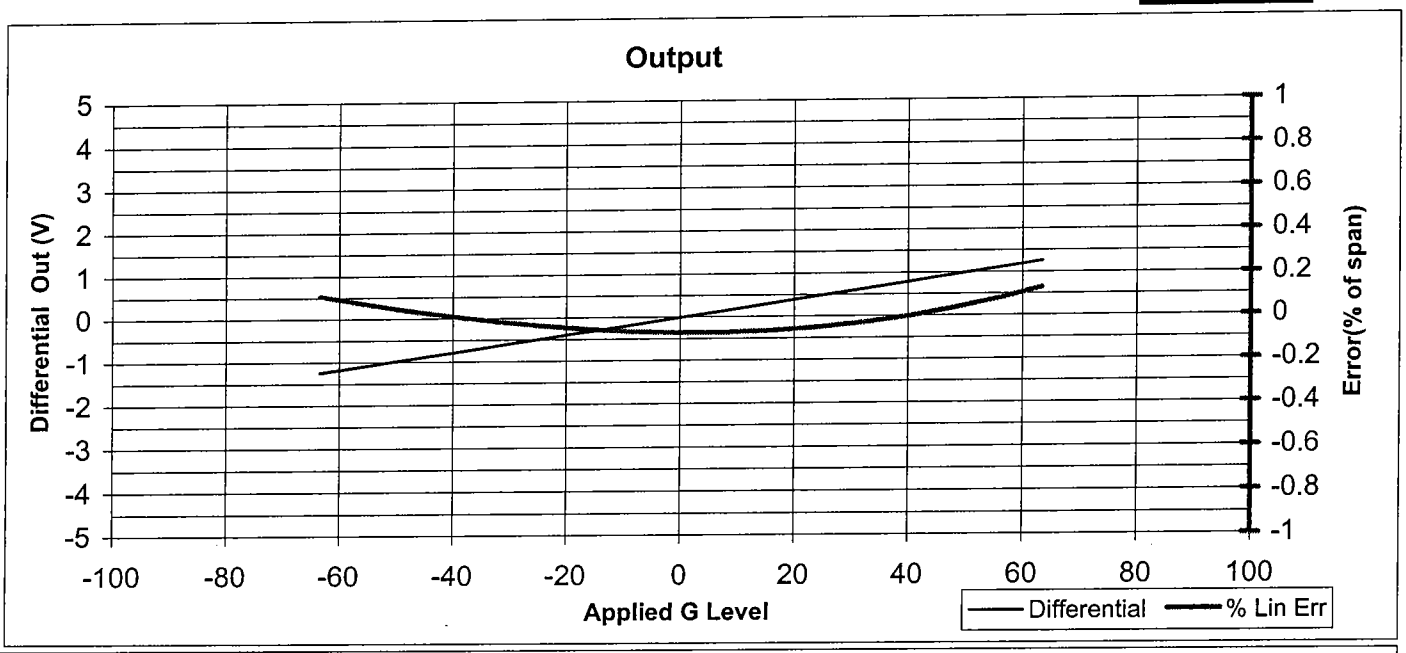
Serial #: **7134** Operator: **ch** +1 G DC: **14 mV DC**

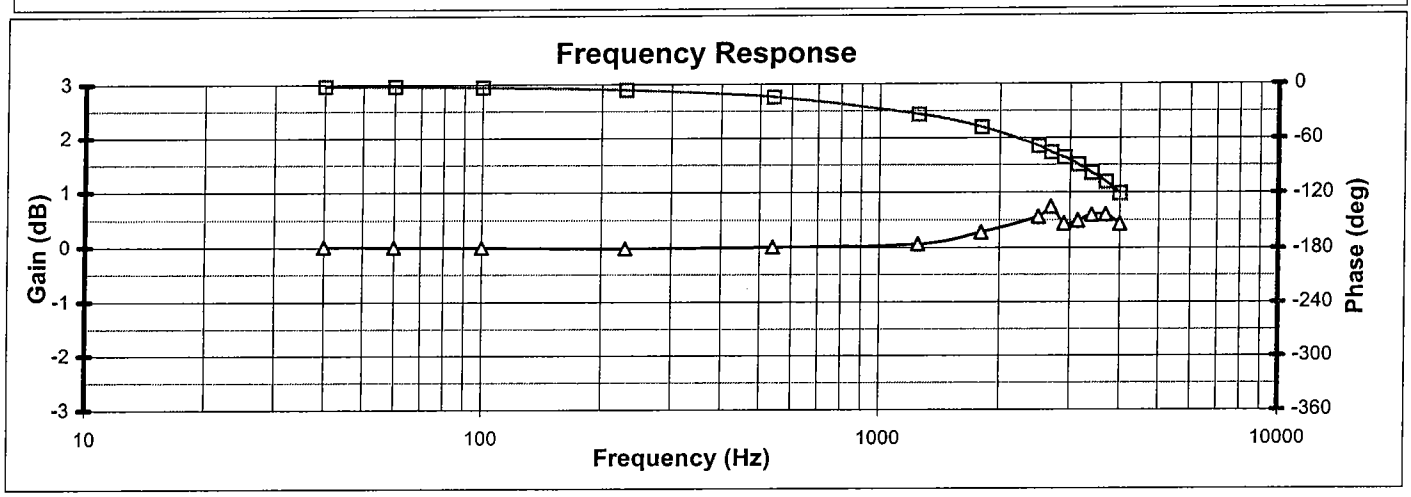
Calibration Date: **02/28/05** -1 G DC: **-25 mV DC**

Full Scale: **200 g** Calibration Freq.: **100 Hz** 0 G Bias **-6 mV DC**

Sensor ID **127944** Scale Factor **19.7 mV/G**

Supply Current: **7.6 mA**





Freq. (Hz)**	40	60	100	230	540	1250	1800	2500	2690	2900	3140	3400	3685	4000
dB Out	0.01	0.01	0.00	-0.02	0.01	0.07	0.28	0.56	0.74	0.44	0.49	0.59	0.60	0.43
SF mV/g	20	20	20	20	20	20	20	21	21	21	21	21	21	21
Phase (deg)	-2	-2	-3	-6	-14	-34	-48	-69	-76	-82	-90	-98	-108	-121

* Reference Frequency is 100 Hz

** 14.142 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90157

Final Status:

Pass:

website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

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CALIBRATION CERTIFICATE PAGE 2

Model: 2210-200 **Part #:** 153-00001-05 **Full Scale:** 200 G

Serial #: 7134 **Op. Number:** 135 **Calibration Date:** 02/28/05

Room Temperature Correction Factors:

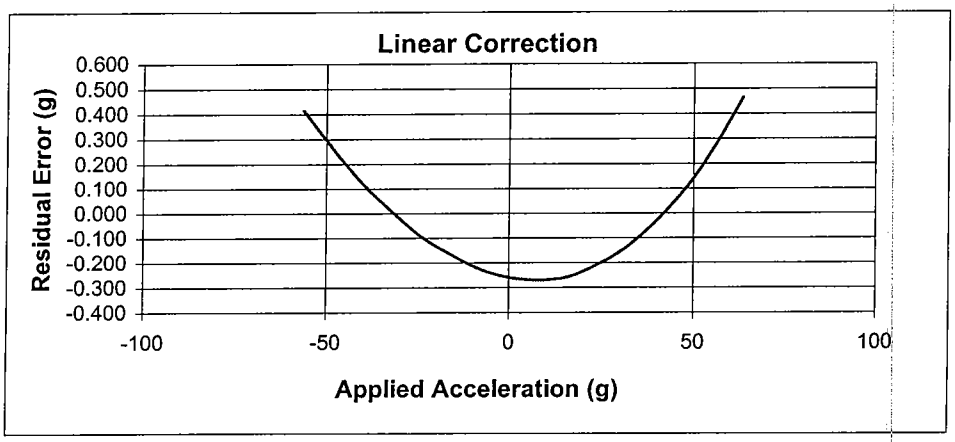
Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

b	3.182E-01
a	5.070E+01

RMS Error 2.389E-01

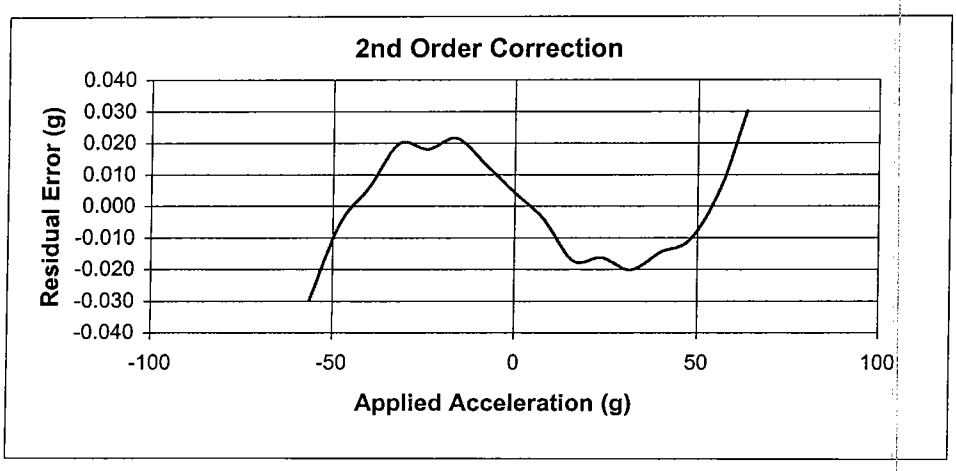


2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

b	5.832E-01
a_1	5.078E+01
a_2	-5.062E-01

RMS Error 1.691E-02

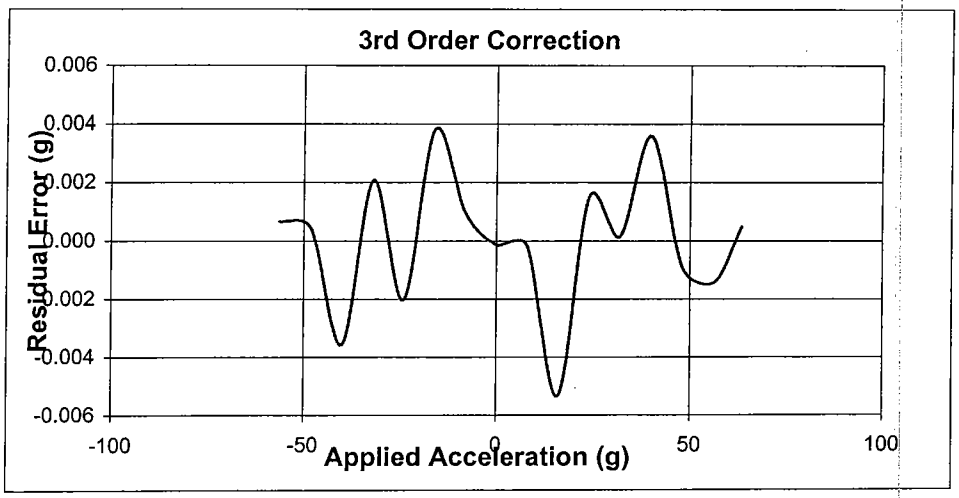


3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

b	5.794E-01
a_1	5.083E+01
a_2	-4.935E-01
a_3	-5.681E-02

RMS Error 2.294E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: 2440-025

Part #: 153-00024-02 Doc. Rev. -

Mfg. Lot #: 4m242a

Serial #: 26

Full Scale: 25 G

Op. Number: 740

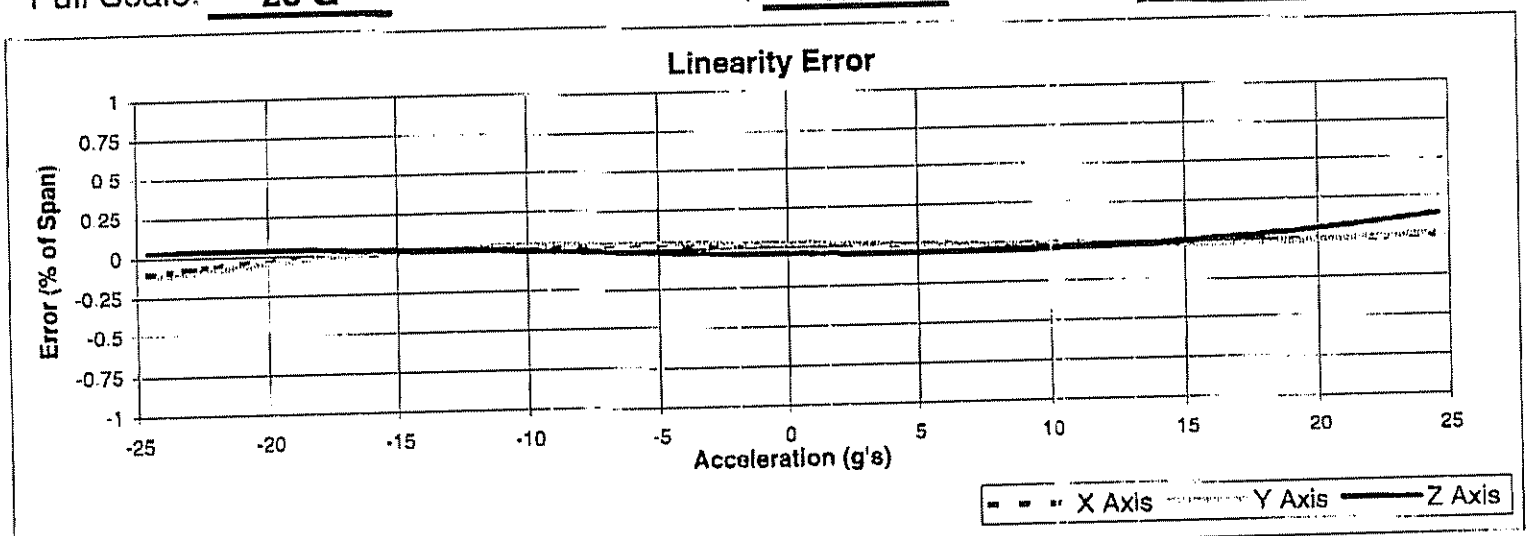
Operator: lynn

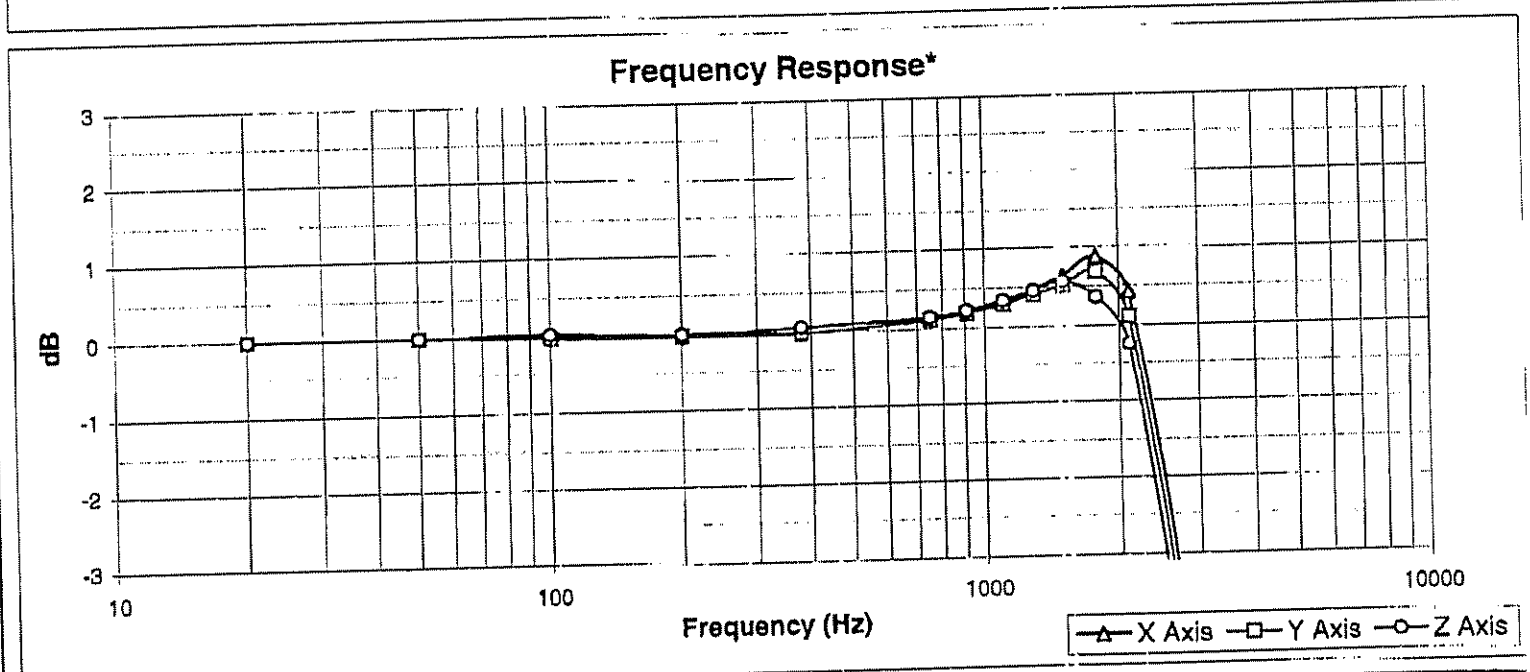
Calibration Date: 09/13/04

Supply Current: 27.2 mA

Calibration Freq. 50 Hz

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	204.0	179.0	219.0	mV DC
-1 G DC:	-193.0	-217.0	-180.0	mV DC
0 G Bias	6.0	-19.0	19.0	mV DC
Scale Factor	197.10	197.10	199.00	mV/G
Sensor ID	165246	166770	166788	





Freq. (Hz)**	20	50	100	200	380	750	910	1100	1285	1500	1775	2100	2900	4000
dB Out - X	-0.002	0	-0.027	-0.028	-0.018	0.112	0.189	0.295	0.461	0.65	0.884	0.43	-4.913	-13.98
dB Out - Y	-0.002	0	-0.023	-0.027	-0.016	0.113	0.188	0.295	0.415	0.523	0.7	0.114	-5.432	-14.97
dB Out - Z	-6E-04	0	0.017	-0.005	0.057	0.144	0.217	0.338	0.458	0.571	0.367	-0.257	-6.089	-15.59

* Reference Frequency is 50 Hz

** 7.071 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90152

Final Status:

Pass:

website: **www.siliconde signs.com** e-mail: **sales@siliconde signs.com**

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CALIBRATION CERTIFICATE PAGE 2

Model: 2440-025 **Part #:** 153-00024-02 **Full Scale:** 25 G

Serial #: 26 **Op. Number:** 740 **Calibration Date:** 09/13/04

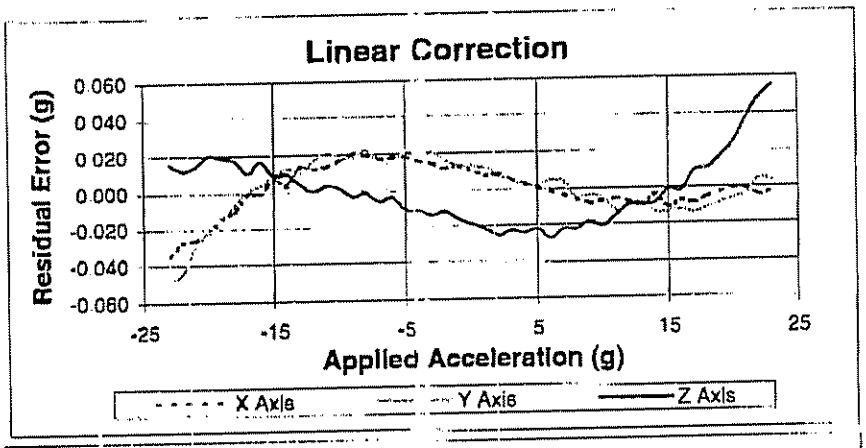
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

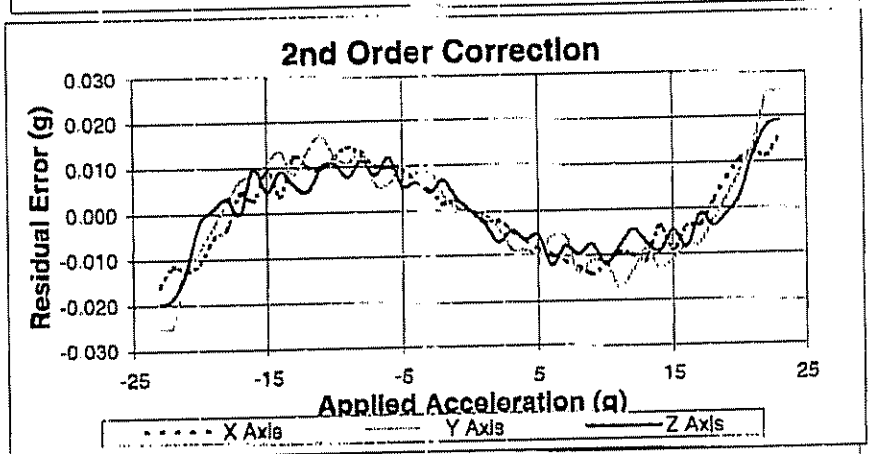
	X-Axis	Y-Axis	Z-Axis
b	-2.172E-02	7.957E-02	-9.900E-02
a	5.074E+00	5.075E+00	5.025E+00
RMS Error	1.295E-02	1.625E-02	1.921E-02



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

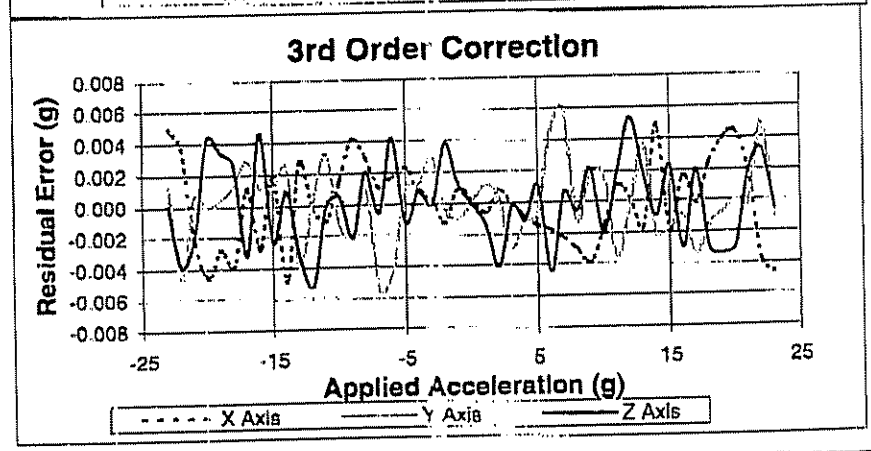
	X-Axis	Y-Axis	Z-Axis
b	-3.190E-02	6.692E-02	-7.957E-02
a_1	5.074E+00	5.075E+00	5.025E+00
a_2	1.394E-03	1.732E-03	-2.607E-03
RMS Error	9.406E-03	1.191E-02	9.003E-03



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	-3.192E-02	6.710E-02	-7.975E-02
a_1	5.081E+00	5.085E+00	5.033E+00
a_2	1.386E-03	1.687E-03	-2.565E-03
a_3	-5.939E-04	-7.860E-04	-5.495E-04
RMS Error	2.671E-03	2.518E-03	2.663E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: 2440-025

Part #: 153-00024-02 Doc. Rev. -

Mfg. Lot #: 4m242a

Op. Number: 740

Operator: lynn

Serial #: 27

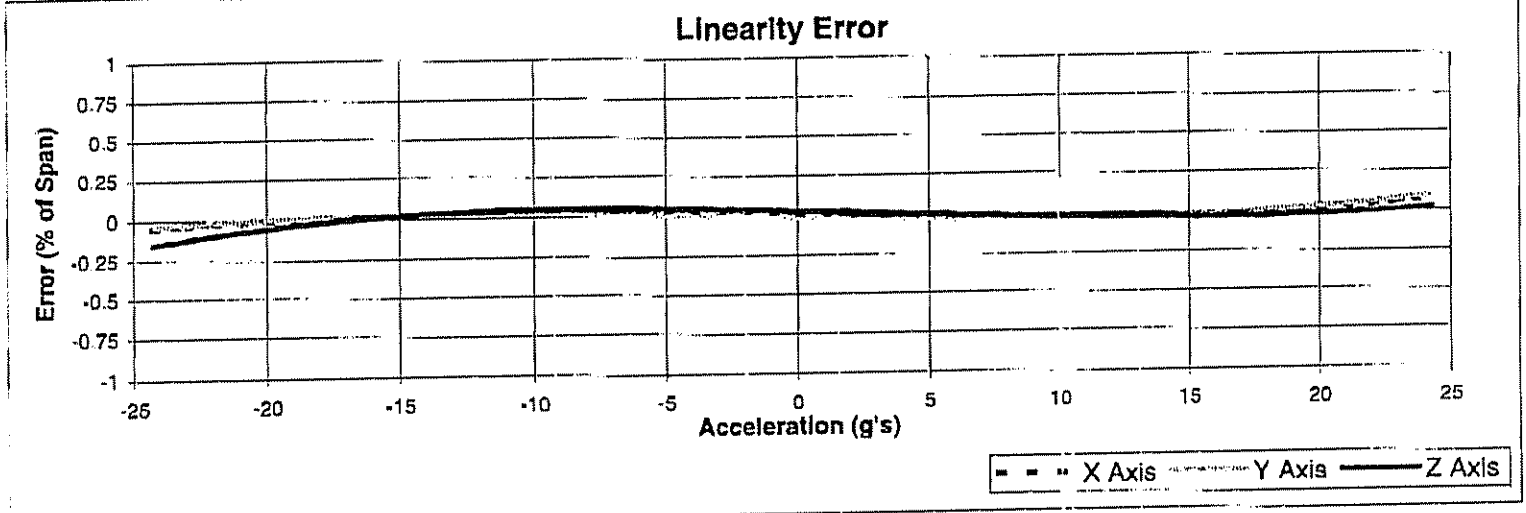
Calibration Date: 09/13/04

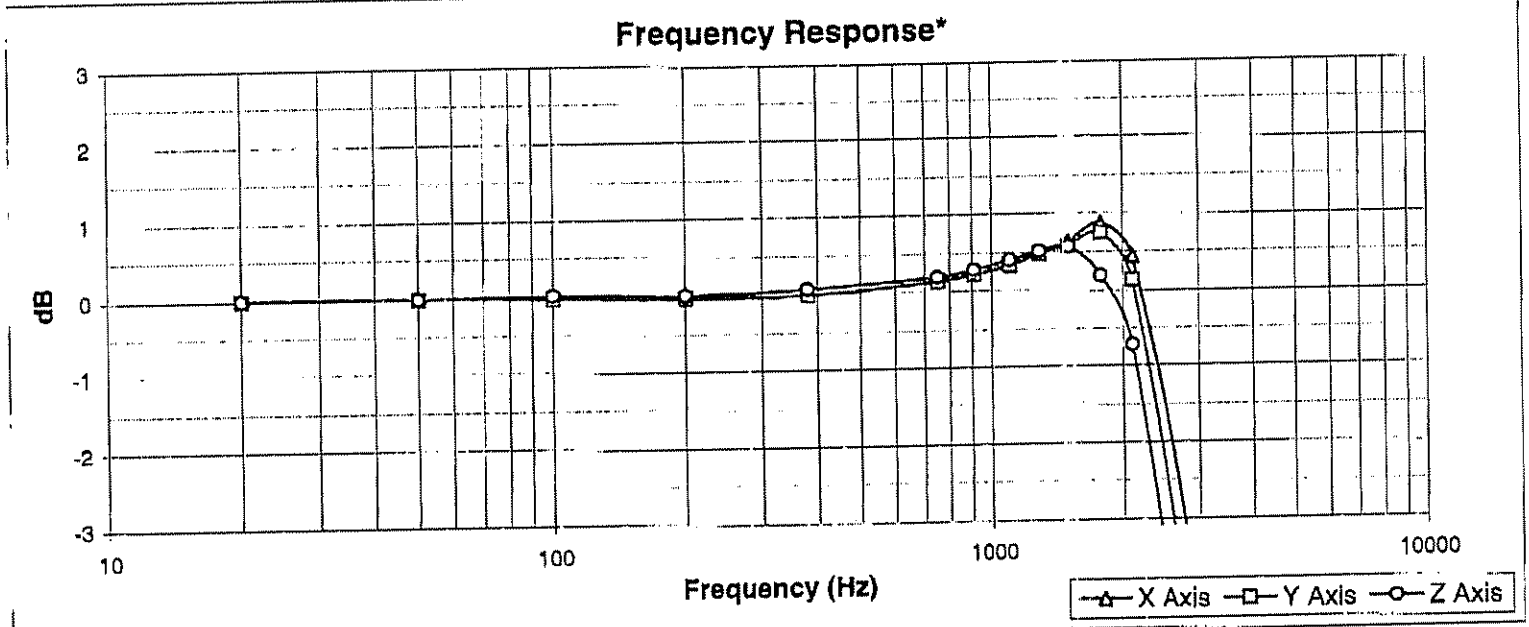
Supply Current: 27.3 mA

Full Scale: 25 G

Calibration Freq. 50 Hz

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	218.0	181.0	240.0	mV DC
-1 G DC:	-177.0	-216.0	-158.0	mV DC
0 G Bias	20.0	-18.0	41.0	mV DC
Scale Factor	196.50	196.90	198.40	mV/G
Sensor ID	166774	166772	166777	





Freq. (Hz)**	20	50	100	200	380	750	910	1100	1285	1500	1775	2100	2900	4000
dB Out - X	-0.003	0	-0.022	-0.029	-0.004	0.142	0.226	0.332	0.486	0.63	0.88	0.441	-3.926	-12.3
dB Out - Y	-0.002	0	-0.021	-0.023	-0.003	0.149	0.233	0.35	0.477	0.585	0.75	0.133	-5.179	-14.21
dB Out - Z	-6E-04	0	0.02	0.005	0.069	0.195	0.281	0.403	0.511	0.562	0.187	-0.727	-6.71	-15.86

* Reference Frequency is 50 Hz

** 7.071 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90152

Final Status:

Pass:

website: www.siliconcesigns.com e-mail: sales@siliconcesigns.com

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CALIBRATION CERTIFICATE PAGE 2

Model: 2440-025 **Part #:** 153-00024-02 **Full Scale:** 25 G

Serial #: 27 **Op. Number:** 740 **Calibration Date:** 09/13/04

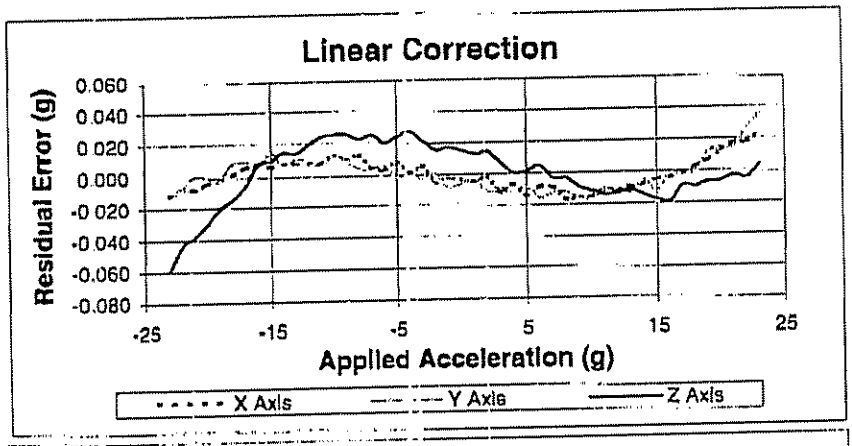
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

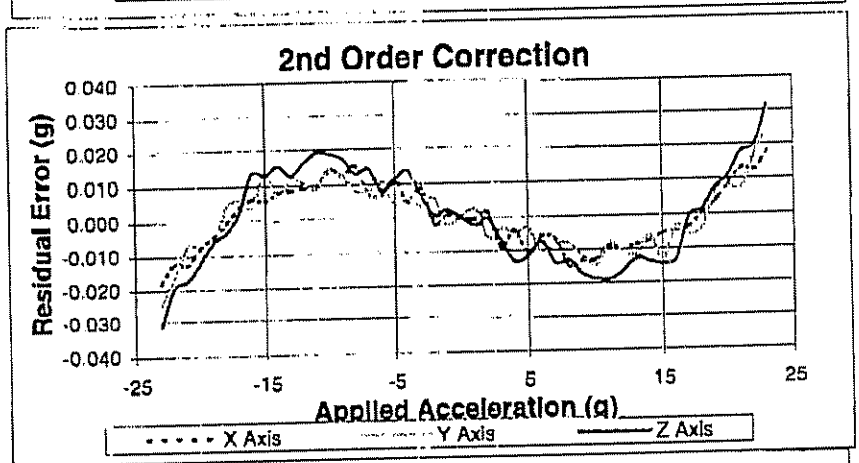
	X-Axis	Y-Axis	Z-Axis
b	-6.310E-02	5.597E-02	-2.511E-01
a	5.088E+00	5.078E+00	5.041E+00
RMS Error	9.897E-03	1.146E-02	1.946E-02



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

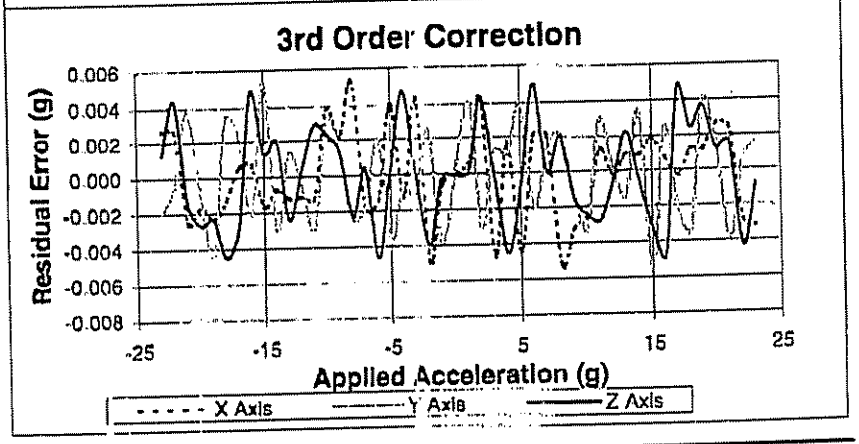
	X-Axis	Y-Axis	Z-Axis
b	-5.950E-02	6.211E-02	-2.661E-01
a_1	5.088E+00	5.078E+00	5.041E+00
a_2	-4.948E-04	-8.425E-04	2.034E-03
RMS Error	9.384E-03	1.012E-02	1.433E-02



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	-5.981E-02	6.219E-02	-2.667E-01
a_1	5.095E+00	5.086E+00	5.053E+00
a_2	-4.707E-04	-8.603E-04	2.157E-03
a_3	-5.977E-04	-6.412E-04	-9.062E-04
RMS Error	2.591E-03	2.773E-03	2.819E-03



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SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: 2440-025

Part #: 153-00024-02 Doc. Rev. -

Mfg. Lot #: 4m242a

Op. Number: 740

Operator: lynn

Serial #: 28

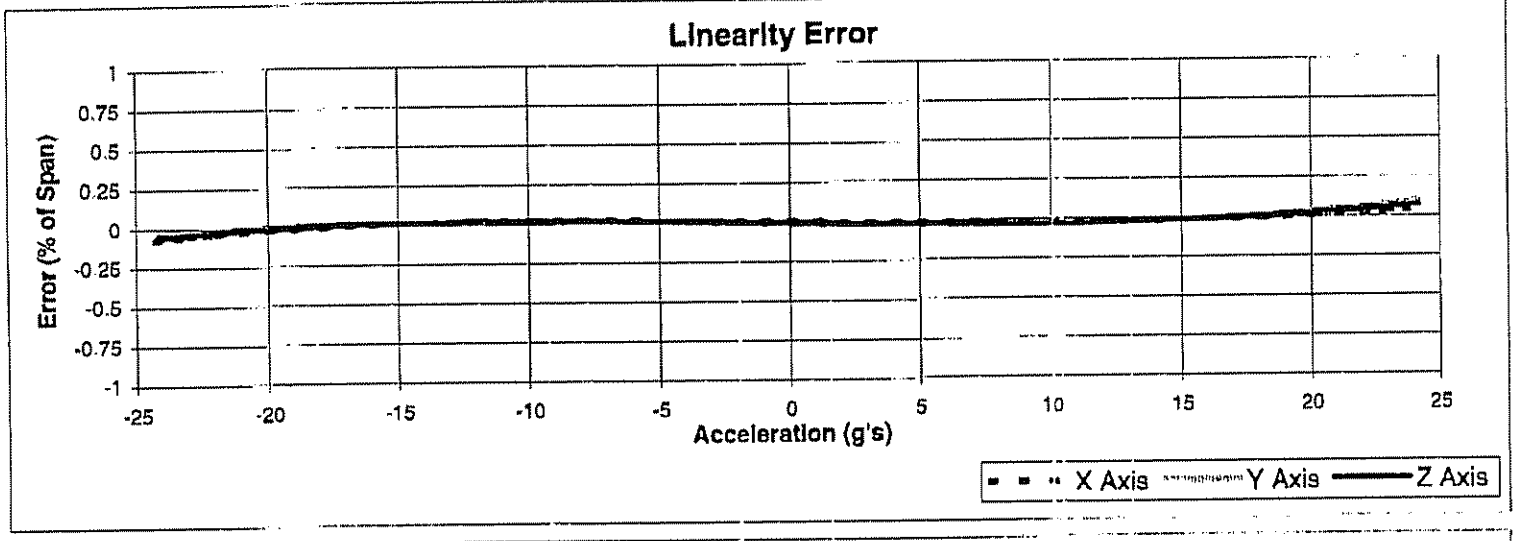
Calibration Date: 09/13/04

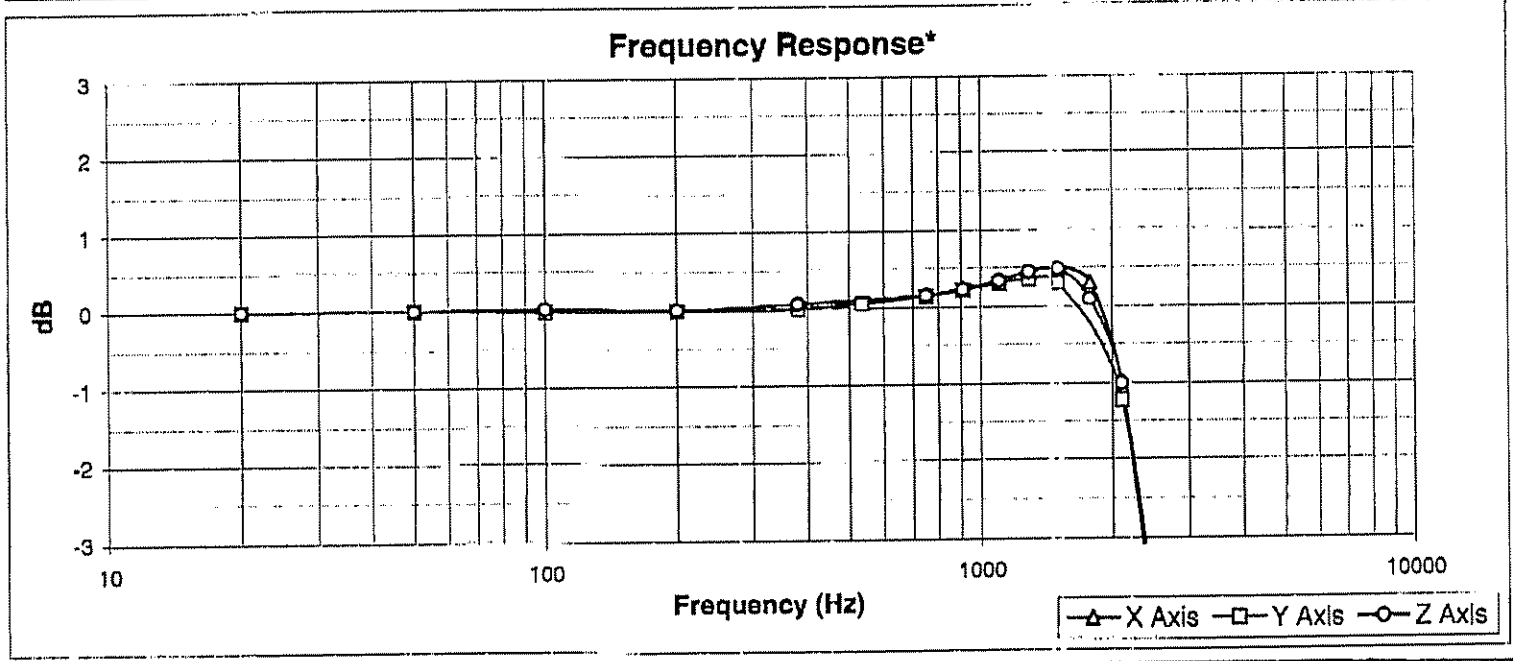
Supply Current: 27.7 mA

Full Scale: 25 G

Calibration Freq. 50 Hz

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	225.0	184.0	226.0	mV DC
-1 G DC:	-170.0	-213.0	-172.0	mV DC
0 G Bias	28.0	-14.0	27.0	mV DC
Scale Factor	197.00	196.70	198.10	mV/G
Sensor ID	165247	165254	166769	





Freq. (Hz)**	20	50	100	200	380	750	910	1100	1285	1500	1775	2100	2900	4000
dB Out - X	-6E-04	0	-0.016	-0.018	-0.005	0.149	0.233	0.326	0.446	0.492	0.307	-1.052	-7.73	-16.87
dB Out - Y	-0.004	0	-0.024	-0.023	-0.005	0.051	0.144	0.216	0.3	0.353	0.3	-1.216	-7.481	-16.5
dB Out - Z	-0.001	0	0.012	-0.009	0.058	0.146	0.22	0.332	0.445	0.49	0.085	-1.008	-7.382	-17.04

* Reference Frequency is 50 Hz

** 7.071 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90152

Final Status:

Pass:

website: www.silicondesigns.com e-mail: sales@siliconde signs.com

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE PAGE 2

Model: 2440-025 **Part #:** 153-00024-02 **Full Scale:** 25 G

Serial #: 28 **Op. Number:** 740 **Calibration Date:** 09/13/04

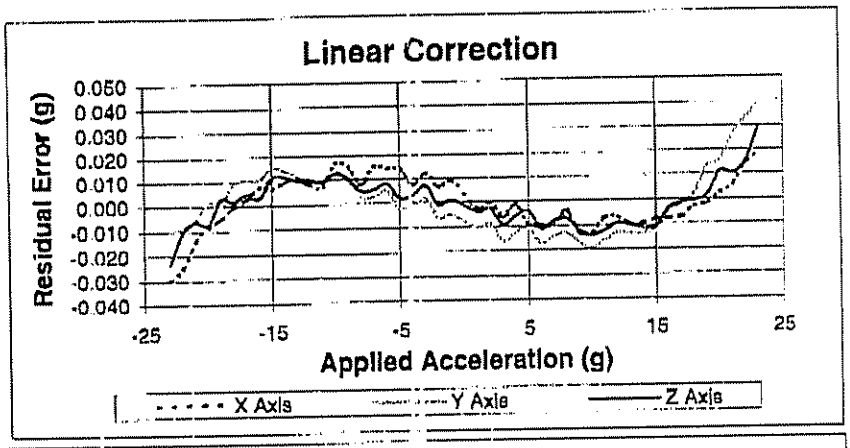
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

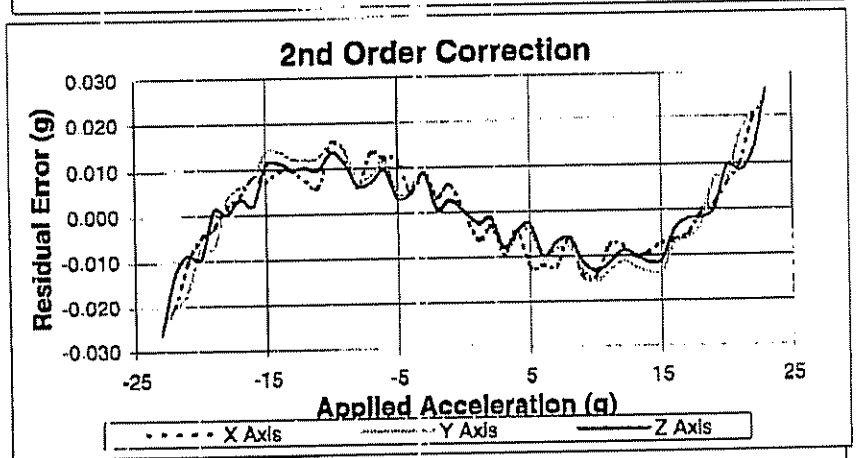
	X-Axis	Y-Axis	Z-Axis
b	-1.284E-01	5.041E-02	-1.993E-01
a	5.077E+00	5.083E+00	5.049E+00
RMS Error	1.098E-02	1.346E-02	9.817E-03



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

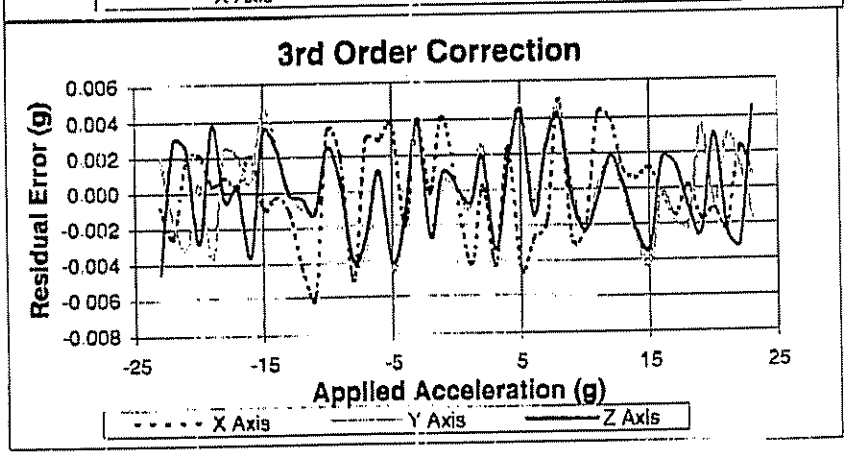
	X-Axis	Y-Axis	Z-Axis
b	-1.315E-01	5.807E-02	-1.978E-01
a_1	5.077E+00	5.083E+00	5.049E+00
a_2	4.273E-04	-1.053E-03	-2.125E-04
RMS Error	1.064E-02	1.167E-02	9.721E-03



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	-1.317E-01	5.816E-02	-1.981E-01
a_1	5.085E+00	5.092E+00	5.057E+00
a_2	4.768E-04	-1.070E-03	-1.398E-04
a_3	-6.768E-04	-7.530E-04	-6.067E-04
RMS Error	2.757E-03	2.510E-03	2.598E-03



website: www.silicondesigns.com e-mail: sales@silicondesigns.com

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE

Model: 2440-025

Part #: 153-00024-02 Doc. Rev. -

Mfg. Lot #: 4m242a

Op. Number: 740

Operator: lynn

Serial #: 29

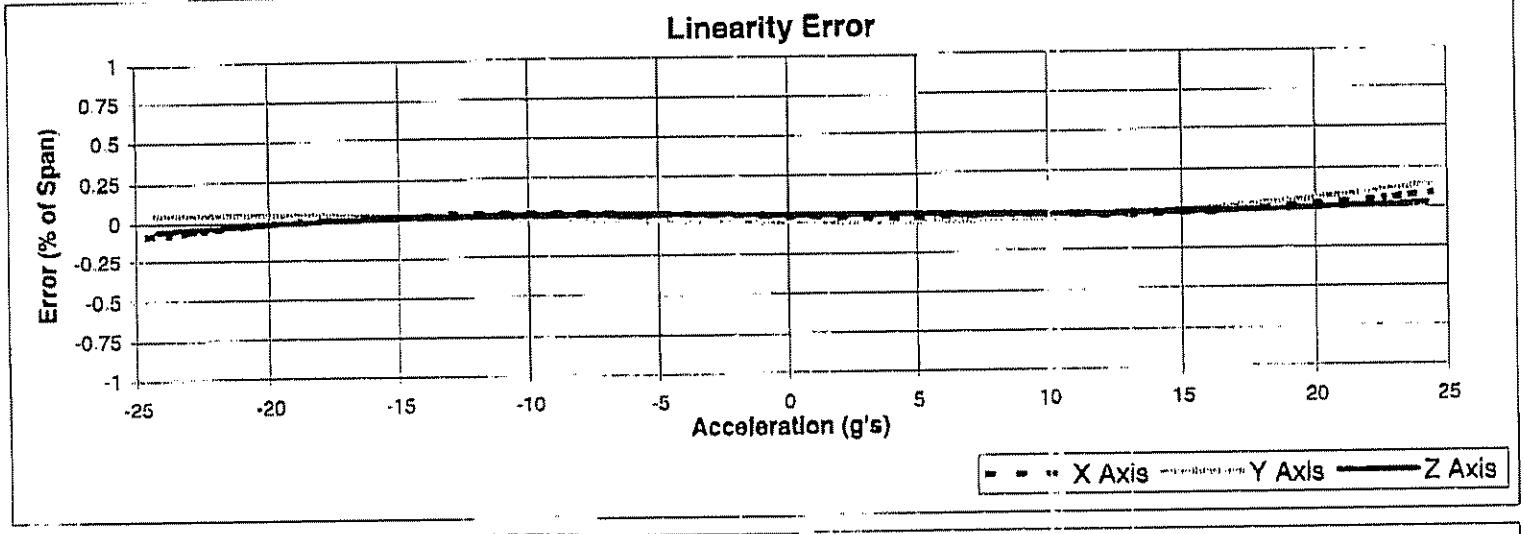
Calibration Date: 09/13/04

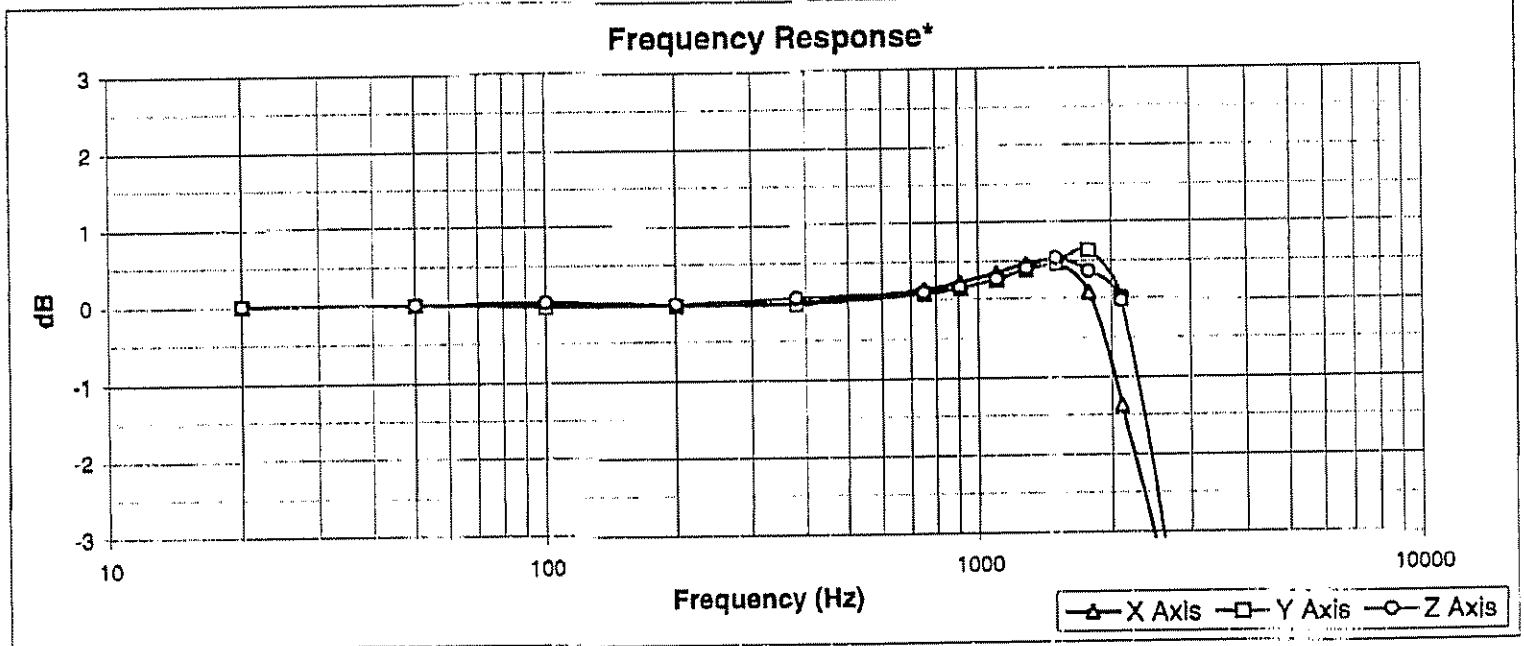
Supply Current: 27.2 mA

Full Scale: 25 G

Calibration Freq. 50 Hz

	X-Axis	Y-Axis	Z-Axis	
+1 G DC:	188.0	214.0	207.0	mV DC
-1 G DC:	-207.0	-184.0	-194.0	mV DC
0 G Bias	-10.0	15.0	6.0	mV DC
Scale Factor	197.00	198.90	198.60	mV/G
Sensor ID	166793	166790	166795	





Freq. (Hz)**	20	50	100	200	380	750	910	1100	1285	1500	1775	2100	2900	4000
dB Out - X	-0.003	0	-0.004	-0.016	-0.009	0.141	0.234	0.343	0.464	0.468	0.083	-1.369	-5.391	-15.2
dB Out - Y	-0.001	0	-0.04	-0.041	-0.03	0.086	0.156	0.258	0.386	0.472	0.638	0.011	-5.276	-15.3
dB Out - Z	0	0	0.021	-0.014	0.051	0.105	0.168	0.267	0.401	0.535	0.363	-0.025	-5.132	-14.2

* Reference Frequency is 50 Hz

** 7.071 g Peak Acceleration Traceable to NIST through Vibration Calibration Standard M-90152

Final Status:

Pass:

website: **www.siliconcdesigns.com** e-mail: **sales@siliconcdesigns.com**

SILICON DESIGNS INC. 1445 NW Mall St., Issaquah WA 98027-5344, (425) 391-8329, FAX (425) 391-0446

CALIBRATION CERTIFICATE PAGE 2

Model: 2440-025 **Part #:** 153-00024-02 **Full Scale:** 25 G

Serial #: 29 **Op. Number:** 740 **Calibration Date:** 09/13/04

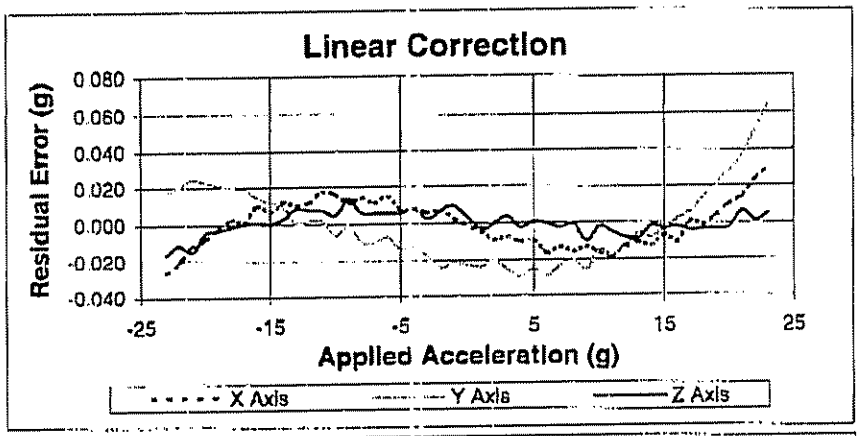
Room Temperature Correction Factors:

Y = G's measured X = Output In Volts

Linear Fit:

$$Y = aX + b$$

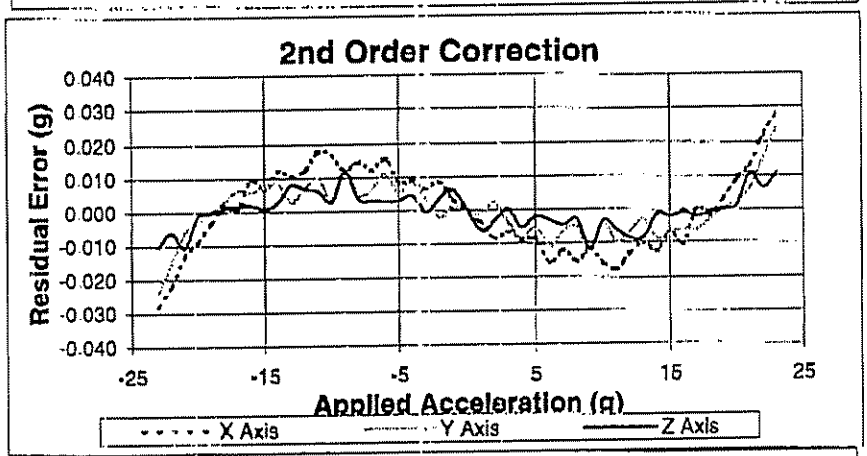
	X-Axis	Y-Axis	Z-Axis
b	4.742E-02	-7.782E-02	-7.992E-02
a	5.077E+00	5.080E+00	5.036E+00
RMS Error	1.278E-02	2.169E-02	6.251E-03



2nd order Fit:

$$Y = a_2 X^2 + a_1 X + b$$

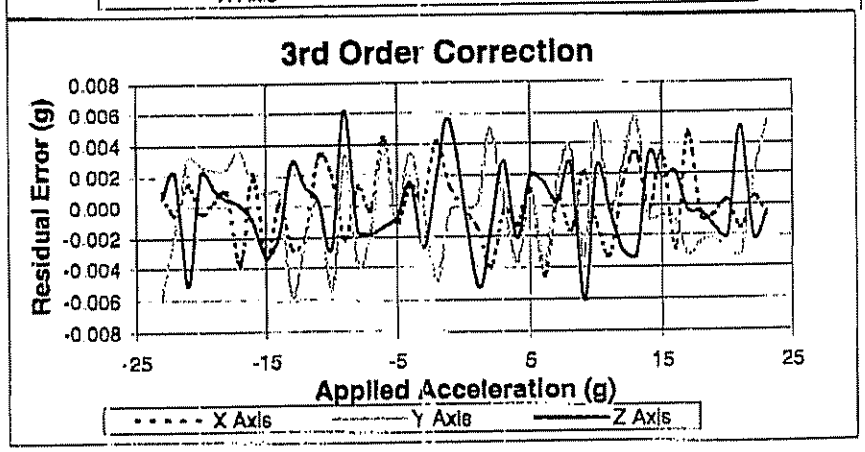
	X-Axis	Y-Axis	Z-Axis
b	4.834E-02	-5.505E-02	-8.319E-02
a_1	5.077E+00	5.080E+00	5.036E+00
a_2	-1.263E-04	-3.125E-03	4.410E-04
RMS Error	1.275E-02	8.628E-03	5.559E-03



3rd order Fit:

$$Y = a_3 X^3 + a_2 X^2 + a_1 X + b$$

	X-Axis	Y-Axis	Z-Axis
b	4.844E-02	-5.519E-02	-8.326E-02
a_1	5.088E+00	5.087E+00	5.040E+00
a_2	-1.488E-04	-3.090E-03	4.551E-04
a_3	-8.270E-04	-5.308E-04	-3.132E-04
RMS Error	2.241E-03	3.133E-03	2.683E-03



website: **www.silicondesigns.com** e-mail: **sales@silicondesigns.com**

ENDEVCO
www.endevco.com

ph: (949) 493-8181 fax: (949) 661-7231
email: customercaremailbox@endevco.com

Calibration Certificate

Document number: 83572

Temperature (deg C): 23
Relative Humidity (%): 47
Input Resistance (ohms): 584
Output Resistance (ohms): 598
ZMO (mV): -3.7
Resonance Frequency (Hz): 16787

Transverse Sensitivity(%): 0.8

Description: 4 Arm PR accelerometer
Manufacturer: ENDEVCO
Model Number: 7264B-500T
Serial Number: B15071

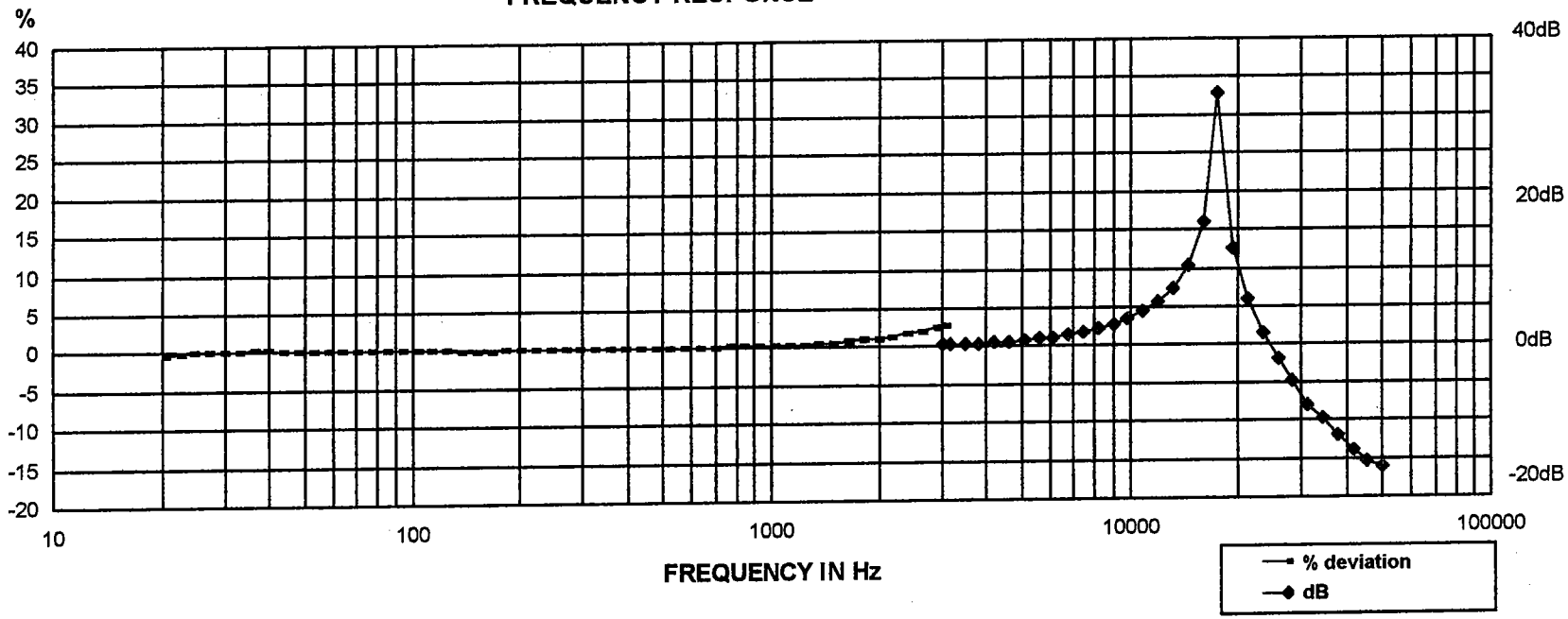
Sensitivity:

0.7447 mV/g @ 100 Hz, 10 g pk
0.07594 mV/ m/s² @ 100 Hz, 98 m/s² pk

Excitation: 10.0 V

Notes:

FREQUENCY RESPONSE



Endevco, a division of Meggitt, located at 30700 Rancho Viejo Road, San Juan Capistrano, CA, certifies that the above instrument was tested using comparison calibrations per ANSI S2.2 using Endevco IM68357. This calibration is traceable to the National Institute of Standards and Technology and is in accordance with ANSI/NCSL Z540-1-1994 (MIL-STD 45662A).

Console serial number: AC23
Equipment used: 2901
Ref Manufacturer: ENDEVCO
Ref Model number: 2270M7A/2771A-10
Ref Serial number: AC56/DP46
NIST traceability #: 822/271199-05
Test Name: FINAL 2901 REV C

Uncertainty estimate (95% confidence, k=2)

+/- 1.2 %	100.0 Hz Sensitivity
+/- 1.5 %	20.0 < f <= 100.0 Hz
+/- 1.2 %	100.0 < f <= 2500.0 Hz
+/- 2.5 %	2500.0 < f <= 10000.0 Hz
+/- 5.0 %	10000.0 < f <= 20000.0 Hz

By: TSB
operator Name and Title
3/7/2005 10:20 AM

MAR 9 '05

PE SBU
s/w 7.03

This certificate shall not be reproduced, except in full, without the written approval of Endevco.

ED421 Rev D

Calibration Certificate

ENDEVCO, a leading authority in precision dynamic measurement, certifies that this instrument meets or exceeds all published specifications

This instrument has been calibrated using standards with accuracies traceable to the National Institute of Standards and Technology (NIST) within the limitations of their calibration services, or have been derived from accepted values or natural physical constraints, or have been derived by ratio or self-calibration techniques.

All activities performed in this calibration comply with ISO/IEC 17025-2000 and ANSI/NCSL Z540-1-1994 (MIL-STD 45662A).

Robert Meyer
President

Alex Johnstone
Director, Product Assurance

MEGGITT

ENDEVCO

An ISO-9001 Certified Company

ED433 Rev D

ACCELEROMETER CALIBRATION CERTIFICATE

Vibra•Metrics®
A Member of MISTRAS Holdings Group

The unit was calibrated at VibraMetrics Laboratory. Measuring and test equipment used in the calibration is traceable to the U.S. National Institute of Standards and Technology. Documentation relative to traceability is on file at this office and is available for examination upon request. Do not reproduce except in full, without written approval

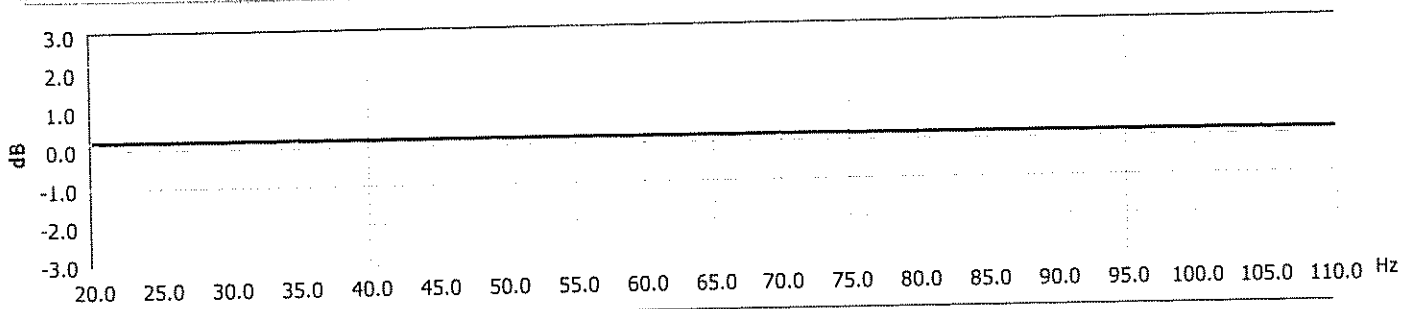
195 Clarksville road
Princeton Jct., NJ 08550-5303
Ph: (609) 716-4130
customerservice@vibrametrics.com

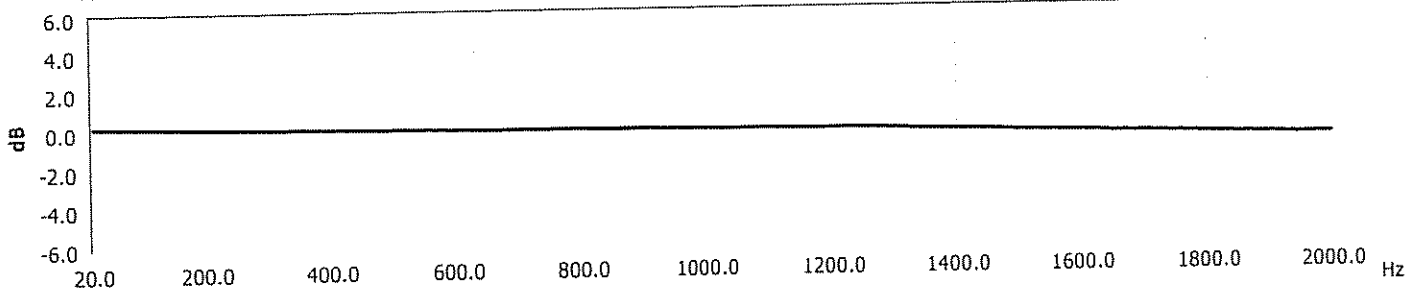
Calibration Proc. #: QOP-760-01 **Customer's Name:**

Quality Assurance: _____

Model No.	Serial No.	By	Date	Basic Sensitivity (mv/g) @ 100 Hz (measured)	Bias Level(volts).	Noise Floor(uv/rms)
7002HG2K	0867	LW	6/7/2005	9.9	11.9	

Freq. Reponse +/-5%.	Freq. Response +/-3db	Resonant Freq. (KHz)	Transverse Sensitivity	Mounting Torque (in-lbs)	NIST Test Number	Power Supply
N/A	2Hz to 2 KHz	N/A	<5%	20	822/268064-03	2 mA @ 24





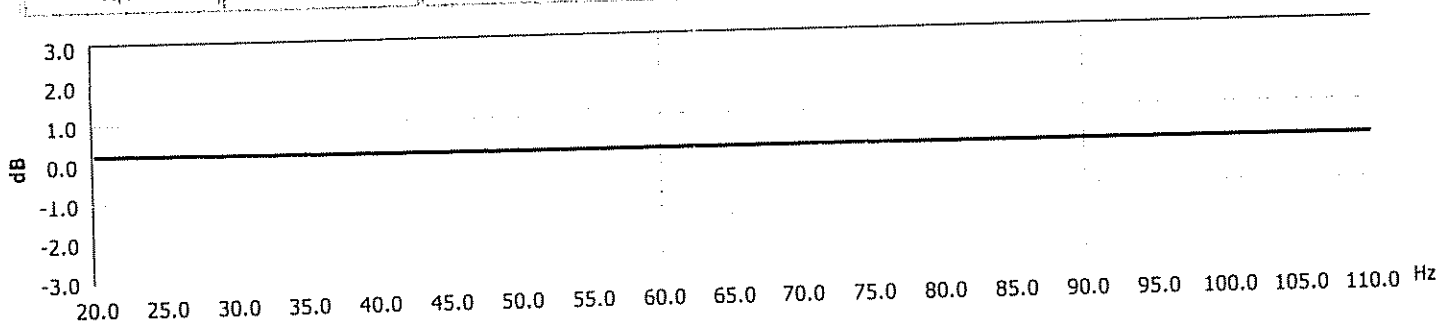
Vibra•Metrics®

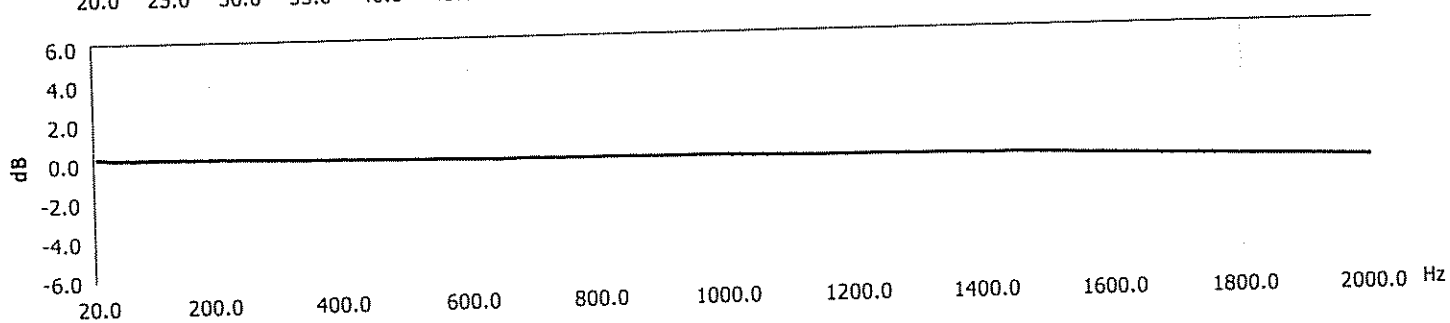
A Member of MISTRAS Holdings Group

ACCELEROMETER CALIBRATION CERTIFICATE

Model No.	Serial No.	Operator	Date	Basic Sensitivity (mv/g) @ 100 Hz	Bias Level(volts).	Noise Floor(uv/rms)
7002HG2K	0902	LW	5/24/2005	9.5	11.3	

Freq. Reponse +/-5%.	Freq. Response +/-3db	Resonant Freq. (KHz)	Transverse Sensitivity	Mounting Torque (in-lbs)	NIST Test Number	Power Supply
N/A	2Hz to 2 KHz	N/A	<5%	20	822/268064-03	2 mA @ 24





POWER SUPPLY CERTIFICATE OF CALIBRATION

We hereby certify that the power supply described below has been calibrated in compliance with the system requirements defined by ANSI/NCSL Z540-1, as amended. Calibration instrumentation used is maintained in accordance with ISO 10012-1, being directly traceable to N.I.S.T. Documentation supporting this traceability is at our facility and available upon request.

MODEL: LP-24-3B SERIAL NUMBER: 182

LED is on

MEASURED CURRENT SOURCE OF 2.2mA ± 0.3 Ma is:
"X"= 2.2, "Y"= 2.2, "Z"= 2.2.

MEASURED VOLTAGE AT INPUT OF 24VDC ± 1.2V is: 24.0V
"X"= 24.0, "Y"= 24.0V, "Z"= 24.0V

FUNCTIONAL TEST USING SCOPE, FOR SIGNAL DISTORTION: ☑

TECHNICIAN: L.A.M

TEST DATE: 6/9/05

QUALITY VERIFICATION STAMP:

ACCEPTANCE DATE: 6/6/05

AUTHORIZED SIGNATURE: Desai Bera.

TITLE: Quality Inspector

QUALITY ASSURANCE DEPT.

QAF-LP24,REV.-

Dytran Instruments, Inc.
21592 Marilla St. Chatsworth, CA 91311 Ph: 818-700-7818 Fax 818-700-7880
www.dytran.com email: info@dytran.com

CALIBRATION CERTIFICATE
UNITY GAIN CURRENT SOURCE POWER UNIT

CUSTOMER:	ENSCO, INC.	TEST REPORT #:	1005 5/18/2005
PURCHASE ORDER #:	85737	SALES ORDER #: 119156	PROCEDURE: TP4023
MODEL:	4110C	SERIAL #:	1005

BATTERY POWERED		LINE POWERED	X	115VAC	X	230VAC	
NEW UNIT	X	RE-CALIBRATION [1]		AS RECEIVED CODE		AS RETURNED CODE	

TEMPERATURE (°C): 22	HUMIDITY (%): 35

CALIBRATION DATA

POWER SUPPLY VOLTAGE (VDC):	24.0	BATTERY VOLTAGE (VDC):	
METER ZERO	X	METER CALIBRATION	X

SENSOR DRIVE CURRENT (mA)

CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8
5.0							
CH 9	**CH 10**	**CH 11**	**CH 12**	**CH 13**	**CH 14**	**CH 15**	**CH 16**

AS RECEIVED DATA

GENERAL CONDITION:			
POWER SUPPLY VOLTAGE (VDC):		BATTERY VOLTAGE (VDC):	
METER CALIBRATION		REPLACED BATTERIES	YES / NO

SENSOR DRIVE CURRENT (mA)

CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8
CH 9	**CH 10**	**CH 11**	**CH 12**	**CH 13**	**CH 14**	**CH 15**	**CH 16**

NOTES:

TEST EQUIPMENT LIST - CALIBRATION STATION # 6

DII #	MANUFACTURER	MODEL	SERIAL #	DESCRIPTION	CAL DATE	DUE DATE
228	DYTRAN INST	4515	117	SENSOR SIMULATOR	06/07/04	06/07/05
464	KENWOOD	CS-4135	5100491	OSCILLOSCOPE	07/28/04	07/28/05
418	KIETHLEY	197A	0765030	DIGITAL MULTIMETER	06/23/04	06/23/05
564	INSTEK	GFG 8020H	D675835	FUNCTION GENERATOR	12/28/04	12/28/05

[1] AS RECEIVED / AS RETURNED CODES:

1 = IN TOLERANCE. NO ADJUSTMENTS
2 = IN TOLERANCE. BUT ADJUSTED
3= OUT OF TOLERANCE
4 = REPAIR RECOMMENDED
5 = REPAIRED AND CALIBRATED
6 = NON-REPAIRABLE. REPLACEMENT RECOMMENDED

THIS CALIBRATION WAS PERFORMED IN ACCORDANCE WITH MIL-STD-45662A. ANSI/NCSL Z540-1-1994. ISO 10012-1 AND IS TRACEABLE TO THE NIST (NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY)

THIS CERTIFICATE SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN PERMISSION FROM DYTRAN INSTRUMENTS, INC.

CALIBRATION TECHNICIAN: L. ROJAS	TEST DATE: 05/18/05
	RECALL DATE: 05/18/06

Dytran Instruments, Inc.
21592 Marilla St. Chatsworth, CA 91311 Ph: 818-700-7818 Fax 818-700-7880
www dytran com email: info@dytran com

CALIBRATION CERTIFICATE
VOLTAGE MODE ACCELEROMETER

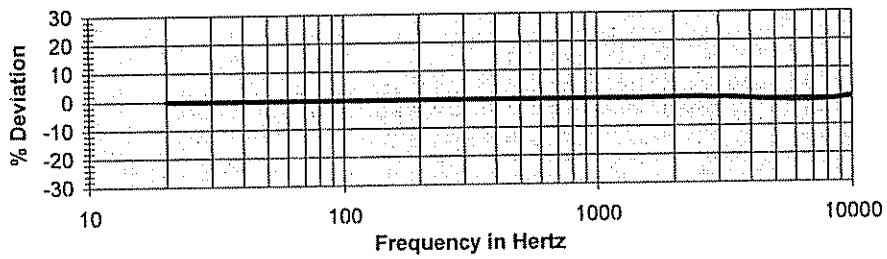
CUSTOMER:	ENSCO, INC.			TEST REPORT #:	12361 5/18/05
PURCHASE ORDER #:	85737	SALES ORDER #:	119156	PROCEDURE:	TP3002
MODEL:	3030B4	SERIAL #:	12361	RANGE, F.S. (g's):	+/- 500
NEW UNIT	X	RE-CALIBRATION [1]		AS RECEIVED CODE	AS RETURNED CODE
REF. SENSITIVITY (mV/g) [2]:	10.10	TEMP (°C):	22	HUMIDITY (%):	38

FREQUENCY RESPONSE [3]

FREQUENCY (Hz)	SENSITIVITY (mV/g)	FREQUENCY (Hz)	SENSITIVITY (mV/g)
20	10.10	500	10.10
30	10.10	1000	10.10
50	10.10	3000	10.10
100	10.10	5000	10.00
300	10.10	8000	10.00
		10000	10.10

TRANSVERSE SENSITIVITY (%):	1.2		
DISCHARGE TIME CONSTANT (sec):	0.50	BIAS VOLTAGE (VDC):	8.9

Amplitude Response



REMARKS:

TEST EQUIPMENT LIST - CALIBRATION STATION # 3

DII #	MANUFACTURER	MODEL	SERIAL #	DESCRIPTION	CAL DATE	DUE DATE
565	INSTEK	FG-8016G	D685002	FUNCTION GENERATOR	12/28/04	12/28/05
389	GOODWILL INST.	GOS-622G	9631068	OSCILLOSCOPE	12/04/04	12/04/05
286	FLUKE	45	7025037	MULTIMETER	12/04/04	12/04/05
213	TRIG-TEK	346B	115	SYNTHESIZED CALIBRATOR	02/23/05	02/23/06
443	NICOLET	3091	85D01977	DIGITAL OSCILLOSCOPE	08/17/04	08/17/05
976	DYTRAN INST.	3010M8	976	ACCELEROMETER	06/17/04	06/17/05

[1] AS RECEIVED / AS RETURNED CODES:
1 = IN TOLERANCE. NO ADJUSTMENTS
2 = IN TOLERANCE. BUT ADJUSTED
3 = OUT OF TOLERANCE < 5%
4 = OUT OF TOLERANCE > 5%
5 = REPAIR REQUIRED
6 = REPAIRED AND CALIBRATED
7 = UNIT NON-REPAIRABLE, RECOMMEND REPLACEMENT
8 = UNIT SERVICEABLE WITH CURRENT CALIBRATION DATA

[2] THE REFERENCE SENSITIVITY IS MEASURED AT 100 Hz. 1G RMS

[3] THIS CALIBRATION WAS PERFORMED IN ACCORDANCE WITH MIL-STD-45662A. ANSI/NCSL Z540-1-1994, ISO 10012-1 USING THE BACK-TO-BACK COMPARISON METHOD PER ISA RP37 2 AND IS TRACEABLE TO THE NIST THROUGH TEST REPORT # 822/270316-04 DUE 06-17-05
ESTIMATED UNCERTAINTY OF CALIBRATION: 2% FROM 5-50 Hz. 1% FROM 100-2000 Hz. 2% FROM 2 5-10 kHz

THIS CERTIFICATE SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN PERMISSION FROM DYTRAN INSTRUMENTS, INC.

CALIBRATION TECHNICIAN: Hung Le	TEST DATE: 05/18/05
HUNG LE	RECALL DATE: 05/18/06

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B01

Serial Number: 95258

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

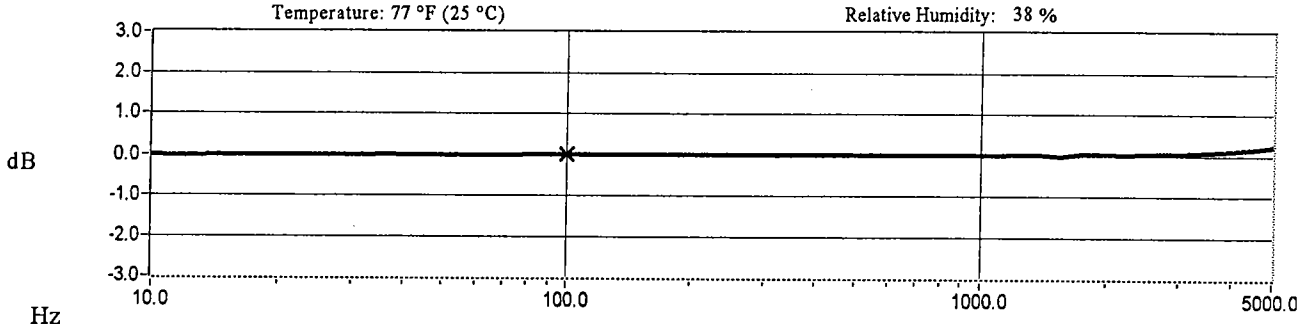
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	**19.69**	**mV/g**	Output Bias	8.4	VDC
	(2.008	**mV/m/s²)**	Transverse Sensitivity	1.7	%
Discharge Time Constant	0.8	seconds	Resonant Frequency	41.7	kHz

Sensitivity Plot

Temperature: 77 °F (25 °C) Relative Humidity: 38 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	-0.2	300.0	0.1
15.0	-0.2	500.0	0.1
30.0	-0.2	1000.0	0.1
50.0	-0.2	3000.0	0.6
REF. FREQ.	0.0	5000.0	2.6

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]

[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)².
[2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.8066 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 822/267400 and PTB Traceable thru Project 1055.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 9001, ISO 10012-1, ANSI/NCSL Z540-1-1994 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Mary Warren Date: 10/29/04

ACCREDITED
Cert No 1862.01

PCB PIEZOTRONICS INC.
VIBRATION DIVISION
3425 Walden Avenue · Depew, NY 14043
TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

cal4 - 3181906965.06

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B01

Serial Number: 95259

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

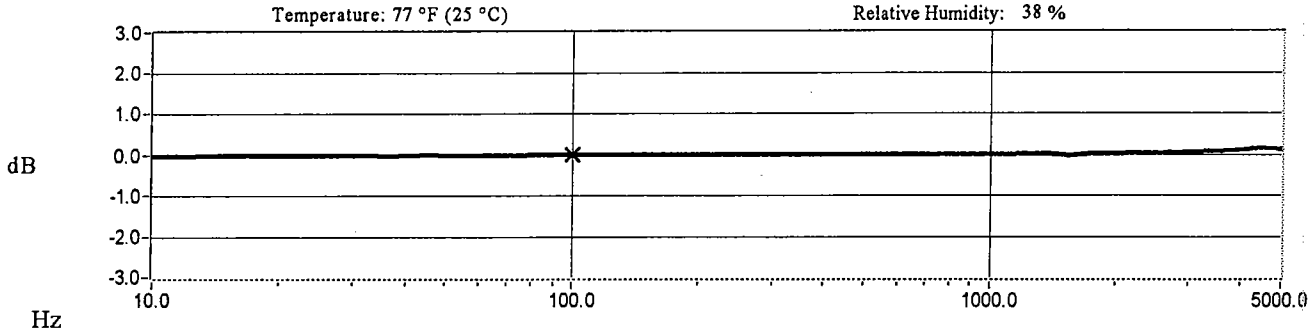
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	**19.34**	**mV/g**	Output Bias	8.5	VDC
	(1.972	**mV/m/s²)**	Transverse Sensitivity	1.0	%
Discharge Time Constant	0.9	seconds	Resonant Frequency	41.2	kHz

Sensitivity Plot

Temperature: 77 °F (25 °C) Relative Humidity: 38 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	-0.3	300.0	0.1
15.0	-0.2	500.0	0.1
30.0	-0.2	1000.0	0.1
50.0	-0.1	3000.0	0.7
REF. FREQ.	0.0	5000.0	1.5

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)².
[2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.8066 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 822/267400 and PTB Traceable thru Project 1055.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 9001, ISO 10012-1, ANSI/NCSL Z540-1-1994 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Mary Warren Date: 10/29/04

ACCREDITED
Cert No 1862.01

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TEL: 888-684-0013 · FAX: 716-685-3886 · www.pcb.com

cal4 - 3181907326.18

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B01

Serial Number: 95603

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

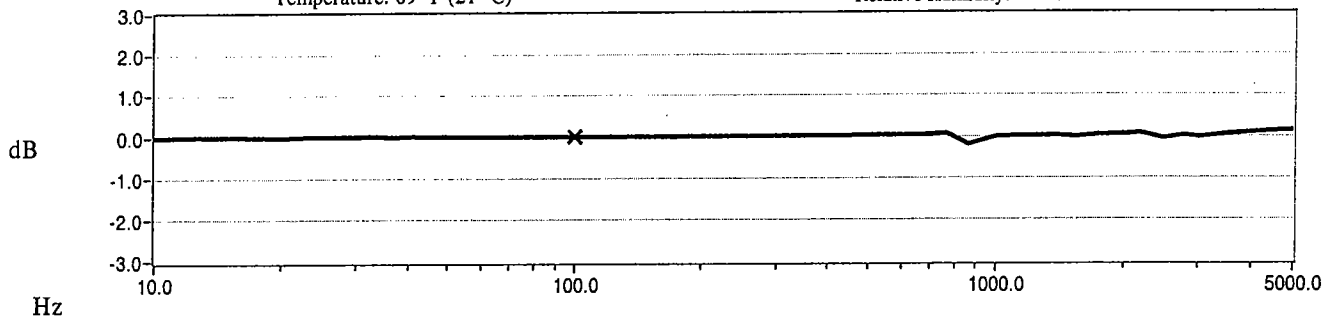
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	**20.66**	**mV/g**	Output Bias	8.5	VDC
	(2.107	**mV/m/s²)**	Transverse Sensitivity	1.5	%
Discharge Time Constant	0.9	seconds	Resonant Frequency	42.5	kHz

Sensitivity Plot

Temperature: 69 °F (21 °C) Relative Humidity: 34 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	-0.3	300.0	0.1
15.0	-0.0	500.0	0.3
30.0	0.1	1000.0	-0.2
50.0	0.1	3000.0	-0.4
REF. FREQ.	0.0	5000.0	1.6

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)². [2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.8066 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 822/267400 and PTB Traceable thru Project 1055.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 9001, ISO 10012-1, ANSI/NCSL Z540-1-1994 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: John Pitruzzella JP Date: 11/03/04

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cal4 - 3182385060.01

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B01

Serial Number: 95604

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

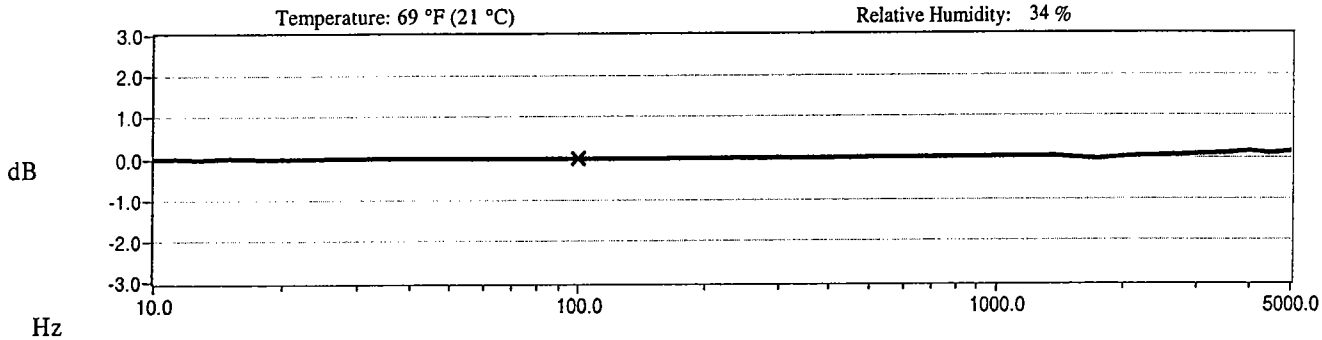
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	**20.49**	**mV/g**	Output Bias	8.5	VDC
	(2.090	**mV/m/s²)**	Transverse Sensitivity	1.5	%
Discharge Time Constant	0.7	seconds	Resonant Frequency	42.5	kHz

Sensitivity Plot

Temperature: 69 °F (21 °C) Relative Humidity: 34 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	0.0	300.0	0.1
15.0	0.1	500.0	0.2
30.0	0.1	1000.0	0.3
50.0	0.0	3000.0	0.8
REF. FREQ.	0.0	5000.0	1.6

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)².
[2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.8066 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 822/267400 and PTB Traceable thru Project 1055.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 9001, ISO 10012-1, ANSI/NCSL Z540-1-1994 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: John Pitruzzella JP Date: 11/03/04

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cal4 - 3182385180.01

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B01

Serial Number: 97687

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

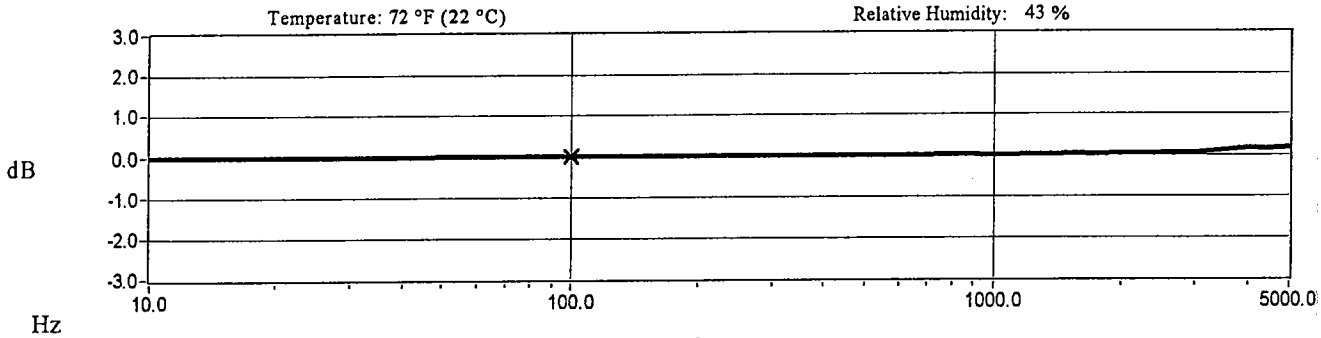
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	**20.21**	**mV/g**	Output Bias	8.6	VDC
	(2.061	**mV/m/s²)**	Transverse Sensitivity	1.3	%
Discharge Time Constant	0.8	seconds	Resonant Frequency	72.5	kHz

Sensitivity Plot

Temperature: 72 °F (22 °C) Relative Humidity: 43 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	-0.2	300.0	0.1
15.0	-0.1	500.0	0.1
30.0	-0.1	1000.0	0.1
50.0	-0.0	3000.0	0.6
REF. FREQ.	0.0	5000.0	2.0

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)².
[2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.8066 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 822/267400 and PTB Traceable thru Project 1055.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
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4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Alan Koetzle AK Date: 10/26/04

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cal2 - 3181688885.80

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B01

Serial Number: 97688

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

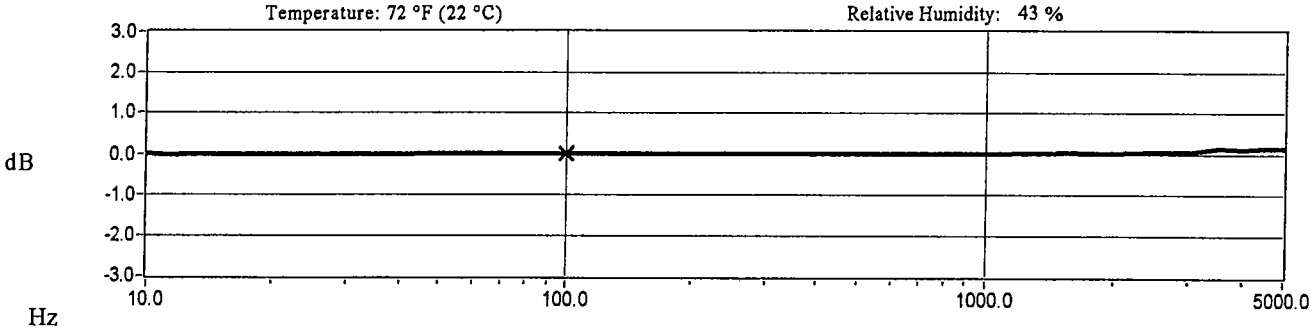
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	**20.41**	**mV/g**	Output Bias	8.6	VDC
	(2.082	**mV/m/s²)**	Transverse Sensitivity	1.1	%
Discharge Time Constant	0.7	seconds	Resonant Frequency	72.4	kHz

Sensitivity Plot

Temperature: 72 °F (22 °C) Relative Humidity: 43 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	0.1	300.0	0.0
15.0	-0.1	500.0	0.1
30.0	-0.1	1000.0	0.1
50.0	-0.0	3000.0	0.6
REF. FREQ.	0.0	5000.0	1.7

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)².
[2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.8066 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

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5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Alan Koetzle AK Date: 10/26/04

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cal2 - 3181639165.01

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B31

Serial Number: 97690

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

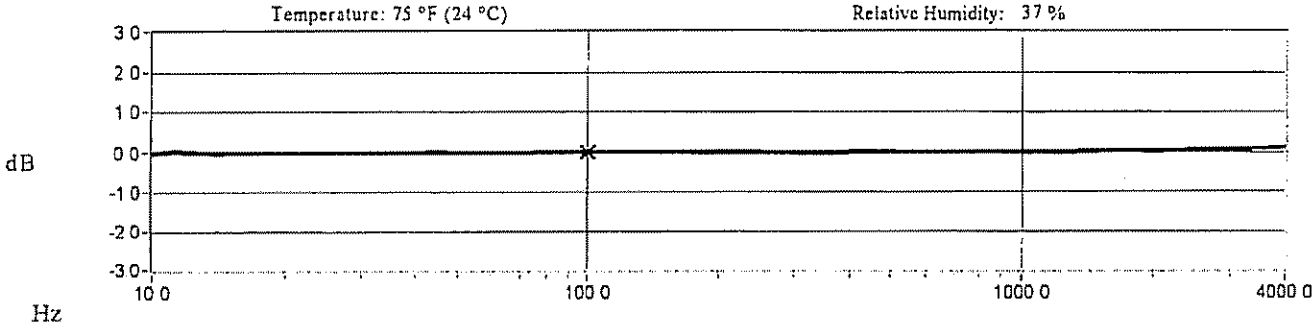
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	51.4	mV/g	Output Bias	9.2	VDC
	(5.24	mV/m/s²)	Transverse Sensitivity	0.5	%
Discharge Time Constant	0.6	seconds	Resonant Frequency	36.3	kHz

Sensitivity Plot

Temperature: 75 °F (24 °C) Relative Humidity: 37 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	-0.4	300.0	-0.1
15.0	-0.2	500.0	0.1
30.0	-0.1	1000.0	0.1
50.0	-0.1	3000.0	0.8
REF. FREQ	0.0	4000.0	1.3

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)².
[2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.8066 m/s²

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 822/267400 and PTB Traceable thru Project 1055.
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4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%

Technician: Robert Zsebehazy R. Z. Date: 10/21/04

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Cert No 1862.01

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cal - 3181255360.45

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B31

Serial Number: 97691

Description: ICP® Accelerometer

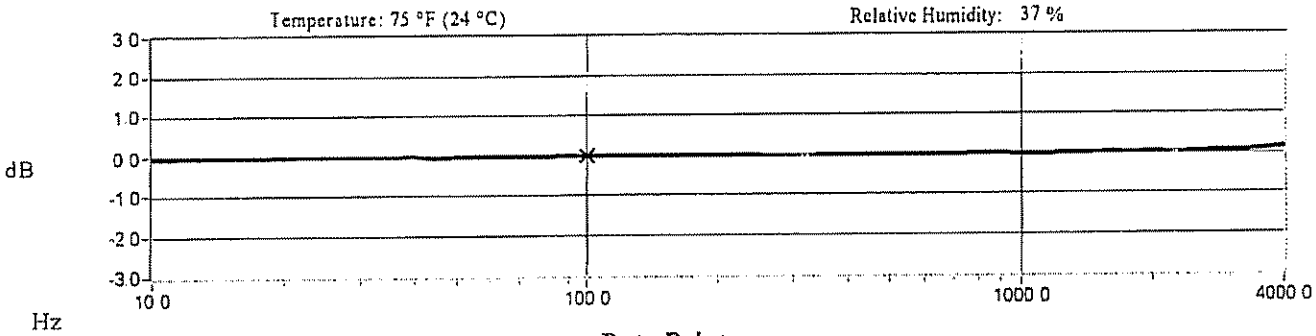
Method: Back-to-Back Comparison Calibration

Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	49.9	mV/g	Output Bias	9.2	VDC
	(5.08	mV/m/s²)	Transverse Sensitivity	2.1	%
Discharge Time Constant	0.9	seconds	Resonant Frequency	35.0	kHz

Sensitivity Plot



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	-0.4	300.0	-0.1
15.0	-0.3	500.0	0.1
30.0	-0.2	1000.0	0.1
50.0	-0.2	3000.0	0.8
REF. FREQ.	0.0	4000.0	1.8

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)*: 10.0 g (98.1 m/s²)*
*The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)²
*The gravitational constant used for calculations by the calibration system is: 1 g = 9.8066 m/s²

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

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4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Robert Zsebehazy R.Z. Date: 10/21/04

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rel4 - 3181257539.51

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: J353B31

Serial Number: 97692

Description: ICP® Accelerometer

Method: Back-to-Back Comparison Calibration

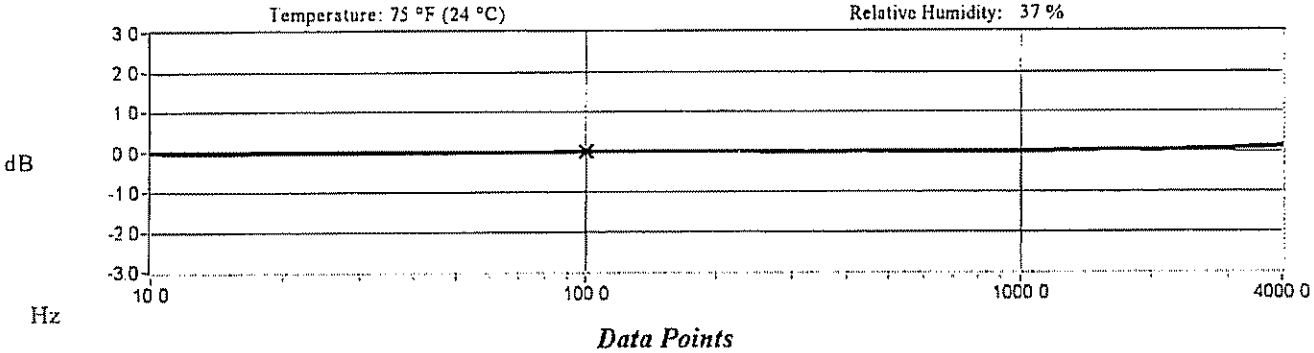
Manufacturer: PCB

Calibration Data

Sensitivity @ 100.0 Hz	50.2	mV/g	Output Bias	9.2	VDC
	(5.12	mV/m/s²)	Transverse Sensitivity	0.4	%
Discharge Time Constant	0.8	seconds	Resonant Frequency	35.5	kHz

Sensitivity Plot

Temperature: 75 °F (24 °C) Relative Humidity: 37 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10.0	-0.2	300.0	-0.1
15.0	-0.3	500.0	0.1
30.0	-0.2	1000.0	0.1
50.0	-0.1	3000.0	0.8
REF. FREQ.	0.0	4000.0	1.4

Mounting Surface: Stainless Steel w/Silicone Grease Coating Fastener: Stud Mount Fixture Orientation: Vertical
Acceleration Level (rms)[1]: 10.0 g (98.1 m/s²)[2]
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.010 x (freq)[1]
[2]The gravitational constant used for calculations by the calibration system is: 1 g = 9.8066 m/s²

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 822/267400 and PTB Traceable thru Project 1055
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4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%

Technician: Robert Zsebehazy RZ. Date: 10/21/04

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calt - 1181357794.36

O M E G A D Y N E I N C.

PRESSURE TRANSDUCER
FINAL CALIBRATION

0 - 200.00 PSIG
Excitation 15.000 Vdc

Job:
Model: PX41C1-200G10T
Date: 1/19/2004
Calibrated: 0.00 - 200.00 PSIG

Serial: 148187
Tested By: BOB
Temperature Range: 60 to 160 F
Specfile: PX41-10T

Pressure PSIG	Unit Data Vdc
0.00	0.0003
100.00	5.0142
200.00	10.0067
100.00	5.0157
0.00	0.0004

Balance 0.0003 Vdc
Sensitivity 10.0064 Vdc

ELECTRICAL LEAKAGE: PASS
PRESSURE CONNECTION/FITTING: 1/4-18 NPT MALE
ELECTRICAL WIRING/CONNECTOR: PIN A = +OUTPUT
PIN B = -OUTPUT
PIN C = -INPUT (EXC)
PIN D = +INPUT (EXC)

This Calibration was performed using Instruments and Standards that are traceable to the United States National Institute of Standards Technology.

S/N	Description		Range	Reference	Cal Cert
C-2020	PPB Pressure Console		0 - 500 lbs	C-2020	C-2020
US36087645	HP34401A DMM	UUT	Unit Under Test	C-2485	
3146A22561	HP34401A DMM	STD	Pressure Monitor	C-2409	

Q.A. Representative : Robert Dengel Date: 1-19-04

This transducer is tested to & meets published specifications. After final calibration our products are stored in a controlled stock room & considered in bonded storage. Depending on environment & severity of use factory calibration is recommended every one to three years after initial service installation date

Omegadyne, Inc., 149 Stelzer Court, Sunbury, OH 43074 (740) 965-9340
http://www.omegadyne.com email: info@omegadyne.com (800) USA-DYNE

O M E G A D Y N E I N C.

PRESSURE TRANSDUCER
FINAL CALIBRATION

0 - 200.00 PSIG
Excitation 15.000 Vdc

Job:
Model: PX41C1-200G10T
Date: 6/27/03
Calibrated: 0.00 - 200.00 PSIG

Serial: 148201
Tested By: BEN
Temperature Range: 60 to 160 F
Specfile: Px41-10T.spf

Pressure PSIG	Unit Data Vdc
0.00	- 0.002
100.00	5.004
200.00	9.998
100.00	5.005
0.00	- 0.003

Balance - 0.002 Vdc
Sensitivity 10.000 Vdc

ELECTRICAL LEAKAGE: PASS
PRESSURE CONNECTION/FITTING: 1/4-18 NPT MALE
ELECTRICAL WIRING/CONNECTOR: PIN A +OUTPUT
PIN B -OUTPUT
PIN C -INPUT
PIN D +INPUT
PINS E&F NC

This Calibration was performed using Instruments and Standards that are traceable to the United States National Institute of Standards Technology.

S/N	Description	Range	Reference	Cal Cert
0078/90-03	1000 PSI DRUCK STD	0 - 1000 lbs	C-2501	C-2501
MY41005	AT34970A DMM UUT	Unit Under Test	C-2470	

Q.A. Representative : _____ Date: 6-27-03

This transducer is tested to & meets published specifications. After final calibration our products are stored in a controlled stock room & considered in bonded storage. Depending on environment & severity of use factory calibration is recommended every one to three years after initial service installation date

Omegadyne, Inc., 149 Stelzer Court, Sunbury, OH 43074 (740) 965-9340
http://www.omegadyne.com email: info@omegadyne.com (800) USA-DYNE

O M E G A D Y N E I N C.

PRESSURE TRANSDUCER
FINAL CALIBRATION

0 - 200.00 PSIG
Excitation 28.000 Vdc

Job:
Model: PX41C1-200G10T
Date: 6/27/03
Calibrated: 0.00 - 200.00 PSIG

Serial: 148202
Tested By: BEN
Temperature Range: 60 to 160 F
Specfile: Px41-10T.spf

Pressure PSIG	Unit Data Vdc
0.00	0.000
100.00	5.009
200.00	10.000
100.00	5.010
0.00	- 0.001

Balance 0.000 Vdc
Sensitivity 10.000 Vdc

ELECTRICAL LEAKAGE: PASS
PRESSURE CONNECTION/FITTING: 1/4-18 NPT MALE
ELECTRICAL WIRING/CONNECTOR:

PIN A	+OUTPUT
PIN B	-OUTPUT
PIN C	-INPUT
PIN D	+INPUT
PINS E&F	NC

This Calibration was performed using Instruments and Standards that are traceable to the United States National Institute of Standards Technology.

S/N	Description	Range	Reference	Cal Cert
0078/90-03	1000 PSI DRUCK STD	0 - 1000 lbs	C-2501	C-2501
MY41005	AT34970A DMM UUT	Unit Under Test	C-2470	

Q.A. Representative : [signature] Date: 6-27-03

This transducer is tested to & meets published specifications. After final calibration our products are stored in a controlled stock room & considered in bonded storage. Depending on environment & severity of use factory calibration is recommended every one to three years after initial service installation date

Omegadyne, Inc., 149 Stelzer Court, Sunbury, OH 43074 (740) 965-9340
http://www.omegadyne.com email: info@omegadyne.com (800) USA-DYNE

GENERAL INFORMATION: WK-SERIES STRAIN GAGES

GENERAL DESCRIPTION: WK-Series gages are a family of fully encapsulated K-alloy strain gages used in both experimental stress analysis and transducer applications. These gages have integral high-endurance lead ribbons with a backing and encapsulation matrix consisting of a high-temperature epoxy-phenolic resin system reinforced with glass fiber.

TEMPERATURE RANGE: -452° to +550° F(-269° to +290° C) for continuous use in static measurements. Useful to +700° F (+370° C) for short term exposure.

SELF TEMPERATURE COMPENSATION: See data curve below.

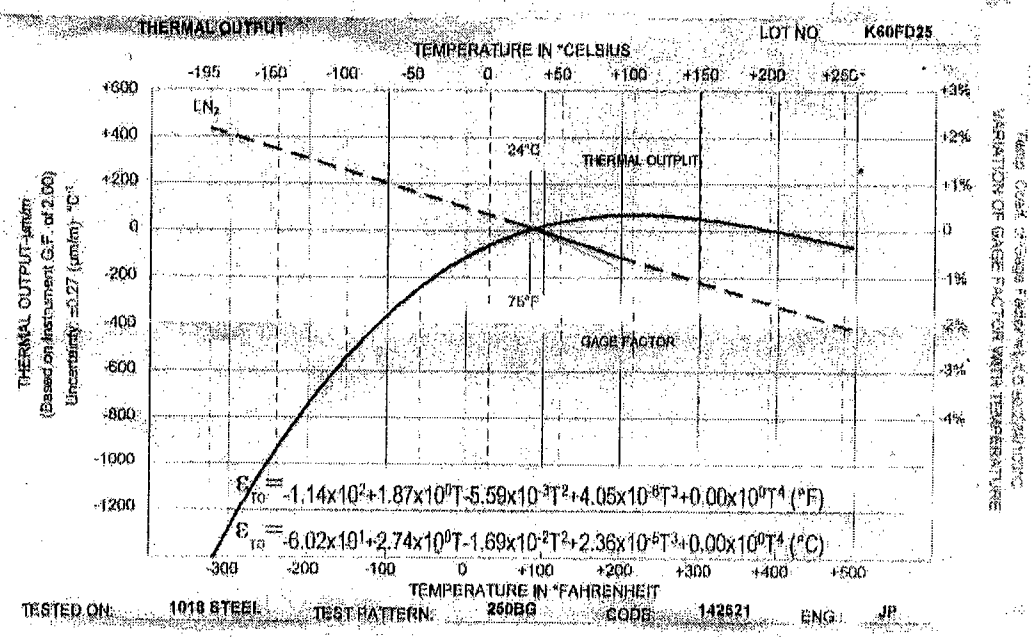
STRAIN LIMITS: ±1.5% at room temperature; ±1.0% at -320° F (-195° C).

FATIGUE LIFE: 10^7 cycles at ±2000μin/in (μm/m); 10^6 cycles at ±2200μin/in (μm/m). Longer gage lengths and lower resistances show greater endurance and less scatter in fatigue life.

BONDING AGENTS: High-temperature epoxy adhesives are recommended for best performance over the entire temperature range. Micro-Measurements M-Bond 610, 600 and M-Bond GA-60 are particularly compatible with WK-Series gages. Refer to M-M Catalog A-110 for information on bonding agents, and Bulletin B-130 for installation procedures.

LEADWIRE SYSTEM: Two flat, high-endurance leads attached to each tab permit 3-wire or 4-wire systems to be carried directly to the gage, minimizing leadwire errors over the wide useful temperature range of the WK-Series strain gages. Option SP-30 WK-Series gages are supplied with single 0.005 in. (0.13 mm) diameter nickel-clad copper wire leads. Option SP-30 reduces fatigue life of WK-Series gages and should not be selected where best cycle endurance is required. Internal tab connections on these gages are made with +770° F (+410° C) solder. Leadwires may be soft soldered, spot-welded or silver soldered. Refer to M-M Bulletin B-132 for information on solders.

G038



TESTED ON: 1018 STEEL TEST PATTERN: 250BG CODE: 142621 ENG: JP

TEST PROCEDURES USED BY MICRO-MEASUREMENTS

OPTICAL DEFECT ANALYSIS	M-M Procedures and Standards
GAGE RESISTANCE AT 24°C AND 50% RH	M-M Procedure, Direct NIST Traceability on Resistance Standards
GAGE FACTOR AT 24°C & 50% RH (UNIAXIAL STRESS FIELD, POISSON RATIO = 0.285)	ASTM E-251 (Constant Stress Cantilever Method)
TEMPERATURE COEFFICIENT OF GAGE FACTOR	ATSM E-261 (Step Deflection Method)
THERMAL OUTPUT	ASTM E-261 (Slow Heating Rate, Continuously Recorded)
TRANSVERSE SENSITIVITY AT 24°C AND 50%H	ASTM E-251
FATIGUE LIFE	NAS-942 (Modified)
STRAIN LIMITS	NAS-942 (Modified)
GAGE THICKNESS	M-M Procedure
CREEP AND DRIFT	M-M Procedure (Similar to NAS 942 Method)

NOTE: Gage resistance, gage factor, temperature coefficient of gage factor, thermal output, and transverse sensitivity testing and information presentation are in compliance with OIML International Recommendation No. 62, "Performance characteristics of metallic resistance strain gages." Silver leads are not included in I.R. NO. 62

T001

An OMEGA Technologies Company

Certificate of Calibration

Infrared Thermometer

OMEGA Engineering, Inc. certifies that the instrument referenced above has been fully inspected, tested and calibrated prior to shipment in accordance with the instruction manual supplied. OMEGA Engineering further certifies that this instrument meets or exceeds all of the published electrical, mechanical and operational performance characteristics.

All tests and calibrations were performed with instruments, equipment, and standards that are traceable to the U.S. National Institute of Standards and Technology.

Specifically, this instrument is accurate to within:

- ±1% of reading, or 3°F whichever is greater.

Accepted By: Todd Pratt

OMEGA Engineering, Inc., One Omega Drive, Box 4047, Stamford, CT 06907-0047
Tel: **(203) 359-1660** • Fax: **(203) 359-7811**
www.omega.com e-mail: info@omega.com

Acela Brake Disc Test - Post Test Instrumentation Evaluation

Boston, MA May 16th, 2005

Personnel Performing Evaluation:
Randall Wingate – Knorr Brake Corporation
Frank Hellmer – Knorr Brake Coporation
Boris Nejikovsky, ENSCO, Inc
Eric Sherrock, ENSCO, Inc
Bill Jordan, ENSCO, Inc

1. Visual evaluation

All sensors mounted on the axle and bearing adapters were visually inspected. No physical damage was found. All accelerometers mountings are solid. All bolts are tight.

2. Impact test

The purpose of the test is to verify that accelerometers and the corresponding measurement channels provide the whole required measurement range (i.e. do not saturate). The sensors mounted on the bearing adapters have been mechanically removed for the test. Electrically the sensors were still connected to data acquisition system. The test was performed by subjecting accelerometers to successively higher impacts until the measurement range was reached. The ENSCO triaxial accelerometer (Silicon Design, Inc., Model 2430-100, range +/-100g) was removed and tested on impact. Levels of up to 70 to 80g were observed with no saturation.

3. Vibration test

The purpose of the test is to verify sensor linearity over the frequency range. The test was performed using a portable shaker (Hardy Instruments, Model DI-803) that allows to set amplitude and frequency of vibration in the range 10Hz to 1KHz). The following table shows the test results

ENSCO accelerometer evaluation

	Shaker setting	Shaker setting	ENSCO System measurement	ENSCO System measurement
	Freq	Ampl	Freq	Ampl
	50Hz	5.0g	50Hz	5g
	100Hz	9.97g	100Hz	9.9g
	200Hz	9.97g	200Hz	10.1g
	500Hz	10g	500Hz	7.5g

Due to mounting configuration only the Vertical acceleration was verified. The Lateral acceleration will be verified post-test.

4. Accelerometer channel frequency sweep

A signal generator (Agilent 3312A serial# MY40027658) was connected to all SCU sensor inputs. A 2V peak to peak sinewave was injected in all inputs. The frequency of a sine waveform was swept through 10, 50, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200Hz frequencies. The roll-off of all channels is at 500Hz. The roll-off acceleration measured value of the axle mounted accelerometer was 35.32 g. The axle mounted accelerometer has a 19.7 mv/g calibrated scale factor with a 1v peak equals 50.76 g and a measured value of 50.56 g.

Conclusion: All instrumentation tested as described above performed in an acceptable manner. There is no evidence of any data quality issues.

ENSCO, Inc.

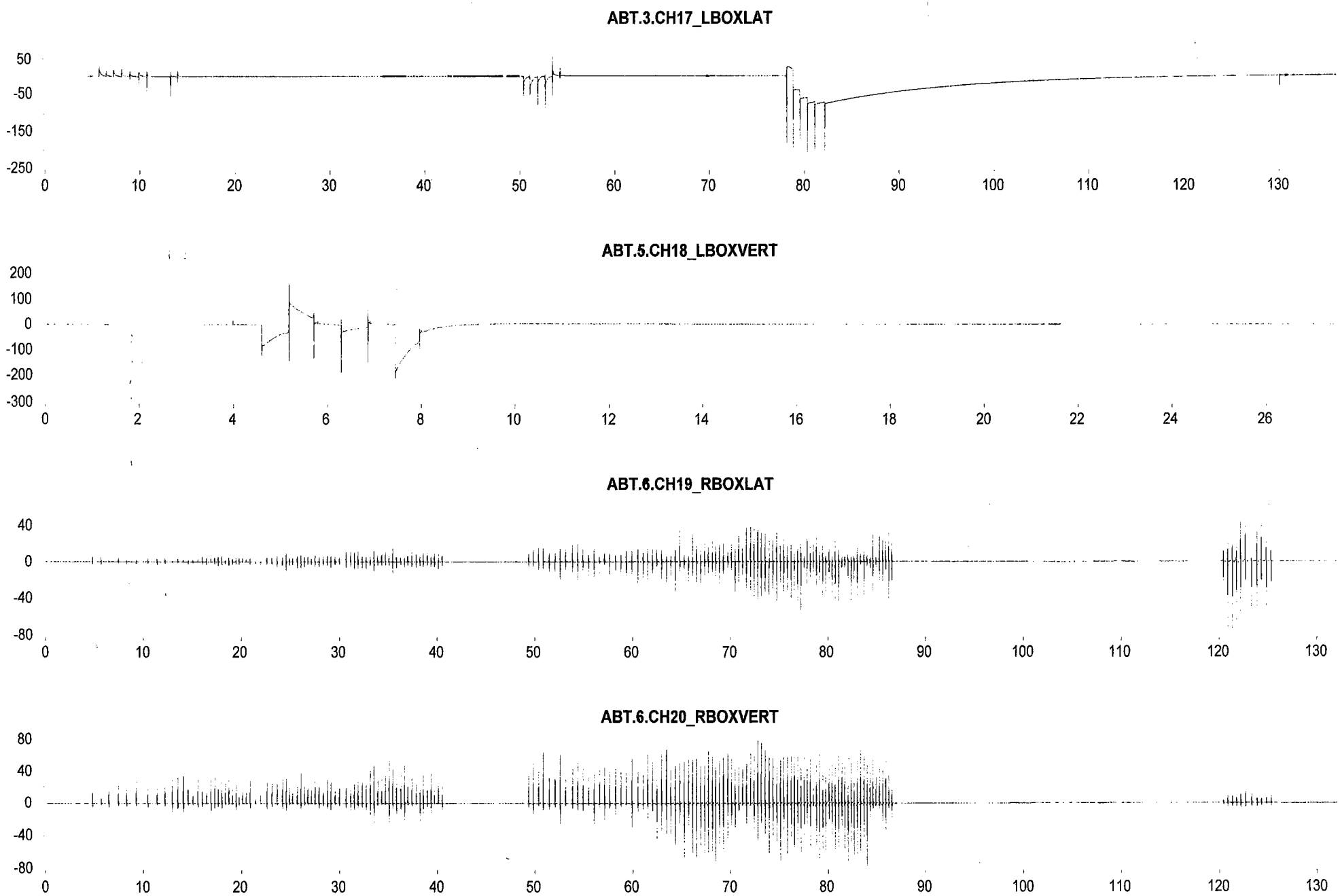
Boris Nejikovsky
Chief Engineer

Eric Sherrock
Senior Engineer

Knorr Brake Corporation

5/16/05
Randall Wingate
Test Engineer

05/16/05
Frank Hellmer
Test Engineer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0 10 20 30 40 50 60 70 80 90 100 110 120 130
ABT.5.CH18_LBOXVERT
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100
0
-100
-200
-300
0 2 4 6 8 10 12 14 16 18 20 22 24 26
ABT.6.CH19_RBOXLAT
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0
-40
-80
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ABT.6.CH20_RBOXVERT
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-40
-80
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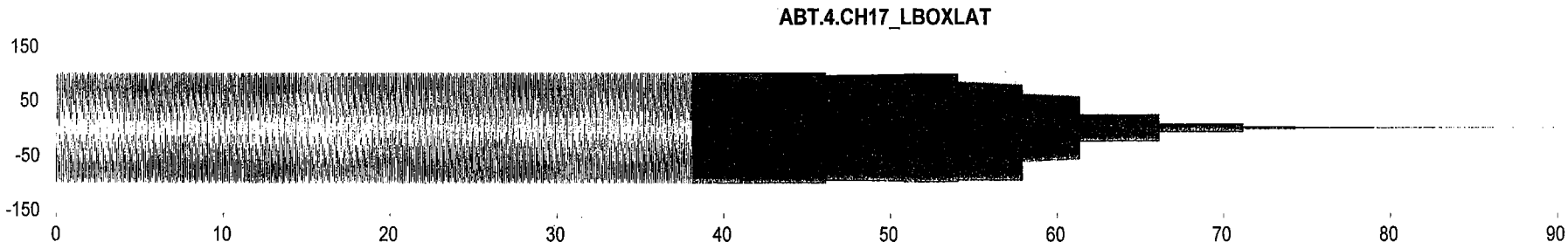
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60
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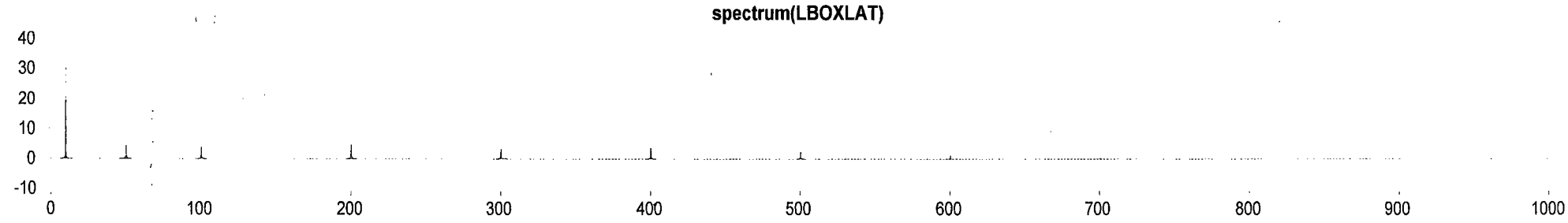
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700
800
900
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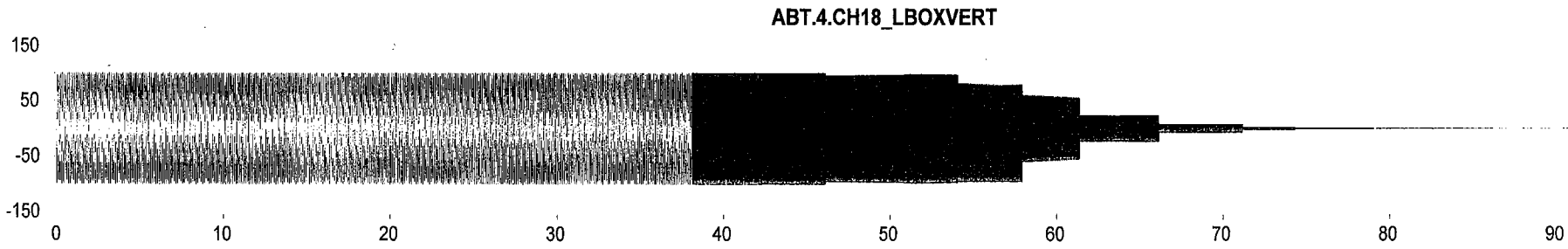
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-150
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30
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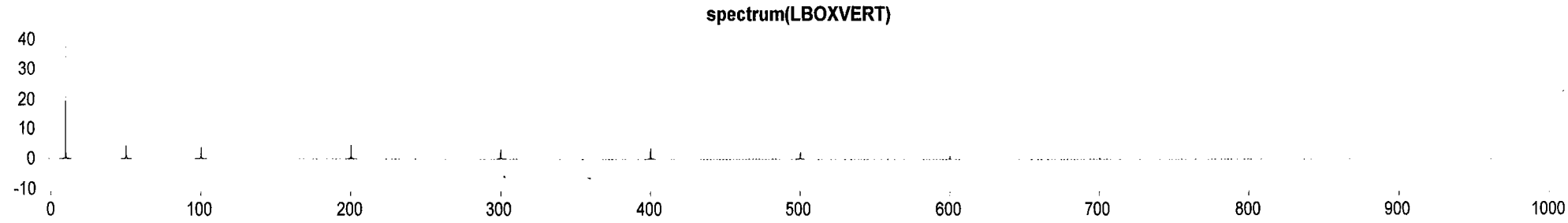
60
70
80
90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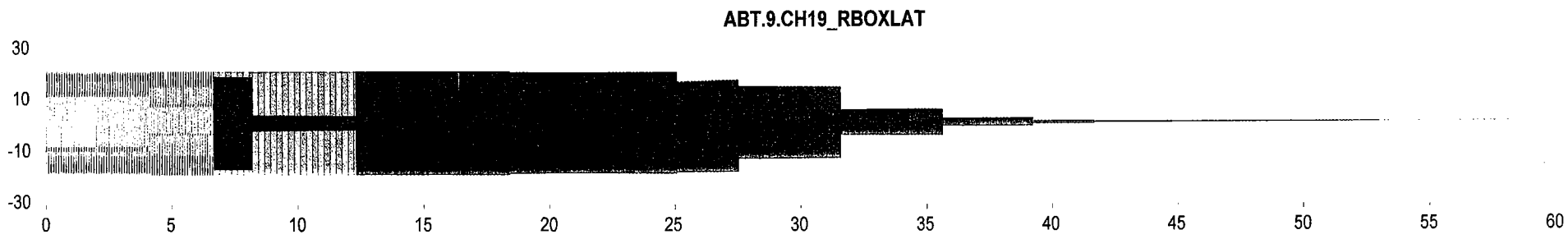
700
800
900
1000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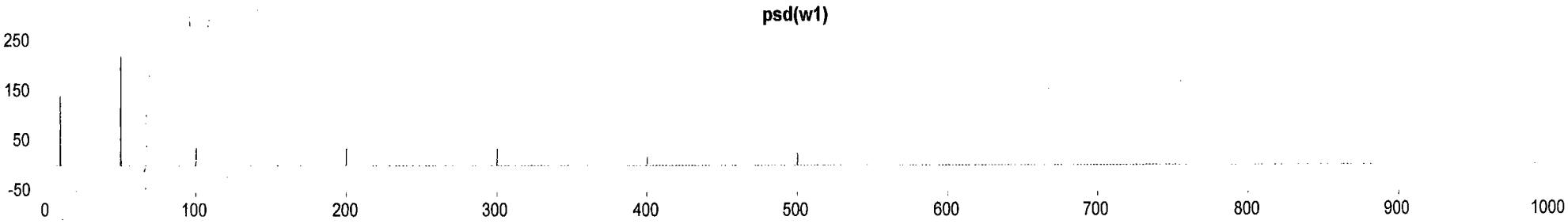
25
30
35
40
45
50
55
60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300
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800
900
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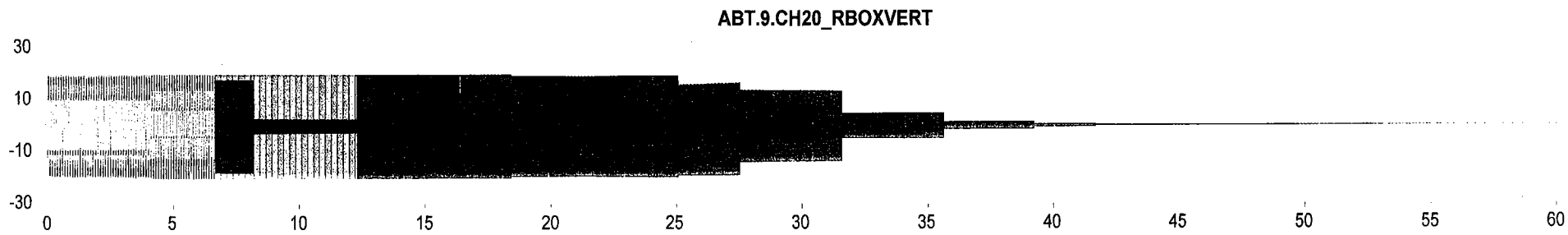
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30
35
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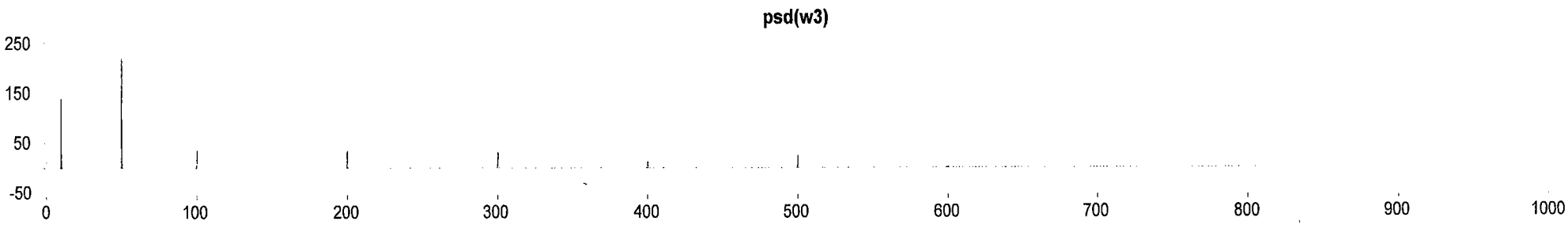
45
50
55
60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800
900
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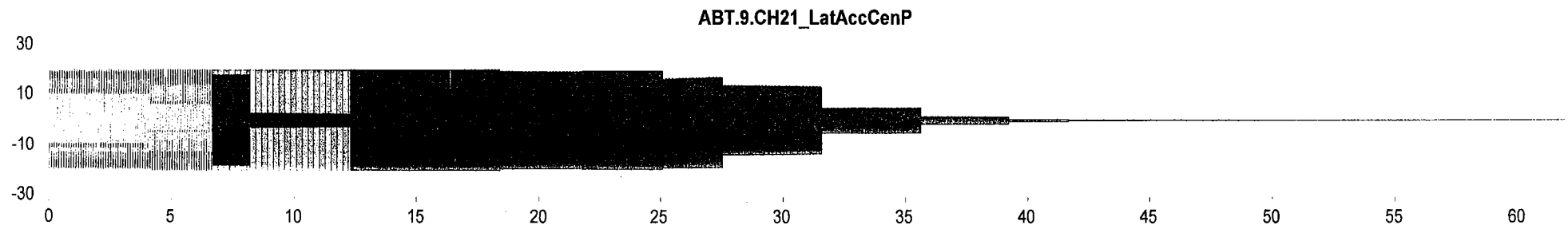
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55
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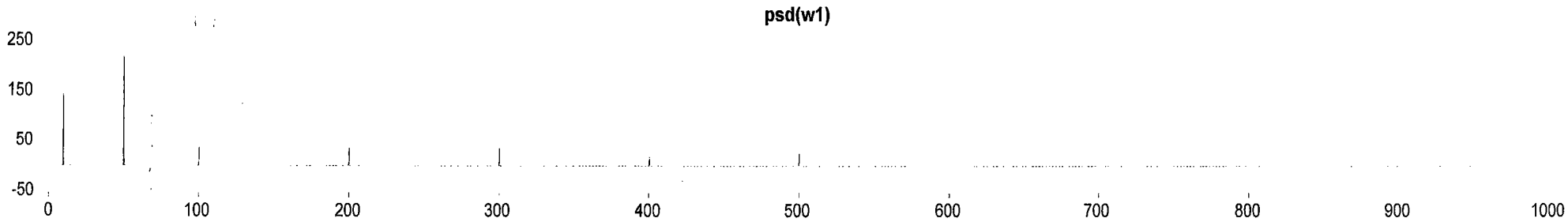
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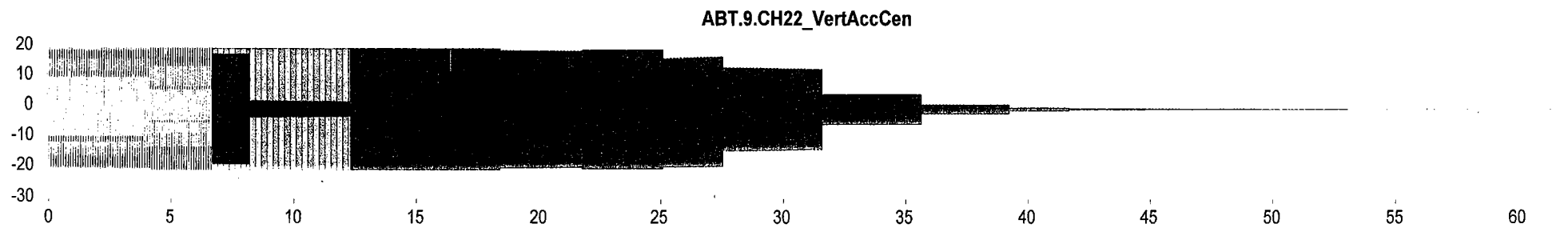
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-20
-30
0
5
10
15
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25
30
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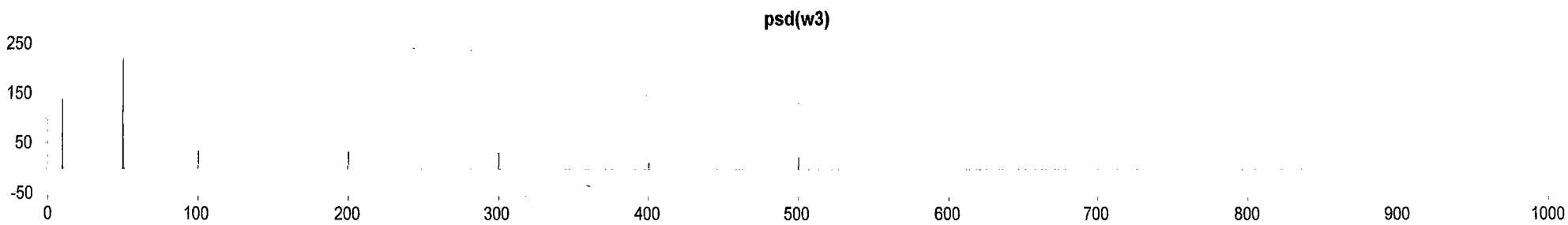
40
45
50
55
60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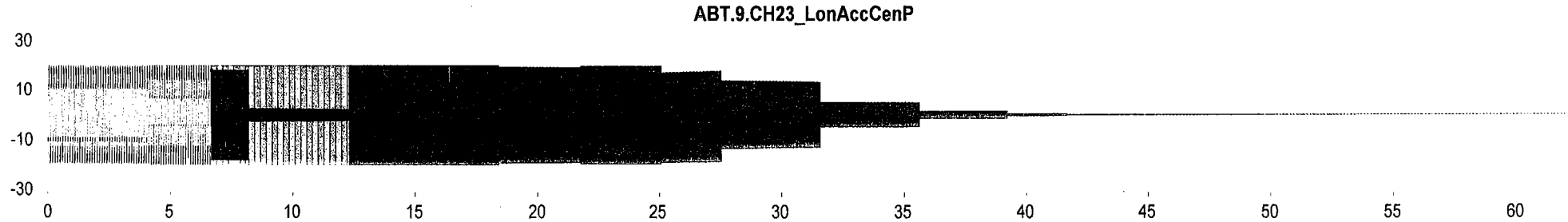
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55
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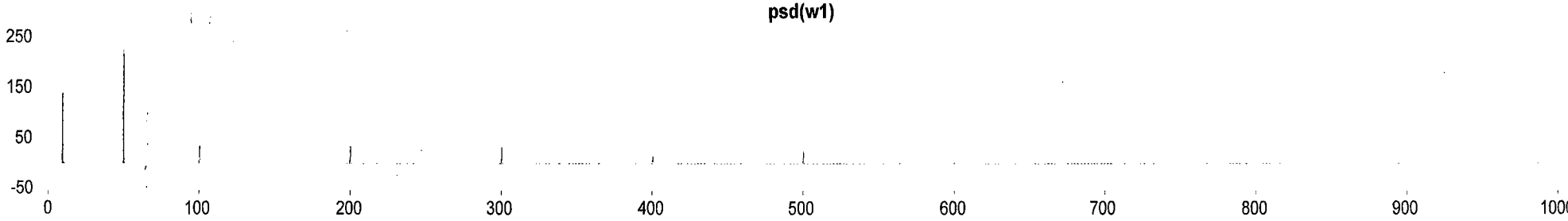
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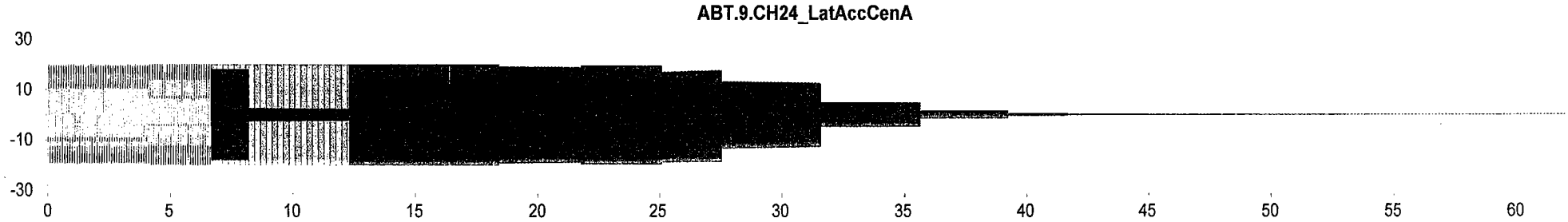
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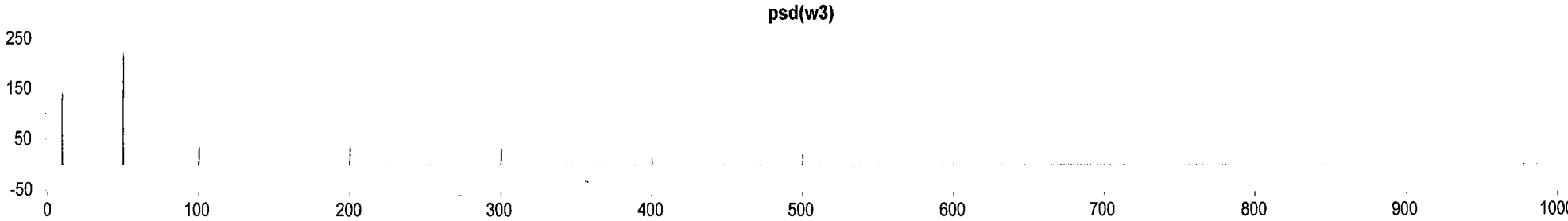
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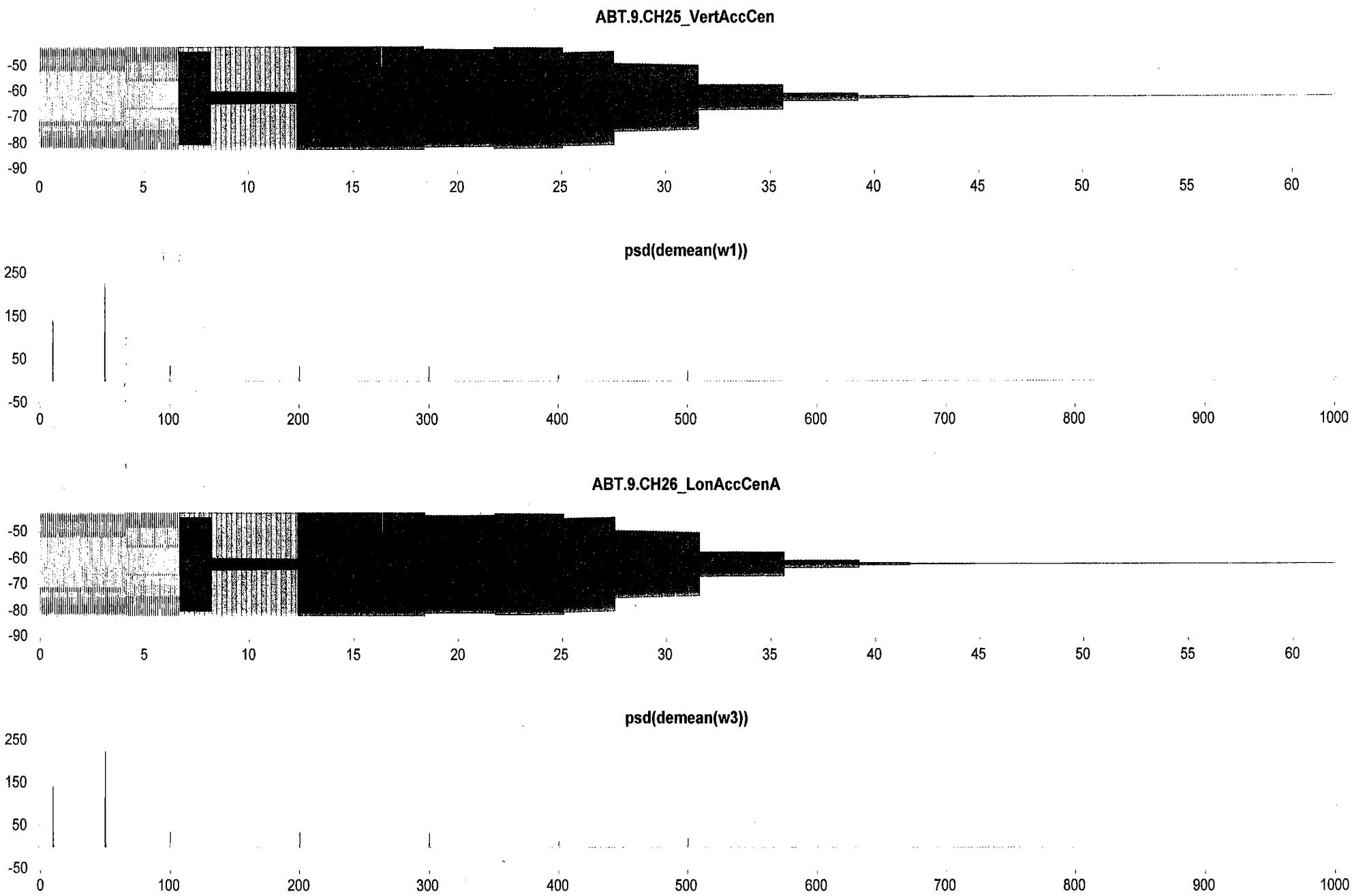
ABT.9.CH25_VertAccCen
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-60
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5
10
15
20
25
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40
45
50
55
60
psd(demean(w1))
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150
50
-50
0
100
200
300
400
500
600
700
800
900
1000
ABT.9.CH26_LonAccCenA
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-60
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-80
-90
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15
20
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35
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45
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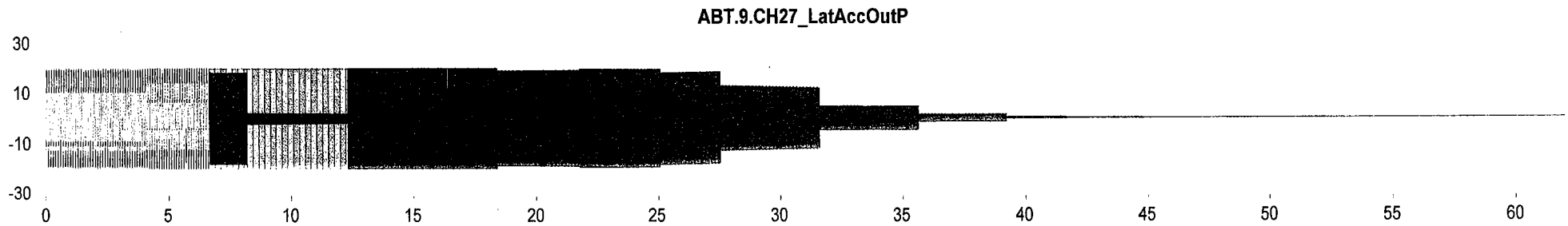
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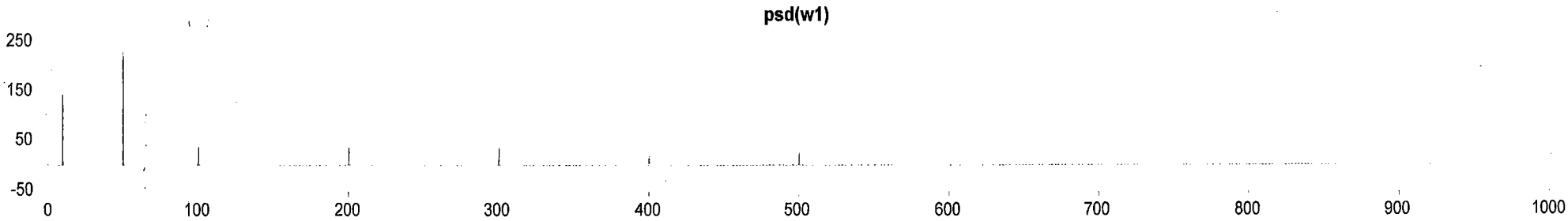
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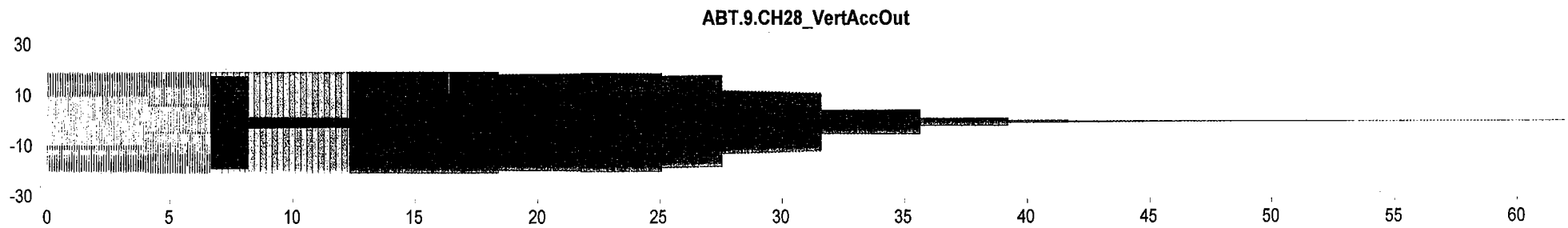
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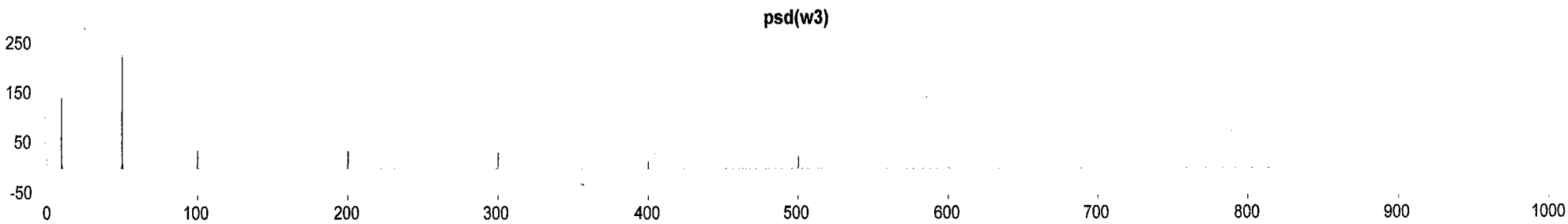
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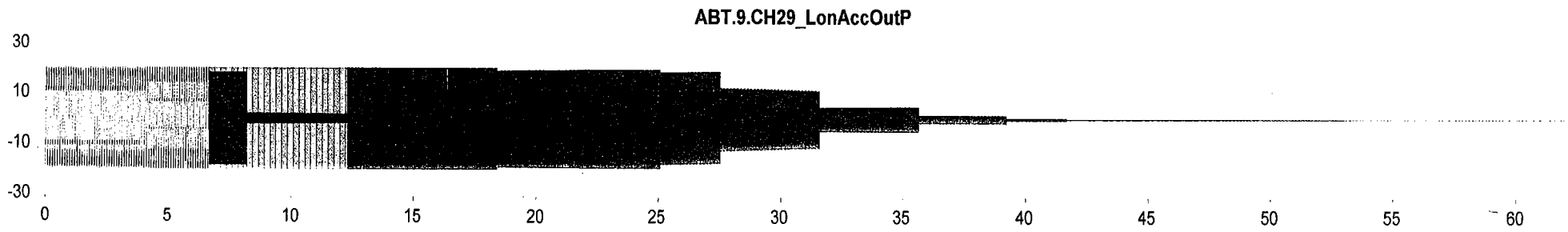
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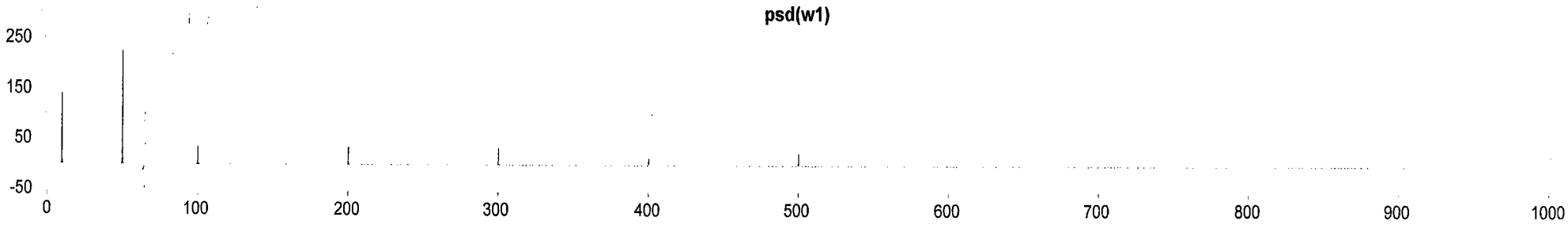
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100
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300
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600
700
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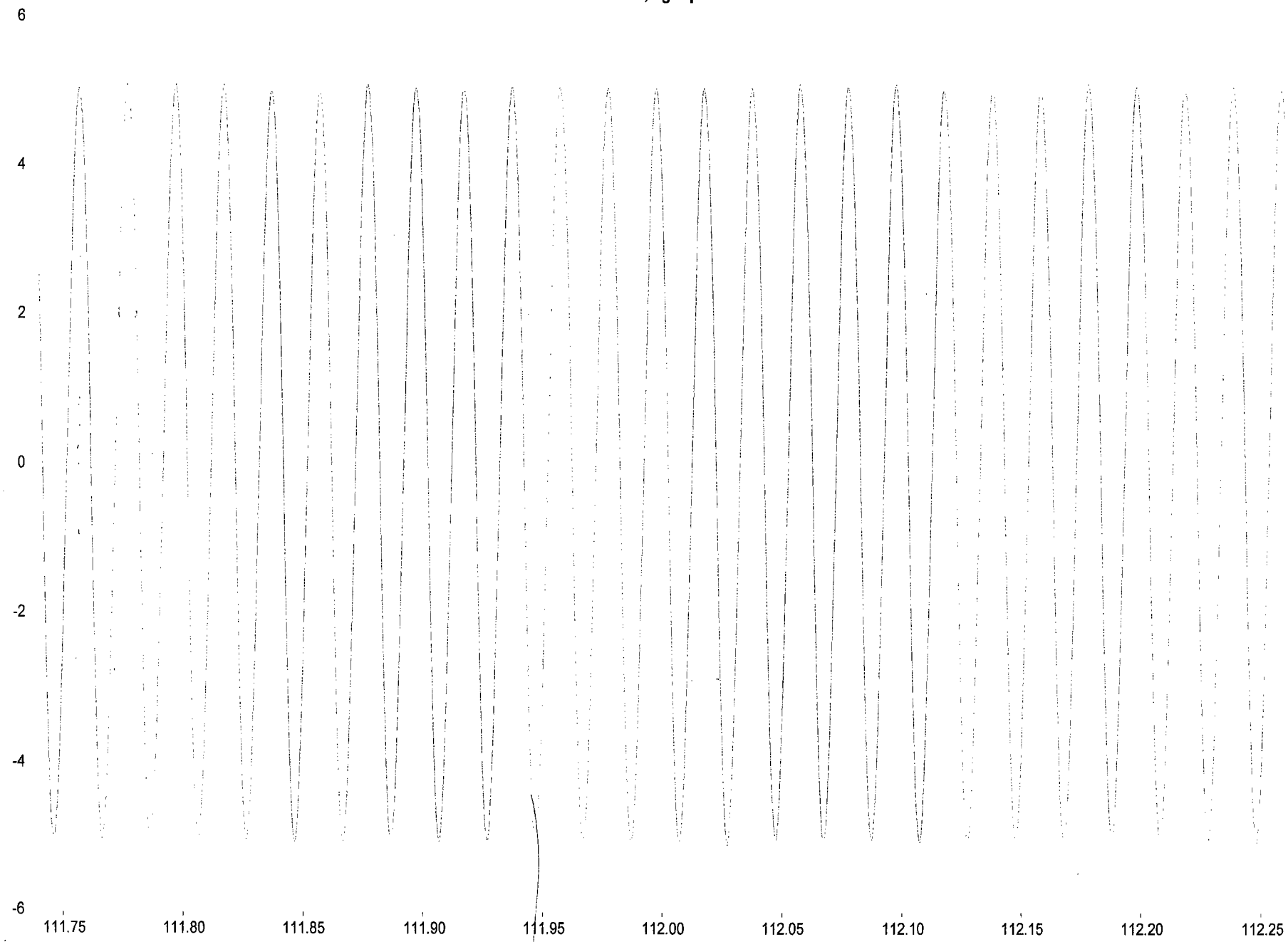
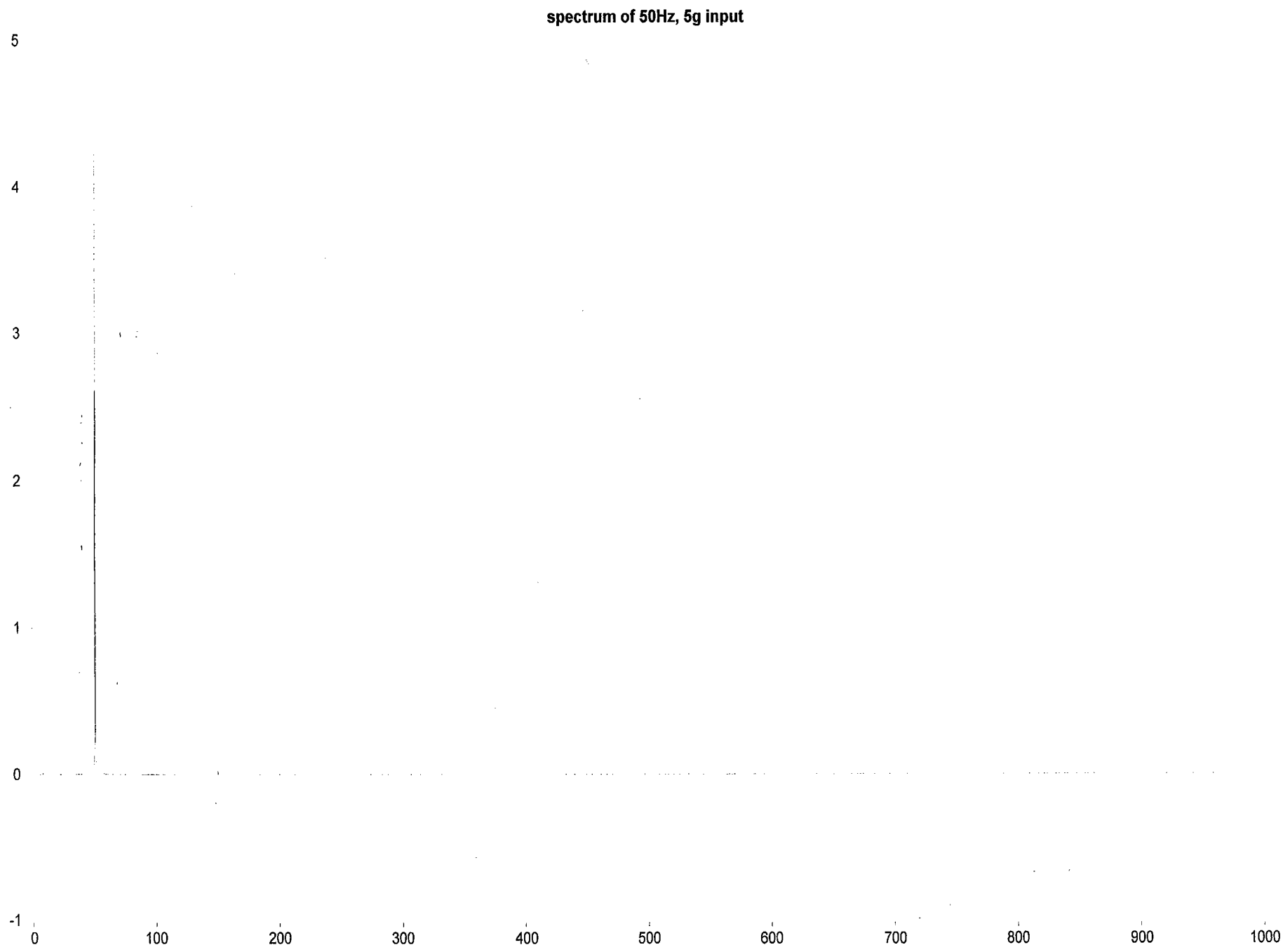
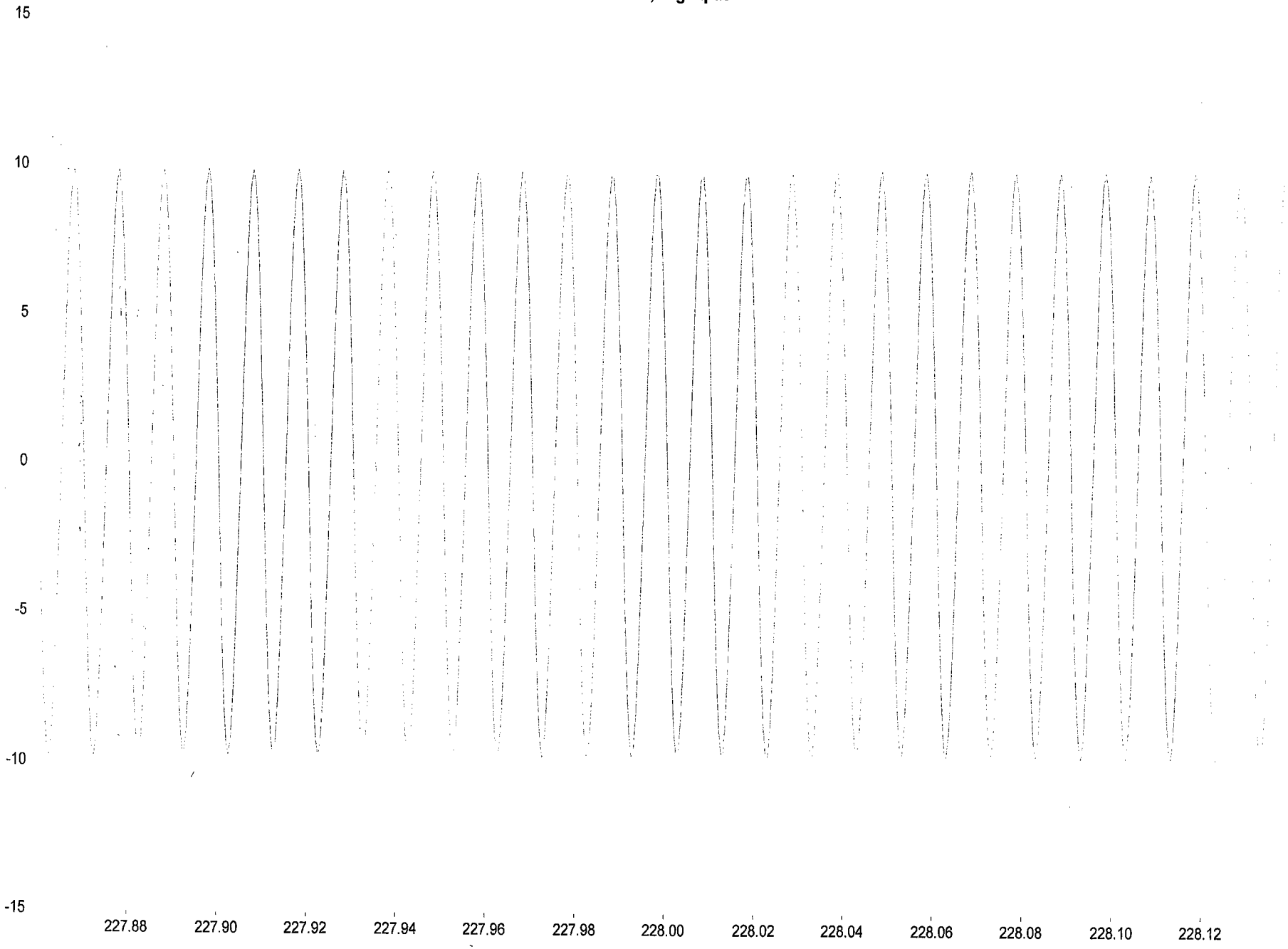
900
1000

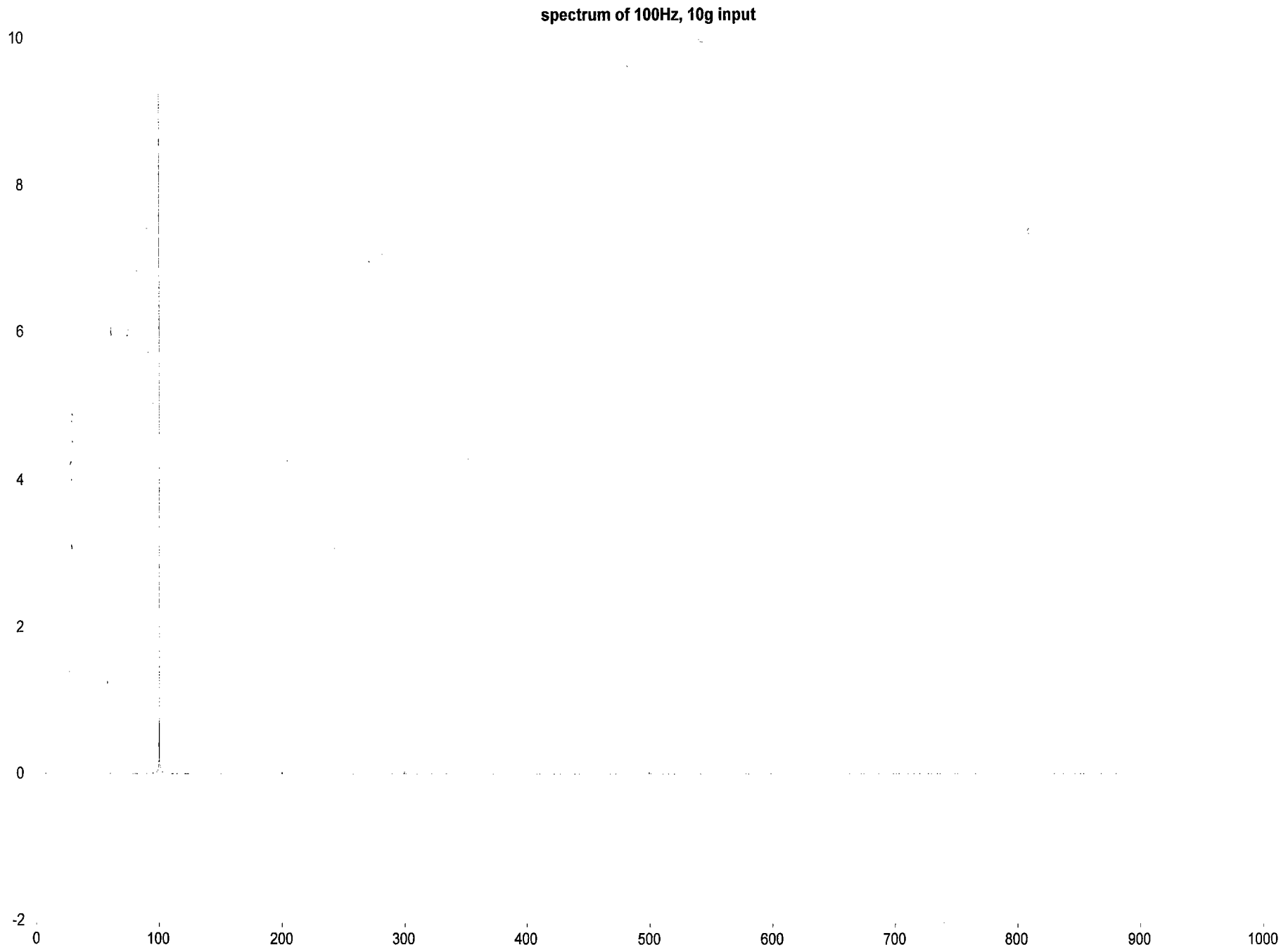
50Hz, 5g input




spectrum of 50Hz, 5g input
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800
900
1000

100 Hz, 10g input




spectrum of 100Hz, 10g input
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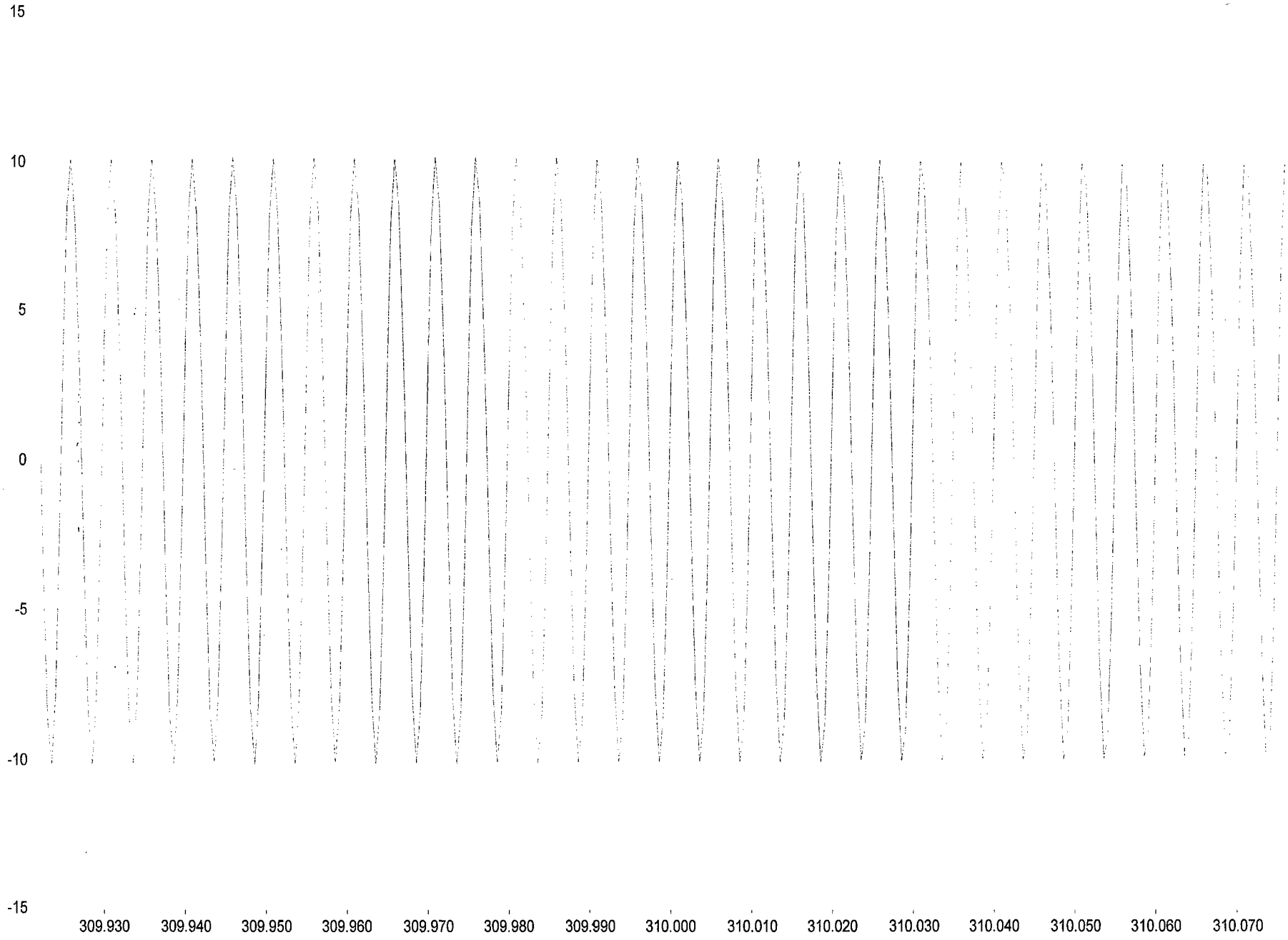
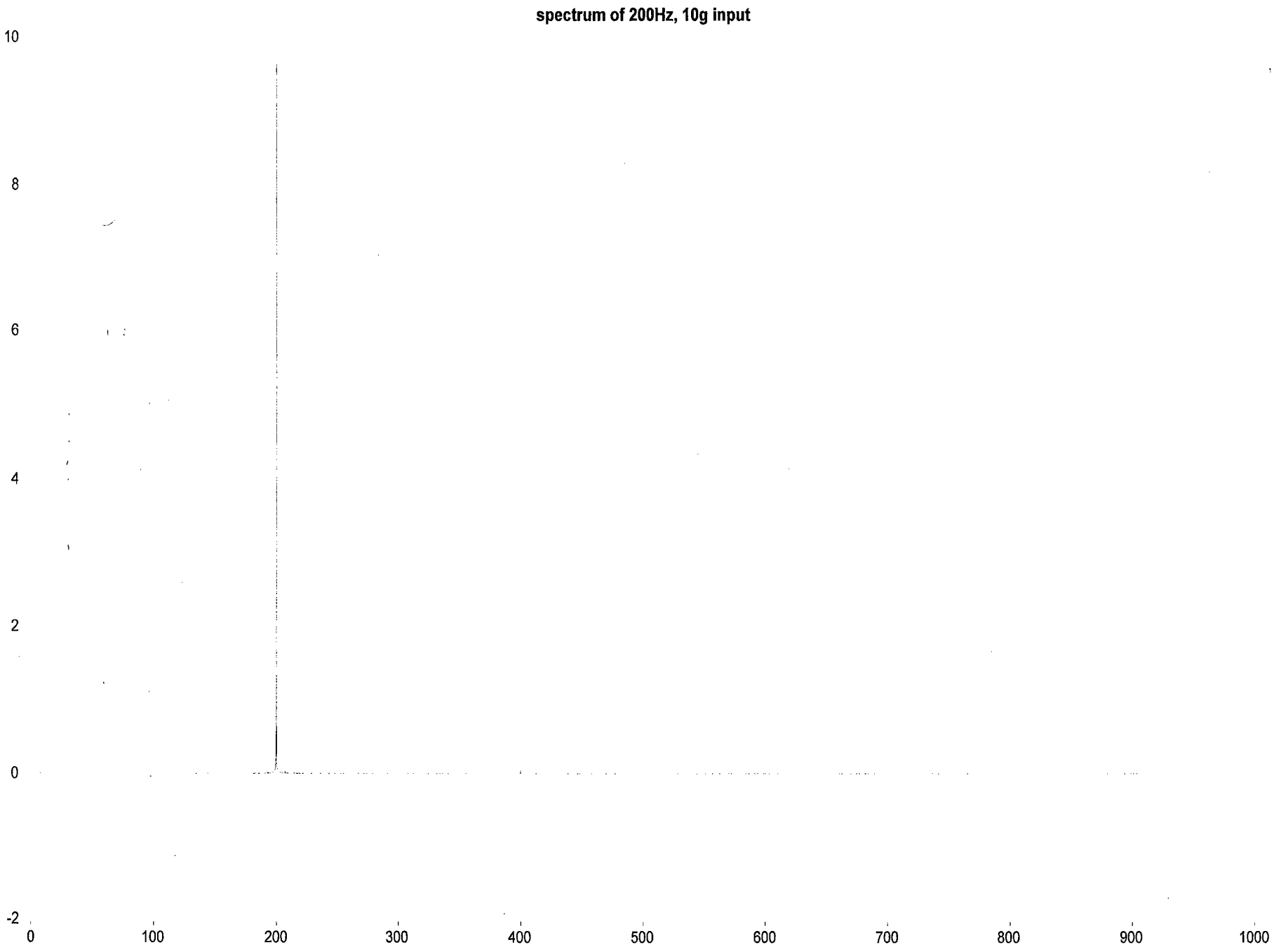
8
6
4
2
0
-2
0
100
200
300
400
500
600
700
800
900
1000

200Hz, 10g input




spectrum of 200Hz, 10g input
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6
4
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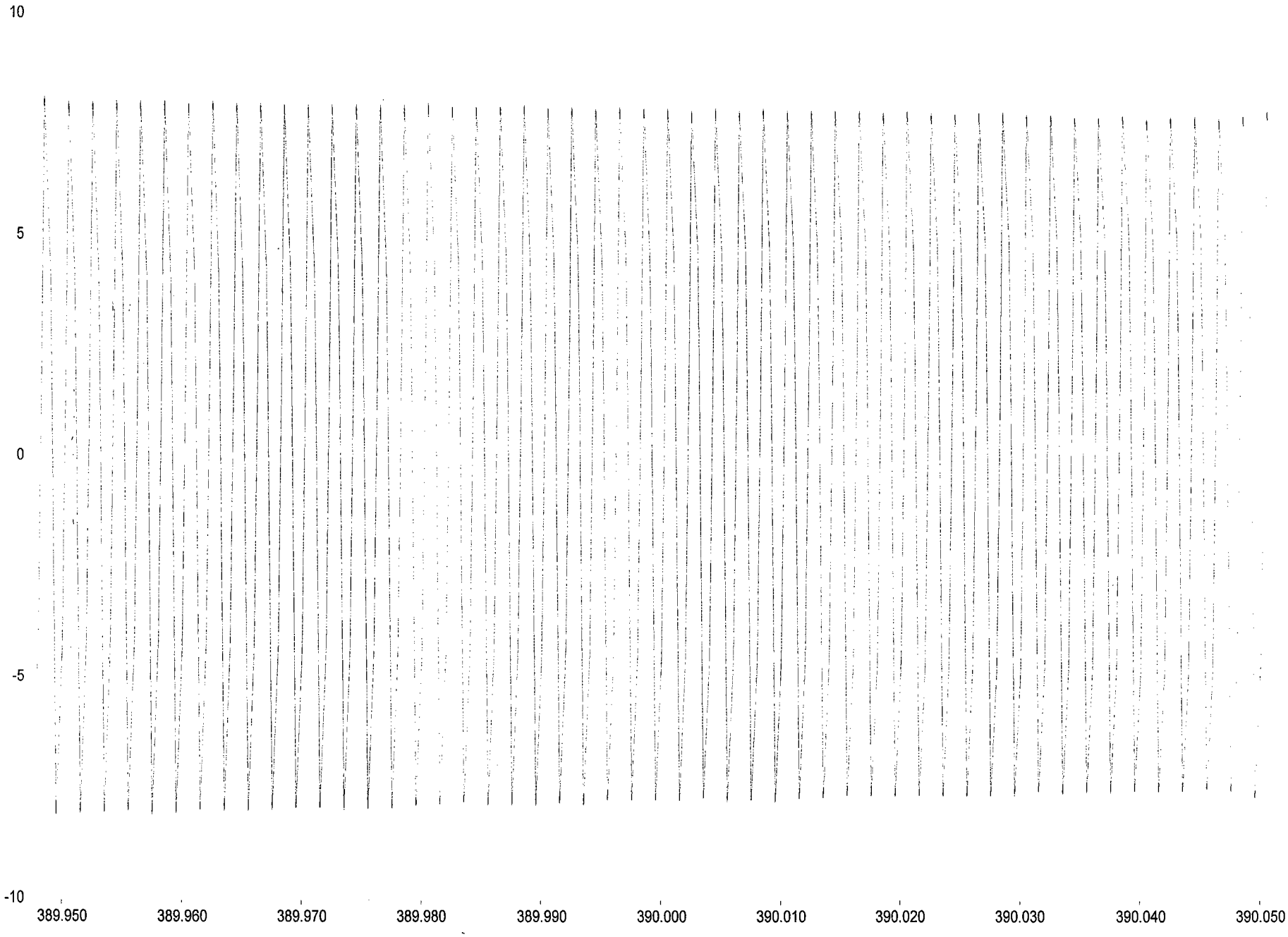
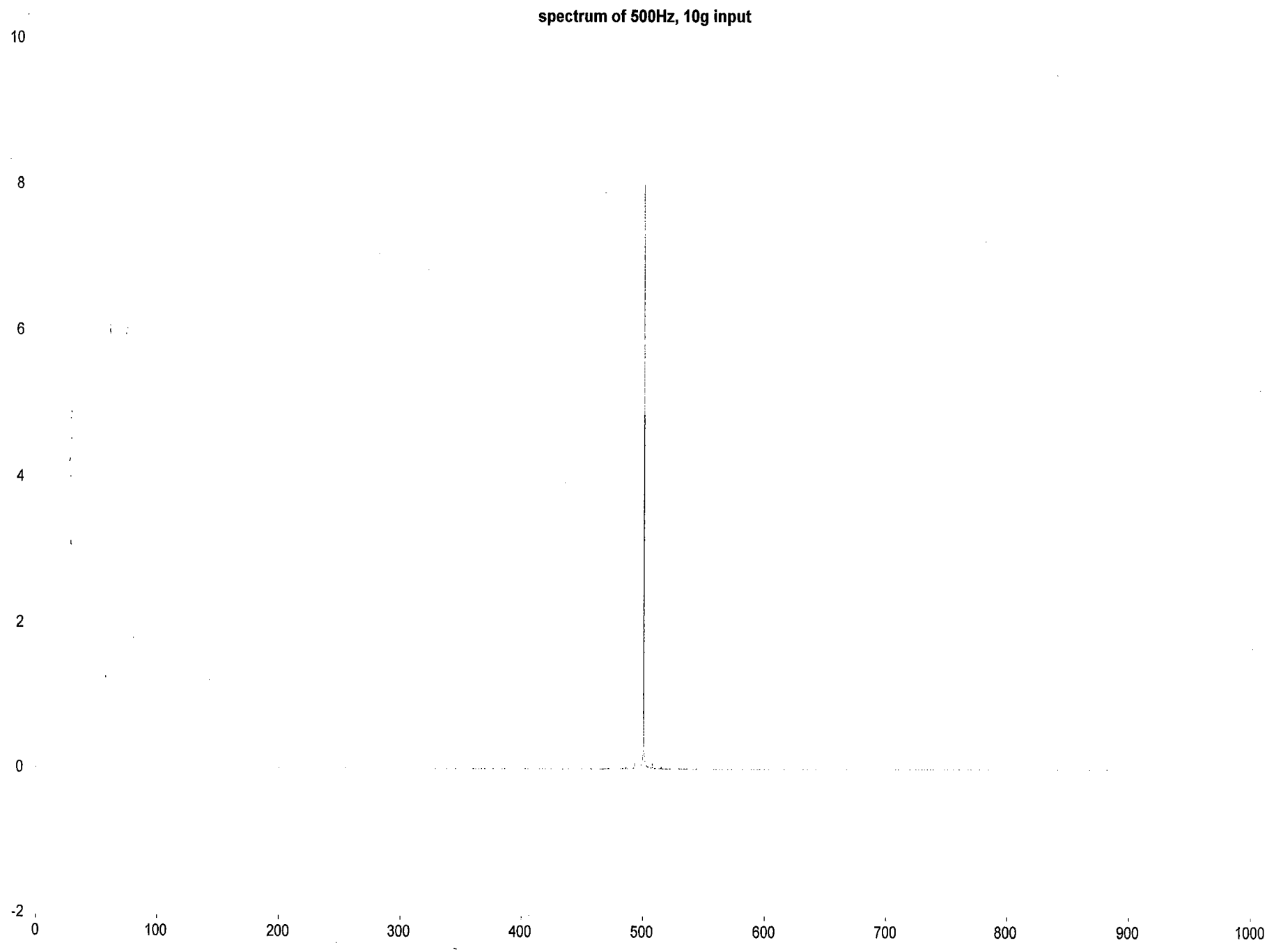
0
-2
0
100
200
300
400
500
600
700
800
900
1000

500Hz, 10g input




spectrum of 500Hz, 10g input
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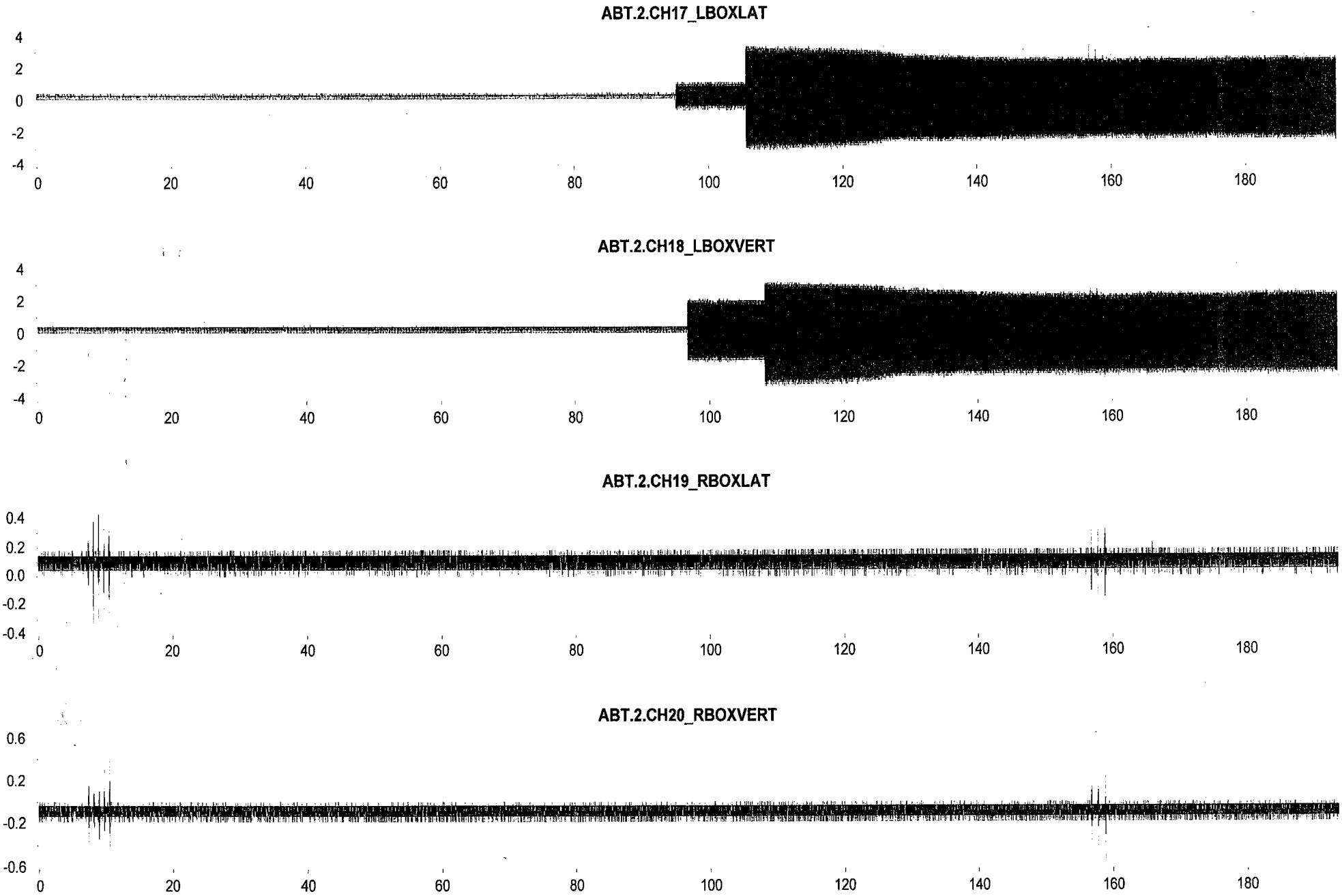
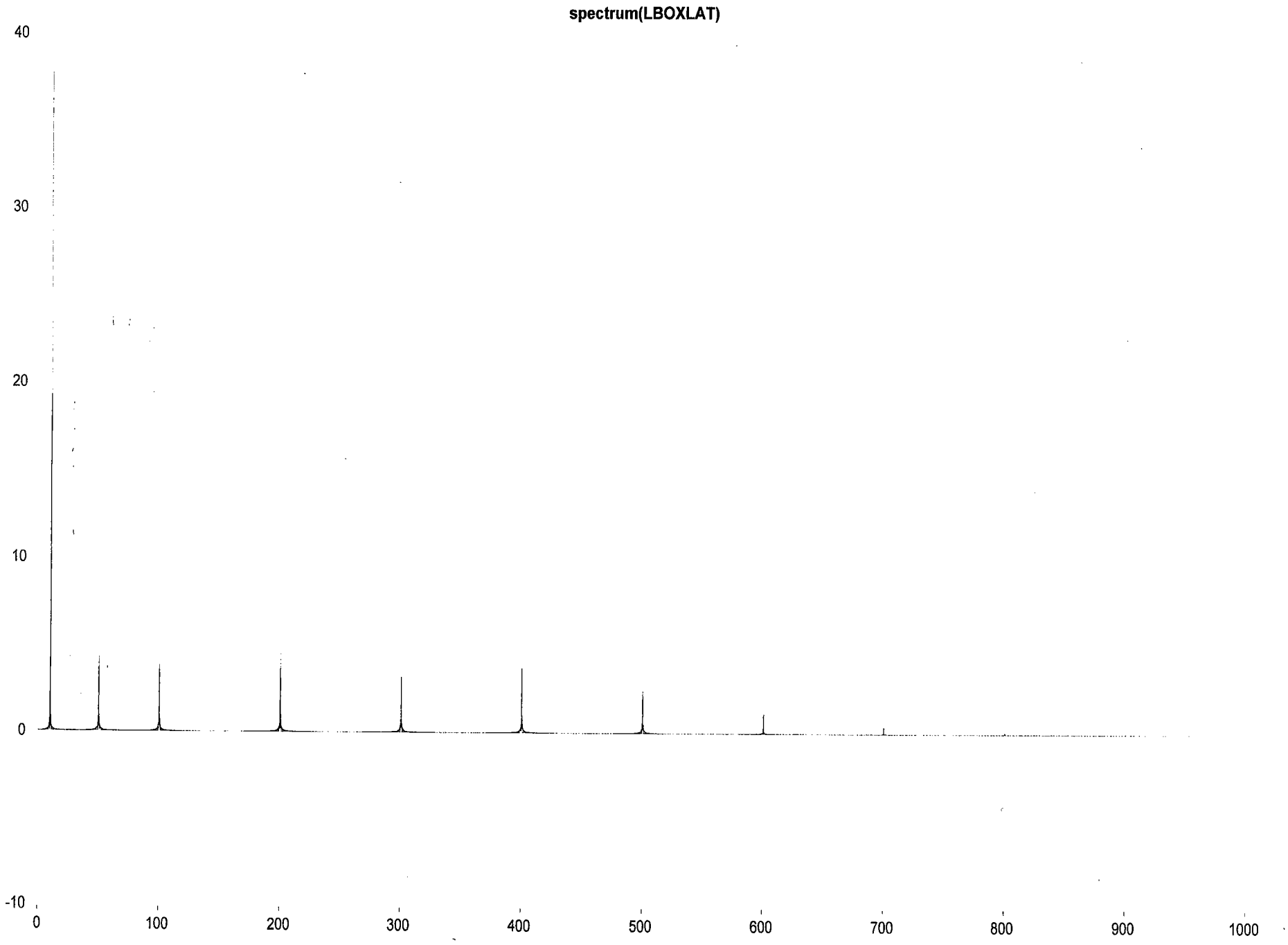
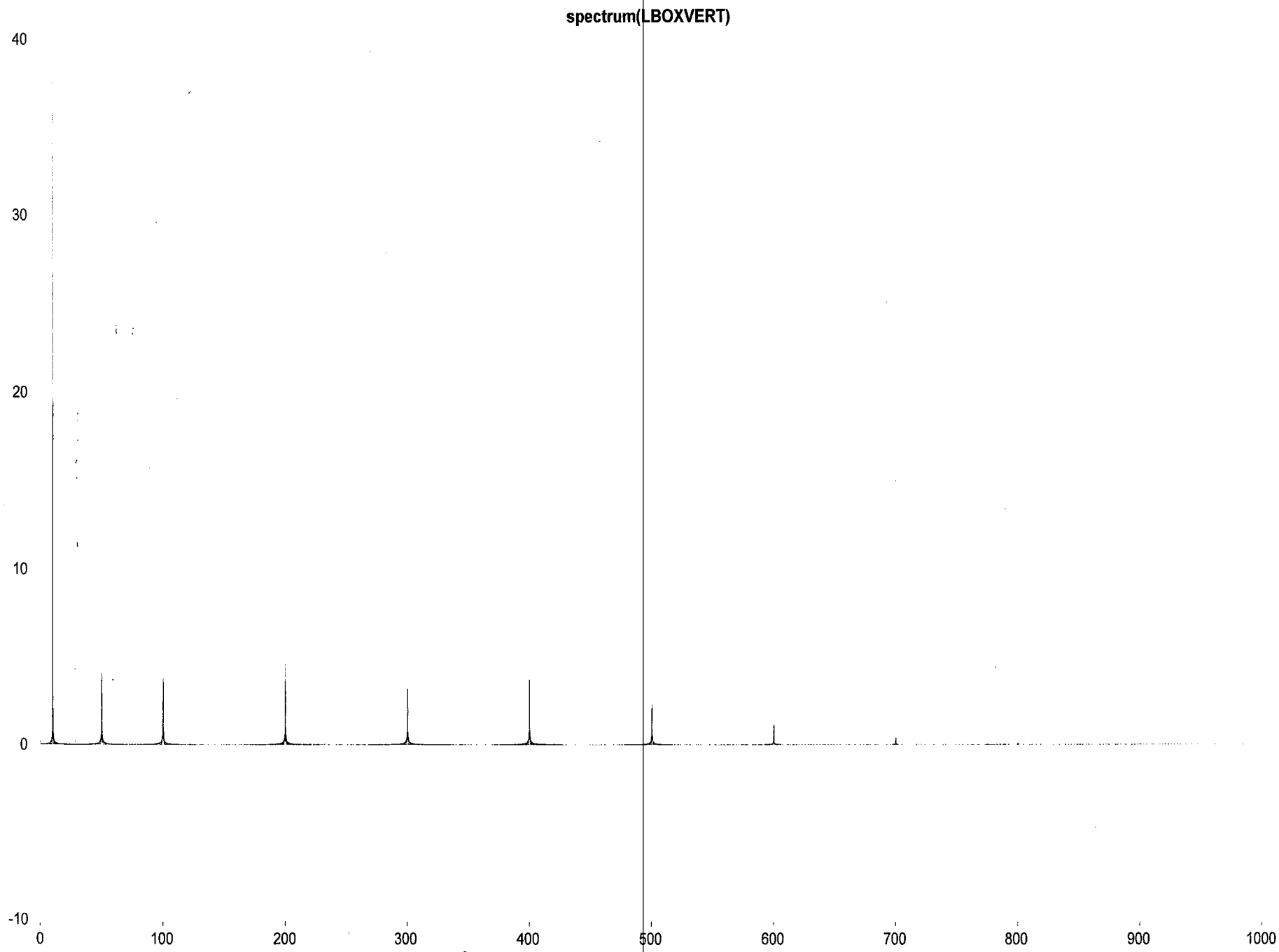
8
6
4
2
0
-2
0
100
200
300
400
500
600
700
800
900
1000

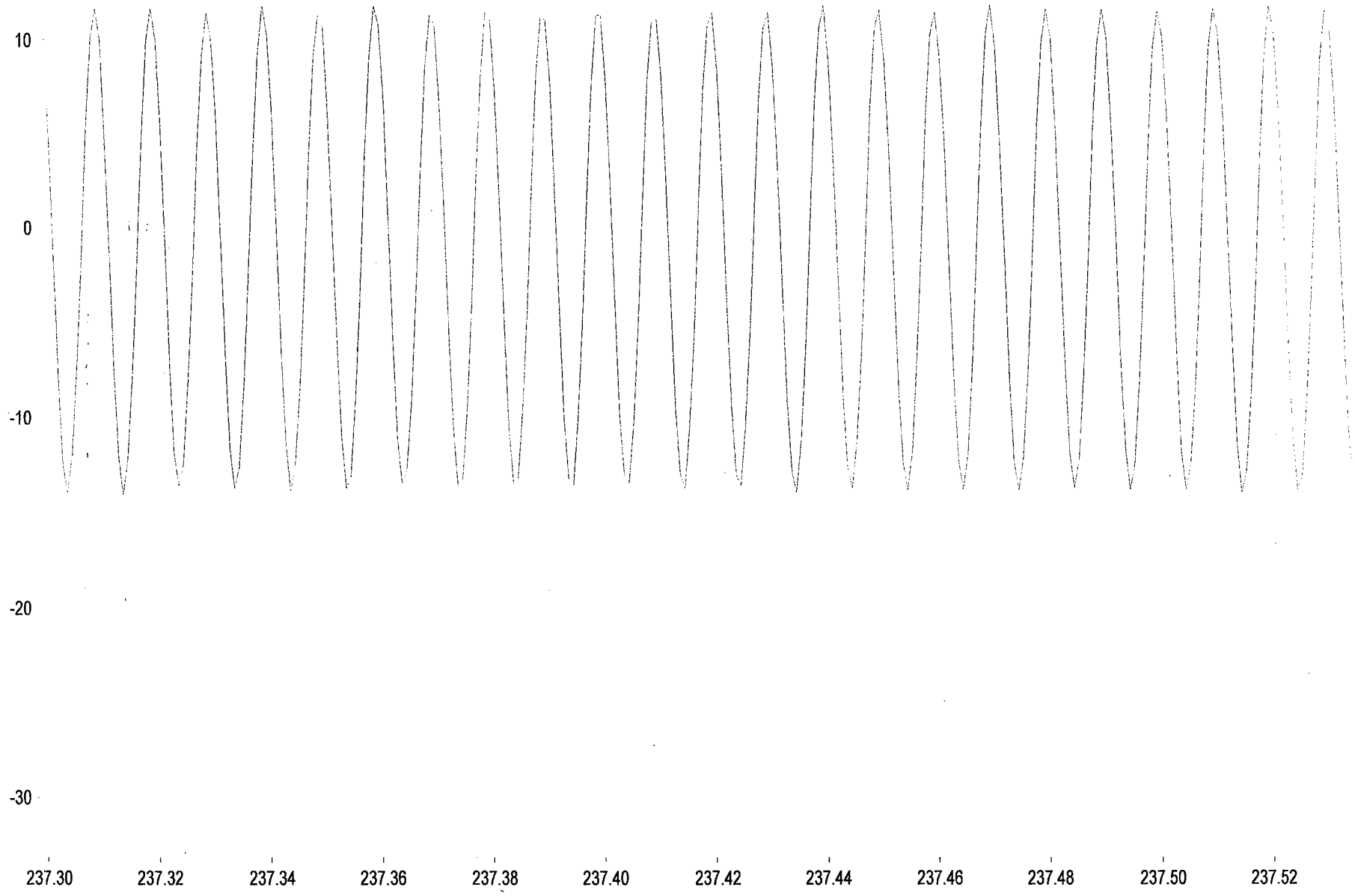

ABT.2.CH17_LBOXLAT
4
2
0
-2
-4
0
20
40
60
80
100
120
140
160
180
ABT.2.CH18_LBOXVERT
4
2
0
-2
-4
0
20
40
60
80
100
120
140
160
180
ABT.2.CH19_RBOXLAT
0.4
0.2
0.0
-0.2
-0.4
0
20
40
60
80
100
120
140
160
180
ABT.2.CH20_RBOXVERT
0.6
0.2
-0.2
-0.6
0
20
40
60
80
100
120
140
160
180


spectrum(LBOXLAT)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700
800
900
1000

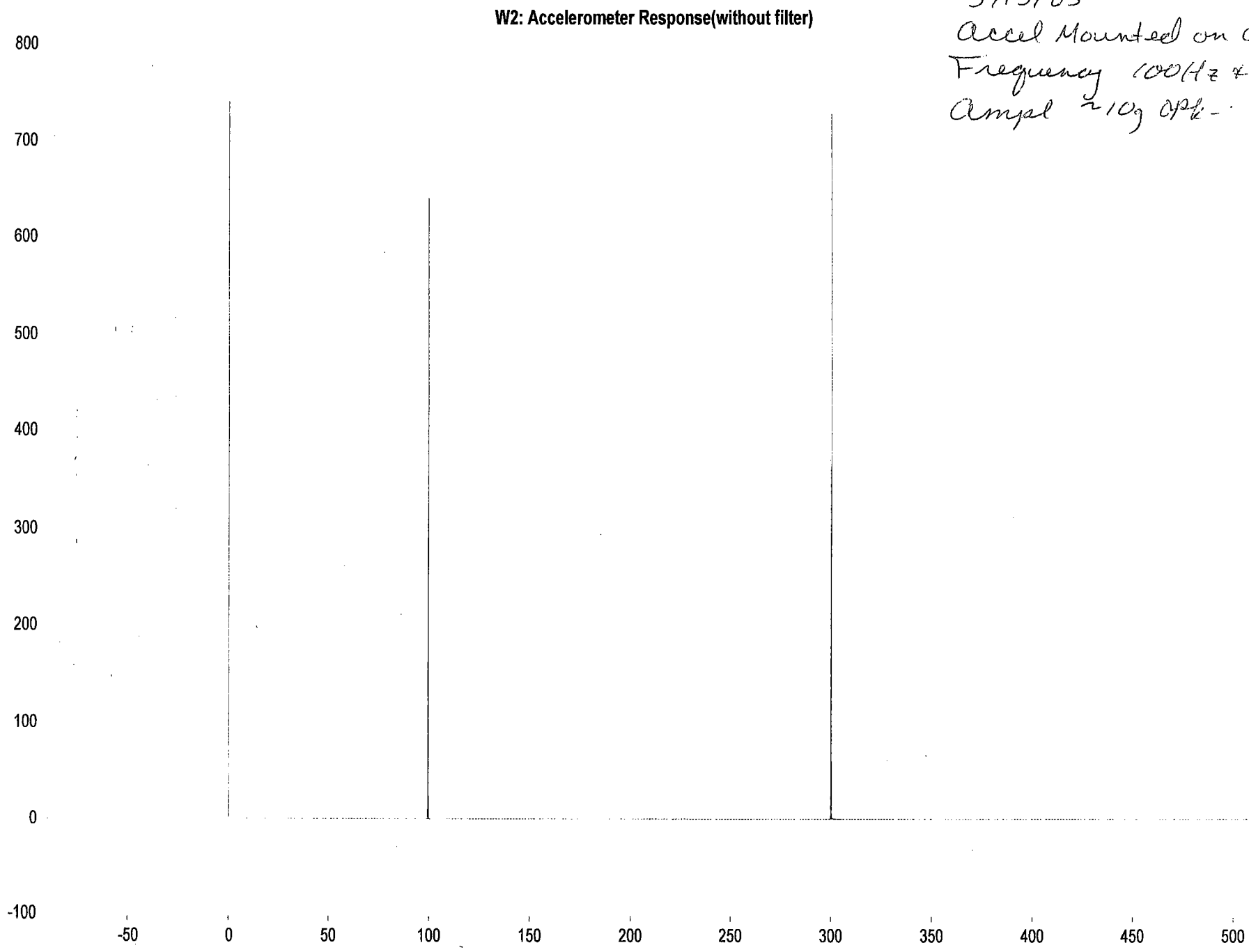

spectrum(LBOXVERT)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700
800
900
1000

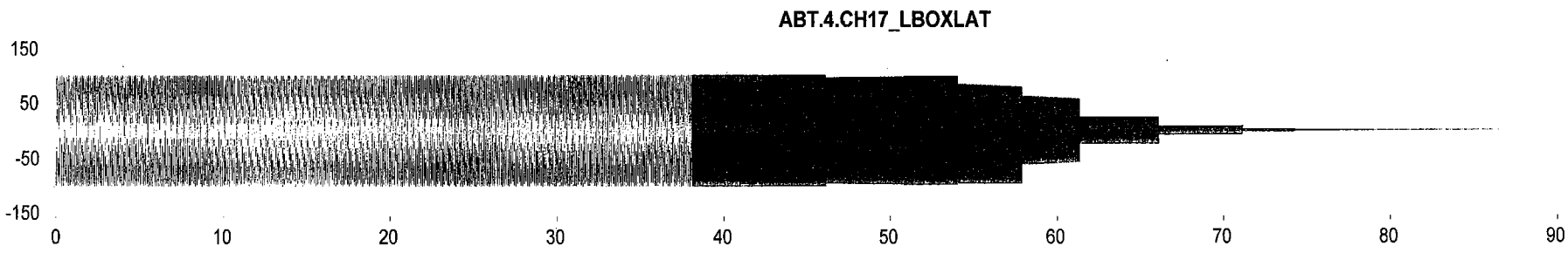
5/15/05
Accel Mounted on Axle
Excited @ 100 Hz
~10g amplitude

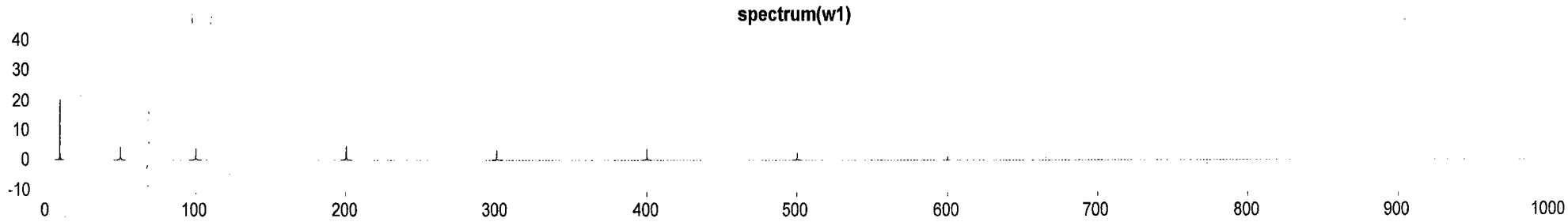
W1: 200 g Accelerometer with 100HZ Excitation

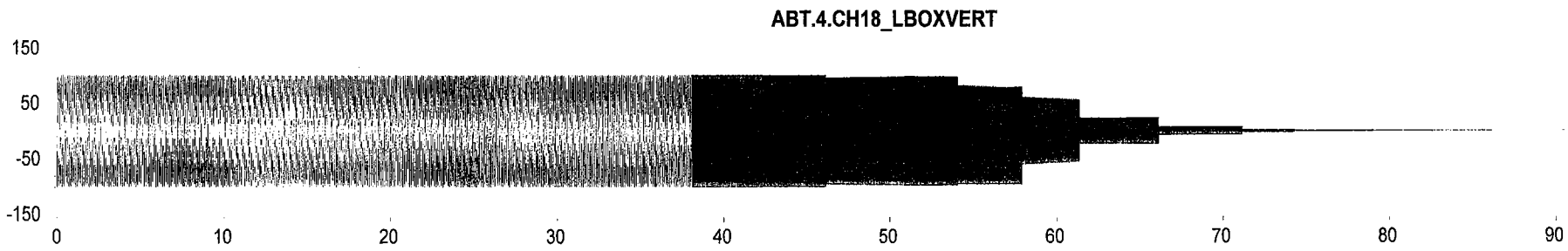


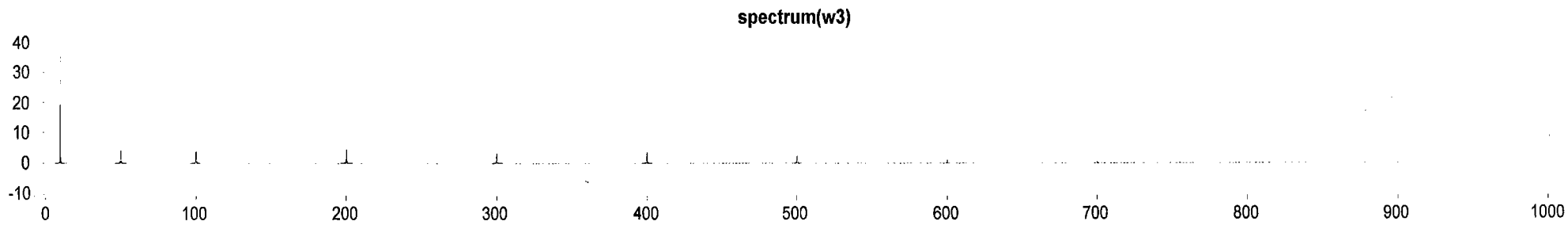
5/15/05
Accel Mounted on axle
Frequency 100Hz & 300Hz
Amp ~10g 0-pk

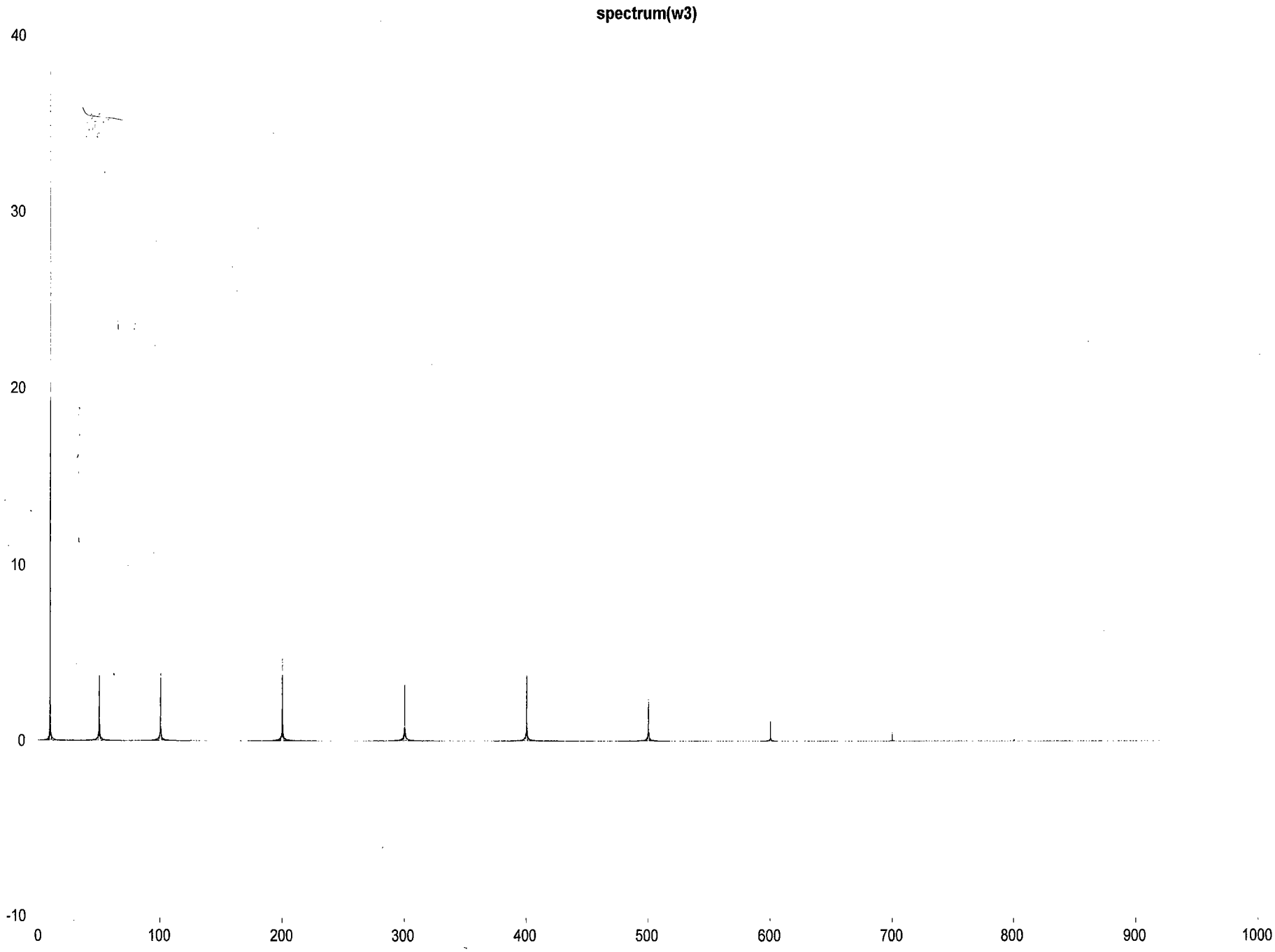



ABT.4.CH17_LBOXLAT
150
50
-50
-150
0
10
20
30
40
50
60
70
80
90


spectrum(w1)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700
800
900
1000


ABT.4.CH18_LBOXVERT
150
50
-50
-150
0
10
20
30
40
50
60
70
80
90


spectrum(w3)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700
800
900
1000


spectrum(w3)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700
800
900
1000