

# Microvibration Dynamometer

Type 9236A1, 9236A2

## -500 ... 500 N, Ceramic top plate

Piezoelectric multicomponent dynamometer for measuring the three orthogonal components of a force. The dynamometer has a ceramic top plate in order to reach the highest possible rigidity and consequently an extraordinary high natural frequency. Its high resolution enables the smallest dynamic changes in small forces to be measured.

- Wide measuring range
- For microvibration measurements
- Extremely rigid design
- Ceramic top plate
- Easy cleanable surface for use in clean rooms
- Calibrated in 6 components

### Description

The high frequency dynamometer Type 9236A is especially designed for measurements in vacuum chambers or clean-rooms, and it is ideally suited for high natural frequencies and measurements of very low forces.

It consists of four 3-component force sensors fitted under high preload between a base plate and a ceramic top plate. Each sensor contains three pairs of quartz plates, one sensitive to pressure in the z direction and the other two responding to shear in the x and y directions respectively. The force components are measured practically without displacement.

The outputs of the four built-in force sensors are connected inside the dynamometer in a way to allow multicomponent measurements of forces and moments to be performed. The eight output signals are available at the 9-conductor flange socket. The four sensors are mounted ground-insulated. Therefore ground loop problems are largely eliminated.

### Application examples

- Dynamic and quasistatic measurement of the three orthogonal components of a force
- Microvibration testing
- Cryo cooler testing
- Reaction wheel testing
- Clean room use



Type 9236A1



Type 9236A2

### Technical data

(at Tref = 25 °C)

			9236A1	9236A2
Measuring range	F <sub>x</sub> , F <sub>y</sub>	N	±500	±500
Force application max. 200 mm (= a <sub>ZTot</sub> ) over the top plate	F <sub>z</sub>			
Overload	F <sub>x</sub> , F <sub>y</sub> , F <sub>z</sub>	N	±600	±600
Calibrated range forces (a <sub>ZTot</sub> = 150 mm)	F <sub>x</sub> , F <sub>y</sub> , F <sub>z</sub>	N	0 ... 200	0 ... 100
Calibrated range moments (a <sub>ZTot</sub> = 150 mm)	M <sub>x</sub>	N·m	0 ... 30	0 ... 19,5
(a <sub>y</sub> = 200 mm)	M <sub>y</sub>	N·m	0 ... -30	0 ... -19,5
(a <sub>x</sub> = 200 mm)	-M <sub>z</sub>	N·m	0 ... -30	0 ... -19,5
	M <sub>z</sub>	N·m	0 ... 30	0 ... 19,5
Maximum static mass on dynamometer		kg	≤50	≤50
Noise RMS (1 Hz ... 10 kHz) <sup>1</sup>	F <sub>x</sub> , F <sub>y</sub>	N	≈0,7 * 10 <sup>-3</sup>	≈0,7 * 10 <sup>-3</sup>
	F <sub>z</sub>	N	≈1,5 * 10 <sup>-3</sup>	≈1,5 * 10 <sup>-3</sup>
	M <sub>x</sub> , M <sub>y</sub> , M <sub>z</sub>	N·m	≈4,0 * 10 <sup>-4</sup>	≈4,0 * 10 <sup>-4</sup>
Sensitivity	F <sub>x</sub> , F <sub>y</sub>	pC/N	-7,8 ±2,5 %	-7,8 ±2,5 %
	F <sub>z</sub>	pC/N	-3,8 ±5 %	-3,8 ±5 %
Linearity incl. Hysteresis	F <sub>x</sub> , F <sub>y</sub> , F <sub>z</sub>	%FSO	≤±0,5	≤±0,5
	M <sub>x</sub> , M <sub>y</sub> , M <sub>z</sub>	%FSO	±1	±1
Cross talk	F <sub>z</sub> → F <sub>x</sub> , F <sub>y</sub>	%	<±1	<±1
	F <sub>x</sub> ↔ F <sub>y</sub>	%	<±2	<±2
	F <sub>x</sub> , F <sub>y</sub> → F <sub>z</sub>	%	<±3	<±3
	F → M	mN·m/N	±15	±15
	M → F	N/N·m	±3	±3
	M ↔ M	%	±3	±3
Isolation		Ω	≥10 <sup>13</sup>	≥10 <sup>13</sup>
Ground insulation		Ω	≥10 <sup>8</sup>	≥10 <sup>8</sup>
Operating and storage temperature range		°C	0 ... 60	0 ... 60
Operating pressure		bar	0,01 ... 1,08	0,01 ... 1,08
Weight		kg	31,5	72

<sup>1</sup> With charge amp Typ 5080A..., 100 pC range, no mass on dynamometer

**Technical data (continuation)**

		9236A1	9236A2
Natural frequency	$f_0$ x	Hz	≥2 600
	$f_0$ y	Hz	≥2 600
	$f_0$ z	Hz	≥4 500
Natural frequency with static mass of 10 kg	$f_0$ x	Hz	≥1 900
	$f_0$ y	Hz	≥1 900
	$f_0$ z	Hz	≥2 000
Material of:		A/2O3 - 99,7 %	
- Top plate		1.2316 (X36CrMo17)	
- Base plate			

		9236A1	9236A2
Preload (5 steps)	kN	50	50
Torque for fixation screw:			
- trough sensor 4xM12 (12.9)	N·m	120	120
- Parafin wax, white oil			
Torque for mounting screw	N·m	20	20
M8 on top plate			
Protection class	EN 60529	IP41	IP41

<sup>1)</sup> With charge amplifier Type 5080A... (AC – powered), 100 pC range, no mass on dynamometer

**Dimensions Type 9236A1**

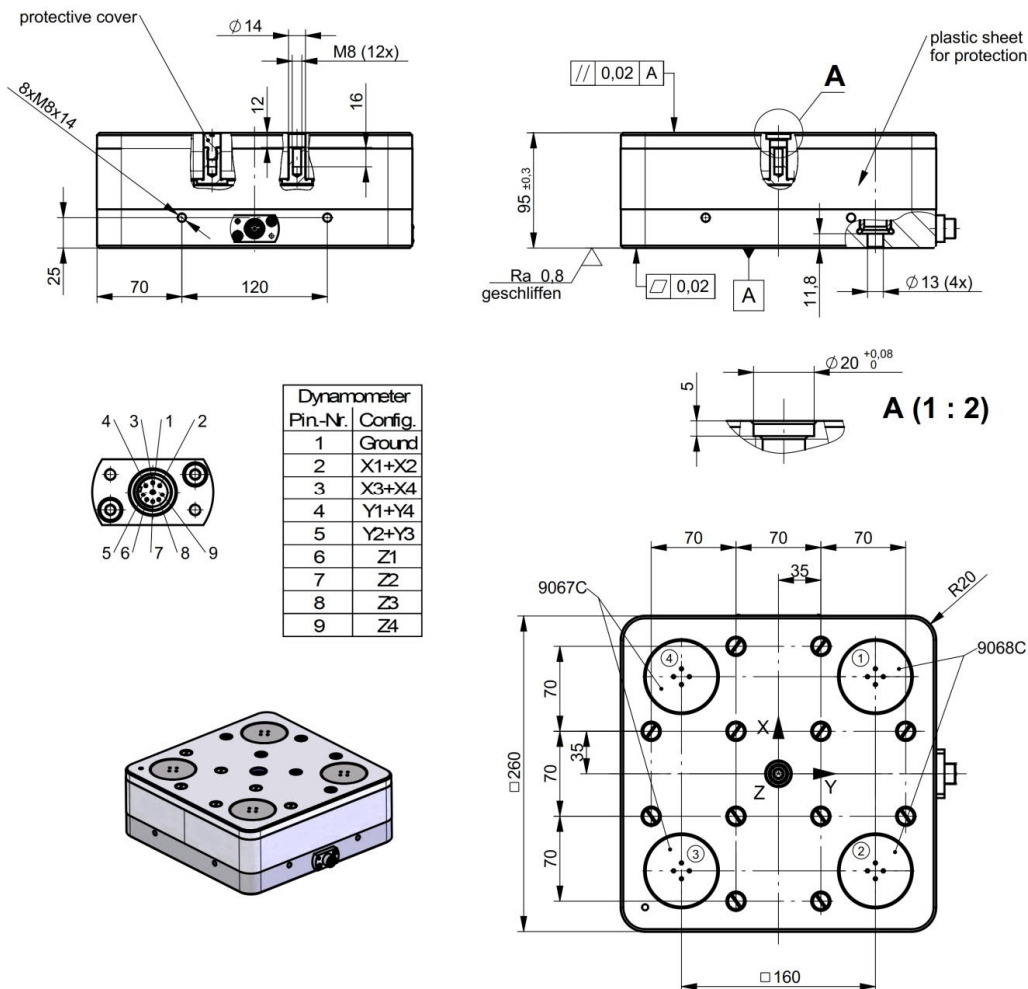


Fig. 1: Dimensions of Microvibration Dynamometer Type 9236A1

**Mounting**

For the best results, the dynamometer must be mounted with screws on a vibration isolated stone table, that is at least 10x heavier than the weight of the test setup. This allows to reach the highest resonant frequency of the measuring system. Uneven supporting surface may set up internal stresses, which will impose severe additional loads on the individual measuring elements and may also increase cross talk.

The supporting surfaces for the force-introducing parts must be face-ground to obtain good mechanical coupling to the cover plate.

The best results are reached in a silent room and a 5080A charge amplifier, which operates at an especially low noise level.

**Dimensions Type 9236A2**

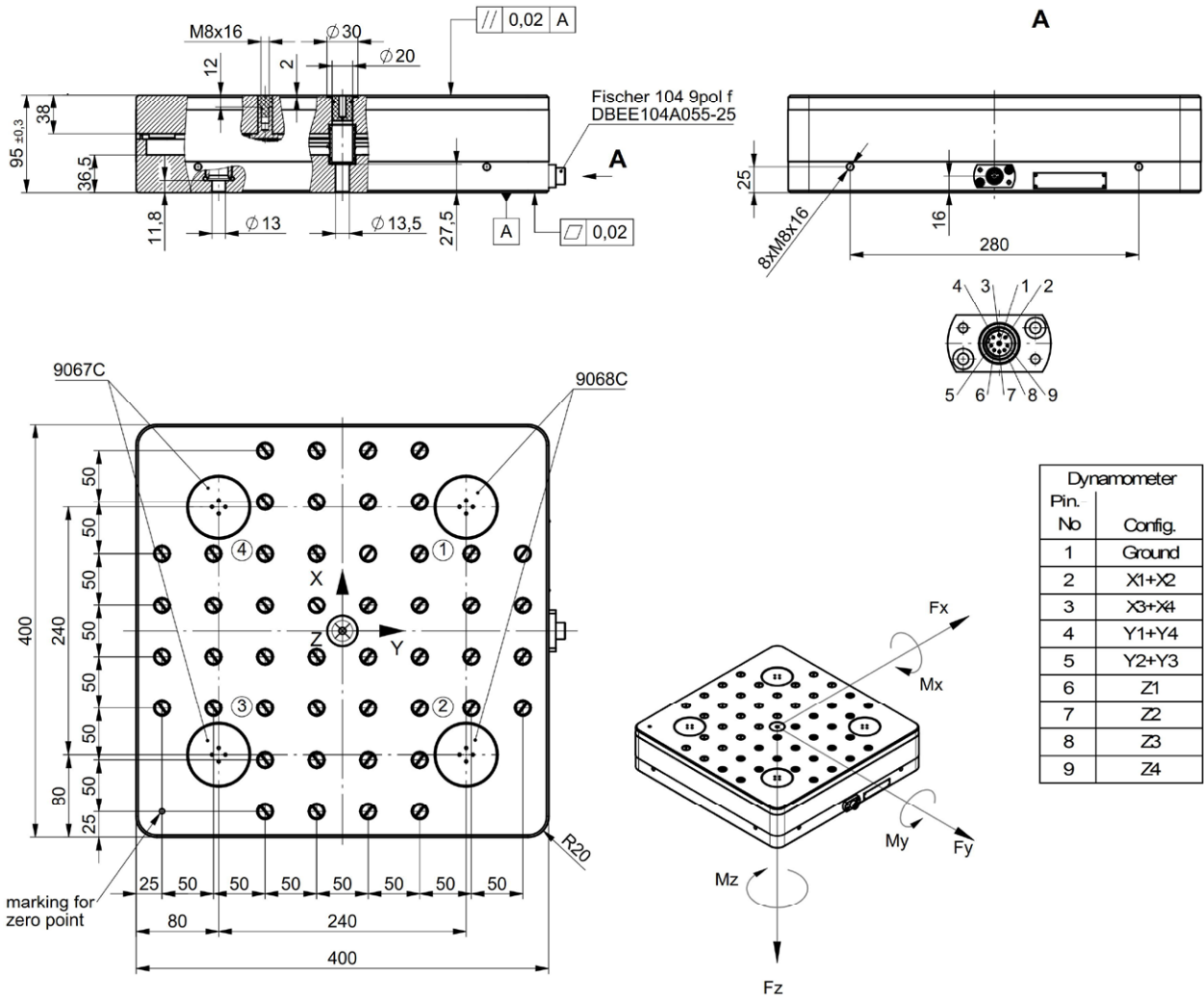


Fig. 2: Dimensions of Microvibration Dynamometer Type 9236A2

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**3-component force measurement  $F_x, F_y, F_z$**

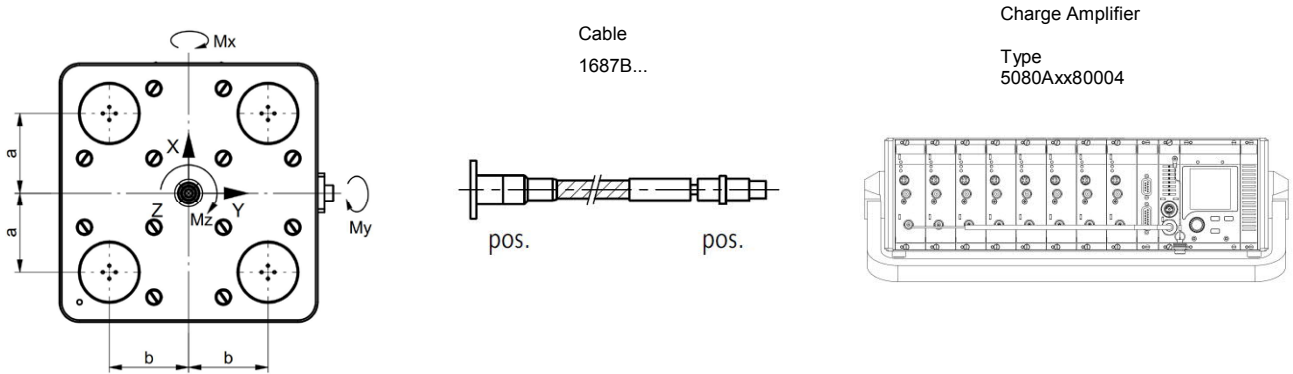


Fig. 2: Measuring system for 3-component measurement with multi-channel charge amplifier

**6-component force-moment-measurement with 8-channel charge amplifier Type 5080A...**

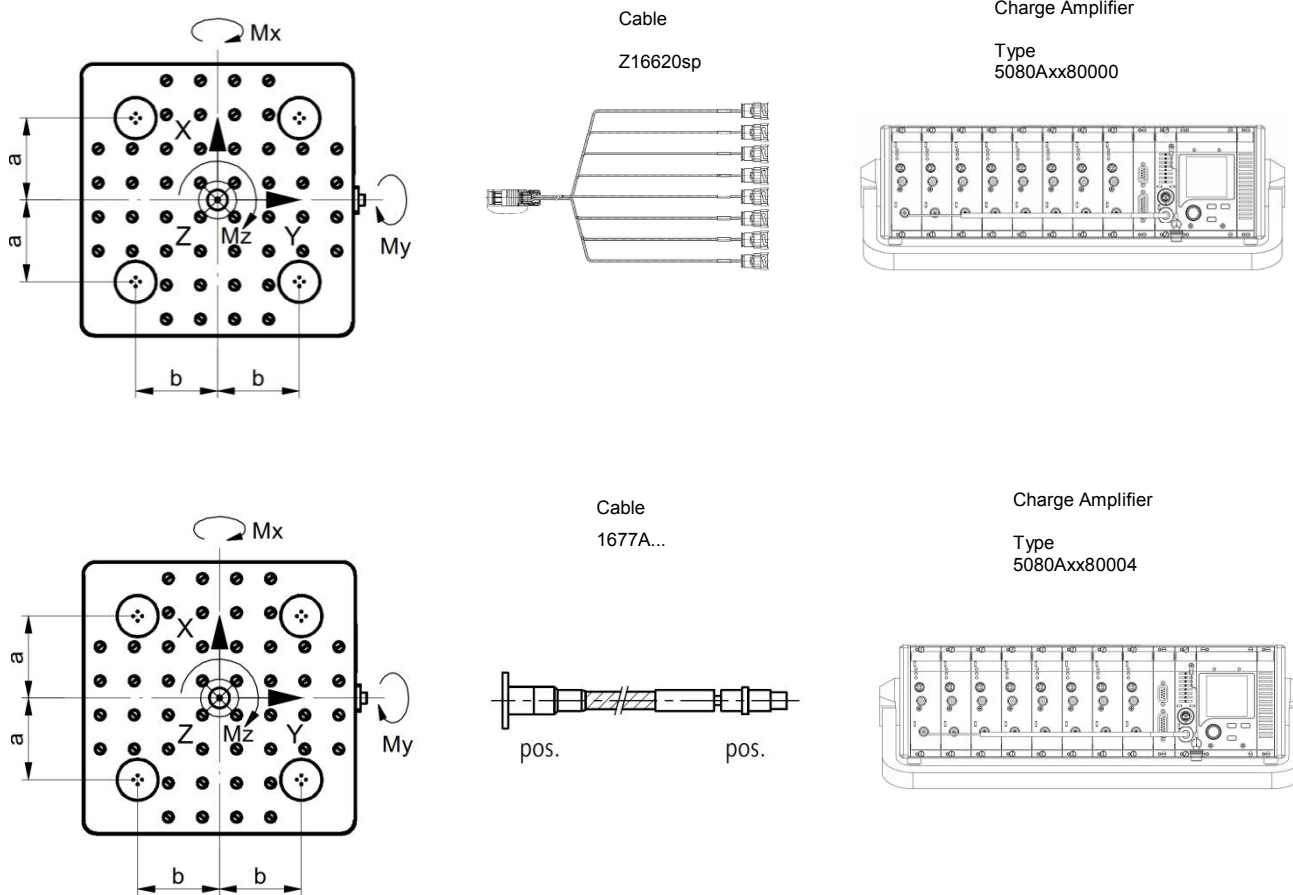


Fig. 3: Measuring system for 6-component measurement with multi-channel charge amplifier

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**Cabling**

Output Signal	Cable	Cable Properties	Length [m]		Temp. Range	IEC/EN 60529	Connector Dynamometer	Connector Amplifier	IEC/EN 60529	Channel														
			min	max						IP65	IP65	IP65	IP67	IP53	IP20	IP40	IP40	IP20	IP20					
sum 3	Z15141sp	PFA	1	20	-5...70°C	IP40 IP65 IP65 IP67 IP67 IP67	9-pole pos. 9-pole pos. 90° Flange 9-pole pos. Flange 9-pole pos. Flange 9-pole pos. Flange 9-pole pos. 90°	3x BNC pos. Fischer 9-pole pos.	IP40 IP65 IP65 IP65 IP65 IP65	5030A	5039A	5073A...	5074A...	5877B...	5015A...	5018A...	5080A...	5165A...	5167A...	KIDAQ				
	1683Asp	PFA with flexible steel hose	2	20						1	1	1-4	1-4	1	1	1	1-4	4,8	4...52					
	1687BQ01...	TPC black Ø3.6mm	1	20						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	1687BQ02...	PFA, steel braiding	1	5						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1687B...	PFA with flexible steel hose	2	20						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1689B...	PFA with flexible steel hose	1	20						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	separate 8	Z16620sp	PFA	1						20	-5...70°C	IP40 IP65 IP65 IP65 IP65 IP67 IP67 IP67	9-pole pos. 9-pole pos. 9-pole pos. 90° 9-pole pos. Flange 9-pole pos. Flange 9-pole pos. Flange 9-pole pos. 90°	8x BNC pos. Fischer 9-pole pos.	IP40 IP65 IP65 IP65 IP65 IP65 IP65 IP65	✓	✓	-	✓	✓	✓	✓	✓	✓
1685B...		TPC black Ø5.6mm	1	20	-	-	-	-	-	-						-	-	-	-	-	-	-	-	
1686A...		TPC black Ø5.6mm	1	20	-	-	-	-	-	-						-	-	-	-	-	-	-	-	
1681B...		PFA with flexible steel hose	1	20	-	-	-	-	-	-						-	-	-	-	-	-	-	-	
1677AQ01..		TPC black Ø5.6mm	1	20	-	-	-	-	-	-						-	-	-	-	-	-	-	-	
1677AQ02..		TPC, steel braiding	1	20	-	-	-	-	-	-						-	-	-	-	-	-	-	-	
1677A...		PFA with flexible steel hose	1	20	-	-	-	-	-	-						-	-	-	-	-	-	-	-	
1679A...		PFA with flexible steel hose	2	20	-	-	-	-	-	-						-	-	-	-	-	-	-	-	
extension 3 8	Z13705sp...	PFA	1	20	-5...70°C	IP40 IP65 IP40 IP40 IP65	9-pole neg. 9-pole neg. 9-pole neg. 9-pole neg. 9-pole neg.	3x BNC pos. Fischer 9-pole pos. 8x BNC pos. 8x KIAG 10-32 neg. Fischer 9-pole pos.	IP40 IP65 IP40 IP65	✓	✓	-	✓	✓	✓	✓	✓	✓	✓					
	1688B...	TPC black Ø3.6mm	1	20						-	-	-	-	-	-	-	-	-	-	-	-	-		
	Z16634sp..	PFA	1	20						-	-	-	-	-	-	-	-	-	-	-	-	-		
	1656Asp	PFA	1	20						✓	-	✓	-	-	-	-	-	-	-	-	-	-		
	1678A...	TPC black Ø5.6mm	1	25						-	-	-	-	-	-	-	-	-	-	-	-	-		

**Included Accessories**

- 4 fixation screws M12x35
- 1 fixation screws M12x50 <sup>2</sup>
- 4 eye bolt M 20x1,5
- 4 spacer
- 1 wrench adapter

**Type/Mat. No.**

- 65012818
- 65012841
- 55151639
- 55151642
- 9475

**Ordering Code**

- Microvibration dynamometer up to 500 N, cover plate 260x260 mm
- Microvibration dynamometer up to 500 N, cover plate 400x400 mm

**Type/Mat. No.**

- 9236A1
- 9236A2

<sup>2</sup> Type 9236A2 only