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MiniDyn

Typ 9119AA2

Multicomponent Dynamometer up to 4 000 N, cover plate 55x80 mm

Multicomponent dynamometer for measuring the three orthogonal components of a force. Its very low threshold and the high sensitivity allow measuring extremely small forces.

- Small design
- High sensitivity and natural frequency
- Small temperature error
- For cutting force measurements in ultra precision machining
- For general multicomponent force measurement
- Modular system for measurement of cutting forces when turning

Description

The dynamometer consists of four 3-component force sensors mounted under high preload between the cover plate and the two lateral base plates.
A low temperature error is obtained by this special mounting of the sensors. Each force sensor contains three crystal rings, of which one is sensitive to pressure in the y-direction and the two others to shear in the x- and z-directions.
The outputs of the four mounted force sensors are fed to the 9-pole flanged socket. There are also multicomponent force-moment measurements possible.
The four sensors are fitted so that they are ground-isolated. This largely eliminates ground loop problems.
The dynamometer is corrosion-resistant and protected against penetration by splashing water or cutting fluid. The dynamo-meter including connecting cable Type 1687B5 or Type 1677A5 meets the degree of protection IP67.

Application examples

- Multicomponent force measurement of small forces
- Cutting force measurement in
  - micromachining
  - superfinish machining
  - Ultra precision machining of brittle materials

Technical data

General configuration (without machine adapter and tool holder)

Measuring range (centrical), single components	F_x, F_y, F_z	kN	–4 ... 4
	M_x, M_y	N·m	–150 ... 150
	M_z	N·m	–300 ... 300
Meas. range when compon. act simult.(centr.), M_x, M_y, M_z = 0	F_x, F_y, F_z	kN	–2,5 ... 2,5
Calibrated measuring range			
100 %	F_x, F_y, F_z	N	0 ... 4 000
10 %	F_x, F_y, F_z	N	0 ... 400
1 %	F_x, F_y, F_z	N	0 ... 40
Overload (centrical), single comp.	F_x, F_y, F_z	kN	–4,5/4,5
Threshold		N	<0,002
Sensitivity	F_x, F_z	pC/N	≈–26
	F_y	pC/N	≈–13
Linearity			
Meas. range 10% ... 100%		%/FSO	≤±0,3
Meas. range 0% ... <10%		%/FSO	≤±0,5
Hysteresis			
Meas. range 10% ... 100%		%/FSO	≤±0,3
Meas. range 0% ... <10%		%/FSO	≤±0,5
Crosstalk	F_z –> F_x, F_y	%	≤±2
	F_x <–> F_y	%	≤±2
	F_x, F_y –> F_z	%	≤±2
Natural frequency (without additional mass)	f_n (x)	kHz	≈4,3
	f_n (y)	kHz	≈4,6
	f_n (z)	kHz	≈4,4
Operating temperature range		°C	–20 ... 70
Capacitance	F_x, F_y, F_z	pF	≈230
Insulation resistance (20 °C)		Ω	$>10^{13}$
Ground isolation		Ω	$>10^{8}$
Degree of protection EN60529		–	IP67 [1]
Weight Dynamometer		kg	1,35
Cover plate		kg	0,72
Mounting surface		mm	55x80

[1] with connection cables Type 1687B5, 1689B5, 1677A5, 1679A5

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Dimensions

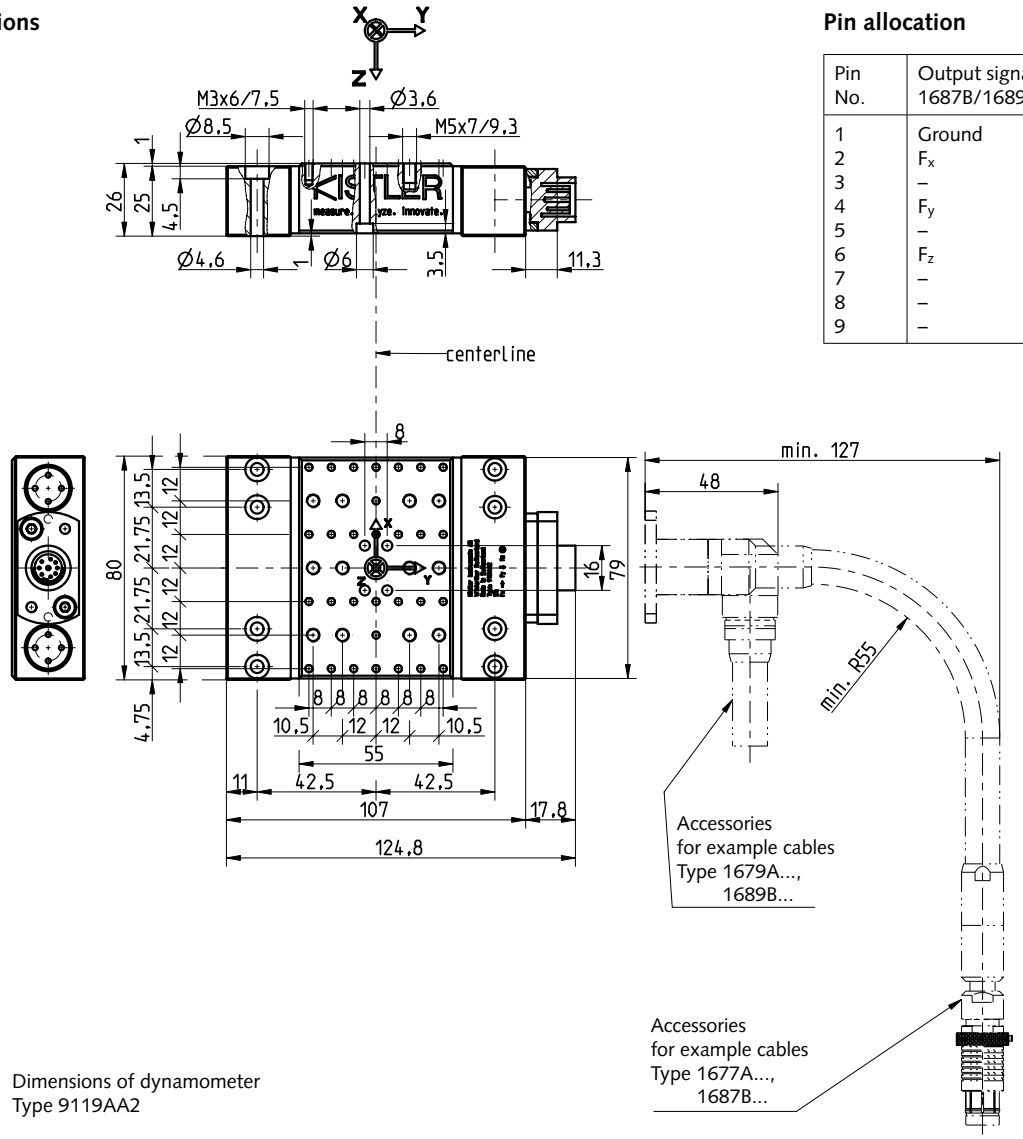

Fig 1: Dimensions of dynamometer
Type 9119AA2

Pin allocation

Pin No.	Output signals 1687B/1689B	Output signals 1677A/1679A
1	Ground	Ground
2	F_x	$F_{x\,1+2}$
3	–	$F_{x\,3+4}$
4	F_y	$F_{y\,1+4}$
5	–	$F_{y\,2+3}$
6	F_z	$F_{z\,1}$
7	–	$F_{z\,2}$
8	–	$F_{z\,3}$
9	–	$F_{z\,4}$

Mounting

The dynamometer can be mounted with eight screws M4 to any face-ground, clean mounting surface such as on a machine tool table. The measuring instrument can also be mounted on a magnetic plate. It must be noted that uneven contact surfaces may cause internal distortions, placing additional heavy stresses on the individual measuring elements and increasing the cross talk.

There are M3 and M5 tapped blind holes in the mounting plate for clamping the force-introducing components such as work-pieces or toolholder. The contact surfaces of the force-introducing parts must be surface ground to achieve good mechanical coupling to the mounting plate.

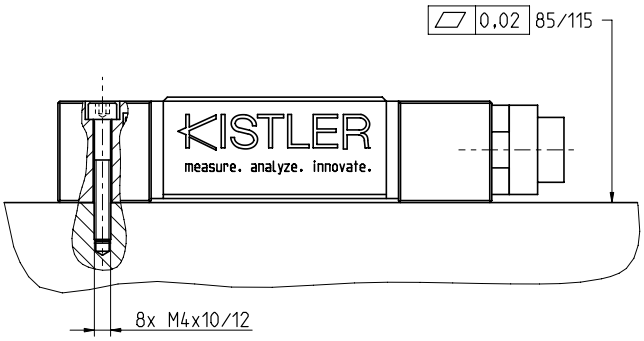

Fig. 2: Mounting of dynamometer Type 9119AA2

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Processing the measurement signals
Charge amplifier channels are also needed to build a complete measuring system (e.g. Type 5080A...). These convert the measurement signal into an electrical voltage. The measured value is exactly proportional to the force acting.

Data acquisition and analysis
Kistler offers with the Type 5697A1 DAQ system an universal and easy to operate package, consisting of a hardware for the data acquisition and the DynoWare software. For details see data sheet 5697A_000-745.

3-component force measurement F_x, F_y, F_z

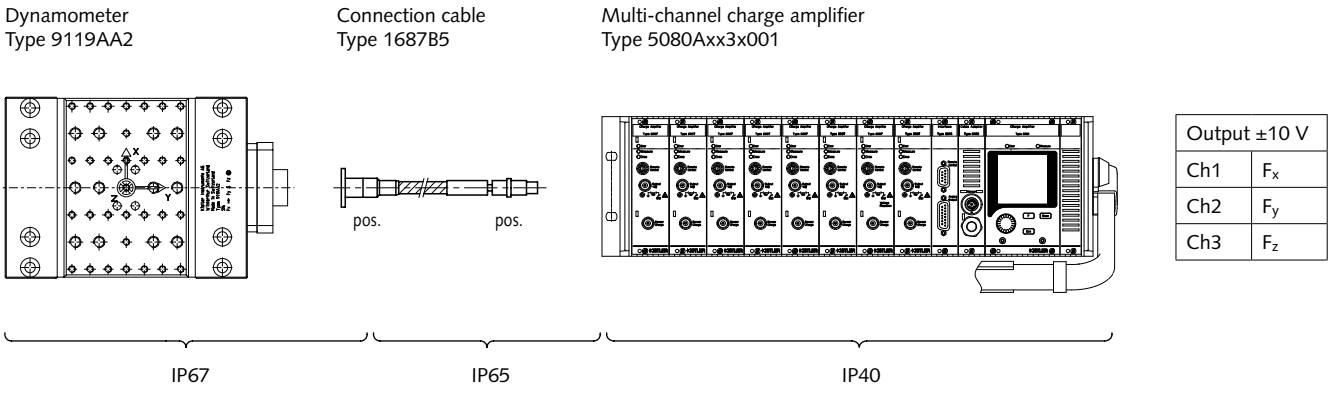

Fig. 3: Measuring system for 3-component measurement with multi-channel charge amplifier

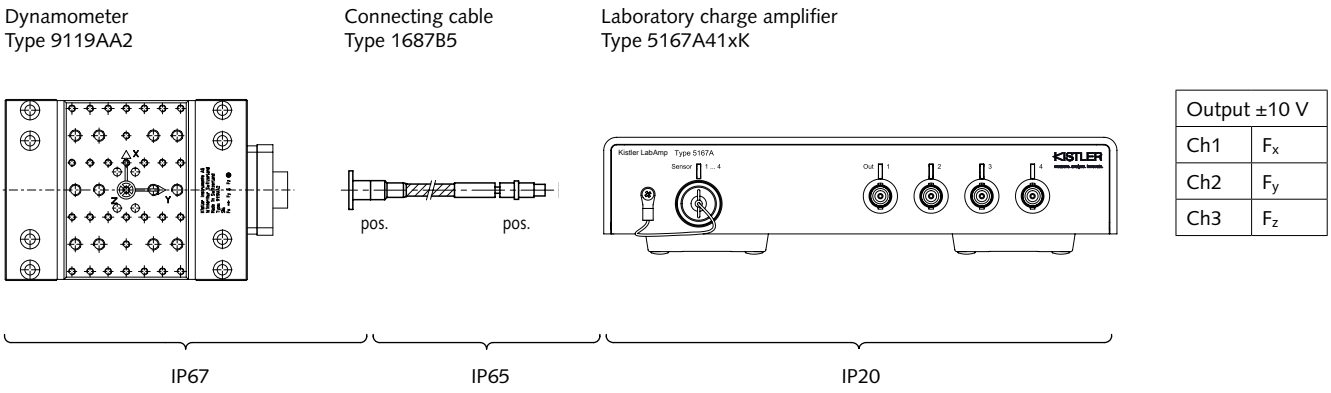

Fig. 4: Measuring system for 3-component measurement with laboratory charge amplifier

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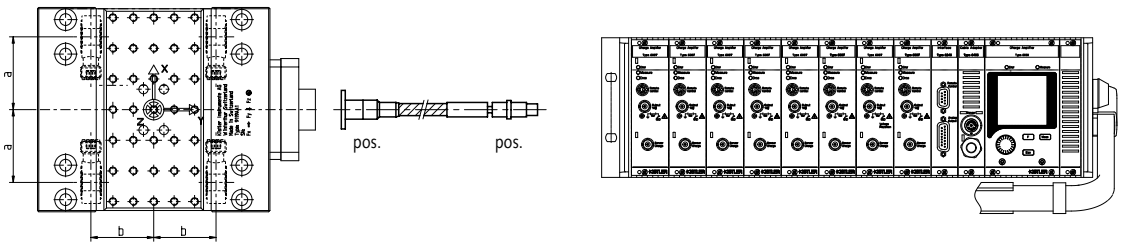
6-component force measurement F_x, F_y, F_z, M_x, M_y, M_z

Dynamometer
Type 9119AA2

Connection cable
Type 1677A5

Multi-channel charge amplifier
Type 5080Axx8x004



IP67 IP65 IP40

Degree of protection EN60529

Output ±10 V	
Ch1	F_{x1+2}
Ch2	F_{x3+4}
Ch3	F_{y1+4}
Ch4	F_{y2+3}
Ch5	F_{z1}
Ch6	F_{z2}
Ch7	F_{z3}
Ch8	F_{z4}

Fig. 5: Measuring system for 6-component measurement with multi-channel charge amplifier

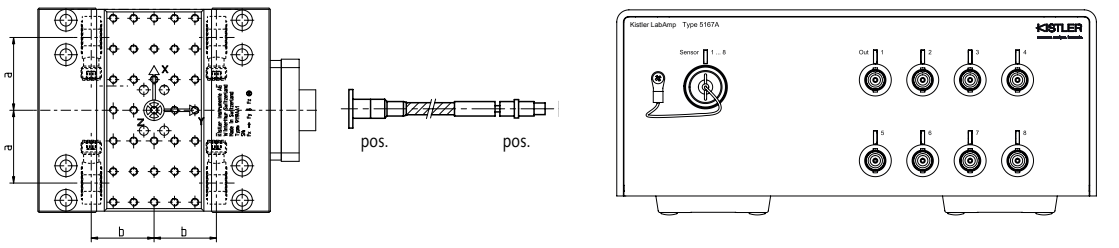
Value a,b for Type 9119AA2:

a mm	b mm
28,5	32,5

Dynamometer
Type 9119AA2

Connecting cable
Type 1677A5

Laboratory charge amplifier
Type 5167A81xK



IP67 IP65 IP20

Degree of protection EN60529

Output ±10 V	
Ch1	F_{x1+2}
Ch2	F_{x3+4}
Ch3	F_{y1+4}
Ch4	F_{y2+3}
Ch5	F_{z1}
Ch6	F_{z2}
Ch7	F_{z3}
Ch8	F_{z4}

Fig. 6: Measuring system for 6-component measurement with laboratory charge amplifier

Value a,b for Type 9119AA2:

a mm	b mm
28,5	32,5

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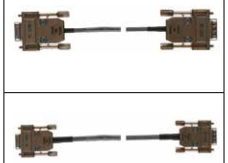
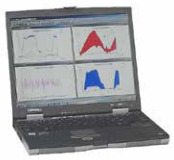
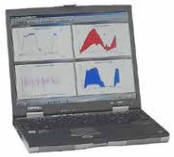
Typical measuring chain with DAQ system Type 5697A1

					
Dynamometer	Connection cable, high impedance	Charge amplifier	Connecting cable	DAQ system	Notebook (from customer side) with DynoWare
Type 9119AA2	Type 16xx	Type 5080A	Type 1700A111A2 Type 1200A27	Type 5697A1	

Typical measuring chain with LabAmp system Type 5167A...

			
Dynamometer	Connection cable, high impedance	Charge amplifier with integrated DAQ	Notebook (from customer side) with DynoWare
Type 9119AA2	Type 16xx	Type 5167A…	

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Cutting force measurement during turning

Modular system based on dynamometer Type 9119AA2 for measurement of cutting forces when turning outside and inside diameters on turret lathes.

- Machine adapters for disk-type turrets with:
  - VDI tool holding fixtures ø16 mm, ø20 mm, ø25 mm, ø30 mm
  - Coromant Capto C3, C4, C5 clamping unit
  - HSK-T63 tool holding fixture
- Machine adapter available in straight, left and right configuration
- Tool holders for external turning tools:
  8x8 mm, 10x10 mm, 12x12 mm, 16x16 mm, 20x20 mm, 0,31x0,31", 0,38x0,38", 0,5x0,5", 0,63x0,63"
- Tool holders for internal turning tools:
  ø8 mm, ø10 mm, ø12 mm, ø16 mm

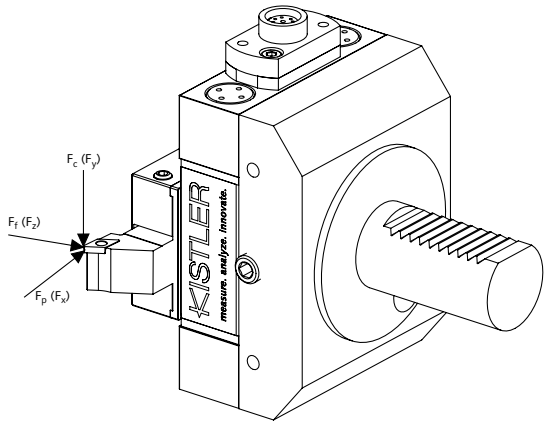

Fig. 7: Dynamometer Type 9119AA2 with tool holder Type 9119AE16 and VDI tool holding fixture Type 9119AB30S

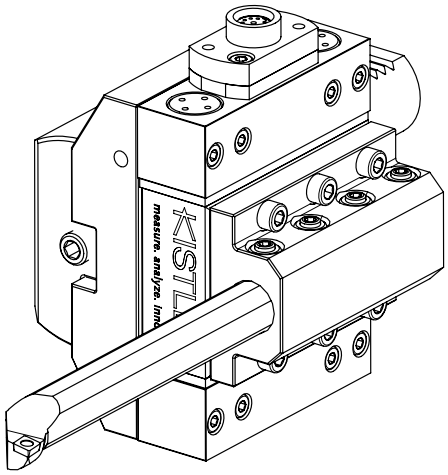

Fig. 8: Dynamometer Type 9119AA2 with tool holder Type 9119AF16 and VDI tool holding fixture Type 9119AB30R

Technical data

Configuration for measurement of cutting force when turning

Max. permitted measuring range (Type 9119AA2 mounted on adapter Type 9119AB30S or 9129AC5S or 9129AH63S with tool adapter Type 9129AE16, a = 25 mm)	F_x, F_z	kN	–2 ... 2
	F_y	kN	–3 ... 3
Permitted measuring ranges (Type 9119AA2 mounted with remaining adapters)	F_x, F_y, F_z		see Fig. 9, 10
Calibrated measuring range*	F_x, F_z	N	0 ... 2 000
	F_y	N	0 ... 3 000
Calibrated partial measuring range*	F_x, F_z	N	0 ... 200
	F_y	N	0 ... 300

* Dynamometer Type 9119AA2 is calibrated with mounted machine adapter Type 9119AB30S, tool holder Type 9119AE16 and dummy tool with 25 mm overhang

Threshold		N	<0,01
Nominal sensitivity	F_x	pC/N	≈–26
	F_y	pC/N	≈–13
	F_z	pC/N	≈–26
Sensitivity deviation dependent on the machine adapter	F_x, F_y, F_z	%	≤±1
Linearity, all ranges	F_x, F_y, F_z	%/FSO	≤±0,5
Hysteresis, all ranges	F_x, F_y, F_z	%/FSO	≤0,5
Crosstalk	F_z –> F_x, F_y	%	≤±3
	F_x <–> F_y	%	≤±3
	F_x, F_y –> F_z	%	≤±3
Natural frequency **	$f_n(x)$	kHz	≈1,25
	$f_n(y)$	kHz	≈1,5
	$f_n(z)$	kHz	≈2,5
Operating temperature range		°C	–20 ... 70
Capacitance	F_x, F_y, F_z	pF	≈230
Insulation resistance		Ω	$>10^{13}$
Ground isolation		Ω	$>10^{8}$
Degree of protection EN60529			IP67
Weight Dynamometer		kg	1,35
Cover plate		kg	0,72
Mounting surface		mm	55x80
Connection			Fischer flange 9 pin neg.

** Type 9119AA2 with mounted machine adapter Type 9119AB30S, and tool holder Type 9119AE16 (mass 200g), with dummy tool (mass 280g)

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Application

- Measurement of the three cutting forces F_c, F_f, F_p while turning outside and inside diameters on lathes with turret-type tool heads

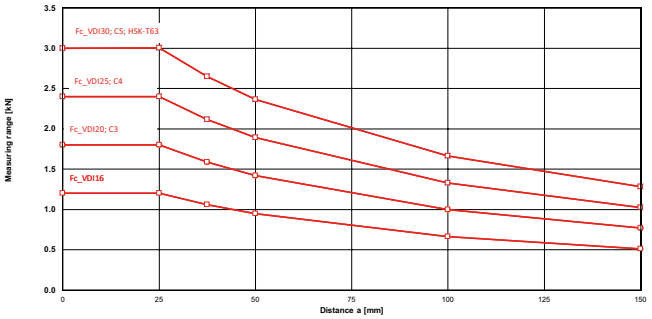


Fig. 9: Max. measuring range of F_c (F_y) of Type 9119AA2 measuring system for various machine adapters as a function of distance a (all forces can occur simultaneously)

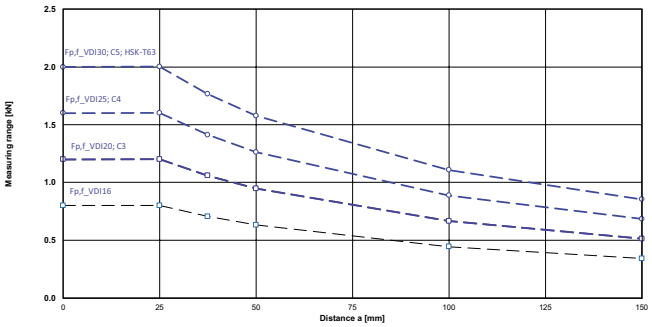


Fig. 10: Max. measuring ranges of F_P (F_x) and F_f (F_z) of Type 9119AA2 measuring system for various machine adapters as a function of distance a (all forces can occur simultaneously)

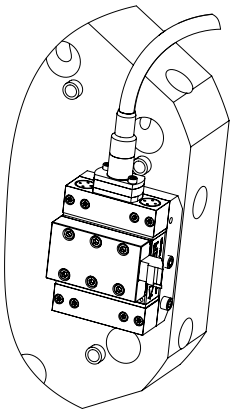
Mounting

The dynamometer is mounted on the tool holding fixture of the disk-type turret using a machine adapter. AMachine adapters for current tool holding fixture systems are offered as accessories. The tool adapter mounted on the mounting plate of the dynamometer accepts the desired lathe tool. Tool adaptersfor current sizes of external and internal turning tools are available. On inclined bed machines with two turret disks, the measuring system can be mounted above as well as below the workpiece. To mount the measuring system with radial or axial tool holders on disk-type turret there are available straight, left and right machine adapters to suit dynamometer Type 9119AA2. The measuring system components are designed so that the position of the cutting angle always lies at the height of the axis of rotation (workpiece center) regardless of the mounting orientation.

Typical design variants

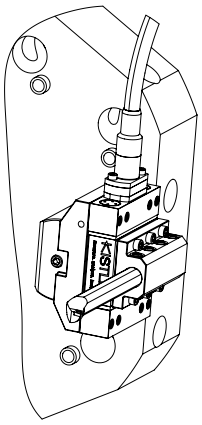
Example 1

Axially mounted dynamometer Type 9119AA2 or turning the outside diameter with machine adapter Type 9119AB30S (VDI tool holding fixture) and tool holder Type 9119AE16.



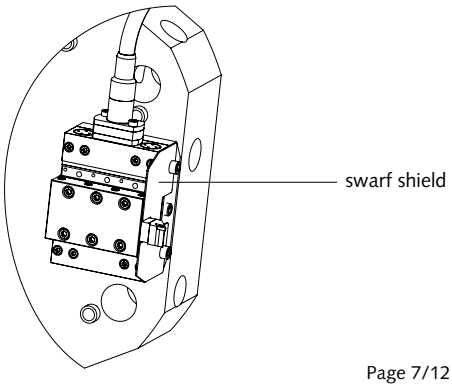
Example 2

Radially mounted dynamometer Type 9119AA2 for turning the inside diameter with machine adapter Type 9119AB30R (VDI tool holding fixture) and tool holder for boring bars Type 9119AF16.



Example 3

As example 1 but with additional swarf shield mounted.



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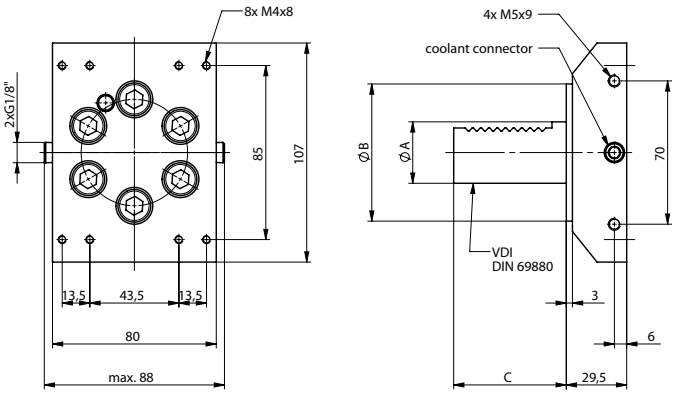
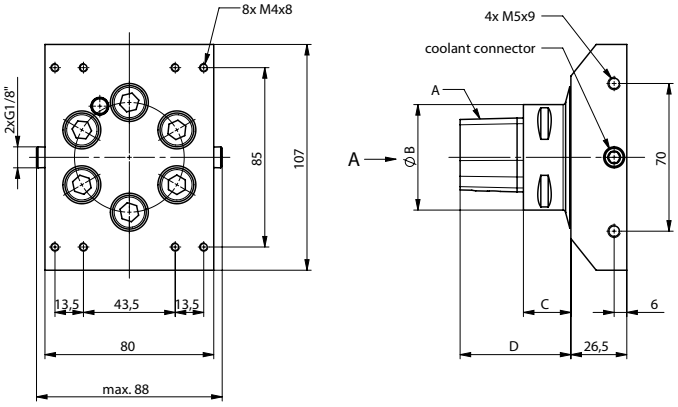


Type	A	øB [mm]	C [mm]
9119AB16S	VDI 16	43	32
9119AB20S	VDI 20	57	40
9119AB25S	VDI 25	57	48
9119AB30S	VDI 30	67	55

Fig. 11: Machine adapter with straight shank for disk-type turret with VDI tool holding fixture, Type 9119AB...S

Dimensions of machine adapters with VDI interface, configuration left/right are given in partcommunity:
http://kistler.partcommunity.com



Type	A [Capto Type]	øB [mm]	C [mm]	D [mm]
9119AC3S	C3	32	20	39
9119AC4S	C4	40	24	48
9119AC5S	C5	50	22,5	52,5

Fig. 12: Machine adapter with Capto C... for disk-type turret with Coromant-Capto clamping unit, Type 9119AC...S

Dimensions of machine adapters with Capto interface, configuration left/right are given in partcommunity:
http://kistler.partcommunity.com

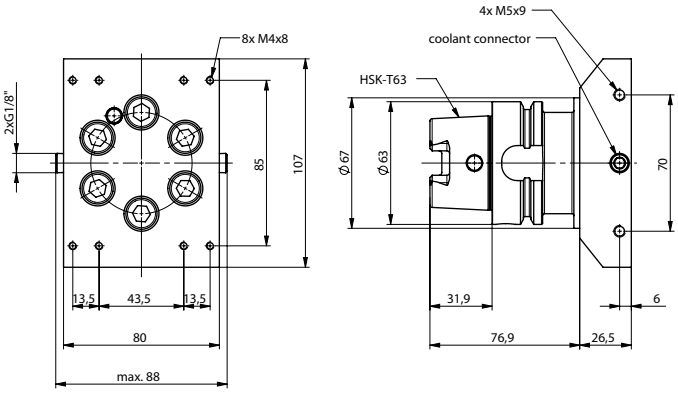


Fig. 13: Machine adapter with HSK-T63 for disk-type turret with HSK-T clamping unit, Type 9119AH63S

Dimensions of machine adapters with HSK-T interface, configuration left/right are given in partcommunity:
http://kistler.partcommunity.com

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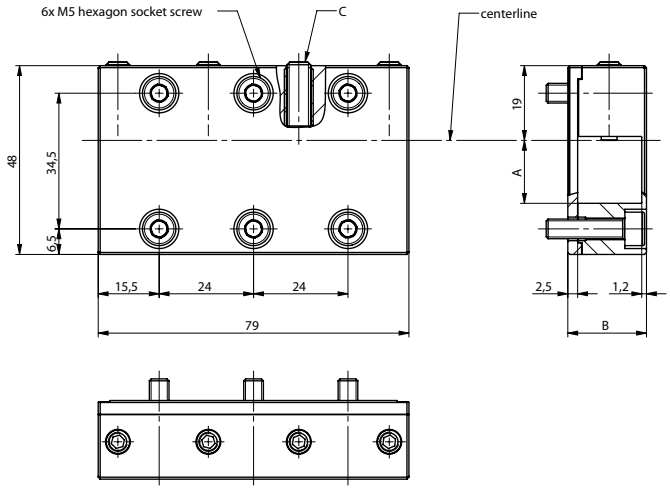
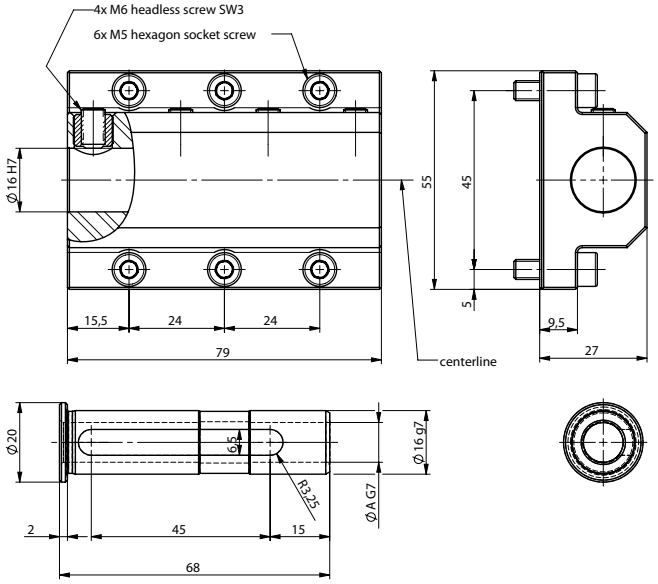


Type	A [mm]	B [mm]	C [mm]
9119AE08	8	12	M5x20
9119AE10	10	14	M5x20
9119AE12	12	16	M6x20
9119AE16	16	20	M6x20
9119AE20	20	29	M6x20
Type	**A [inch]**	**B [mm]**	**C [mm]**
9119AE0,31	0,31	12	M5x20
9119AE0,38	0,38	14	M5x20
9119AE0,50	0,50	16	M6x20
9119AE0,63	0,63	20	M6x20

Fig. 14: Tool holder for lathe chisel for axially mounted dynamometer, Type 9119AE...



øA [mm]	Reducing bushing	Article No.	Weight bushing [g]	Weight [g]
16	none	–	0	≈230
12	ø16/12	55061003	15	≈245
10	ø16/10	55061002	20	≈250
8	ø16/8	55060544	25	≈255

Fig. 15: Tool holder for boring bars up to ø16 mm with reducing bushings ø16/12 mm, ø16/10, ø16/8 mm, Type 9119AF16

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Measuring system components

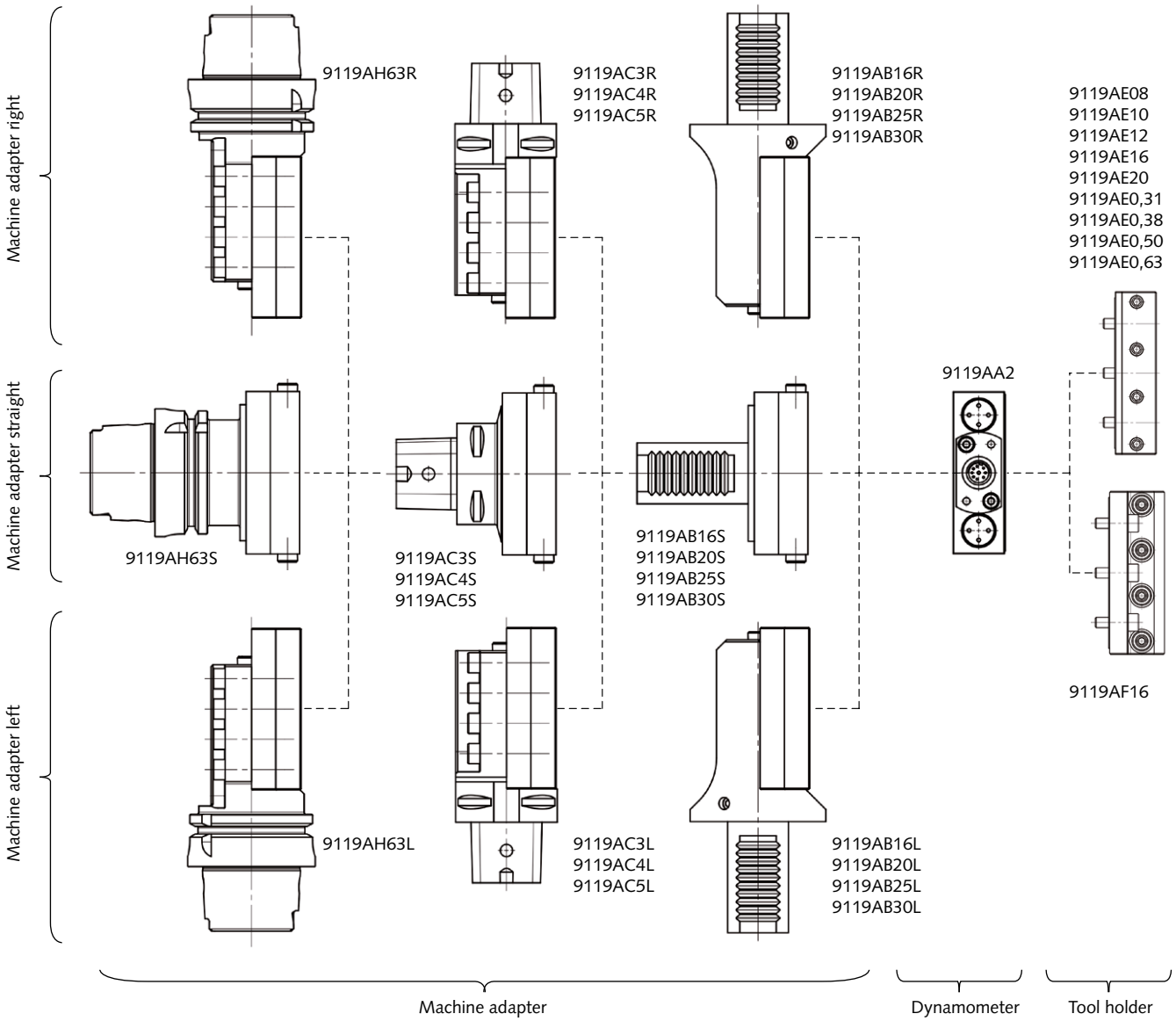

Fig. 16: Configuration of standard components

9119AA2_003-055e-07.18

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Ordering code	Type/Art. No.
• Multicomponent dynamometer up to 4 kN, cover plate 55x80 mm	**9119AA2**

Included accessories

• Mounting screws M4x25 (8 pieces)	65012704

Machine adapter with straight shank VDI

• Machine adapter with straight shank for disk-type turret with VDI tool holding fixture (DIN 69880) for Type 9119AA2

9119AB ☐☐

Dimensions VDI adapter

Shank diameter 16 mm	**16**
Shank diameter 20 mm	**20**
Shank diameter 25 mm	**25**
Shank diameter 30 mm	**30**

Configuration

Straight design	**S**
Left design	**L**
Right design	**R**

Machine adapter with Capto

• Machine adapter with Capto for disk-type turret with Coromant-Capto tool holding fixture (ISO 26623) for Type 9119AA2

9119AC ☐☐

Dimensions Capto

Size C3	**3**
Size C4	**4**
Size C5	**5**

Configuration

Straight design	**S**
Left design	**L**
Right design	**R**

Tool holder for lathe chisel (metric)

• Tool holder for lathe chisel with square shaft for Type 9119AA2

9119AE ☐

Dimensions lathe chisel shaft

8x8 mm	**08**
10x10 mm	**10**
12x12 mm	**12**
16x16 mm	**16**
20x20 mm	**20**

Included accessories

• Mounting screws (6 pieces)

Tool holder for lathe chisel (imperial)

• Tool holder for lathe chisel with square shaft for Type 9119AA2

9119AE0, ☐

Dimensions lathe chisel shaft

0,31x0,31"	**31**
0,38x0,38"	**38**
0,50x0,50"	**50**
0,63x0,63"	**63**

Included accessories

• Mounting screws (6 pieces)

Tool holder for boring bars (metric)

• Tool holder for boring bars with round shaft for Type 9119AA2 **9119AF16**

Included accessories

• Mounting screws M5x16 (6 pieces)	65012895
• Reducing bushing ø16/12	55061003
• Reducing bushing ø16/10	55061002
• Reducing bushing ø16/8	55060544

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Machine adapter with tapered hollow shank HSK-T

- Machine adapter with tapered hollow shank for disk-type turret with HSK-T tool holding fixture (ISO 12164-3/4) for Type 9119AA2

9119AH ☐☐

Dimensions HSK-T adapter

HSK-T63	**63**

Configuration

Straight design	**S**
Left design	**L**
Right design	**R**

Other machine adapters and tool holders on request.

Optional accessories	Type/Art. No.
For 3-component force measurement F_x, F_y, F_z	
• Connecting cable, 3 wire, with flexible metal sheath (L = 5 m)	**1687B5**
• Connecting cable, 3 wire, steel braided, flexibel (L = 5 m)	**1687BQ02**
• Extension cable, 3 wire, high insulation (L = 5 m)	**1688B5**
• Connecting cable, 3 wire, with flexible metal sheath and angle connector (L = 5 m)	**1689B5**
For 6-component force and moment measurement F_x, F_y, F_z / M_x, M_y, M_z	
• Connecting cable, 8 wire, with flexible metal sheath (L = 5 m)	**1677A5**
• Connecting cable, 8 wire, with steel braided, flexibel (L = 5 m)	**1677AQ02**
• Extension cable, 8 wire, high insulation (L = 5 m)	**1678A5**
• Connecting cable, 8 wire, with flexible metal sheath and angle connector (L = 5 m)	**1679A5**

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