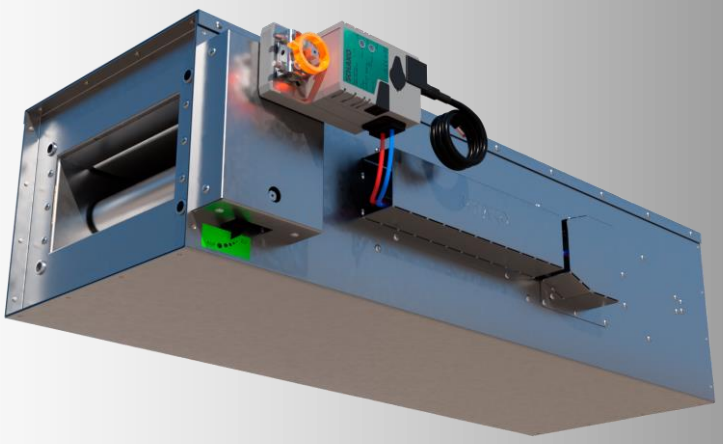
TECHNICAL DOCUMENTATION



PIANO

Sound-damped volumetric flow controller

SPECIAL FEATURES

- Compact dimensions and low height
- Integrated high-performance silencer
- High precision, easy mode of operation and reliable control
- Optimised for low-speed systems
- Low pressure losses
- Significant savings in operating costs during installation
- Low mounting and maintenance expenditure
- Direct connection to rectangular ducts according to DIN EN 1505 without transition pieces
- Installation in pipes according to DIN EN 1506 via US-R transition piece

PERFORMANCE DATA AND FIELD OF APPLICATION

- Ambient temperature range from 0 °C to 50 °C
- Differential pressure range from 50 Pa to 1000 Pa
- Air velocity in duct from 0.7 m/s to 6.5 m/s
- Volumetric flow measurement range from 50 m³/h to 4680 m³/h
- Controller connection voltage 24 V AC/DC @ 50/60 Hz
- Controller control signal 0…10 V DC or 2…10 V DC
- For supply and return air systems
- For constant or variable volumetric flows
- Positive control V_{min}, V_{max}, or "CLOSED"

Suitable for constant and variable volumetric flow control, room and duct pressure control

TESTS AND STANDARDS

- **VDI 6022:** Hygienic requirements of ventilation and air-conditioning systems
- **DIN EN 13779**: Ventilation of non-residential buildings
- **DIN EN 1751:** Leakage air

APPROVALS AND CERTIFICATES

- RoHS 2011/65/EG
- EMC 2014/30/EC
- Low voltage (LVD) 2014/35/EC

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DESCRIPTION

The sound-damped volumetric flow controller PIANO in rectangular design is suitable for use in supply or return air systems for constant and variable volumetric flows at high acoustic requirements. The aim is to meet the air flow requirements in this type of system, where low air velocity and low noise levels are required.

The housing is made of galvanised steel with thermo-acoustic insulation and hygienic mineral wool according to VDI 6022 with an integrated silencer section, as well as a damper made of extruded aluminium profile with an EPDM seal and aerodynamically optimised aluminium differential pressure measuring profile.

The PIANO meets the most stringent tightness requirement as defined by DIN EN 1751. Housing leakage, class C and damper leaf leakage, class 4.

The PIANO sound-damped volumetric flow controller with rectangular connection can be connected to rectangular ducts without special connection elements according to DIN EN 1505 or to spiral ducts according to DIN EN 1506 via a transition piece (US-R).

The PIANO sound-damped volumetric flow controller can already be used at a static pressure difference of as little as 50 Pa in the duct network, i.e., the duct network and the fan can be designed for low air velocities. This makes the PIANO suitable for use in low-pressure systems. Due to the minimal pressure loss, the running operating costs of the ventilation system are also reduced.

To further reduce the flow noise, the PIANO-S type can be used, which has an extended silencer unit with higher efficiency. Therefore, no additional silencer is required. The radiated noise can be reduced further by providing the VAS with an acoustic cladding (-FD1) at an extra charge.

The air flow is regulated by means of an integrated electronic controller.

The PIANO series consists of 8 nominal widths covering a wide range of volumetric flows.

FUNCTION

The integrated volumetric flow controller allows the volumetric flow in ducts to be kept constant or variable or to be regulated using positive control V_{min}, V_{max} or "CLOSED". It can also be used for controlling room or duct pressure. In VAV systems, the integrated PIANO volumetric flow controller can regulate variable volumetric flows between V_{min} and V_{max} as a function of the supply air temperature. A controller compares this value with the setpoint, and the signal of the drive is adjusted, depending on how much it deviates. The actual value can be measured via the output signal.

Setpoints are initially set ex works. During this in-factory setting, the functions of all sound-damped volumetric flow controllers are checked. The volumetric flow setpoints V_{min} and V_{max} can also be altered at the controller at a later stage, even after installation.

The maximum deviation of the volumetric flows is ±5 %, relative to the nominal volumetric flow V_{nenn}.

CONSTRUCTION

Housing
Made of galvanised sheet steel, lined with mineral wool, with thermo-acoustic insulation, hygienically tested according to VDI 6022.

Damper leaves
Aluminium profile of aerodynamic design for low pressure loss. Fitted with an EPDM seal in an aluminium profile of high resistance to deformation and high temperatures.

Measuring profiles
Aerodynamically optimised aluminium profiles.

Gear wheel segments
Made of steel, external, arranged on one side, covered.

MODEL

PIANO

-K	Compact model (standard)
-S	Extended model
-10	Nominal width 10
-20	Nominal width 20
-30	Nominal width 30
-40	Nominal width 40
-50	Nominal width 50
-60	Nominal width 60
-70	Nominal width 70
-80	Nominal width 80
-Z	Supply air (standard)
-A	Return air

ATTACHMENT ASSEMBLY

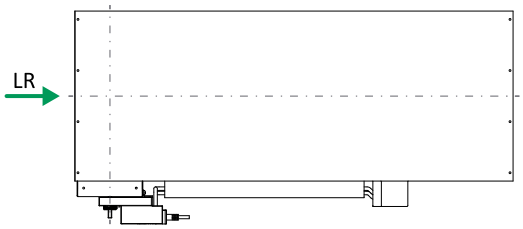
-A008	NMV-D3-MF Compact (standard for NW 10…40)
-A005	SMV-D3-MP Compact (standard for NW 50…80)
-A143	VRU-D3-BAC and NM24A-VST (for NW 10…40)
-A149	VRU-D3-BAC and SF24A-VST (for NW 50…80)
-A151	VRU-M1-BAC and NM24A-VST (for NW 10…40)
-A157	VRU-M1-BAC and SF24A-VST (for NW 50…80)
-0	Mode 0…10 V
-2	Mode 2…10 V (standard)
-0000	Factory-set according to Table (standard)
-xxxx	4-digit value in m³/h
-NA	No spring return actuator (standard)
-NO	Currentless OPEN – normally open (only for actuators with spring return)
-NC	Currentless CLOSED – normally closed (only for drives with spring return)

ADDITIONAL ELEMENTS

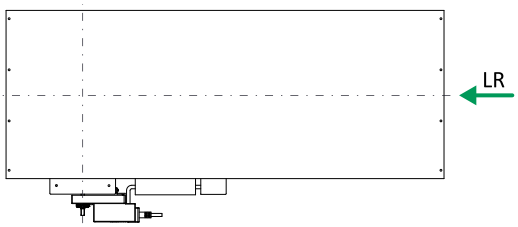
-FD1	With flat-bed acoustic cladding
-H2	Heating register with 2 rows of pipes
-H4	Heating register with 4 rows of pipes

Operating side

Supply air, standard operating side, top view

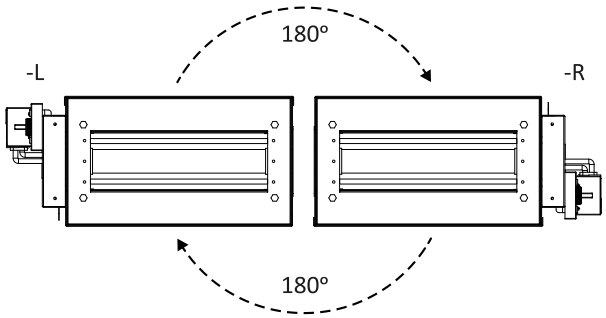


Return air, standard operating side, top view



LR = Air flow direction

NOTE
The device has a symmetrical design and can therefore be installed upside down if you want to mount the attachment assembly on the other side.

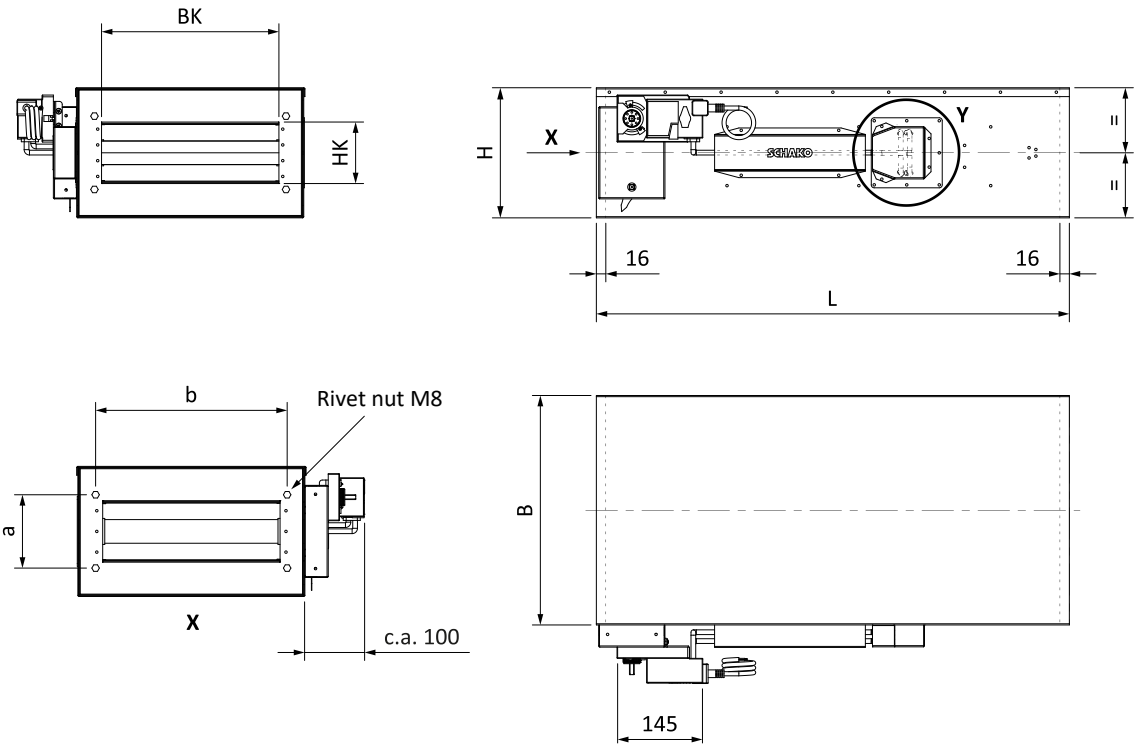


ACCESSORIES

TRANSITION PIECE (US)

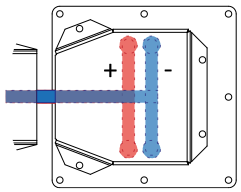
-E	For rectangular ducts
-R	For ductwork
-GD1	With rubber lip seal

DIMENSIONS

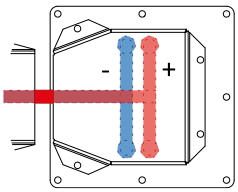


Detail Y

Supply air



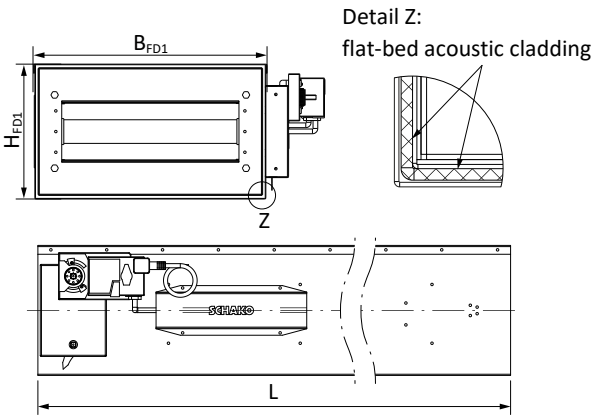
Return air



NW	L (mm)		B	H	b	a	BK	HK	FQ	Weight (kg)	
	-K	-S	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m²)	-K	-S
10	800	1250	280	220	224	124	200	100	0.02	17	22
20	800	1250	380	220	324	124	300	100	0.03	21	27
30	1000	1450	380	270	324	174	300	150	0.05	26	34
40	1000	1450	580	270	524	174	500	150	0.08	35	47
50	1000	1450	880	270	824	174	800	150	0.12	48	63
60	1250	2000	480	370	424	274	400	250	0.10	46	65
70	1250	2000	680	370	624	274	600	250	0.15	60	84
80	1250	2000	880	370	824	274	800	250	0.20	73	100

DIMENSIONS OF ACCESSORIES

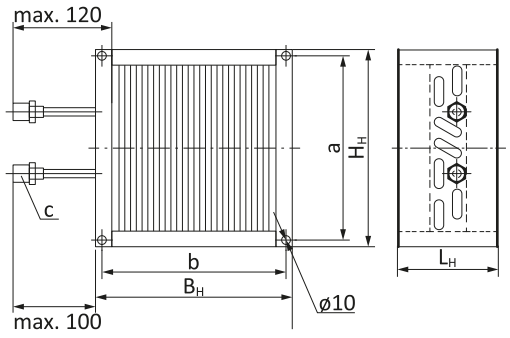
FLAT-BED ACOUSTIC CLADDING (-FD1)



NW	L (mm)		B_{FD1}	H_{FD1}	Weight (kg)*	
	(-K)	(-S)	(mm)	(mm)	(-K)	(-S)
10	800	1250	286	226	26	33
20	800	1250	386	226	31	40
30	1000	1450	386	276	40	51
40	1000	1450	586	276	53	70
50	1000	1450	886	276	72	95
60	1250	2000	486	376	69	97
70	1250	2000	686	376	89	125
80	1250	2000	886	376	108	147

* Total weight of the device including flat-bed acoustic cladding (-FD1)

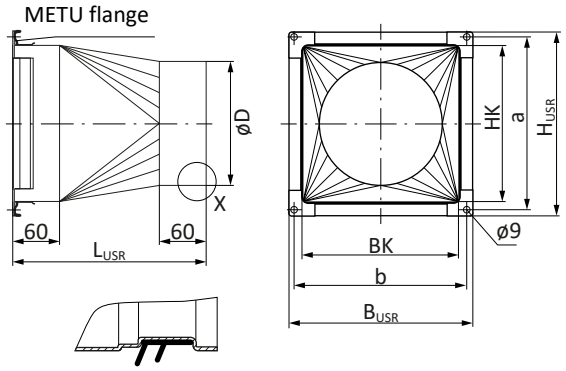
HEATING REGISTER (-H2/-H4)



NW	L_H (mm)		B_H	H_H	a	b
	(-H2)	(-H4)	(mm)	(mm)	(mm)	(mm)
10	120	180	240	140	124	224
20	120	180	340	140	124	324
30	120	180	340	190	174	324
40	120	180	540	190	174	524
50	120	180	840	190	174	824
60	120	180	440	290	274	424
70	120	180	640	290	274	624
80	120	180	840	290	274	824

TRANSITION PIECE (US)

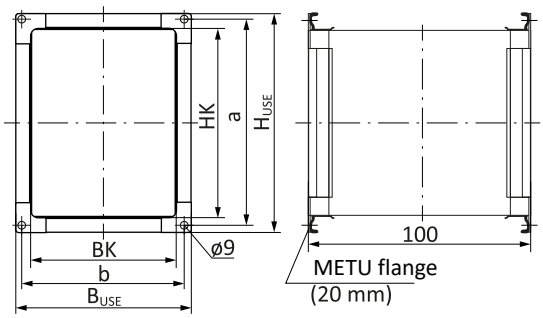
For ductwork (US-R)



Detail X: rubber lip seal

NW	L_{USR} (mm)	B_{USR} (mm)	H_{USR} (mm)	øD (mm)	a (mm)	b (mm)
10	250	240	140	160	124	224
20	250	340	140	200	124	324
30	250	340	190	250	174	324
40	400	540	190	315	174	524
50	750	840	190	400	174	824
60	250	440	290	400	274	424
70	350	640	290	500	274	624
80	600	840	290	500	274	824

For rectangular ducts (US-E)



NW	B_{USE} (mm)	H_{USE} (mm)	a (mm)	b (mm)
10	240	140	224	124
20	340	140	324	124
30	340	190	324	174
40	540	190	524	174
50	840	190	824	174
60	440	290	424	274
70	640	290	624	274
80	840	290	824	274

TECHNICAL DATA

VOLUMETRIC FLOW RANGE

NW	**V** (m³/h) [l/s]	
	v_k = 0.7 m/s (min.)	**v_k = 6.5 m/s (max.)**
10	50 [14]	468 [130]
20	76 [21]	702 [195]
30	113 [32]	1053 [293]
40	189 [53]	1755 [488]
50	302 [84]	2808 [780]
60	252 [70]	2340 [650]
70	378 [105]	3510 [975]
80	504 [140]	4680 [1300]

NOTE
Attention, the following specifications are important for programming the volumetric flow controllers:

- this table merely specifies the complete measuring range of the controller (volumetric flow range)
- The calibration curve corresponds to the maximum volumetric flow at 6.5 m/s. If the customer requires a different calibration curve, this must first be checked before approval!
- When the air volume drops below the V_{min} shown in the chart, the correct functioning of the volumetric flow controller is no longer guaranteed!
- If only one air volume is specified in the order (as V_{max} value), the volumetric flow controller will be delivered as variable volumetric flow controller. The V_{min} value will be set to the value specified in the catalogue.
- If only one air volume is specified in the order (as V_{min} or $V_{konstant}$ value or without value specification), then the volumetric flow controller will be delivered as a constant volumetric flow controller. The volume specified in the order is set to the V_{min} value, and the V_{max} value is set to 100%.
- The air volumes can be changed using setting devices specific for the controller make, depending on the calibration curve set ex works.
- For the parameter setting of the control components (all controllers), an air density of 1.2 kg/m³ has been taken into account.
- Belimo compact controllers are height-compensated. They are calibrated ex works to the specific system elevation of the specified installation site.
- If no system height is given in the order, the controllers will be set to the elevation of the delivery address.
- If no volumetric flows are specified, they will be set to the values in the table.

STATIC MINIMUM PRESSURE DIFFERENCE

NW	v_k (m/s)	**V** (m³/h) [l/s]	$\Delta p_{t\,min}$ (Pa)	
			PIANO-Z	PIANO-A
10	0.7	50 [14]	1	1
	2.6	187 [52]	12	4
	4.6	331 [92]	37	14
	6.5	468 [130]	73	28
20	0.7	76 [21]	1	1
	2.6	281 [78]	8	4
	4.6	497 [138]	25	14
	6.5	702 [195]	50	27
30	0.7	113 [32]	1	1
	2.6	421 [117]	6	3
	4.6	745 [207]	19	11
	6.5	1053 [293]	38	22
40	0.7	189 [53]	1	1
	2.6	702 [195]	6	3
	4.6	1242 [345]	19	11
	6.5	1755 [488]	38	21
50	0.7	302 [84]	1	1
	2.6	1123 [312]	6	3
	4.6	1987 [552]	18	9
	6.5	2808 [780]	35	18
60	0.7	252 [70]	1	1
	2.6	936 [260]	7	5
	4.6	1656 [460]	21	15
	6.5	2340 [650]	42	30
70	0.7	378 [105]	1	1
	2.6	1404 [390]	7	5
	4.6	2484 [690]	22	14
	6.5	3510 [975]	43	29
80	0.7	504 [140]	1	1
	2.6	1872 [520]	7	4
	4.6	3312 [920]	21	12
	6.5	4680 [1300]	41	24

FLOW GENERATED NOISE

PIANO-K-Z (compact model, supply air)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	25	<	<	<	<	<	<	<	**<**	31	<	<	<	<	<	<	<	**<**	27	17	15	<	<	<	<	<	**<**
	2.6	187	52	37	20	21	<	<	<	<	<	**18**	39	31	30	18	<	<	<	<	**24**	41	34	33	21	18	<	<	<	**27**
	4.6	331	92	36	25	29	23	19	<	<	<	**25**	40	36	37	27	23	15	<	<	**31**	42	40	40	29	24	16	<	<	**34**
	6.5	468	130	28	23	29	28	27	19	15	<	**30**	40	36	40	32	30	25	21	<	**36**	43	42	44	34	31	26	22	16	**38**
20	0.7	76	21	42	20	16	<	<	<	<	<	**19**	42	20	19	<	<	<	<	<	**20**	34	23	22	<	<	<	<	<	**19**
	2.6	281	78	40	23	24	<	<	<	<	<	**21**	40	31	30	19	15	<	<	<	**25**	41	35	34	22	19	<	<	<	**28**
	4.6	497	138	39	28	32	26	22	<	<	<	**28**	40	36	37	27	23	16	<	<	**32**	42	41	41	29	25	16	<	<	**35**
	6.5	702	195	35	30	36	35	33	26	21	15	**37**	42	38	42	34	32	27	22	16	**37**	44	43	45	35	32	27	23	17	**40**
30	0.7	113	32	22	<	<	<	<	<	<	<	**<**	31	15	15	<	<	<	<	<	**<**	33	20	19	<	<	<	<	<	**15**
	2.6	421	117	37	29	25	15	<	<	<	<	**21**	40	36	34	22	<	<	<	<	**27**	40	39	37	25	16	<	<	<	**31**
	4.6	745	207	37	35	33	26	19	<	<	<	**28**	44	42	41	29	22	16	<	<	**34**	45	45	44	32	24	17	<	<	**37**
	6.5	1053	293	36	36	37	31	27	23	20	<	**34**	47	44	44	36	29	25	22	17	**39**	49	48	48	38	30	26	23	19	**42**
40	0.7	189	53	24	<	<	<	<	<	<	<	**<**	33	18	17	<	<	<	<	<	**<**	35	22	21	<	<	<	<	<	**18**
	2.6	702	195	39	32	28	17	<	<	<	<	**23**	42	39	36	24	15	<	<	<	**30**	43	41	39	27	18	<	<	<	**33**
	4.6	1242	345	39	37	35	28	21	16	<	<	**31**	46	44	43	32	24	18	<	<	**37**	47	47	46	35	26	19	15	<	**40**
	6.5	1755	488	38	38	39	33	29	25	22	15	**36**	50	46	46	38	31	27	24	20	**41**	51	50	50	40	32	28	25	21	**44**
50	0.7	302	84	32	19	18	<	<	<	<	<	**16**	39	23	23	19	<	<	<	<	**20**	40	27	26	18	18	<	<	<	**22**
	2.6	1123	312	39	31	27	17	<	<	<	<	**23**	41	38	36	23	15	<	<	<	**29**	43	42	39	28	18	<	<	<	**33**
	4.6	1987	552	40	37	35	28	22	16	<	<	**31**	47	45	44	32	25	19	15	<	**37**	48	49	47	36	27	21	16	15	**41**
	6.5	2808	780	40	40	41	35	31	27	23	17	**37**	51	47	48	39	33	29	26	21	**42**	53	52	52	42	34	30	27	23	**46**
60	0.7	252	70	31	18	<	<	<	<	<	<	**<**	34	24	20	<	<	<	<	<	**16**	35	28	23	<	<	<	<	<	**19**
	2.6	936	260	40	35	28	19	15	<	<	<	**25**	43	43	36	24	19	<	<	<	**31**	45	46	40	27	20	<	<	16	**34**
	4.6	1656	460	43	40	36	27	25	19	16	<	**32**	46	47	43	32	28	21	18	16	**38**	50	51	47	35	29	22	19	20	**41**
	6.5	2340	650	49	43	37	31	31	29	27	22	**37**	49	49	47	38	34	31	29	26	**42**	52	52	50	41	36	32	31	28	**45**
70	0.7	378	105	33	20	<	<	<	<	<	<	**<**	36	26	22	<	<	<	<	<	**18**	37	30	25	16	<	<	<	<	**21**
	2.6	1404	390	42	37	30	21	18	<	<	<	**27**	45	45	38	26	21	<	<	<	**33**	48	48	42	29	22	<	<	18	**36**
	4.6	2484	690	45	42	38	29	27	21	18	<	**34**	49	49	45	34	30	24	21	18	**40**	52	53	49	37	31	25	21	22	**43**
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80	0.7	504	140	42	29	19	<	<	<	<	<	**20**	42	32	28	18	<	<	<	<	**24**	42	35	30	20	<	<	<	15	**26**
	2.6	1872	520	43	38	31	21	18	<	<	<	**27**	45	45	39	26	21	<	<	<	**34**	49	49	43	30	23	<	<	19	**37**
	4.6	3312	920	47	44	40	31	29	23	19	<	**36**	50	51	47	36	32	25	22	20	**42**	54	55	51	39	33	26	23	24	**45**
	6.5	4680	1300	52	47	40	35	35	33	31	26	**41**	55	54	52	43	39	36	35	32	**48**	57	57	55	46	41	37	36	33	**50**

< = Values below 15 dB

PIANO-K-A (compact model, return air)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	32	<	<	<	<	<	<	<	**<**	39	16	<	<	<	<	<	<	**15**	40	15	<	<	<	<	<	<	**16**
	2.6	187	52	35	16	<	<	<	<	<	<	**<**	40	28	27	20	<	<	<	<	**23**	41	31	32	24	16	<	<	<	**27**
	4.6	331	92	39	20	22	15	<	<	<	<	**19**	40	28	27	19	<	<	<	<	**22**	40	32	33	25	<	<	<	<	**27**
	6.5	468	130	42	26	27	23	18	<	<	<	**25**	42	30	29	23	18	<	<	<	**26**	40	33	32	24	17	<	<	<	**27**
20	0.7	76	21	41	16	16	<	<	<	<	<	**19**	43	20	15	<	<	<	<	<	**19**	41	16	<	<	<	<	<	<	**18**
	2.6	281	78	42	23	20	<	<	<	<	<	**20**	42	30	29	22	<	<	<	<	**25**	42	32	34	25	17	<	<	<	**28**
	4.6	497	138	42	24	25	18	<	<	<	<	**22**	43	31	30	22	<	<	<	<	**25**	42	34	35	27	16	<	<	<	**29**
	6.5	702	195	43	27	28	24	19	<	<	<	**26**	43	31	30	24	19	<	<	<	**27**	43	35	34	26	19	<	<	<	**29**
30	0.7	113	32	40	21	20	<	<	<	<	<	**19**	41	23	19	<	<	<	<	<	**19**	39	22	20	<	<	<	<	<	**19**
	2.6	421	117	40	25	20	<	<	<	<	<	**19**	40	34	33	20	<	<	<	<	**26**	41	38	38	25	22	<	<	<	**31**
	4.6	745	207	41	25	24	15	<	<	<	<	**22**	41	33	30	20	<	<	<	<	**25**	41	37	36	24	17	<	<	<	**30**
	6.5	1053	293	40	28	31	24	18	<	<	<	**27**	41	33	31	25	18	<	<	<	**27**	42	38	35	26	20	<	<	<	**30**
40	0.7	189	53	36	23	21	<	<	<	<	<	**16**	39	21	23	<	<	<	<	<	**18**	43	24	23	15	19	<	<	<	**21**
	2.6	702	195	37	25	21	<	<	<	<	<	**17**	39	37	33	19	17	<	<	<	**27**	39	40	38	23	23	<	<	<	**32**
	4.6	1242	345	41	28	27	19	<	<	<	<	**24**	41	38	32	21	16	<	<	<	**27**	40	40	38	24	20	<	<	<	**32**
	6.5	1755	488	39	32	33	27	23	<	<	15	**29**	41	39	34	27	23	<	<	15	**30**	40	40	37	26	22	<	<	<	**32**
50	0.7	302	84	42	30	27	<	<	<	<	<	**22**	41	23	25	15	<	<	<	<	**20**	39	21	19	<	15	<	<	<	**18**
	2.6	1123	312	40	28	23	<	<	<	<	<	**20**	41	39	35	21	19	<	<	<	**29**	42	43	41	26	26	<	<	<	**35**
	4.6	1987	552	41	28	27	19	<	<	<	<	**24**	42	39	33	23	18	<	<	<	**29**	43	43	41	27	23	<	<	<	**35**
	6.5	2808	780	40	33	34	28	24	15	15	16	**31**	42	40	35	28	24	15	15	16	**32**	43	43	40	29	25	<	<	16	**34**
60	0.7	252	70	33	23	18	<	<	<	<	<	**<**	38	26	23	15	<	<	<	<	**19**	39	29	23	18	<	<	<	<	**21**
	2.6	936	260	38	26	21	<	<	<	<	<	**19**	43	41	31	23	<	<	<	<	**28**	43	44	36	27	17	<	<	<	**32**
	4.6	1656	460	39	29	27	23	15	<	<	<	**25**	44	36	31	25	16	<	<	<	**28**	47	45	36	28	19	<	<	<	**33**
	6.5	2340	650	44	35	32	29	23	15	18	17	**30**	46	36	33	30	24	16	19	17	**31**	47	41	34	30	25	16	19	18	**32**
70	0.7	378	105	35	24	20	<	<	<	<	<	**15**	39	28	24	16	<	<	<	<	**21**	41	30	25	19	<	<	<	<	**22**
	2.6	1404	390	40	27	22	<	<	<	<	<	**20**	44	42	32	24	<	<	<	<	**29**	44	46	37	28	18	<	<	<	**33**
	4.6	2484	690	40	30	29	24	16	<	<	<	**26**	45	37	32	27	18	<	<	<	**29**	48	46	37	30	20	<	15	<	**34**
	6.5	3510	975	45	36	33	30	25	17	19	18	**32**	47	38	34	31	25	17	20	19	**32**	48	42	36	32	26	18	20	19	**34**
80	0.7	504	140	42	31	27	<	<	<	<	<	**22**	41	30	26	18	<	<	<	<	**23**	42	32	26	20	<	<	<	<	**24**
	2.6	1872	520	41	29	23	<	<	<	<	<	**21**	43	41	31	23	<	<	<	<	**28**	45	47	38	30	20	<	<	<	**34**
	4.6	3312	920	42	32	31	26	18	<	15	<	**28**	45	37	32	27	18	<	15	<	**29**	47	45	36	29	19	<	15	<	**33**
	6.5	4680	1300	50	40	37	34	29	21	23	22	**36**	50	41	37	34	28	20	23	22	**36**	51	45	39	35	29	21	23	22	**37**

< = Values below 15 dB

PIANO-S-Z (extended model, supply air)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	25	<	<	<	<	<	<	<	**<**	31	<	<	<	<	<	<	<	**<**	27	16	<	<	<	<	<	<	**<**
	2.6	187	52	37	19	17	<	<	<	<	<	**<**	39	30	26	<	<	<	<	<	**20**	41	33	29	<	<	<	<	<	**23**
	4.6	331	92	36	24	25	<	<	<	<	<	**19**	40	35	33	18	<	<	<	<	**26**	42	39	36	20	<	<	<	<	**30**
	6.5	468	130	28	22	25	19	<	<	<	<	**20**	40	35	36	23	15	<	<	<	**29**	43	41	40	25	16	<	<	<	**33**
20	0.7	76	21	42	19	<	<	<	<	<	<	**17**	42	19	15	<	<	<	<	<	**17**	34	22	18	<	<	<	<	<	**<**
	2.6	281	78	40	22	20	<	<	<	<	<	**17**	40	30	26	<	<	<	<	<	**21**	41	34	30	<	<	<	<	<	**24**
	4.6	497	138	39	27	28	17	<	<	<	<	**22**	40	35	33	18	<	<	<	<	**27**	42	40	37	20	<	<	<	<	**31**
	6.5	702	195	35	29	32	26	20	<	<	<	**28**	42	37	38	25	19	<	<	<	**32**	44	42	41	26	19	<	<	<	**34**
30	0.7	113	32	22	<	<	<	<	<	<	<	**<**	31	<	<	<	<	<	<	<	**<**	33	19	15	<	<	<	<	<	**<**
	2.6	421	117	37	28	21	<	<	<	<	<	**17**	40	35	30	<	<	<	<	<	**24**	40	38	33	17	<	<	<	<	**27**
	4.6	745	207	37	34	29	18	<	<	<	<	**23**	44	41	37	21	<	<	<	<	**31**	45	44	40	24	<	<	<	<	**34**
	6.5	1053	293	36	35	33	23	<	<	<	<	**27**	47	43	40	28	17	<	<	<	**34**	49	47	44	30	18	<	<	<	**37**
40	0.7	189	53	24	<	<	<	<	<	<	<	**<**	33	17	<	<	<	<	<	<	**<**	35	21	17	<	<	<	<	<	**<**
	2.6	702	195	39	31	24	<	<	<	<	<	**20**	42	38	32	16	<	<	<	<	**26**	43	40	35	19	<	<	<	<	**29**
	4.6	1242	345	39	36	31	20	<	<	<	<	**25**	46	43	39	24	<	<	<	<	**33**	47	46	42	27	<	<	<	<	**36**
	6.5	1755	488	38	37	35	25	18	<	<	<	**29**	50	45	42	30	20	<	16	<	**36**	51	49	46	32	21	16	17	16	**39**
50	0.7	302	84	30	16	<	<	<	<	<	<	**<**	37	20	19	<	<	<	<	<	**16**	38	24	22	<	<	<	<	<	**17**
	2.6	1123	312	37	28	23	<	<	<	<	<	**18**	39	35	32	<	<	<	<	<	**25**	41	39	35	19	<	<	<	<	**28**
	4.6	1987	552	38	34	31	19	<	<	<	<	**25**	45	42	40	23	<	<	<	<	**33**	46	46	43	27	15	<	<	<	**36**
	6.5	2808	780	38	37	37	26	19	<	16	<	**31**	49	44	44	30	21	16	19	16	**37**	51	49	48	33	22	17	20	18	**41**
60	0.7	252	70	30	<	<	<	<	<	<	<	**<**	33	21	<	<	<	<	<	<	**<**	34	25	16	<	<	<	<	<	**<**
	2.6	936	260	39	32	21	<	<	<	<	<	**19**	42	40	29	<	<	<	<	<	**26**	44	43	33	<	<	<	<	<	**29**
	4.6	1656	460	42	37	29	<	<	<	<	<	**25**	45	44	36	20	<	<	<	<	**31**	49	48	40	23	<	<	<	<	**35**
	6.5	2340	650	48	40	30	19	<	<	<	<	**28**	48	46	40	26	18	<	16	18	**35**	51	49	43	29	20	<	18	20	**38**
70	0.7	378	105	32	16	<	<	<	<	<	<	**<**	35	22	15	<	<	<	<	<	**<**	36	26	18	<	<	<	<	<	**15**
	2.6	1404	390	41	33	23	<	<	<	<	<	**21**	44	41	31	<	<	<	<	<	**28**	47	44	35	18	<	<	<	<	**31**
	4.6	2484	690	44	38	31	18	<	<	<	<	**27**	48	45	38	23	<	<	<	<	**33**	51	49	42	26	16	<	<	<	**37**
	6.5	3510	975	50	41	32	22	19	<	17	16	**30**	51	47	42	29	21	17	20	20	**37**	53	50	46	32	23	18	21	23	**40**
80	0.7	504	140	41	26	<	<	<	<	<	<	**17**	41	29	22	<	<	<	<	<	**19**	41	32	24	<	<	<	<	<	**21**
	2.6	1872	520	42	35	25	<	<	<	<	<	**22**	44	42	33	16	<	<	<	<	**29**	48	46	37	20	<	<	<	<	**33**
	4.6	3312	920	46	41	34	21	<	<	<	<	**29**	49	48	41	26	18	<	<	<	**36**	53	52	45	29	19	<	<	16	**40**
	6.5	4680	1300	51	44	34	25	21	18	18	18	**32**	54	51	46	33	25	21	22	24	**40**	56	54	49	36	27	22	23	25	**43**

< = Values below 15 dB

PIANO-S-A (extended model, return air)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	32	<	<	<	<	<	<	<	**<**	39	15	<	<	<	<	<	<	**15**	40	<	<	<	<	<	<	<	**17**
	2.6	187	52	35	15	<	<	<	<	<	<	**<**	40	27	22	19	<	<	<	<	**21**	41	30	27	23	<	<	<	<	**24**
	4.6	331	92	39	19	17	<	<	<	<	<	**17**	40	27	22	18	<	<	<	<	**20**	40	31	28	24	<	<	<	<	**25**
	6.5	468	130	42	25	22	22	<	<	<	<	**23**	42	29	24	22	<	<	<	<	**24**	40	32	27	23	<	<	<	<	**25**
20	0.7	76	21	41	15	<	<	<	<	<	<	**18**	43	19	<	<	<	<	<	<	**19**	41	15	<	<	<	<	<	<	**19**
	2.6	281	78	42	22	16	<	<	<	<	<	**19**	42	29	25	21	<	<	<	<	**23**	42	31	30	24	<	<	<	<	**26**
	4.6	497	138	42	23	21	17	<	<	<	<	**21**	43	30	26	21	<	<	<	<	**24**	42	33	31	26	<	<	<	<	**27**
	6.5	702	195	43	26	24	23	16	<	<	<	**24**	43	30	26	23	16	<	<	<	**25**	43	34	30	25	16	<	<	<	**27**
30	0.7	113	32	40	20	16	<	<	<	<	<	**18**	41	22	<	<	<	<	<	<	**18**	39	21	16	<	<	<	<	<	**18**
	2.6	421	117	40	24	16	<	<	<	<	<	**18**	40	33	29	18	<	<	<	<	**24**	41	37	34	23	18	<	<	<	**28**
	4.6	745	207	41	24	20	<	<	<	<	<	**19**	41	32	26	18	<	<	<	<	**23**	41	36	32	22	<	<	<	<	**27**
	6.5	1053	293	40	27	27	22	<	<	<	<	**24**	41	32	27	23	<	<	<	<	**25**	42	37	31	24	16	<	<	<	**27**
40	0.7	189	53	36	22	17	<	<	<	<	<	**<**	39	20	19	<	<	<	<	<	**18**	43	23	19	<	15	<	<	<	**22**
	2.6	702	195	37	24	17	<	<	<	<	<	**16**	39	36	29	17	<	<	<	<	**24**	39	39	34	21	19	<	<	<	**28**
	4.6	1242	345	41	27	23	17	<	<	<	<	**21**	41	37	28	19	<	<	<	<	**25**	40	39	34	22	16	<	<	<	**28**
	6.5	1755	488	39	31	29	25	19	<	<	<	**27**	41	38	30	25	19	<	<	<	**28**	40	39	33	24	18	<	<	<	**28**
50	0.7	302	84	41	28	23	<	<	<	<	<	**20**	40	21	21	<	<	<	<	<	**19**	38	19	<	<	<	<	<	<	**17**
	2.6	1123	312	39	26	19	<	<	<	<	<	**18**	40	37	31	<	<	<	<	<	**26**	41	41	37	20	20	<	<	<	**30**
	4.6	1987	552	40	26	23	<	<	<	<	<	**20**	41	37	29	17	<	<	<	<	**25**	42	41	37	21	17	<	<	<	**30**
	6.5	2808	780	39	31	30	22	18	<	<	<	**26**	41	38	31	22	18	<	<	<	**27**	42	41	36	23	19	<	<	<	**30**
60	0.7	252	70	32	20	<	<	<	<	<	<	**<**	37	23	17	<	<	<	<	<	**16**	38	26	17	<	<	<	<	<	**17**
	2.6	936	260	37	23	<	<	<	<	<	<	**15**	42	38	25	17	<	<	<	<	**24**	42	41	30	21	<	<	<	<	**27**
	4.6	1656	460	38	26	21	17	<	<	<	<	**20**	43	33	25	19	<	<	<	<	**23**	46	42	30	22	<	<	<	<	**29**
	6.5	2340	650	43	32	26	23	16	<	16	<	**26**	45	33	27	24	17	<	17	<	**27**	46	38	28	24	18	<	17	16	**28**
70	0.7	378	105	34	21	<	<	<	<	<	<	**<**	38	25	18	<	<	<	<	<	**16**	40	27	19	<	<	<	<	<	**18**
	2.6	1404	390	39	24	16	<	<	<	<	<	**16**	43	39	26	16	<	<	<	<	**25**	43	43	31	20	<	<	<	<	**29**
	4.6	2484	690	39	27	23	16	<	<	<	<	**20**	44	34	26	19	<	<	<	<	**24**	47	43	31	22	<	<	<	<	**29**
	6.5	3510	975	44	33	27	22	18	<	15	15	**26**	46	35	28	23	18	<	16	16	**27**	47	39	30	24	19	15	16	16	**29**
80	0.7	504	140	41	28	21	<	<	<	<	<	**19**	40	27	20	<	<	<	<	<	**19**	41	29	20	<	<	<	<	<	**20**
	2.6	1872	520	40	26	17	<	<	<	<	<	**18**	42	38	25	18	<	<	<	<	**25**	44	44	32	25	<	<	<	<	**30**
	4.6	3312	920	41	29	25	21	<	<	<	<	**23**	44	34	26	22	<	<	<	<	**25**	46	42	30	24	<	<	<	<	**29**
	6.5	4680	1300	49	37	31	29	24	19	20	20	**31**	49	38	31	29	23	18	20	20	**31**	50	42	33	30	24	19	20	20	**33**

< = Values below 15 dB

RADIATED NOISE

PIANO-Z-DS0 (supply air, without acoustic cladding)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	28	<	<	<	<	<	<	<	**<**	32	<	<	<	<	<	<	<	**<**	29	18	<	<	<	<	<	<	**15**
	2.6	187	52	39	21	18	<	<	<	<	<	**18**	41	30	25	20	18	<	<	<	**24**	43	33	28	23	23	<	<	<	**27**
	4.6	331	92	40	28	28	21	<	<	<	<	**24**	43	37	34	26	21	<	<	<	**30**	45	40	36	30	25	17	<	<	**33**
	6.5	468	130	36	26	28	27	24	<	<	<	**28**	45	39	39	30	24	16	<	<	**33**	48	43	41	34	27	19	<	<	**36**
20	0.7	76	21	42	17	<	<	<	<	<	<	**19**	42	20	16	17	17	<	<	<	**21**	36	24	18	<	15	17	<	<	**21**
	2.6	281	78	41	23	20	<	<	<	<	<	**20**	41	30	25	20	18	<	<	<	**24**	43	33	28	24	23	15	<	<	**28**
	4.6	497	138	40	28	27	20	<	<	<	<	**23**	42	35	33	25	19	<	<	<	**28**	45	39	35	30	25	16	<	<	**32**
	6.5	702	195	37	27	29	28	25	<	<	<	**29**	43	37	37	28	22	<	<	<	**32**	46	42	40	33	25	17	<	<	**35**
30	0.7	113	32	30	<	<	<	<	<	<	<	**<**	38	16	18	<	<	<	<	<	**16**	40	21	21	<	15	<	<	<	**19**
	2.6	421	117	42	31	24	<	<	<	<	<	**22**	45	38	33	21	15	<	<	<	**28**	45	41	37	25	20	<	<	<	**31**
	4.6	745	207	44	40	33	20	<	<	<	<	**28**	48	45	40	27	18	<	<	<	**34**	49	48	43	31	23	15	<	<	**37**
	6.5	1053	293	46	42	38	28	20	<	<	<	**32**	52	48	43	32	22	15	<	<	**38**	53	51	46	35	26	17	<	<	**41**
40	0.7	189	53	29	<	<	<	<	<	<	<	**<**	37	15	17	<	<	<	<	<	**15**	40	20	20	<	<	<	<	<	**18**
	2.6	702	195	41	30	23	<	<	<	<	<	**21**	44	37	33	20	15	<	<	<	**27**	45	40	36	25	19	<	<	<	**31**
	4.6	1242	345	43	39	32	19	<	<	<	<	**27**	47	44	39	26	18	<	<	<	**33**	48	47	42	30	22	<	<	<	**36**
	6.5	1755	488	45	41	37	27	20	<	<	<	**32**	51	47	43	31	21	<	<	<	**37**	52	50	46	34	25	17	<	<	**40**
50	0.7	302	84	38	15	16	<	<	<	<	<	**16**	43	20	23	15	<	<	<	<	**21**	43	24	24	15	17	<	<	<	**22**
	2.6	1123	312	41	30	22	<	<	<	<	<	**20**	42	36	31	18	<	<	<	<	**26**	43	39	34	23	18	<	<	<	**29**
	4.6	1987	552	42	38	31	19	<	<	<	<	**27**	47	44	39	25	17	<	<	<	**33**	48	47	42	30	22	<	<	<	**36**
	6.5	2808	780	45	41	36	26	19	<	<	<	**31**	51	47	43	31	21	<	<	<	**37**	52	50	46	34	25	17	<	<	**40**
60	0.7	252	70	35	21	<	<	<	<	<	<	**<**	39	28	22	<	<	<	<	<	**20**	41	32	24	18	15	<	<	<	**23**
	2.6	936	260	44	37	29	15	<	<	<	<	**26**	46	45	36	23	18	<	<	<	**32**	49	48	40	28	22	16	<	<	**36**
	4.6	1656	460	48	44	37	23	15	<	<	<	**32**	51	50	44	29	21	15	<	<	**38**	53	53	47	34	26	19	<	<	**41**
	6.5	2340	650	57	48	39	30	24	<	<	<	**37**	55	52	48	34	24	16	<	<	**42**	57	55	51	37	28	20	<	<	**45**
70	0.7	378	105	34	20	<	<	<	<	<	<	**<**	38	27	21	<	<	<	<	<	**19**	40	31	24	17	<	<	<	<	**22**
	2.6	1404	390	43	36	28	<	<	<	<	<	**25**	46	44	36	22	17	<	<	<	**32**	48	47	39	27	21	15	<	<	**35**
	4.6	2484	690	47	43	36	22	<	<	<	<	**31**	50	49	43	29	21	<	<	<	**37**	52	52	46	33	25	18	<	<	**40**
	6.5	3510	975	56	47	39	29	23	<	<	<	**36**	55	51	47	33	23	15	<	<	**41**	56	54	50	37	27	19	<	<	**44**
80	0.7	504	140	41	27	18	<	<	<	<	<	**19**	41	31	24	16	<	<	<	<	**22**	41	33	25	19	16	<	<	<	**24**
	2.6	1872	520	43	36	27	<	<	<	<	<	**25**	44	43	34	21	16	<	<	<	**30**	47	46	38	26	20	<	<	<	**34**
	4.6	3312	920	48	45	37	23	15	<	<	<	**32**	50	50	43	29	21	15	<	<	**38**	52	52	46	33	25	18	<	<	**40**
	6.5	4680	1300	55	47	38	29	23	<	<	<	**35**	57	54	50	35	25	17	<	<	**43**	58	56	52	38	29	20	<	<	**45**

< = Values below 15 dB

PIANO-A-DS0 (return air, without acoustic cladding)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	34	<	<	<	<	<	<	<	**<**	38	<	<	<	<	<	<	<	**<**	38	<	<	16	<	<	<	<	**16**
	2.6	187	52	34	17	<	<	<	<	<	<	**<**	39	28	24	26	<	<	<	<	**25**	41	32	28	30	22	15	<	<	**29**
	4.6	331	92	37	19	<	<	<	<	<	<	**15**	39	29	25	22	<	<	<	<	**23**	39	31	29	30	18	<	<	<	**29**
	6.5	468	130	38	24	17	16	<	<	<	<	**18**	42	31	25	22	<	<	<	<	**24**	41	34	30	27	15	<	<	<	**27**
20	0.7	76	21	41	15	<	<	<	<	<	<	**18**	42	19	<	17	<	<	<	<	**19**	41	17	<	19	<	<	<	<	**19**
	2.6	281	78	42	25	19	15	<	<	<	<	**20**	43	31	27	29	15	<	<	<	**28**	42	34	30	31	23	16	<	<	**31**
	4.6	497	138	42	23	17	<	<	<	<	<	**19**	43	32	28	26	<	<	<	<	**26**	43	35	33	35	22	<	<	<	**33**
	6.5	702	195	42	27	21	20	<	<	<	<	**22**	43	33	26	24	<	<	<	<	**25**	44	36	32	30	18	<	<	<	**30**
30	0.7	113	32	40	20	15	<	<	<	<	<	**18**	41	22	19	<	<	<	<	<	**20**	40	21	21	16	<	<	<	<	**21**
	2.6	421	117	40	28	22	<	<	<	<	<	**20**	41	38	35	26	18	<	<	<	**29**	42	40	37	31	29	<	<	<	**34**
	4.6	745	207	41	25	19	<	<	<	<	<	**19**	42	38	29	22	<	<	<	<	**26**	42	41	37	29	22	<	<	<	**32**
	6.5	1053	293	40	28	26	17	<	<	<	<	**22**	42	37	28	21	<	<	<	<	**26**	44	42	35	26	19	<	<	<	**31**
40	0.7	189	53	44	23	22	<	<	<	<	<	**20**	41	23	20	<	<	<	<	<	**19**	40	25	23	<	20	<	<	<	**22**
	2.6	702	195	37	27	22	<	<	<	<	<	**18**	42	39	36	24	22	<	<	<	**31**	44	43	40	30	31	<	<	<	**36**
	4.6	1242	345	43	30	23	<	<	<	<	<	**21**	42	40	34	20	16	<	<	<	**29**	43	43	41	28	25	<	<	<	**35**
	6.5	1755	488	42	33	28	20	<	<	<	<	**24**	44	41	35	22	17	<	<	<	**30**	43	42	40	23	21	<	<	<	**33**
50	0.7	302	84	44	23	22	<	<	<	<	<	**19**	43	25	22	<	16	<	<	<	**20**	42	27	26	16	22	<	<	<	**24**
	2.6	1123	312	43	33	28	<	<	<	<	<	**24**	44	41	38	26	23	<	<	<	**32**	45	43	41	30	31	<	<	<	**36**
	4.6	1987	552	44	31	24	<	<	<	<	<	**22**	45	42	37	23	19	<	<	<	**31**	46	46	44	31	28	<	<	<	**38**
	6.5	2808	780	44	35	30	21	<	<	<	<	**26**	46	43	37	24	19	<	<	<	**32**	47	47	44	28	25	<	<	<	**37**
60	0.7	252	70	34	23	19	<	<	<	<	<	**<**	39	28	24	16	<	<	<	<	**20**	41	31	25	20	<	<	<	<	**23**
	2.6	936	260	38	26	20	<	<	<	<	<	**18**	46	43	34	25	<	<	<	<	**31**	46	47	39	30	20	<	<	<	**35**
	4.6	1656	460	39	27	25	17	<	<	<	<	**21**	45	37	32	27	17	<	<	<	**29**	49	47	38	31	21	<	16	<	**35**
	6.5	2340	650	42	30	28	21	<	<	<	<	**24**	46	37	33	28	19	<	16	<	**30**	48	45	36	29	20	<	16	<	**33**
70	0.7	378	105	36	25	21	<	<	<	<	<	**16**	41	30	26	18	<	<	<	<	**22**	43	33	27	22	15	<	<	<	**25**
	2.6	1404	390	40	28	22	<	<	<	<	<	**20**	48	45	36	27	16	<	15	15	**33**	48	50	41	32	22	<	<	<	**37**
	4.6	2484	690	41	29	27	20	<	<	<	<	**23**	47	39	34	29	19	<	16	<	**31**	51	49	40	33	23	15	19	16	**37**
	6.5	3510	975	44	32	30	23	<	<	15	15	**26**	48	39	35	30	21	<	18	15	**32**	50	47	38	31	22	<	18	15	**35**
80	0.7	504	140	39	28	24	<	<	<	<	<	**20**	43	31	28	19	<	<	<	<	**24**	45	35	29	24	17	<	<	<	**27**
	2.6	1872	520	43	30	25	<	<	<	<	<	**23**	50	47	38	29	18	16	17	16	**35**	50	52	43	34	24	15	15	15	**39**
	4.6	3312	920	42	30	28	21	<	<	<	<	**24**	48	41	35	30	21	<	18	15	**32**	52	50	41	34	24	16	20	17	**38**
	6.5	4680	1300	45	33	31	24	<	<	16	16	**27**	49	40	36	31	22	15	19	16	**33**	51	48	39	32	23	16	19	17	**36**

< = Values below 15 dB

PIANO-Z-FD1 (supply air, with acoustic cladding)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	27	<	<	<	<	<	<	<	**<**	31	<	<	<	<	<	<	<	**<**	28	16	<	<	<	<	<	<	**<**
	2.6	187	52	38	19	<	<	<	<	<	<	**<**	40	28	21	15	<	<	<	<	**20**	42	31	24	18	17	<	<	<	**23**
	4.6	331	92	39	26	24	16	<	<	<	<	**20**	42	35	30	21	<	<	<	<	**26**	44	38	32	25	19	<	<	<	**28**
	6.5	468	130	35	24	24	22	18	<	<	<	**23**	44	37	35	25	18	<	<	<	**29**	47	41	37	29	21	<	<	<	**32**
20	0.7	76	21	42	16	<	<	<	<	<	<	**18**	42	19	<	<	<	<	<	<	**19**	36	23	15	<	<	<	<	<	**19**
	2.6	281	78	41	22	17	<	<	<	<	<	**18**	41	29	22	17	<	<	<	<	**21**	43	32	25	21	17	<	<	<	**24**
	4.6	497	138	40	27	24	17	<	<	<	<	**21**	42	34	30	22	<	<	<	<	**26**	45	38	32	27	19	<	<	<	**29**
	6.5	702	195	37	26	26	25	19	<	<	<	**25**	43	36	34	25	16	<	<	<	**29**	46	41	37	30	19	<	<	<	**32**
30	0.7	113	32	28	<	<	<	<	<	<	<	**<**	36	<	<	<	<	<	<	<	**<**	38	18	16	<	<	<	<	<	**16**
	2.6	421	117	40	28	19	<	<	<	<	<	**18**	43	35	28	15	<	<	<	<	**24**	43	38	32	19	<	<	<	<	**27**
	4.6	745	207	42	37	28	<	<	<	<	<	**24**	46	42	35	21	<	<	<	<	**30**	47	45	38	25	16	<	<	<	**33**
	6.5	1053	293	44	39	33	22	<	<	<	<	**28**	50	45	38	26	15	<	<	<	**33**	51	48	41	29	19	<	<	<	**36**
40	0.7	189	53	28	<	<	<	<	<	<	<	**<**	36	<	<	<	<	<	<	<	**<**	39	18	16	<	<	<	<	<	**16**
	2.6	702	195	40	28	19	<	<	<	<	<	**18**	43	35	29	15	<	<	<	<	**25**	44	38	32	20	<	<	<	<	**27**
	4.6	1242	345	42	37	28	<	<	<	<	<	**25**	46	42	35	21	<	<	<	<	**30**	47	45	38	25	16	<	<	<	**33**
	6.5	1755	488	44	39	33	22	<	<	<	<	**28**	50	45	39	26	15	<	<	<	**34**	51	48	42	29	19	<	<	<	**37**
50	0.7	302	84	36	<	<	<	<	<	<	<	**<**	41	19	20	<	<	<	<	<	**19**	41	23	21	<	<	<	<	<	**20**
	2.6	1123	312	39	29	19	<	<	<	<	<	**18**	40	35	28	<	<	<	<	<	**23**	41	38	31	19	<	<	<	<	**26**
	4.6	1987	552	40	37	28	15	<	<	<	<	**24**	45	43	36	21	<	<	<	<	**31**	46	46	39	26	18	<	<	<	**34**
	6.5	2808	780	43	40	33	22	15	<	<	<	**28**	49	46	40	27	17	<	<	<	**34**	50	49	43	30	21	15	<	<	**37**
60	0.7	252	70	32	17	<	<	<	<	<	<	**<**	36	24	16	<	<	<	<	<	**16**	38	28	18	<	<	<	<	<	**18**
	2.6	936	260	41	33	23	<	<	<	<	<	**21**	43	41	30	16	<	<	<	<	**28**	46	44	34	21	<	<	<	<	**31**
	4.6	1656	460	45	40	31	16	<	<	<	<	**27**	48	46	38	22	<	<	<	<	**33**	50	49	41	27	18	<	<	<	**36**
	6.5	2340	650	54	44	33	23	16	<	<	<	**32**	52	48	42	27	16	<	<	<	**37**	54	51	45	30	20	<	<	<	**40**
70	0.7	378	105	32	17	<	<	<	<	<	<	**<**	36	24	16	<	<	<	<	<	**16**	38	28	19	<	<	<	<	<	**18**
	2.6	1404	390	41	33	23	<	<	<	<	<	**21**	44	41	31	16	<	<	<	<	**28**	46	44	34	21	<	<	<	<	**31**
	4.6	2484	690	45	40	31	16	<	<	<	<	**27**	48	46	38	23	<	<	<	<	**33**	50	49	41	27	18	<	<	<	**36**
	6.5	3510	975	54	44	34	23	16	<	<	<	**32**	53	48	42	27	16	<	<	<	**37**	54	51	45	31	20	<	<	<	**39**
80	0.7	504	140	39	24	<	<	<	<	<	<	**17**	39	28	19	<	<	<	<	<	**19**	39	30	20	<	<	<	<	<	**20**
	2.6	1872	520	41	33	22	<	<	<	<	<	**21**	42	40	29	<	<	<	<	<	**27**	45	43	33	20	<	<	<	<	**30**
	4.6	3312	920	46	42	32	17	<	<	<	<	**29**	48	47	38	23	<	<	<	<	**34**	50	49	41	27	18	<	<	<	**36**
	6.5	4680	1300	53	44	33	23	16	<	<	<	**32**	55	51	45	29	18	<	<	<	**40**	56	53	47	32	22	<	<	<	**42**

< = Values below 15 dB

PIANO-A-FD1 (return air, with acoustic cladding)

NW	v_k	V_{ZU}		Δp_t = 50 Pa									Δp_t = 150 Pa									Δp_t = 250 Pa								
				L_W [dB]									L_W [dB]									L_W [dB]								
	(m/s)	(m³/h)	(l/s)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	L_{WA} (dB(A))
10	0.7	50	14	34	<	<	<	<	<	<	<	**<**	38	<	<	<	<	<	<	<	**<**	38	<	<	<	<	<	<	<	**16**
	2.6	187	52	34	16	<	<	<	<	<	<	**<**	39	27	22	23	<	<	<	<	**22**	41	31	26	27	19	<	<	<	**27**
	4.6	331	92	37	18	<	<	<	<	<	<	**<**	39	28	23	19	<	<	<	<	**20**	39	30	27	27	15	<	<	<	**26**
	6.5	468	130	38	23	<	<	<	<	<	<	**17**	42	30	23	19	<	<	<	<	**22**	41	33	28	24	<	<	<	<	**25**
20	0.7	76	21	41	15	<	<	<	<	<	<	**18**	42	19	<	16	<	<	<	<	**19**	41	17	<	18	<	<	<	<	**20**
	2.6	281	78	42	25	19	<	<	<	<	<	**20**	43	31	27	28	<	<	<	<	**27**	42	34	30	30	21	<	<	<	**30**
	4.6	497	138	42	23	17	<	<	<	<	<	**19**	43	32	28	25	<	<	<	<	**26**	43	35	33	34	20	<	<	<	**33**
	6.5	702	195	42	27	21	19	<	<	<	<	**21**	43	33	26	23	<	<	<	<	**25**	44	36	32	29	16	<	<	<	**29**
30	0.7	113	32	40	17	<	<	<	<	<	<	**16**	41	19	<	<	<	<	<	<	**18**	40	18	17	<	<	<	<	<	**18**
	2.6	421	117	40	25	18	<	<	<	<	<	**18**	41	35	31	20	<	<	<	<	**25**	42	37	33	25	24	<	<	<	**29**
	4.6	745	207	41	22	<	<	<	<	<	<	**17**	42	35	25	16	<	<	<	<	**23**	42	38	33	23	17	<	<	<	**28**
	6.5	1053	293	40	25	22	<	<	<	<	<	**19**	42	34	24	15	<	<	<	<	**22**	44	39	31	20	<	<	<	<	**27**
40	0.7	189	53	44	21	19	<	<	<	<	<	**20**	41	21	17	<	<	<	<	<	**18**	40	23	20	<	16	<	<	<	**20**
	2.6	702	195	37	25	19	<	<	<	<	<	**15**	42	37	33	19	18	<	<	<	**27**	44	41	37	25	27	<	<	<	**32**
	4.6	1242	345	43	28	20	<	<	<	<	<	**20**	42	38	31	15	<	<	<	<	**26**	43	41	38	23	21	<	<	<	**31**
	6.5	1755	488	42	31	25	15	<	<	<	<	**22**	44	39	32	17	<	<	<	<	**27**	43	40	37	18	17	<	<	<	**30**
50	0.7	302	84	44	22	20	<	<	<	<	<	**20**	43	24	20	<	<	<	<	<	**20**	42	26	24	<	18	<	<	<	**22**
	2.6	1123	312	43	32	26	<	<	<	<	<	**22**	44	40	36	21	19	<	<	<	**30**	45	42	39	25	27	<	<	<	**34**
	4.6	1987	552	44	30	22	<	<	<	<	<	**21**	45	41	35	18	15	<	<	<	**30**	46	45	42	26	24	<	<	<	**35**
	6.5	2808	780	44	34	28	16	<	<	<	<	**24**	46	42	35	19	15	<	<	<	**30**	47	46	42	23	21	<	<	<	**35**
60	0.7	252	70	34	21	16	<	<	<	<	<	**<**	39	26	21	<	<	<	<	<	**18**	41	29	22	15	<	<	<	<	**21**
	2.6	936	260	38	24	17	<	<	<	<	<	**16**	46	41	31	20	<	<	<	<	**28**	46	45	36	25	16	<	<	<	**32**
	4.6	1656	460	39	25	22	<	<	<	<	<	**19**	45	35	29	22	<	<	<	<	**26**	49	45	35	26	17	<	<	<	**32**
	6.5	2340	650	42	28	25	16	<	<	<	<	**22**	46	35	30	23	<	<	<	<	**27**	48	43	33	24	16	<	<	<	**31**
70	0.7	378	105	36	24	19	<	<	<	<	<	**15**	41	29	24	<	<	<	<	<	**21**	43	32	25	18	<	<	<	<	**23**
	2.6	1404	390	40	27	20	<	<	<	<	<	**19**	48	44	34	23	<	<	<	15	**31**	48	49	39	28	19	<	<	<	**35**
	4.6	2484	690	41	28	25	16	<	<	<	<	**22**	47	38	32	25	16	<	16	<	**29**	51	48	38	29	20	<	19	16	**35**
	6.5	3510	975	44	31	28	19	<	<	<	15	**25**	48	38	33	26	18	<	18	15	**30**	50	46	36	27	19	<	18	15	**33**
80	0.7	504	140	39	27	21	<	<	<	<	<	**18**	43	30	25	<	<	<	<	<	**22**	45	34	26	20	<	<	<	<	**25**
	2.6	1872	520	43	29	22	<	<	<	<	<	**21**	50	46	35	25	16	16	17	16	**33**	50	51	40	30	22	<	15	15	**37**
	4.6	3312	920	42	29	25	17	<	<	<	<	**23**	48	40	32	26	19	<	18	15	**30**	52	49	38	30	22	16	20	17	**36**
	6.5	4680	1300	45	32	28	20	<	<	16	16	**26**	49	39	33	27	20	<	19	16	**30**	51	47	36	28	21	16	19	17	**34**

< = Values below 15 dB

INSERTION LOSS

Insertion loss according to ISO 7235

Air throw	Model	NW	D_e (dB/Okt)							
			63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Supply air -Z	-K	10	0	8	12	31	46	65	82	84
		20	0	7	12	29	44	62	76	73
		30	0	7	14	31	48	68	80	65
		40	0	6	14	28	45	64	73	55
		50	0	6	13	27	43	61	69	49
		60	1	6	16	29	49	70	77	49
		70	1	5	15	27	46	66	71	42
		80	1	5	15	26	45	64	67	38
	-S	10	0	9	16	41	61	81	92	89
		20	0	8	16	38	58	77	86	79
		30	1	8	18	39	60	81	89	70
		40	1	8	18	36	56	76	82	60
		50	1	7	17	34	54	73	77	55
		60	2	10	22	41	65	87	89	57
		70	2	9	22	39	61	82	82	50
		80	3	10	22	37	59	79	79	46
Return air -A	-K	10	0	7	11	25	38	56	57	38
		20	0	7	10	24	36	52	51	34
		30	0	7	12	25	38	53	50	33
		40	0	6	11	23	35	49	44	29
		50	0	6	11	22	33	46	40	27
		60	0	7	13	24	37	50	43	29
		70	1	6	13	22	34	46	38	25
		80	1	6	12	21	32	44	35	24
	-S	10	0	8	15	26	42	56	57	39
		20	0	8	15	24	39	52	51	35
		30	0	8	16	26	41	54	50	34
		40	0	8	16	25	38	49	44	30
		50	1	8	15	24	37	46	41	28
		60	1	10	20	30	43	52	45	31
		70	2	9	19	30	41	49	41	28
		80	2	9	19	30	39	47	40	26

HEATING REGISTER OUTPUT

PIANO-H2 (heating register with 2 rows of pipes)

NW	V (m³/h) [l/s]	Pa_L (Pa)	Q (kW)	Pa_W (kPa)	V_W (l/h)
10	50 [14]	3	0.4	0.0	15
	187 [52]	22	0.8	0.2	35
	331 [92]	56	1.1	0.3	45
	468 [130]	99	1.3	0.3	52
20	76 [21]	3	0.6	0.1	23
	281 [78]	22	1.4	0.5	55
	497 [138]	56	1.8	0.8	75
	702 [195]	99	2.1	1.0	87
30	113 [32]	3	1.0	0.4	40
	421 [117]	22	2.2	1.8	93
	745 [207]	56	3.0	3.0	126
	1053 [293]	99	3.5	4.1	148
40	189 [53]	3	1.6	0.2	64
	702 [195]	22	3.6	0.8	149
	1242 [345]	56	4.8	1.3	201
	1755 [488]	99	5.6	1.8	237
50	302 [84]	3	2.7	0.7	115
	1123 [312]	22	6.2	3.0	265
	1987 [552]	56	8.3	5.2	358
	2808 [780]	99	9.8	7.0	422
60	252 [70]	3	2.0	0.1	79
	936 [260]	22	4.6	0.6	189
	1656 [460]	56	6.2	1.0	257
	2340 [650]	99	7.3	1.3	303
70	378 [105]	3	3.2	0.2	127
	1404 [390]	22	7.2	0.7	299
	2484 [690]	56	9.6	1.2	404
	3510 [975]	99	11.3	1.7	477
80	504 [140]	3	4.3	0.2	175
	1872 [520]	22	9.7	0.8	407
	3312 [920]	56	13.0	1.4	551
	4680 [1300]	99	15.3	1.9	649

t_E = 15 °C | Δt_W = 70 °C - 50 °C

PIANO-H4 (heating register with 4 rows of pipes)

NW	V (m³/h) [l/s]	Pa_L (Pa)	Q (kW)	Pa_W (kPa)	V_W (l/h)
10	50 [14]	5	0.4	0.3	30
	187 [52]	44	0.9	1.4	78
	331 [92]	112	1.3	2.6	108
	468 [130]	198	1.5	3.6	130
20	76 [21]	5	0.6	0.7	47
	281 [78]	44	1.4	3.9	122
	497 [138]	112	2.0	7.3	172
	702 [195]	198	2.4	10.2	207
30	113 [32]	5	0.8	0.3	68
	421 [117]	44	2.1	1.6	175
	745 [207]	112	2.9	3.0	246
	1053 [293]	198	3.5	4.1	296
40	189 [53]	5	1.4	0.3	115
	702 [195]	44	3.5	1.8	298
	1242 [345]	112	4.9	3.3	419
	1755 [488]	198	5.9	4.6	504
50	302 [84]	5	2.2	0.5	190
	1123 [312]	44	5.7	2.7	490
	1987 [552]	112	8.0	5.0	690
	2808 [780]	198	9.6	6.9	831
60	252 [70]	5	1.9	0.9	160
	936 [260]	44	4.8	4.7	412
	1656 [460]	112	6.7	8.8	581
	2340 [650]	198	8.1	12.3	700
70	378 [105]	5	2.8	0.5	237
	1404 [390]	44	7.1	2.9	612
	2484 [690]	112	10.0	5.4	862
	3510 [975]	198	12.0	7.6	1038
80	504 [140]	5	3.7	0.7	320
	1872 [520]	44	9.6	3.7	826
	3312 [920]	112	13.5	6.9	1165
	4680 [1300]	198	16.2	9.6	1404

t_E = 15 °C | Δt_W = 45 °C - 35 °C

CONTROLLER SELECTION

Code	Compatibility	Controller	Actuator	Torque (Nm)	Controller size	Measuring principle	Emergency setting function	Additional information
A008	NW 10…40	NMV-D3-MF	(compact)	10	Volumetric flow	dynamic	-	Page 22
A005	NW 50…80	SMV-D3-MP	(compact)	20	Volumetric flow	dynamic	-	Page 22
A143	NW 10…40	VRU-D3-BAC	NM24A-VST	10	Volumetric flow/pressure	dynamic	-	Pages 23, 25
A149	NW 50…80	VRU-D3-BAC	SF24A-VST	20	Volumetric flow/pressure	dynamic	Spring return	Pages 23, 25
A151	NW 10…40	VRU-M1-BAC	NM24A-VST	10	Volumetric flow/pressure	static	-	Pages 23, 25
A157	NW 50…80	VRU-M1-BAC	SF24A-VST	20	Volumetric flow/pressure	static	Spring return	Pages 23, 25

Type of the models listed in the table: electric controller
Power supply for the models listed in the table: AC/DC 24 V
Manufacturer of the models listed in the table: Belimo
Other controllers upon request (Belimo, Gruner, Sauter and Siemens are available)

Control type

Controller	MP-Bus	DC 0…10 V	DC 2…10 V	BACnet	Modbus
NMV-D3-MF	-	✓	✓	-	-
SMV-D3-MP	✓	✓	✓	-	-
VRU-D3-BAC	✓	✓	✓	✓	✓
VRU-M1-BAC	✓	✓	✓	✓	✓

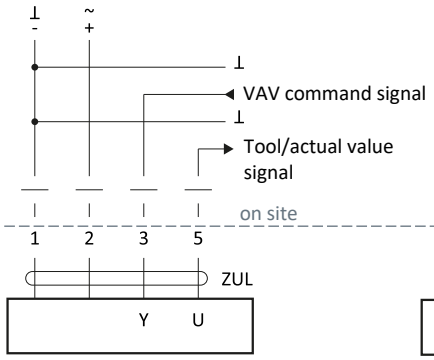
Minimum torque

Nominal width	-10	-20	-30	-40	-50	-60	-70	-80
Nm	10	10	10	10	20	20	20	20

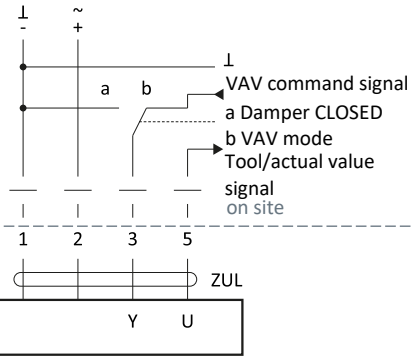
CIRCUIT DIAGRAMS

NMV-D3-MF/SMV-D3-MP (Belimo)

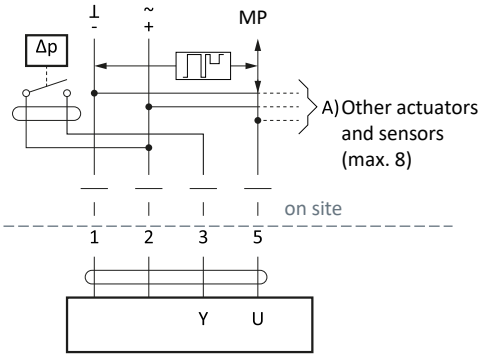
VAV, analogue command signal



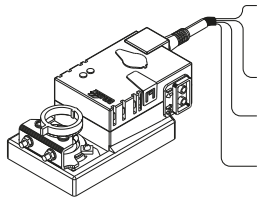
VAV with lock (CLOSED), mode 2…10 V



Connection of external switching contact (SMV)



Lock mode (CLOSED): In the 2…10 V mode, the following functions can be performed with a 0-10 V signal:

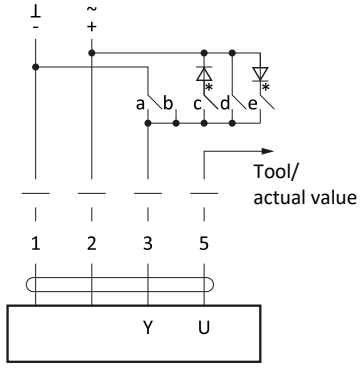


N.	Designation	Wire colour	Function
1	– ⊥	black	⊥ – AC/DC 24 V supply
2	+ ~	red	~ +
3	Y	white	VAV/CAV command signal
5	U	orange	actual value signal MP-Bus (SMV)

Y command signal	Volumetric flow	Function
< 0.1 V*	0	Damper CLOSED, VAV control inactive
0.2 V … 2V	V_{min}	V_{min} operating stage active
2 V … 10 V	V_{min}…V_{max}	Continuous operation V_{min} …V_{max}

*Attention: Controller/DDC must be able to set the command signal to 0 V.

CAV operation/positive contacts



Mode setting	---	0 … 10 V	0 … 10 V	0 … 10 V	0 … 10 V
	2 … 10 V	2 … 10 V	2 … 10 V	2 … 10 V	2 … 10 V
Signal	⊥ -	0 … 10 V 2 … 10 V	~	~ +	~
Function	3	3	3	3	3
Damper CLOSED	a) CLOSED		c) CLOSED*		
V_{min}…V_{max}		b) VAV			
CAV – V_{min}	everything open - V_{min} active				
Damper OPEN					e) OPEN*
CAV – V_{max}				d) V_{max}	

NOTE
Please ensure mutual locking of the contacts!

	Contact closed, function active
	Contact closed, function active, in mode 2 ...10 V only
	Contact open

* not available for DC 24 V supply

VRU-D3-BAC/VRU-M1-BAC

AC/DC 24 V, continuous (VAV)

Priority rule – analogue VAV control (a)

1. z1
2. z2
3. a) Adaptation
   b) Synchronisation
4. Y continuous: min...max

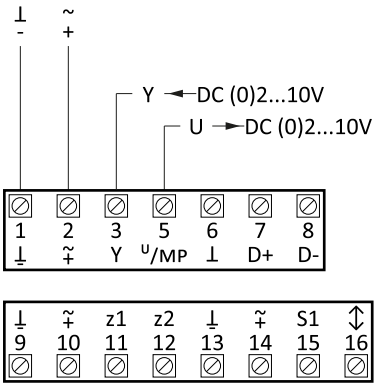
(see positive control z1/z2)

Forced command 'Damper CLOSED' via Y command signal (in mode 2...10 V):

< 0.3 V = damper CLOSED

> 0.3...2 V = V_{min}

2...10 V = V_{min}...V_{max}



AC/DC 24 V, step switching (CAV)

Priority rule – analogue CAV step control (b)

1. z1
2. z2
3. a) Adaptation
   b) Synchronisation
4. Y steps: CLOSED-MIN-MAX

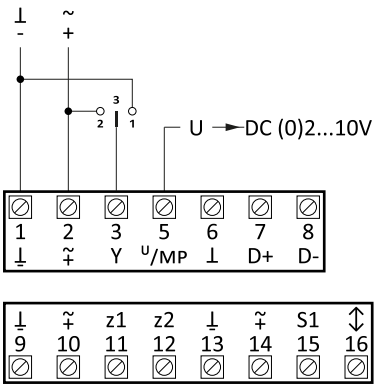
(see positive control z1/z2)

Contacts 2-3 = MAX

3 unassigned = MIN

Contacts 1-3 = ZU (mode 2...10 V)

MIN (mode 0...10 V)



AC/DC 24 V, positive control z1/z2

Positive control z1

Contacts 11-9 = motor STOP

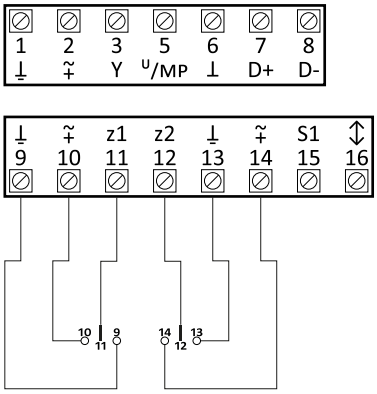
Contacts 11-10 = damper OPEN

Positive control z2

Contacts 12-13 = damper CLOSED

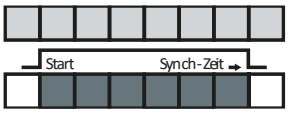
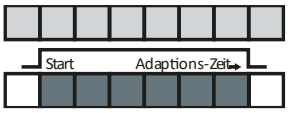
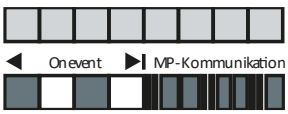
Contacts 12-14 = MAX.

11/12 unassigned = priority rule a/b/c/d/e



LED FUNCTION TABLE

NMV-D3-MF/SMV-D3-MP (Belimo)

Application	Function	Description / action	LED	Adaptation ⊕ LED 1 power Adresse ⊕ LED 2 status
N1 operation	Status display	– 24 V power supply ok – VAV-Compact ready for operation	LED 1 LED 2	
S1 service function	Synchronisation	Synchronisation started via a) operating/service unit b) manual triggering on the VAV-Compact c) "power ON" behaviour	LED 1 LED 2	
S2 service function	Adaptation	Adaptation started via: a) operating/service unit b) button on the VAV-Compact	LED 1 LED 2	
B1 bus operation	Addressing via MP master (acknowledgement on the VAV-Compact)	a) Addressing has been triggered at the MP master	LED 1 LED 2	
		b) Press the addressing button. LED will switch to communication display as soon as the addressing process is complete	LED 1 LED 2	
B2 bus operation	Addressing via MP master (with serial number)	Addressing on the MP master was triggered. LED will switch to communication display as soon as the addressing process is complete	LED 1 LED 2	
B3 bus operation communication	Display of MP-PP communication	Communication display via MP master or operating / service unit	LED 1 LED 2	

green LED (power) is on
yellow LED (status) is on
yellow LED is oscillating

TECHNICAL DATA OF THE CONTROLLERS

NMV-D3-MF/SMV-D3-MP (Belimo)
Compact controller with integrated pressure sensor and damper actuator.

Nominal voltage	AC/DC 24 V, 50/60 Hz
Functional range	AC 19.2...28.8 V/DC 21.6...28.8 V
Torque NMV/SMV	10 Nm/20 Nm
Power consumption	3 W
Dimensioning NMV/SMV	5 VA/5.5 VA (max. 8 A @ 5 ms)
Connection	Cable, 4 x 0.75 mm², pre-assembled
Control function	VAV/CAV and position control (open loop)
V_{nom}	Nominal volumetric flow setting, suitable for the VAV unit
Δp @ V_{nom} NMV/SMV	38…500 Pa/38…450 Pa
V_{max}	20...100 % of V_{nom}, adjustable
V_{mid}	>V_{min}...<V_{max}, adjustable
V_{min}	0…100 % of V_{nom}, adjustable (<V_{max})
Mode (Y)	0…10 V / 2…10 V / (Y and U5 individually) adjustable, input resistance 100 kΩ (0/4…20 mA with 500 Ω resistor)
Actual value signal (U)	0...10 V / 2...10 V, max. 0.5 mA volumetric flow / damper position / Δp, selectable
Operating stages	ZU/V_{min}/V_{mid}*)/V_{max}/OPEN*) *) AC 24 V supply required
Communication (SMV)	Belimo MP-Bus
Addressing (SMV)	MP1…8 (analogue activation: PP)
Bus Client (SMV)	DDC with MP interface
Activation (SMV)	Setpoint value specification in % between the set V_{min}/V_{max} values
Sensor connection (SMV)	Passive sensor (Pt1000, Ni1000 …) or active sensor (0…10 V) Switching contact (0/1) (switching capacity 16 mA @ 24 V)
Assistant App (smartphone) (SMV)	Contactless connection via integrated NFC interface
ZTH EU service tool, PC-Tool	Local connection socket/remote via PP/MP connection or MP client (SMV)
LED	Indication of supply, status and communication
Button	Addressing, rotation angle adjustment and test function
Rotary / linear design	Brushless motor, stall-proof, with energy-saving mode
Rotation direction	Left/right or up/down, adjustable
Angle of rotation	95° or 150 / 200 / 300 mm stroke, adjustable mechanical or electrical limit
Gear disengagement	Pushbutton, self-resetting without functional impairment
Position indicator	Mechanical or readable (tool, Bus Client)
Axis mount	Clamping block for round and square axles
Differential pressure sensor	Belimo D3 sensor, dynamic measuring principle
Measurement range, functional range	–20…500 Pa, 0…500 Pa
Overload capacity	±3000 Pa
Height compensation	Adjustment to system height (setting range 0...3000 m above sea level)
Installation position	Position-independent, no zero setting required
Wetted materials	Glass, epoxy resin, PA, TPE
Measuring air condition	Comfort range 0...50 °C/5...95 % RH, non-condensing
Protection class IEC/EN	III, Protective extra-low voltage (PELV)
Degree of protection IEC/EN	IP54
EMC	CE according to 2014/30/EU
Certification IEC/EN	IEC/EN 60730-1 and IEC/EN 60730-2-14
Rated surge voltage supply/control	0.8 kV
Contamination level of the environment	3
Ambient temperature	–30...50 °C
Storage temperature	–40...80 °C
Ambient humidity	95 % RH, non-condensing
Maintenance	Maintenance-free. Depending on use, the differential pressure sensor (measuring cross, measuring orifice ...) of the VAV unit must be checked occasionally and cleaned if necessary.
Weight NMV/SMV	0.70 kg/0.83 kg

VRU-D3-BAC
VAV-Universal, modular control solution with integrated Δp sensor.

Nominal voltage	AC/DC 24 V
Rated voltage frequency	50/60 Hz
Functional range	AC 19.2...28.8 V / DC 21.6...28.8 V
Power consumption during operation	1.5 W
Power consumption/ dimensioning	2 VA plus connected VST actuator
Power consumption/ dimensioning Note	I_{max} 20 A @ 5 ms, incl. actuator
Connection of supply/ control	2.5 mm² terminals
S1 sensor input	Connection of external sensor (passive/active/switch)
Actuator connection (I) (M)	AC/DC 24 V, PP-Link for VST actuator
Communicative control	BACnet MS/TP Modbus RTU MP-Bus
Number of nodes	BACnet/Modbus see interface description, MP-Bus max. 8
Y operating range	2...10 V
Input resistance	100 kΩ
Variable Y operating range	0.5...10 V
Position feedback U note	Max. 0.5 mA, options: volume/Δp/position
Position feedback U variable	0...10 V Start point 0...8 V End point 2...10 V
Positive control	z1 motor stop/damper OPEN (AC/DC 24 V) z2 damper CLOSED / MAX (AC/DC 24 V)
Programming	Via Belimo Assistant App/PC-Tool
Measuring principle	Belimo D3, flow sensor (dynamic measurement)
Installation position	Position-independent, no zero setting required
Pressure measuring range	-20...500 Pa
Functional range differential pressure	0...500 Pa
Accuracy differential pressure	±1 Pa @ 0...20 Pa ±5% @ 20...500 Pa
Maximum system pressure	1500 Pa
Influence of pipe length	Max. +2.5%, linear value for hose length of 20 m (inner diameter 5 mm) at duct pressure control (STP)
Bursting pressure	±10 kPa
Height compensation	System height adjustment (range 0...3000 m above sea level)

Measuring air condition	0...50 °C/5...95% RH, non-condensing
Pressure hose connection	Nipple diameter 5.3 mm, pressure hose length max. 20 m (inner diameter 5 mm) for duct pressure control (STP)
Protection class IEC/EN	III, Safety extra-low voltage (SELV)
Protection class UL	III, Safety extra-low voltage (SELV)
Power source UL	Class 2 supply
Degree of protection IEC/EN	IP42
Protection type NEMA/UL	NEMA 1
Housing	UL enclosure type 1
EU conformity	CE marking
Certification IEC/EN	IEC/EN 60730-1
Certification UL	cULus according to UL60730-1, CAN/CSA E60730-1
UL 2043-compliant	Suitable for use in air boxes in accordance with section 300.22(C) of the NEC standard and section 602 of the IMC standard
Mode of action	Type 1
Rated surge voltage supply / control	0.8 kV
Degree of soiling	2
Ambient temperature	0...50 °C
Storage temperature	-40...80° C
Ambient humidity	Max. 95 % RH, non-condensing
Maintenance	maintenance-free
Weight	0.30 kg

VRU-M1-BAC
VAV-Universal, modular control solution with integrated Δp sensor for contaminated media.

Nominal voltage	AC/DC 24 V
Rated voltage frequency	50/60 Hz
Functional range	AC 19.2...28.8 V / DC 21.6...28.8 V
Power consumption during operation	1.5 W
Power consumption/dimensioning	2 VA plus connected VST actuator
Power consumption/dimensioning Note	I_{max} 20 A @ 5 ms, incl. actuator
Connection of supply/control	2.5 mm² terminals
S1 sensor input	Connection of external sensor (passive/active/switch)
Actuator connection (I) (M)	AC/DC 24 V, PP-Link for VST actuator
Communicative control	BACnet MS/TP Modbus RTU MP-Bus
Number of nodes	BACnet/Modbus see interface description, MP-Bus max. 8
Y operating range	2...10 V
Input resistance	100 kΩ
Variable Y operating range	0.5...10 V
Position feedback U note	Max. 0.5 mA, options: volume/Δp/position
Position feedback U variable	0...10 V Start point 0...8 V End point 2...10 V
Positive control	z1 motor stop/damper OPEN (AC/DC 24 V) z2 damper CLOSED / MAX (AC/DC 24 V)
Programming	Via Belimo Assistant App/PC-Tool
Measuring principle	Belimo M1, diaphragm sensor
Installation position	Position-independent, no zero setting required
Functional range differential pressure	0...600 Pa
Accuracy differential pressure	±0.6 Pa
Maximum system pressure	1500 Pa
Bursting pressure	±7 kPa
Height compensation	System height adjustment for volumetric flow measurement (range 0...3000 m above sea level)

Measuring air condition	0...50 °C/5...95 % RH, non-condensing
Pressure hose connection	Nipple diameter 5.3 mm for pressure hose (inner diameter 5 mm)
Protection class IEC/EN	III, Safety extra-low voltage (SELV)
Protection class UL	III, Safety extra-low voltage (SELV)
Power source UL	Class 2 supply
Degree of protection IEC/EN	IP42
Protection type NEMA/UL	NEMA 1
Housing	UL enclosure type 1
EU conformity	CE marking
Certification IEC/EN	IEC/EN 60730-1
Certification UL	cULus according to UL60730-1, CAN/CSA E60730-1
UL 2043-compliant	Suitable for use in air boxes in accordance with section 300.22(C) of the NEC standard and section 602 of the IMC standard
Mode of action	Type 1
Rated surge voltage supply/control	0.8 kV
Degree of soiling	2
Ambient temperature	0...50 °C
Storage temperature	-40...80 °C
Ambient humidity	Max. 95 % RH, non-condensing
Maintenance	maintenance-free
Weight	0.30 kg

NM24A-VST
Plug-in rotary actuator for VAV and CAV units.

Nominal voltage	AC/DC 24 V
Rated voltage frequency	50/60 Hz
Functional range	AC 19.2...28.8 V / DC 21.6...28.8 V
Power consumption during operation	2 W
Power consumption in idle position	0.4 W
Power consumption/dimensioning	4 VA
Connection of supply/control	Cable 0.5 m with VST connection plug
Parallel operation	No
Torque, motor	10 Nm
Changeable direction of movement	For VRU-..-BAC with Belimo Assistant App
Manual adjustment	Via pushbutton, lockable
Motor runtime	120 s / 90°
Variable control range adjustment	For VRU-..-BAC, triggered by pressing the 'Adaptation' button or via Belimo Assistant App
Sound power level, motor	35 dB(A)
Spindle driver	Universal clamping block 8...26.7 mm
Position indicator	mechanical, plug-in
Protection class IEC/EN	III Safety extra-low voltage (SELV)
Degree of protection IEC/EN	IP54
EMC	CE according to 2014 / 30 / EC
Certification IEC/EN	IEC/EN 60730-1 and IEC/EN 60730-2-14
Mode of action	Type 1
Rated surge voltage supply/control	0.8 kV
Contamination level of the environment	3
Ambient temperature	-30...50 °C
Storage temperature	-40...80 °C
Ambient humidity	Max. 95 % RH, non-condensing
Maintenance	maintenance-free
Weight	0.8 kg

SF24A-VST
Plug-in rotary actuator with emergency setting function for VAV and CAV units.

Nominal voltage	AC/DC 24 V
Rated voltage frequency	50/60 Hz
Functional range	AC 19.2...28.8 V / DC 21.6...28.8 V
Power consumption during operation	8.5 W
Power consumption in idle position	3.5 W
Power consumption/dimensioning	11 VA
Connection of supply / control	Cable 0.5 m with VST connection plug
Parallel operation	No
Torque, motor	20 Nm
Torque, emergency setting function	20 Nm
Changeable direction of movement	For VRU-..-BAC with Belimo Assistant App
Manual adjustment	By means of hand lever and locking switch
Motor runtime	120 s / 90°
Runtime of emergency setting function	<20 s / 90°
Variable control range adjustment	For VRU-..-BAC, triggered by pressing the 'Adaptation' button or via Belimo Assistant App
Sound power level, motor	40 dB(A)
Spindle driver	Universal clamping block 10...25.4 mm
Position indicator	Mechanical
Lifetime	Min. 60,000 emergency positions
Protection class IEC/EN	III Safety extra-low voltage (SELV)
Degree of protection IEC/EN	IP54
EMC	CE according to 2014 / 30 / EC
Certification IEC/EN	IEC/EN 60730-1 and IEC/EN 60730-2-14
Mode of action	Type 1.AA
Rated surge voltage supply/control	0.8 kV
Contamination level of the environment	3
Ambient temperature	-30...50 °C
Storage temperature	-40...80 °C
Ambient humidity	Max. 95 % RH, non-condensing
Maintenance	maintenance-free
Weight	2.2 kg

INSTALLATION

Upon reception of the PIANO volumetric flow controller, the components must be checked carefully to ensure that no damage has occurred during transport. Moreover, all components must be checked as to whether they match the order. Should the device exhibit production-related damage, please contact your local sales office prior to installation.

TRANSPORT, LIFTING AND HANDLING

The sound-damped volumetric flow controller types must not be carried on the regulation components, measuring cross or the damper leaf, but only on the housing.

STORAGE

The units must be carefully stored on site. They must be protected from dust, dirt and from direct weather effects.

MOUNTING

- The installation site must have sufficient space and the necessary resources for carrying out mounting and maintenance activities of all device components.
- The devices are suspended by means of U-profiles (on site).
- The sound-damped volumetric flow controllers are not suitable for air containing sticky and oily particles. When using the controllers in systems with heavy dust contamination, suitable filters must be connected upstream.
- For polluted air, the sound-damped volumetric flow controllers with integrated controller and static diaphragm pressure sensor VRU-M1-BAC (Belimo) must be used.
- Inspection, mounting and start-up must be carried out by trained personnel, observing the current regulations.
- If a fire damper or a baffle silencer is mounted in front of the return air model, a minimum distance of 300 mm must be maintained.

COMMISSIONING

WITH PC-TOOL

Direct connection via switch cabinet or socket (classic application)

ZTH EU as MP level converter:

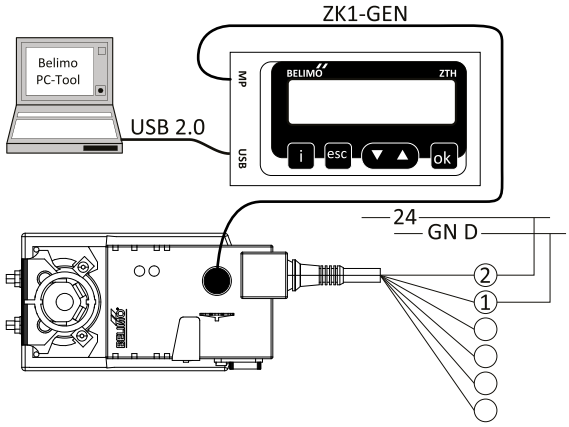
Description
The ZTH EU is also a potential-free interface between the USB port of a PC and the Belimo MP bus. It is used to connect the Belimo PC-Tool directly to the MP-Bus or directly to a programmable MFT actuator.

Power supply
The ZTH EU is supplied with power by the USB port. The MP bus voltage is obtained internally by means of DC/DC converter. This is why no external power supply is necessary.

Driver
To be able to work with the ZTH EU, a suitable driver must be installed on the PC. The driver can be downloaded from the Belimo website (download section). After installation of the driver, the ZTH EU device will log in to the PC as a virtual COM interface.

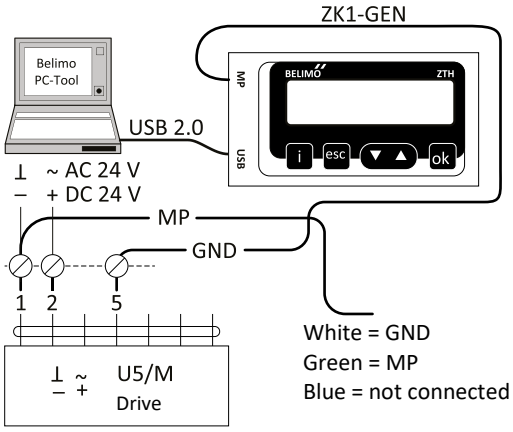
NOTE
For connection to USB ports of PCs and BELIMO 24 V actuators only (to safety extra-low voltage (SELV) or US class 2 power supply).

Connection diagram 1



Local connection via service socket of the MF/MP using a ZK1-GEN cable.

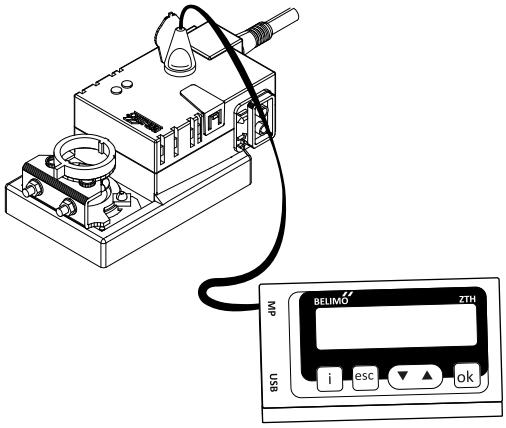
Connection diagram 2



Local connection via connecting cable of the MF/MP using a ZK2-GEN cable.

USING A ZTH EU SERVICE TOOL FOR ADJUSTMENT AND DIAGNOSTICS (BELIMO)

ZTH EU (Belimo)



Brief description

The ZTH EU service tool enables efficient testing of VAV and CAV systems. Installations fitted with the Belimo VAV controller can be simply adapted to the room and user requirements. The ZTH EU service tool replaces the previous ZTH GEN service tool (2007-2014).

All standard Belimo VAV controllers with integrated PP communication (from 1992) that are sold in the EU can be set using the ZTH EU.

Specifications

- Simple and quick setting of the VAV units parameters.
- Diagnostics function.
- One tool for all VAV units.
- voltage supplied by VAV controllers - no batteries required!
- Service socket VAV/CR24 controller, PP connection incl. RJ12 (6/4) connecting cable, 6-pin plug.
- New generation, MP-Bus tester for function tests, backwards compatible for all Belimo PP/MP units from 1992 onwards.
- efficient handling, can be operated with one hand
- Selection of stages for test (OPEN/CLOSE/MIN/MAX/STOP).
- Damper position indicator for diagnostics.
- Display of the setpoint / actual volume and $V_{min}/_{max}$ setting in m³/s (l/s).
- Dimensions 85 x 65 x 23 (WxHxD)

Buttons/display

2 x 16-digit LCD with background lighting

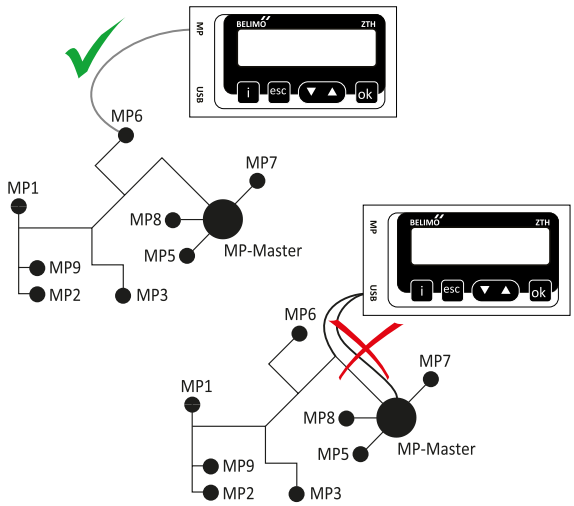
▼▲	Forwards/backwards, change value/status
OK	Confirm input
ESC	Cancel input/exit submenu/reject change
i	Shows additional information if available

Connection and supply

Locally via service socket.

Stand-alone operation: Connection including power supply takes place via the service socket on the VAV controller or via the connection terminals.

Bus operation: The ZTH EU can be used with the following units during bus operation if it is connected via the local service socket: VAV-Compact L/N/SMV-D3-MP, NMVAX-D3- MP, L/NMV-D3LON. With the VRP-M, L/NMV-D3-M and NMVAX-D3-MP, the MP-Bus must be disconnected when the service socket is used.



Restriction: Direct connection in an MP network or to an MP-Bus master is not possible.

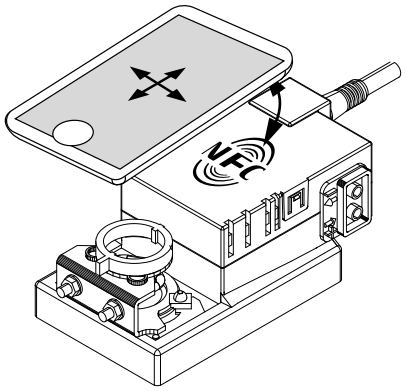
The ZTH EU comes with a quick start guide in English and German to be affixed to the back of the unit.

CONTROLLER CONFIGURATION ASSISTANT

BELIMO ASSISTANT

The NFC antenna area of the VAV Compact is located between the Belimo or OEM logo and the NFC label.

Align NFC-capable android smartphone with loaded Assistant app on the VAV-Compact such that the two antennae are above one another.



The Belimo Assistant app can be downloaded from the Google Play Store.

NFC-capable devices: LMV-D3-MP, NMV-D3-MF, SMV-D3-MP and LHV-D3-MP with imprinted NFC label.

Non-NFC-capable devices: All devices without NFC label, -MF/-MOD/-KNX.

MAINTENANCE

CLEANING OF THE DYNAMIC DIFFERENTIAL PRESSURE SENSOR

The pressure sensor integrated in the controllers only needs to be maintained in dirty environments.

However, if, depending on the degree of pollution of the air, unexpected volumetric flow deviations occur, then the following procedure is recommended:

1 Pull off the pressure hoses from the sensor connection spigot of the NMV-D3-MF or the VRD3. Attention! Make a note of the (+) and (-) assignments.
2 Using a suitable hand pump, blow air into the (-) connection spigot of the sensor (this will blow any dirt deposited inside the sensor out of the (+) connection spigot)
3 Remove any dirt from the spigots and hose ends.
4 Reconnect the (+) and (-) pressure hoses as before.
5 Check the controller function.

LEGEND

V	(m³/h) [l/s]	=	Air volume
V_{ZU}	(m³/h) [l/s]	=	Supply air volume
V_{AB}	(m³/h) [l/s]	=	Return air volume
V_W	[l/s]	=	Water flow volume
V_{min}	(m³/h) [l/s]	=	Minimum volumetric flow
V_{max}	(m³/h) [l/s]	=	Maximum volumetric flow
$V_{konstant}$	(m³/h) [l/s]	=	constant volumetric flow
V_{nenn}	(m³/h) [l/s]	=	Nominal volumetric flow
V_{mid}	(m³/h) [l/s]	=	Medium volumetric flow
V_{nom}	(m³/h) [l/s]	=	Nominal volumetric flow
<		=	L_W values smaller than 15
f_m	(Hz)	=	Octave centre frequency
f	(Hz)	=	Frequency
D_e	(dB/Okt)	=	Insertion loss
L_{WA}	[dB(A)]	=	A-weighted sound power level
L_W	[dB]	=	Sound power level
LR	(-)	=	Air flow direction
Δp_t	(Pa)	=	Pressure loss
$\Delta p_{t\ min}$	(Pa)	=	Minimum pressure difference
Pa_L	(Pa)	=	Air-side pressure loss
Pa_W	(Pa)	=	Water-side pressure loss
Δt_W	(°C)	=	Water inlet/outlet temperature
t_E	(°C)	=	Air inlet temperature
v_K	(m/s)	=	Duct velocity
v_{min}	(m/s)	=	Minimum end velocity of jet
v_{max}	(m/s)	=	Maximum end velocity of jet
Q	(kW)	=	Thermal capacity
NW	(-)	=	Nominal width
WK	(St.)	=	Water circuits
AG	(Inch)	=	Connecting thread
FQ	(m²)	=	Free cross-section
ρ	(kg/m³)	=	Density

PIANO ORDER CODE

01	02	03	04	05	06
Type	Model	Nominal width	Material	Air throw	Attachment assembly
Example					
PIANO	-K	-10	-SV	-Z	-A008

07	08	09	10	11	12
Mode	Volumetric flow V_{min}	Volumetric flow V_{max}	Damper position	Acoustic cladding	Heating register
-2	-0000	-0000	-NA	-DS0	-H0

Sample

PIANO-K-10-SV-Z-A008-2-0000-0000-NA-DS0-H0

PIANO sound-damped volumetric flow controller | compact model | NW 10 | galvanised sheet steel | supply air | with BELIMO NMV-D3-MF Compact electronic controller (10 Nm) | 2-10 V | factory-set | factory-set | without spring return actuator | without flat-bed acoustic cladding | without heating register

ORDER DETAILS

01 - Type

PIANO = PIANO sound-damped volumetric flow controller

02 - Model

K = Compact model (standard)
S = Extended model

03 - Nominal width

10 = NW 10
20 = NW 20
30 = NW 30
40 = NW 40
50 = NW 50
60 = NW 60
70 = NW 70
80 = NW 80

04 - Material

SV = Galvanised sheet steel (standard)
DD = Galvanised sheet steel with DD coating

05 - Air throw

Z = Supply air (standard)
A = Return air

06 - Attachment assembly

A008 = with electronic controller BELIMO NMV-D3-MF Compact (10 Nm) (standard for nominal width 1...4)
A005 = with electronic controller BELIMO SMV-D3-MP Compact (20 Nm) (standard for nominal width 5...8)
A143 = with electronic controller BELIMO VRU-D3-BAC, actuator NM24A-VST (10 Nm)
A149 = with electronic controller BELIMO VRU-D3-BAC, actuator SF24A-VST (20 Nm)
A151 = with electronic controller BELIMO VRU-M1-BAC, actuator NM24A-VST (10 Nm)
A157 = with electronic controller BELIMO VRU-M1-BAC, actuator SF24A-VST (20 Nm)

* other controllers available upon request

07 - Mode

0 = 0-10 V
2 = 2-10 V (standard)

08 - Volumetric flow V_{min}

0000 = Factory-set (standard)
xxxx = 4-digit value in m³/h (see table)

09 - Volumetric flow V_{max}

0000 = Factory-set (standard)
xxxx = 4-digit value in m³/h (see table)

10 - Damper position

NA = No spring return actuator (standard)
NO = Currentless OPEN – normally open (only for actuators with spring return)
NC = Currentless CLOSED – normally closed (only for drives with spring return)

11 - Acoustic cladding

DS0 = Without flat-bed acoustic cladding (standard)
FD1 = With flat-bed acoustic cladding

12 - Heating register

H0 = Without heating register (standard)
H2 = Heating register with 2 rows of pipes
H4 = Heating register with 4 rows of pipes

US ORDER CODE

01	02	03	04	05
Type	Volumetric flow controller	Model	Nominal width	Duct connection
Example				
US	-PIA	-R	-10	-KA0

Sample

US-PIA-R-1-KA0

Transition piece | for PIANO | for ductwork | NW 10 | without rubber lip seal

ORDER DETAILS

01 - Type

US = Transition piece

02 - Volumetric flow controller

PIA = For PIANO

03 - Model

R = For ductwork
E = For rectangular ducts

04 - Nominal width

10 = NW 10
20 = NW 20
30 = NW 30
40 = NW 40
50 = NW 50
60 = NW 60
70 = NW 70
80 = NW 80

05 - Duct connection

KA0 = Without rubber lip seal (standard)
GD1 = With rubber lip seal (for -R version only)

SPECIFICATION TEXT

Sound-damped volumetric flow controller for use in supply or return air systems. Connection to rectangular ducts according to DIN EN 1505 without reduction or transition piece; connection to ductwork according to DIN EN 1506 possible with US-R transition piece. Symmetrical device with the option of installation in any position for control on the right or left. Volumetric flow controller for controlling constant or variable volumetric flows and for room or duct pressure regulation. With positive control V_{min}, V_{max} or "CLOSED". It is possible to subsequently adjust the manufacturer-set operating volumetric flow at any time. The actual throughput of the volumetric flow can be measured via the U5 signal. The output signal can be used for master/slave or parallel operation of several controllers or for actual value display 2-10 V DC (0-10 V DC), which corresponds to 0-100 % of the set V_{nom} value in DDC/ZLT systems.
The housing is made of galvanised steel (-SV) with thermo-acoustic insulation and hygienic mineral wool according to VDI 6022 with a damper made of extruded aluminium profile with an EPDM seal.
The PIANO meets the most stringent tightness requirement as defined by DIN EN 1751. Housing leakage, class C and damper leaf leakage, class 4.
The differential pressure signal is measured using an aerodynamically optimised aluminium profile and evaluated in the electronic controller.

- For use in supply air systems, with an NMV-D3-MF electric controller, control voltage 24 V AC, 50/60 Hz, temperature compensation of 10-40 °C, wired and adjusted at the factory.
  Product: SCHAKO type PIANO-K-…-Z or PIANO-S-…-Z with extended silencer unit.
- For use in return air systems, with an NMV-D3-MF electric controller, control voltage 24 V AC, 50/60 Hz, temperature compensation of 10-40 °C, wired and adjusted at the factory.
  Product: SCHAKO types PIANO-K-…-A and PIANO-S-…-A with extended silencer unit.

Accessories (at an extra charge)

- Flat-bed acoustic cladding (-FD1), for reducing the radiated noise, made of sound-absorbing material arranged inside the housing, thus same outer dimensions.
- Heating register with 2 rows of pipes (-H2) or 4 rows of pipes (-H4), connection via an external thread, operating pressure 8 bar, test pressure 16 bar, consisting of galvanised sheet steel frame, copper pipes, steel collector, aluminium blades.
- DD coating (-DD) against aggressive return air.
- Transition piece, high-pressure side, made of galvanised sheet steel. For connection of ductwork (US-R). For connection of rectangular ducts (US-E).
- Rubber lip seal (-GD1) made of special rubber (for US-R only).