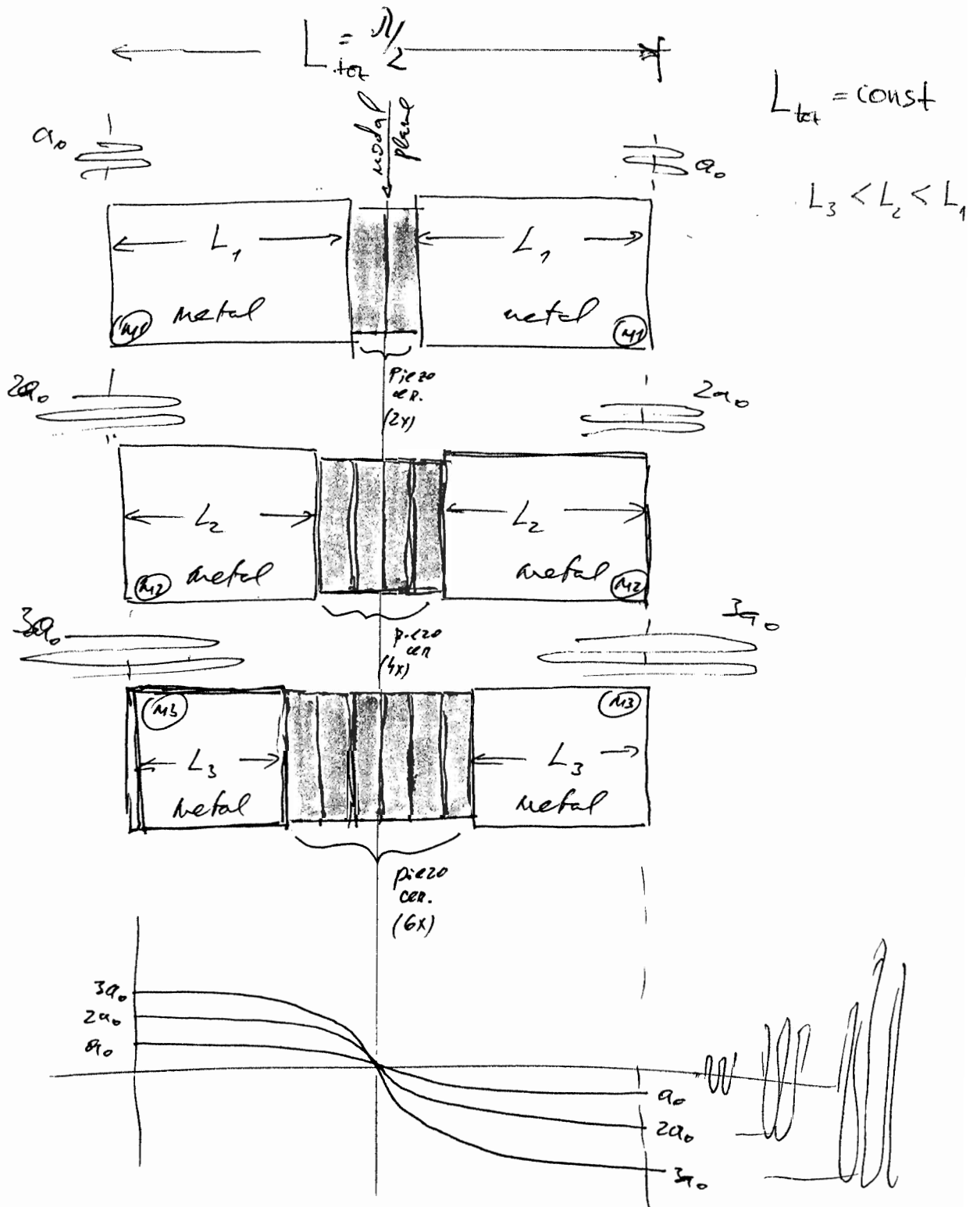


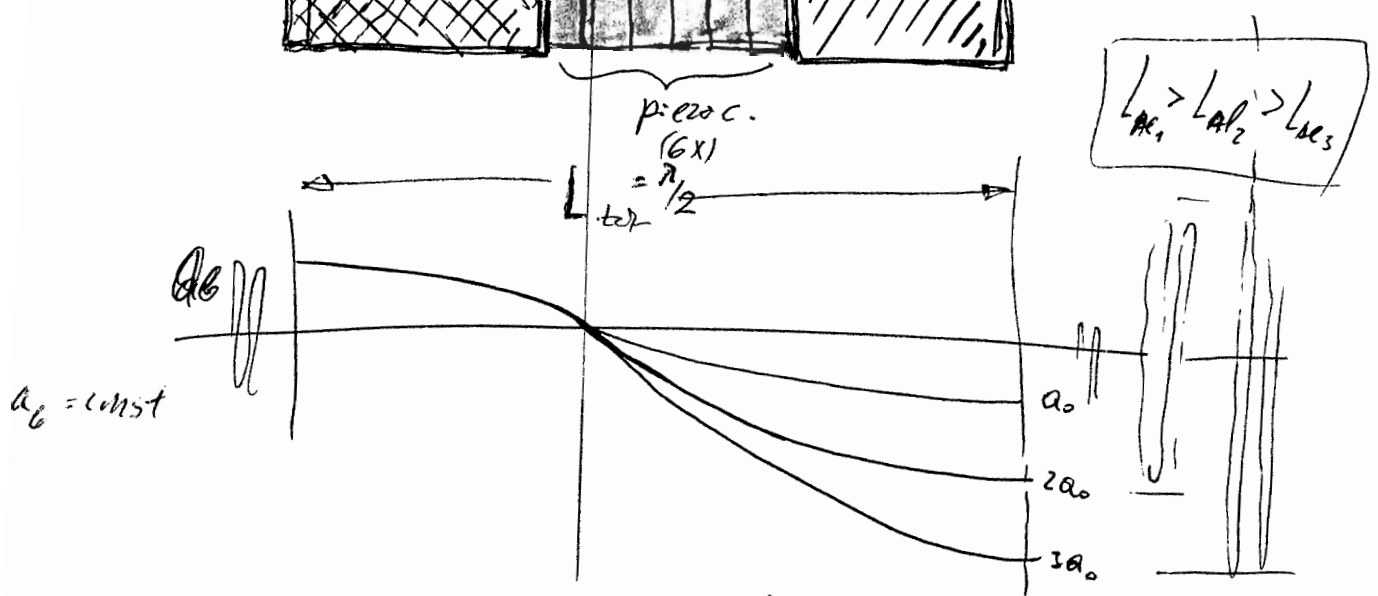
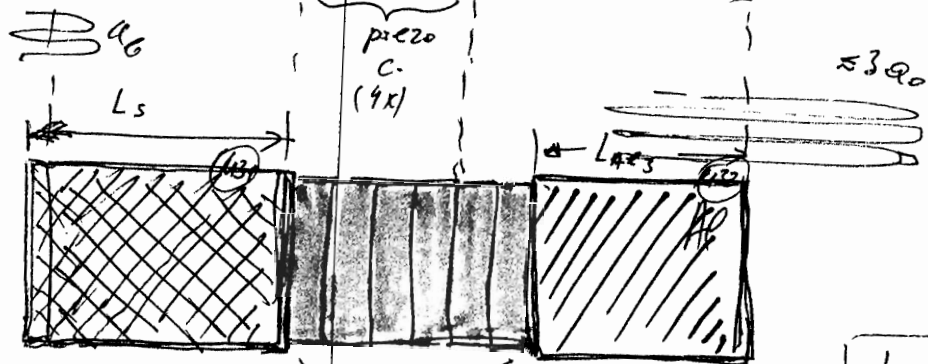
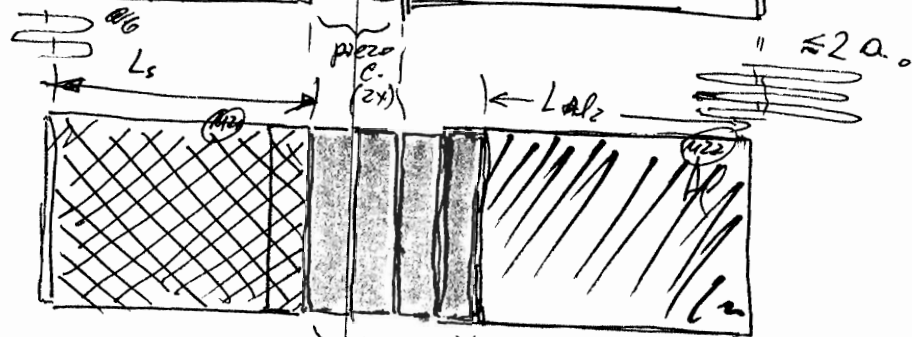
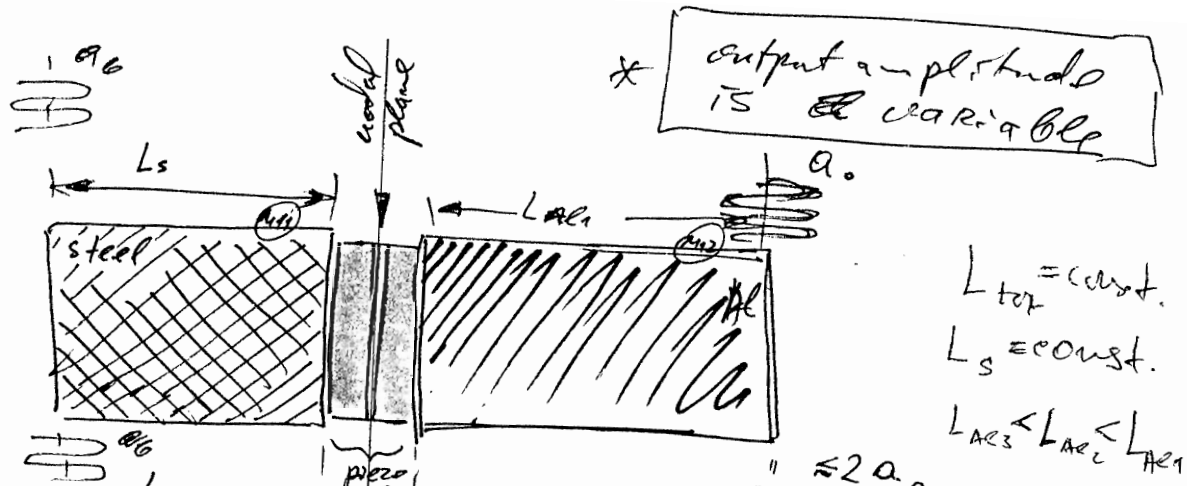
Nodal plane position and output BLT amplitude

**MP Interconsulting
Miodrag Prokic
Marais 36
CH-2400, Le Locle
Switzerland
Fax: +41-32-9314045
E-mail: MPI@bluewin.ch**

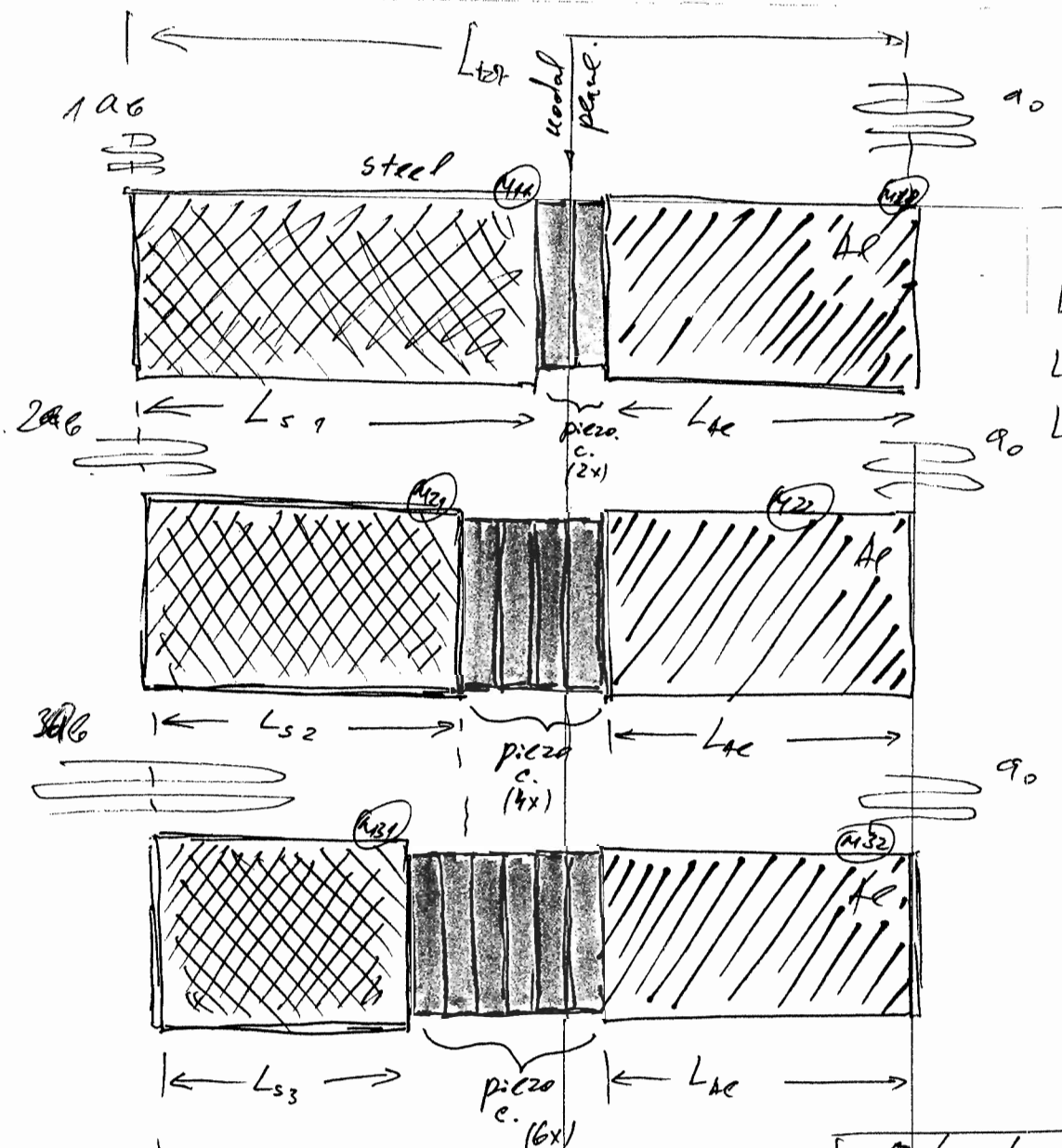


$\lambda/2$: Symmetrical converter configurations

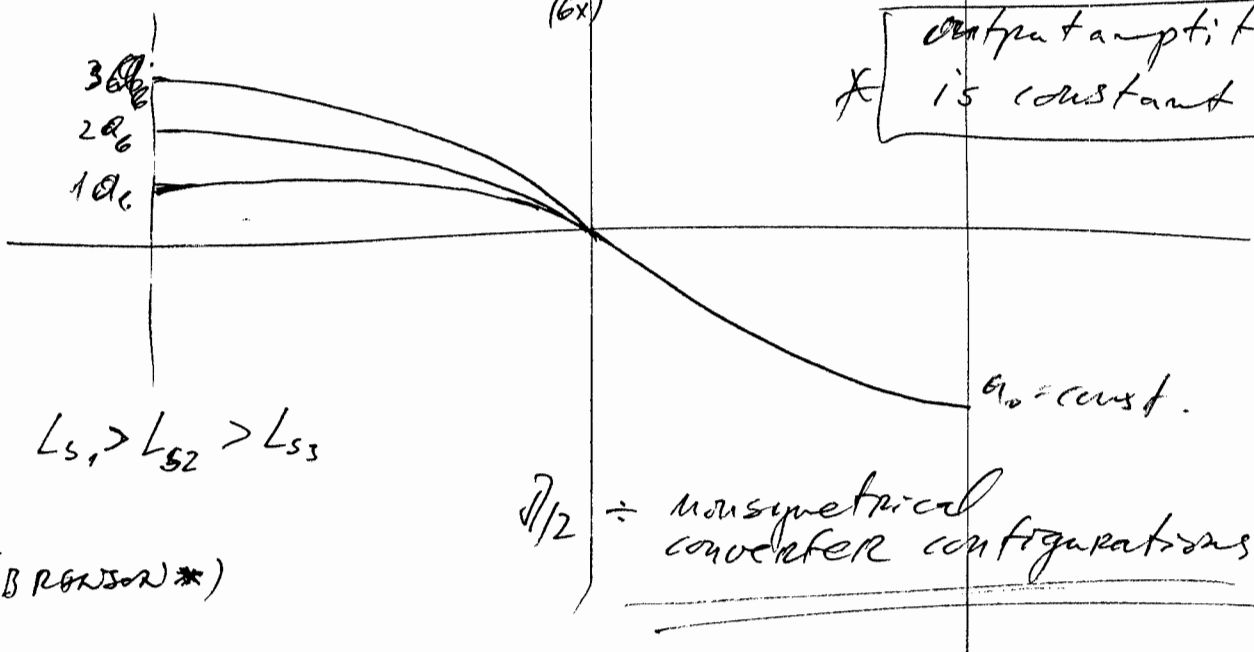
The importance of nodal plane position



$\lambda/2 \div$ unsymmetrical converter configurations.



$L_{tot} = \text{const}$
 $L_{s1} < L_{s2} < L_{s3}$
 $L_{pe} = \text{const.}$



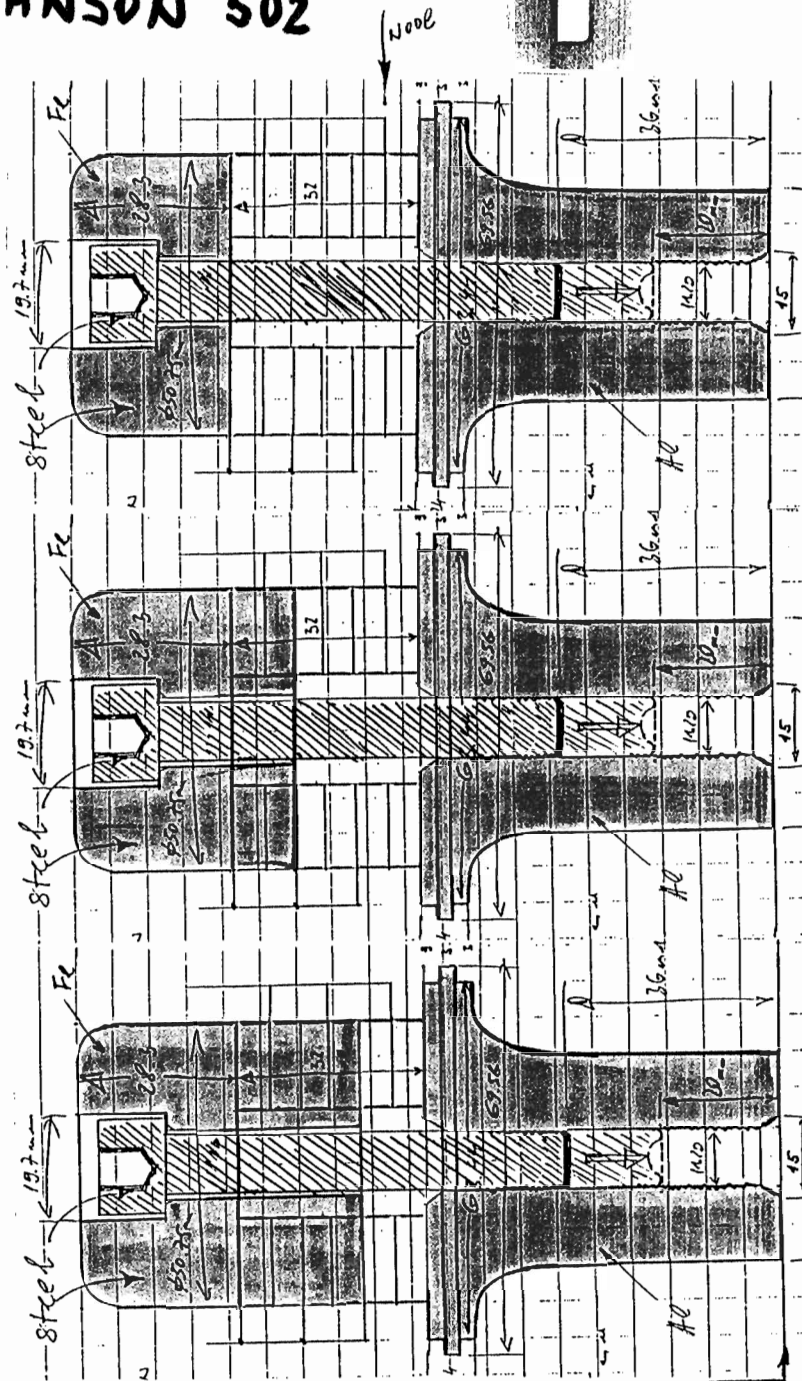
(BRONSON*)

BRANSON 502

502(A)
3 KW

502(B)
2 KW

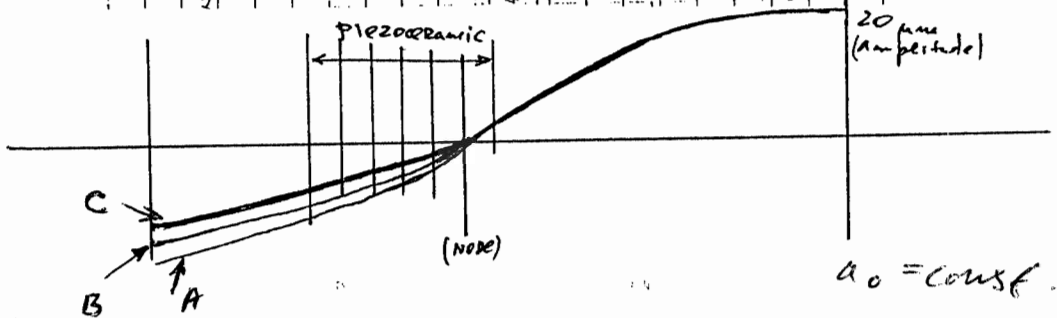
502(C)
1 KW



6 X PZT8
2"

4 X PZT8
2"

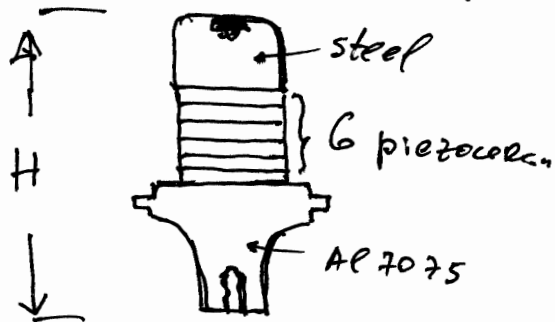
2 X PZT8
2"



①

$$\bar{f} = 19.848 \text{ kHz}$$

$$\Delta f = 2.121 \text{ kHz}$$



$$f_1 = 18.788 \text{ kHz}$$

$$f_2 = 20.909 \text{ kHz}$$

$$P_{\text{diss}} = 10 \div 13 \text{ W}$$

$$A_{\text{pp}} = 20 \mu\text{m}$$

$$(18 \div 22) \mu\text{m}$$

$$\textcircled{1} \quad P_{\text{diss}} = 11 \text{ W}$$

$$A_{\text{pp}} = 19 \mu\text{m}$$

$$f_{\text{oper}} = 21.06 \text{ kHz}$$

$$\textcircled{2} \quad P_{\text{diss}} = 12 \text{ W}$$

$$A_{\text{pp}} = 20.3 \mu\text{m}$$

$$f_{\text{oper}} = 21.16 \text{ kHz}$$

$$\textcircled{3} \quad P_{\text{diss}} = 13 \text{ W}$$

$$A_{\text{pp}} = 21.5 \mu\text{m}$$

$$f_{\text{oper}} = 21.28 \text{ kHz}$$

$$\textcircled{4} \quad P_{\text{diss}} = 13 \text{ W}$$

$$A_{\text{pp}} = 22.2 \mu\text{m}$$

$$f_{\text{oper}} = 21.36 \text{ kHz}$$

$$\textcircled{5} \quad P_{\text{diss}} = 9 \text{ W}$$

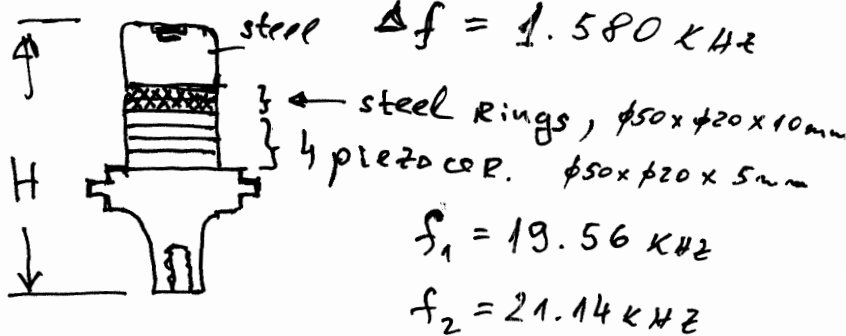
$$A_{\text{pp}} = 21 \mu\text{m}$$

$$f_{\text{oper}} = 21.47 \text{ kHz}$$

①

2 piezoceramic replaced by 1 steel ring

$$\bar{f} = 20.350 \text{ kHz}$$

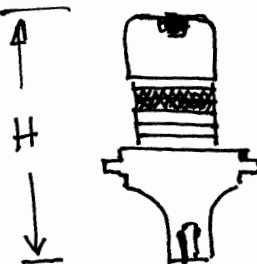


$$\Delta f = 1.580 \text{ kHz}$$

$$f_1 = 19.56 \text{ kHz}$$

$$f_2 = 21.14 \text{ kHz}$$

②



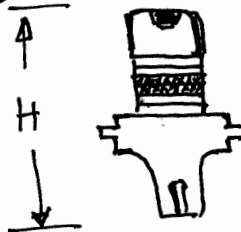
$$\bar{f} = 20.575 \text{ kHz}$$

$$\Delta f = 1.35 \text{ kHz}$$

$$f_1 = 19.90 \text{ kHz}$$

$$f_2 = 21.25 \text{ kHz}$$

③



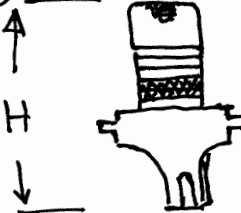
$$\bar{f} = 20.740 \text{ kHz}$$

$$\Delta f = 1.24 \text{ kHz}$$

$$f_1 = 20.12 \text{ kHz}$$

$$f_2 = 21.36 \text{ kHz}$$

④



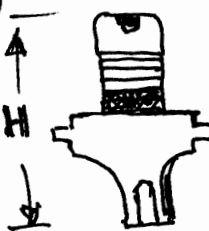
$$\bar{f} = 20.855 \text{ kHz}$$

$$\Delta f = 1.23 \text{ kHz}$$

$$f_1 = 20.24 \text{ kHz}$$

$$f_2 = 21.47 \text{ kHz}$$

⑤



$$\bar{f} = 20.74 \text{ kHz}$$

$$\Delta f = 1.46 \text{ kHz}$$

$$f_1 = 20.01 \text{ kHz}$$

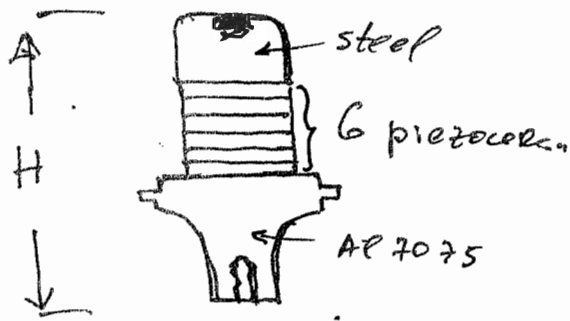
$$f_2 = 21.47 \text{ kHz}$$

BRANSON 502, 105, 925 conv.

①

$$\bar{f} = 19.848 \text{ kHz}$$

$$\Delta f = 2.121 \text{ kHz}$$



$$f_1 = 18.788$$

$$f_2 = 20.909$$

$$P_{diss} = 10 \div 13 \text{ W}$$

$$A_{pp} = 20 (18 \div 22) \mu\text{m}$$

①

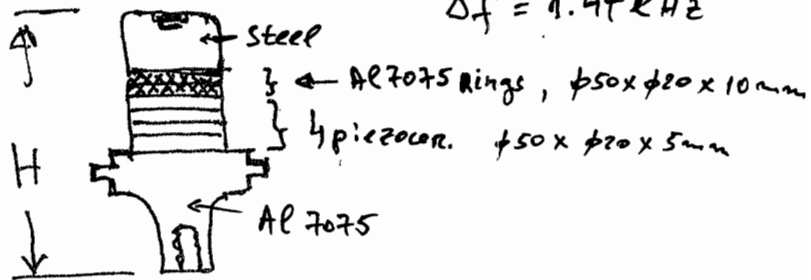
2 piezoceramics replaced by 1 AL7075 ring

$$\bar{f} = 19.845 \text{ kHz}$$

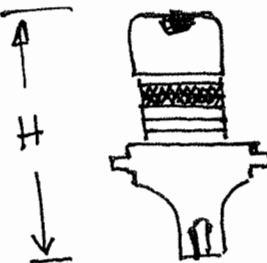
$$f_1 = 19.11 \text{ kHz}$$

$$f_2 = 20.58 \text{ kHz}$$

$$\Delta f = 1.47 \text{ kHz}$$



②



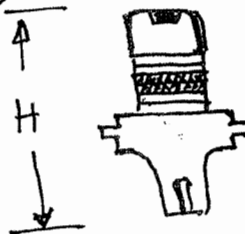
$$\bar{f} = 19.675 \text{ kHz}$$

$$\Delta f = 1.35 \text{ kHz}$$

$$f_1 = 19 \text{ kHz}$$

$$f_2 = 20.35 \text{ kHz}$$

③



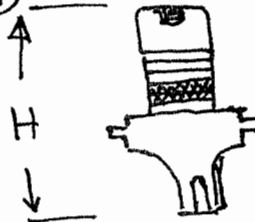
$$\bar{f} = 19.505 \text{ kHz}$$

$$\Delta f = 1.23 \text{ kHz}$$

$$f_1 = 18.89 \text{ kHz}$$

$$f_2 = 20.12 \text{ kHz}$$

④



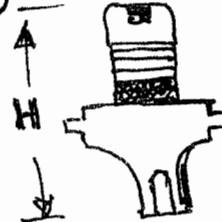
$$\bar{f} = 19.505 \text{ kHz}$$

$$\Delta f = 1.23 \text{ kHz}$$

$$f_1 = 18.89 \text{ kHz}$$

$$f_2 = 20.12 \text{ kHz}$$

⑤



$$\bar{f} = 19.505 \text{ kHz}$$

$$\Delta f = 1.01 \text{ kHz}$$

$$f_1 = 19 \text{ kHz}$$

$$f_2 = 20.01 \text{ kHz}$$

①

$$P_{diss} = 9 \text{ W}$$

$$A_{pp} = 17 \mu\text{m}$$

$$f_{open} \approx f_2 = 20.58 \text{ kHz}$$

②

$$P_{diss} = 10 \text{ W}$$

$$A_{pp} = 17.5 \mu\text{m}$$

$$f_{open} \approx f_2 = 20.35 \text{ kHz}$$

③

$$P_{diss} = 11 \text{ W}$$

$$A_{pp} = 18 \mu\text{m}$$

$$f_{open} \approx f_2 = 20.12 \text{ kHz}$$

④

$$P_{diss} = 8 \text{ W}$$

$$A_{pp} = 19.4 \mu\text{m}$$

$$f_{open} \approx f_2 = 20.12 \text{ kHz}$$

⑤

$$P_{diss} = 11 \text{ W}$$

$$A_{pp} = 21 \mu\text{m}$$

$$f_{open} \approx f_2 = 20.01 \text{ kHz}$$

BRANSON 502, 405, 925 conv.

CARD Calibration: Piezoceramics wave speed

- A -

INITIAL DATA:

Taken as geometric average values for f-avg (before calibration)

f-avg = 19706 Hz:

G-average wave speed = $(3576 \times 2848)^{0.5} =$ 3191 m/s

G-average Young's Modulus = $(97 \times 61)^{0.5} =$ 76.9 GPa

CALCULATED DATA:

Wave speed	3126 m/sec
Gain correction factor (default)	0.025
Resonator gain (calculated, no correction) .	2.44
Largest axial stress (1 micron output)	1.04 MPa at 77.2 mm
Nodes ... 44.2 mm	
Total strain energy (1 micron output)	3.8E-4 joule
Power dissipated (1 micron output)	3.9E-3 watt
Q (overall)	12054
Weight	1.150 kg

Difference regarding wave speed = 3191 – 3126 = 65 m/s
--

MATERIALS:	Thin-wire Wave Speed (m/sec)	Modulus (GPa)	(kg/m ³)	Poisson's Ratio	Q
3 7075-T6 aluminum	5086	73.6	2845	0.33	100000
4 303 stainless steel	4935	195.5	8027	0.25	1000
5 SP-8	3126	76.9	7612	0.31	26000

CARD Calibration: Piezoceramics wave speed

- B -

INITIAL DATA:

Taken as arithmetic average values for f-avg (before calibration)

f-avg = 19706 Hz:

A-average wave speed = $0.5 \times (3576 + 2848) =$ 3212 m/s

A-average Young's Modulus = $0.5 \times (97 + 61) =$ 79 GPa

CALCULATED DATA:

Wave speed	3124 m/sec
Gain correction factor (default)	0.025
Resonator gain (calculated, no correction) .	2.44
Largest axial stress (1 micron output)	1.04 MPa at 77.2 mm
Nodes ... 44.2 mm	
Total strain energy (1 micron output)	3.9E-4 joule
Power dissipated (1 micron output)	4.0E-3 watt
Q (overall)	12138
Weight	1.150 kg

Difference regarding wave speed = $3212 - 3124 = 88$ m/s
--

MATERIALS:	Thin-wire Wave Speed (m/sec)	Modulus (GPa)	(kg/m ³)	Poisson's Ratio	Q
3 7075-T6 aluminum	5086	73.6	2845	0.33	100000
4 303 stainless steel	4935	195.5	8027	0.25	1000
5 SP-8	3124	79	7612	0.31	26000

Example:

BUC 502, Modified
Back mass stainless steel (304)
Front mass AL 7075
Piezoceramics: SP8, CeramTec, 50 x 20 x 5 mm
Central Bolt: Unbrako, 3" long, UNF20, 1/2"

Results after Network Impedance Analyzer Measurements:

$F_s = f_1 = 18762 \text{ Hz}$,
 $F_p = f_2 = 20650 \text{ Hz}$,
 $f\text{-avg} = 0.5(f_1 + f_2) = 19706 \text{ Hz}$

CARD input data, GENERAL REQUIREMENTS:

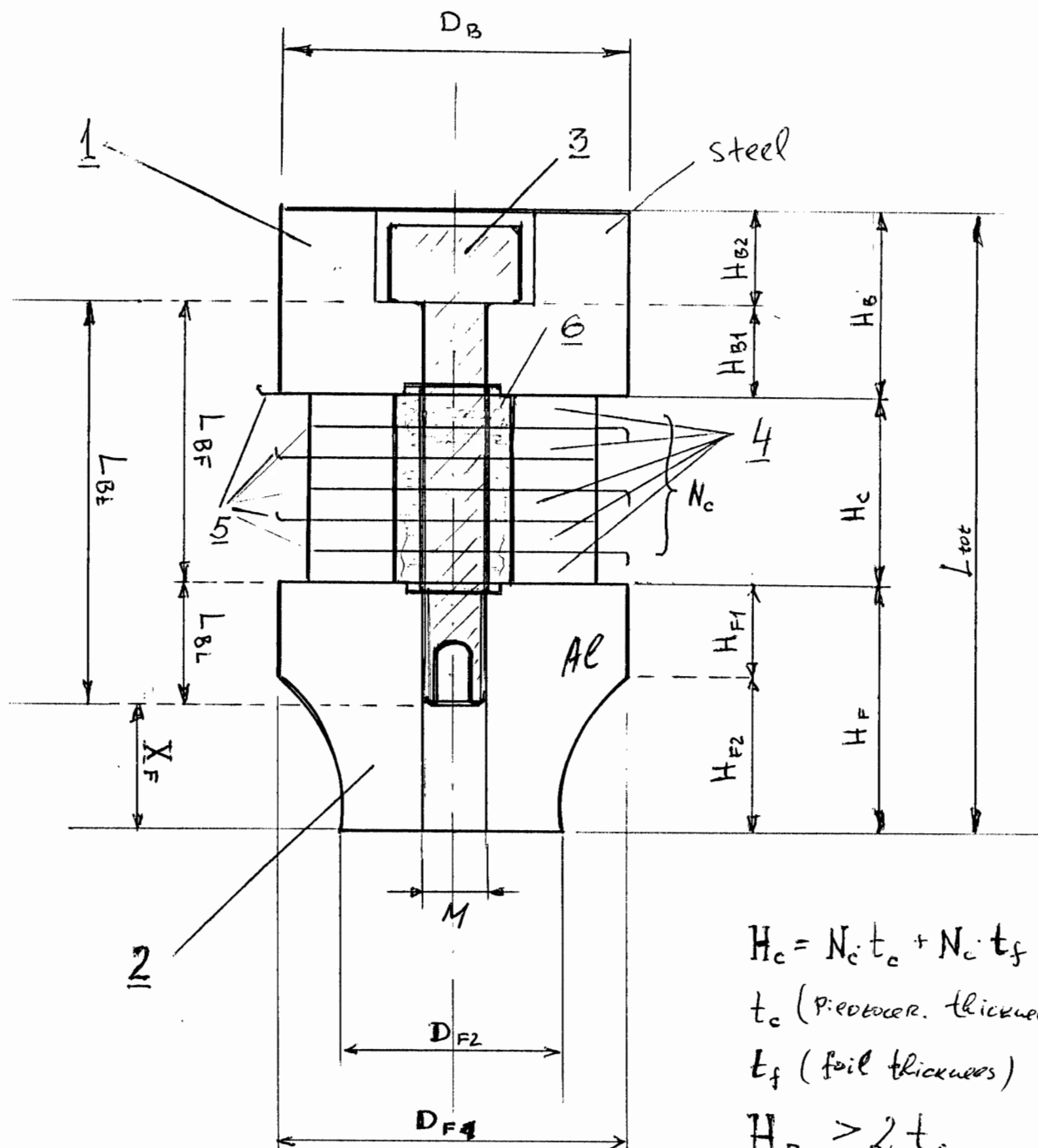
FILE F:\502-F-avg.XDU (10/12/2002)
TITLE BUC 502 xdu, average res-ils (modified M. Prokic)
MODE CALIBRATE (piezoceramics wave speed)
UNITS Metric

Resonator type Cylindrical (unslotted)
Frequency 19706 Hz
Resonator gain (specified) 0.00
Number of half wavelengths 1
Equipment Default
Sensitivity Low

INPUT DATA: OTHER PARAMETERS

Rear stud 12.70 dia. x 76.20 long, inside dia. = 0.00, hole depth = 76.20,
recess depth = 0.00
Front stud None
Rear spanner holes None
Front spanner holes 3: 5.00 dia. x 6.00 deep x 7.50 from face to centerline
Rear wrench flats None
Front wrench flats None
Face cavities None

**BLT
Common
Recommendations
Regarding Dimensions**



$$H_c = N_c \cdot t_c + N_c \cdot t_f$$

t_c (piezocer. thickness)
 t_f (foil thickness)

$$H_{B1} > 2t_c$$

$$(X_F)_{\min} \leq X_F \leq \frac{1}{2} H_F$$

$$L_{BL} \geq (L_{BL})_{\min}$$

$$L_{BL} \leq \frac{1}{2} H_F$$

- 1 BACK MASS E, ρ, N_1
- 2 FRONT MASS $Al, (\text{dural, INVAR}),$
- 3 CENTRAL BOLT Steel (spec.)
- 4 PIEZOCERAMICS (2, 4, 6) $SP8$ (see spec.)
- 5 CONTACT FOILS, ELECTRODES (N_1)
- 6 ISOLATING CYLINDER (TEFLON)

General Criteria for Transducer Design:

INPUT (known, or given in advance): L_{tot} , t_c , t_f , H_C , $f_{Res.}$, P_{max} .

Known approximately and conditionally (in intervals): L_{BL} , L_{BF} , L_{Bt} .

OUTPUT (have to be calculated): H_F , H_B , H_{B1} , H_{B2} , H_{F1} , H_{F2} .

Precise choice has to be made for: L_{BL} , L_{BF} , L_{Bt} .

Approximate input data related to the choice of central bolt, for 20 and 25 kHz, (T1):

T1. CHOICE OF THE CENTRAL BOLT					
Range, (Frequency / Power)	L_{BF} [mm]	L_{BL} [mm]	L_{Bt} [mm]	Thread, approx.	Torque (Moment) [Kp m] approx.
	min / max	min / max	min / max	M[mm]	
20 kHz / 1 KW	40 / 60	20 / 30	60 / 75	10	9/11
20 kHz / 2 KW	40 / 60	25 / 35	67 / 78	11	11/13
20 kHz / 3 KW	40 / 60	30 / 40	75 / 80	12	13/15
25 kHz / 1 KW	30 / 50	20 / 30	50 / 60	10	9/11
25 kHz / 2 KW	30 / 50	25 / 35	55 / 65	11	11/13
25 kHz / 3 KW	30 / 50	30 / 40	60 / 70	12	13/15

PRINCIPAL CONDITIONS (which have to be approximately satisfied and used for calculations of the output data)

$$1. H_F + H_C + H_B = L_{tot} = \text{Const.} = C_1; \frac{1}{3} \left(\frac{C_F}{2f_{Res}} + \frac{C_C}{2f_{Res}} + \frac{C_B}{2f_{Res}} \right) < L_{tot} < \min. \left\{ \frac{C_F}{2f_{Res}}, \frac{C_B}{2f_{Res}} \right\}$$

-(L_{tot} could be experimentally determined length, or calculated by FEA)

$$H_C = N_{ctc} + N_{ctf} = \text{Const.} = C_2$$

-(H_C known in advance, t_c , known from the catalogue of piezoceramic),

$$\Rightarrow H_F + H_B = C_1 - C_2 = \text{Const.}$$

$$H_B = H_{B1} + H_{B2}, H_B \geq 0.5 H_C$$

$$2t_c \leq H_{B1} \leq H_B$$

$$H_F = H_{F1} + H_{F2} = L_{BL} + X_F,$$

$$2t_c \leq H_{F1} \leq H_F,$$

$$X_{Fmin} \leq X_F \leq 0.5 H_F,$$

-(X_{Fmin} , known in advance, by calculation, or experimentally)

$$2. L_{BL} + L_{BF} = L_{Bt} \left(\approx \frac{\lambda_{BOLT}}{4} = \frac{C_{BOLT}}{4f_{Res}} \right)$$

-(L_{Bt} taken from the catalogue of bolts supplier, according to T1.),

$$C_3 \leq L_{Bt} \leq C_4$$

$$C_5 \leq L_{BL} \leq C_6$$

$$C_7 \leq L_{BF} \leq C_8$$

$$\text{Const.} = X_{Fmin} \leq L_{BLmin} \leq L_{BL} \leq 0.5 H_F$$

$$L_{BLmin} = \text{Const.} = C_5$$

-(L_{BLmin} known in advance, by calculation, or experimentally from T1),

$$C_7 \leq (L_{BF} = H_C + H_{B1}) \leq C_8.$$

MODEL	Fr	L _{lot}	H _B	H _F	H _c	H _{B1}	H _{B2}	H _{F1}	H _{F2}	L _{BF}	L _{BL}	L _{BT}	X _F	D _B	D _{F1}	D _{F2}	Piezo. thick.	N _c	Cont. foil	Piezo	Bolt (Inch), M [mm]	Comment
(power [W])	[kHz]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	(2,4,6)	t _f [mm]	[mm]		
BRANSON, standard, 925/502/105, 3kW	20.00	121.18	28.58	60.33	32.28	13.34	15.24	8.71	51.61	45.62	24.24	69.85	36.09	50.80	63.50	38.10	5.08	6.00	0.30	50.08	1/2	Good, Lat is too small
BRANSON, modified, B 925/502/105, 2kW	20.00	120.22	38.38	60.33	21.52	23.50	14.88	8.71	51.61	45.02	24.84	69.85	35.49	50.80	63.50	38.10	5.08	4.00	0.30	50.08	1/2	Good, Lat is too small
BRANSON, modified, F 925/502/105, 2kW	20.00	120.58	28.58	70.49	21.52	13.34	15.24	18.87	51.61	45.02	24.84	69.85	35.49	50.80	63.50	38.10	5.08	4.00	0.30	50.08	1/2	Good, Lat is too small
BRANSON, 922 (*), 2kW	20.00	117.10	28.58	67.00	21.52	13.34	15.24	10.50	56.50	34.86	35.00	69.85	32.01	50.80	63.50	38.10	5.08	4.00	0.30	50.08	1/2	Problematic
DUKANE, standard, 2kW	20.00	113.22	29.00	61.00	23.22	10.58	18.42	7.00	54.00	33.80	39.33	73.13	21.67	50.80	57.00	28.00	5.45	4.00	0.35	50.08	1/2	OK
BRANSON, standard, 102, 1kW	20.00	124.32	19.00	83.80	21.52	11.40	7.60	25.10	58.70	32.92	17.08	50.00	25.00	40.80	60.30	38.10	5.08	4.00	0.30	40.8, approx 5.08, 20.7	approx M10	OK
MECASONIC standard, 1kW	20.00	116.50	50.00	56.20	10.30	50.00	0.00	56.20	0.00	15.80	36.70	75.20	16.00	53.00	53.00	53.00	5.00	2.00	0.30	50, 28, M 16		Good
AVERAGE	20.00	119.02	31.73	65.59	21.70	19.35	12.37	19.30	46.29	36.15	28.86	67.98	28.82	49.69	60.61	38.79	5.12	4.00	0.31			
MIN	20.00	113.22	19.00	56.20	10.30	10.58	0.00	7.00	0.00	15.80	17.08	50.00	16.00	40.80	53.00	28.00	5.00	2.00	0.30			
MAX.	20.00	124.32	50.00	83.80	32.28	50.00	18.42	56.20	58.70	45.62	39.33	75.20	36.09	53.00	63.50	53.00	5.45	6.00	0.35			
OPTIMUM	20									35/50	30/40	75/80	25/30						0.3			

MODEL (description, power [W])	Fr	L _{tot}	H _B	H _F	H _c	H _{B1}	H _{B2}	H _{F1}	H _{F2}	L _{Bf}	L _{BL}	L _{Bt}	X _F	D _B	D _{F1}	D _{F2}	Piezo. thick.	N _c	Cont. foil	Piezo	Bolt, (Inch), M[mm]	Comment
	[kHz]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	(2,4,6)	[mm]	[mm]	
Design prop., "A", 3kW	20.00	121.18	29.38	60.00	31.80	18.20	11.18	10.00	50.00	50.00	30.00	80.00	30.00	50.80	63.50	38.10	5.00	6.00	0.30	50, 20, 5	1/2	(*) OK
BRANSON, standard,3kW	20.00	121.18	28.58	60.33	32.28	13.34	15.24	8.71	51.61	45.62	24.24	69.85	36.09	50.80	63.50	38.10	5.08	6.00	0.30	50.08 20.7, 5.08	1/2	Good, L _{Bt} is too small
Design prop., "B", 3kW	20.00	121.18	24.38	65.00	31.80	18.20	6.18	10.00	55.00	50.00	30.00	80.00	35.00	50.80	63.50	38.10	5.00	6.00	0.30	50, 20, 5	1/2	(*) OK
Design prop., "A", 2kW	20.00	121.20	40.00	60.00	21.20	18.80	21.20	10.00	50.00	40.00	30.00	70.00	30.00	50.80	63.50	38.10	5.00	4.00	0.30	50, 20, 5	M11	(*) OK
Design prop., "B", 2kW	20.00	121.20	35.00	65.00	21.20	16.34	18.66	10.00	55.00	37.54	32.46	70.00	32.54	50.80	63.50	38.10	5.00	4.00	0.30	50, 20, 5	M11	(*) OK
Design prop., "A", 1kW	20.00	121.20	50.60	60.00	10.60	29.00	21.60	10.00	50.00	39.60	25.40	65.00	34.60	50.80	63.50	38.10	5.00	2.00	0.30	50, 20, 5	M10	not tested
Design prop., "B", 1kW	20.00	121.20	45.60	65.00	10.60	34.00	11.60	10.00	55.00	44.60	25.40	70.00	39.60	50.80	63.50	38.10	5.00	2.00	0.30	50, 20, 5	M10	not tested
AVERAGE	20.00	121.19	36.22	62.19	22.78	21.13	15.09	9.82	52.37	43.91	28.21	72.50	33.98	50.80	63.50	38.10	5.01	4.29	0.30			
MIN	20.00	121.18	24.38	60.00	10.60	13.34	6.18	8.71	50.00	37.54	24.24	65.00	30.00	50.80	63.50	38.10	5.00	2.00	0.30			
MAX	20.00	121.20	50.60	65.00	32.28	34.00	21.60	10.00	55.00	50.00	32.46	80.00	39.60	50.80	63.50	38.10	5.08	6.00	0.30			
OPTIMUM	20									35/50	30/40	75/80	25/30						0.3			

MODEL (description, power [W])	Fr [kHz]	L _{tot} [mm]	H _B [mm]	H _F [mm]	H _c [mm]	H _{B1} [mm]	H _{B2} [mm]	H _{F1} [mm]	H _{F2} [mm]	L _{BF} [mm]	L _{BL} [mm]	L _{at} [mm]	X _F [mm]	D _B [mm]	D _{F1} [mm]	D _{F2} [mm]	Piezo. thick. t _c [mm]	N _c (2,4,6)	Cont. foil t _f [mm]	Piezo [mm]	Bolt, (Inch), M[mm]	Comment
Design prop., "A", 3kW	20.00	121.18	35.38	66.00	19.80	18.20	17.18	6.00	60.00	38.00	32.00	70.00	34.00	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop., "B", 3kW	20.00	121.18	35.00	66.38	19.80	13.34	21.67	8.71	57.67	33.14	31.87	65.00	34.52	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop., "C", 3kW	20.00	121.18	30.38	71.00	19.80	18.20	12.18	6.00	65.00	38.00	32.00	70.00	39.00	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop., "A", 2kW	20.00	121.20	44.00	64.00	13.20	18.80	25.20	6.00	58.00	32.00	33.00	65.00	31.00	50.80	63.50	38.10	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop., "B", 2kW	20.00	121.20	39.00	69.00	13.20	16.34	22.66	6.00	63.00	29.54	30.46	60.00	38.54	50.80	63.50	38.10	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop., "A", 1kW	20.00	121.20	52.60	62.00	6.60	29.00	23.60	6.00	56.00	35.60	29.40	65.00	32.60	50.80	63.50	38.10	3.00	2.00	0.30	50, 20, 3	M10	not tested
Design prop."B", 1kW	20.00	121.20	47.60	67.00	6.60	34.00	13.60	6.00	61.00	40.60	19.40	60.00	47.60	50.80	63.50	38.10	3.00	2.00	0.30	50, 20, 3	M10	not tested
AVERAGE	20.00	121.19	40.56	66.48	14.14	21.13	19.44	6.39	60.10	35.27	29.73	65.00	36.75	50.80	63.50	38.10	3.00	4.29	0.30			
MIN	20.00	121.18	30.38	62.00	6.60	13.34	12.18	6.00	56.00	29.54	19.40	60.00	31.00	50.80	63.50	38.10	3.00	2.00	0.30			
MAX	20.00	121.20	52.60	71.00	19.80	34.00	25.20	8.71	65.00	40.60	33.00	70.00	47.60	50.80	63.50	38.10	3.00	6.00	0.30			
OPTIMUM	20									30/45	20/35	60/70	25/40						0.3			

MODEL	Fr	L _{tot}	H _B	H _F	H _c	H _{B1}	H _{B2}	H _{F1}	H _{F2}	L _{BF}	L _{BL}	L _{Bt}	X _F	D _B	D _{F1}	D _{F2}	Piezo. thick.	N _c	Cont. foil	Piezo [mm]	Bolt, (Inch), M[mm]	Comment
(power [W])	[kHz]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	(2,4,6)	t[mm]	[mm]	
Design prop.	25.00	83.75	13.00	38.95	31.80	13.00	0.00	19.50	19.45	44.80	20.20	65.00	18.75	51.00	51.00	40.00	5.00	6.00	0.30	50, 20,	M12	not tested
"A", 3kW																				5		
Design prop.	25.00	83.75	15.00	36.95	31.80	13.00	2.00	18.50	18.45	44.80	20.20	65.00	16.75	51.00	51.00	40.00	5.00	6.00	0.30	50, 20,	M12	not tested
"B", 3kW																				5		
Design prop.	25.00	83.75	11.43	40.53	31.80	11.43	0.00	19.88	20.65	43.23	21.78	65.0	18.75	51.00	51.00	40.00	5.00	6.00	0.30	50; 20;	M12	not tested
"C", 3kW																				5		
Design prop.	25.00	83.75	20.00	42.55	21.20	18.80	1.20	21.30	21.25	40.00	25.00	65.00	17.55	51.00	51.00	40.00	5.00	4.00	0.30	50, 20,	M11	not tested
"A", 2kW																				5		
Design prop.	25.00	83.75	22.03	40.53	21.20	17.00	5.03	19.88	20.65	38.20	21.80	60	18.73	51.00	51.00	40.00	5.00	4.00	0.30	50; 20;	M11	not tested
"B", 2kW																				5		
Design prop.	25.00	83.75	20.00	42.55	21.20	15.00	5.00	21.30	21.25	36.20	23.80	60.00	18.75	51.00	51.00	40.00	5.00	4.00	0.30	50, 20,	M11	not tested
"C", 2kW																				5		
Design prop.	25.00	84.70	33.00	41.10	10.60	24.00	9.00	20.50	20.60	34.60	20.40	55.00	20.70	51.00	51.00	40.00	5.00	2.00	0.30	50, 20,	M10	(*) OK
"A", 1kW																				5		
Design prop.	25.00	84.70	33.00	41.10	10.60	28.00	5.00	20.50	20.60	38.60	21.40	60.00	19.70	51.00	51.00	40.00	5.00	2.00	0.30	50, 20,	M10	(*) OK
"B", 1kW																				5		
Ei-Nis, 1kW	25.00	84.70	33.00	38.50	13.20	20.00	13.00	19.00	19.50	33.20	21.80	55	16.70	51.00	51.00	40.00	6.35	2.00	0.25	50, 20,	M10	Very good
Ei-Nis, 500W	25.00	82.90	31.30	41.00	10.60	20.00	11.30	41.00	0.00	30.60	19.40	50	21.60	40.00	40.00	40.00	5.00	2.00	0.30	38;	M8	(*) OK
Ei-Nis, 500W	25.00	82.80	31.30	41.00	10.50	20.00	11.30	41.00	0.00	30.50	14.50	45.00	26.50	40.00	40.00	40.00	5.00	2.00	0.25	15; 5	M8	Very good
AVERAGE	25.00	83.85	23.91	40.43	19.50	18.20	5.71	23.85	16.58	37.70	20.93	59.29	19.50	49.00	49.00	40.00	5.12	3.64	0.29			
MIN	25.00	82.80	11.43	36.95	10.50	11.43	0.00	18.50	0.00	30.50	14.50	45.00	16.70	40.00	40.00	40.00	5.00	2.00	0.25			
MAX.	25.00	84.70	33.00	42.55	31.80	28.00	13.00	41.00	21.25	44.80	25.00	65.00	26.50	51.00	51.00	40.00	6.35	6.00	0.30			
OPTIMUM										30/50	20/40	50/70	20/30						0.3			

MODEL	Fr	L _{tot}	H _B	H _F	H _C	H _{B1}	H _{B2}	H _{F1}	H _{F2}	L _{BF}	L _{BL}	L _{BT}	X _F	D _B	D _{F1}	D _{F2}	Piezo. thick. t _p [mm]	N _c (2,4,6)	Cont. foil t _f [mm]	Piezo [mm]	Bolt, (Inch), M[mm]	Comment
(power [W])																						
Design prop.	25.00	83.75	19.00	44.95	19.80	13.00	6.00	19.50	25.45	32.80	22.20	55.00	22.75	51.00	51.00	40.00	3.00	6.00	0.30	50, 20,	M12	not tested
"A", 3kW																				3		
Design prop.	25.00	83.75	21.00	42.95	19.80	13.00	8.00	18.50	24.45	32.80	22.20	55.00	20.75	51.00	51.00	40.00	3.00	6.00	0.30	50, 20,	M12	not tested
"B", 3kW																				3		
Design prop.	25.00	83.75	17.43	46.53	19.80	11.43	6.00	19.88	26.65	31.23	23.78	55.00	22.75	51.00	51.00	40.00	3.00	6.00	0.30	50, 20,	M12	not tested
"C", 3kW																				3		
Design prop.	25.00	83.75	24.00	46.55	13.20	18.80	5.20	21.30	25.25	32.00	23.00	55.00	23.55	51.00	51.00	40.00	3.00	4.00	0.30	50, 20,	M11	not tested
"A", 2kW																				3		
Design prop.	25.00	83.75	26.03	44.53	13.20	17.00	9.03	19.88	24.65	30.20	24.80	55.00	19.75	51.00	51.00	40.00	3.00	4.00	0.30	50, 20,	M11	not tested
"B", 2kW																				3		
Design prop.	25.00	83.75	24.00	46.55	13.20	15.00	9.00	21.30	25.25	28.20	26.80	55.00	19.75	51.00	51.00	40.00	3.00	4.00	0.30	50, 20,	M11	not tested
"C", 2kW																				3		
Design prop.	25.00	84.70	35.00	43.10	6.60	24.00	11.00	20.50	22.60	30.60	19.40	50.00	23.70	51.00	51.00	40.00	3.00	2.00	0.30	50, 20,	M10	not tested
"A", 1kW																				3		
Design prop.	25.00	84.70	35.00	43.10	6.60	28.00	7.00	20.50	22.60	34.60	20.40	55.00	22.70	51.00	51.00	40.00	3.00	2.00	0.30	50, 20,	M10	not tested
"B", 1kW																				3		
Design prop.	25.00	82.90	33.30	43.00	6.60	20.00	13.30	41.00	2.00	26.60	18.40	45.00	24.60	40.00	40.00	40.00	3.00	2.00	0.30	38; 20; 3	M8	not tested
500W																						
AVERAGE	25.00	83.87	26.08	44.58	13.20	17.80	8.28	22.48	22.10	31.00	22.33	53.33	22.25	49.78	49.78	40.00	3.00	4.00	0.30			
MIN	25.00	82.90	17.43	42.95	6.60	11.43	5.20	18.50	2.00	26.60	18.40	45.00	19.73	40.00	40.00	40.00	3.00	2.00	0.30			
MAX.	25.00	84.70	35.00	46.55	19.80	28.00	13.30	41.00	26.65	34.60	26.80	55.00	24.60	51.00	51.00	40.00	3.00	6.00	0.30			
OPTIMUM	25									30/40	20/30	45/55	20/30						0.3			

MODEL (description, power [W])	Fr [kHz]	Lw [mm]	Hb [mm]	Hf [mm]	Hc [mm]	Hb1 [mm]	Hb2 [mm]	Hf1 [mm]	Hf2 [mm]	LbF [mm]	LbL [mm]	LbR [mm]	Xf [mm]	Dg [mm]	Df1 [mm]	Df2 [mm]	Piezo: thick. t [mm]	Nc (2,4,6)	Cont. foil t [mm]	Piezo [mm]	Bolt, (inch), M[mm]	Comment
Design prop., 3kW	20.00	121.18	29.38	60.00	31.80	18.20	11.18	10.00	50.00	50.00	30.00	80.00	30.00	50.80	63.50	38.10	5.00	6.00	0.30	50, 20, 5	1/2	(*) OK
BRANSON, standard, 3kW	20.00	121.18	28.58	60.33	32.28	13.34	15.24	8.71	51.61	45.62	24.24	69.85	36.09	50.80	63.50	38.10	5.08	6.00	0.30	50.08 20.7, 5.08	1/2	Good, L _{bf} is too small
Design prop., "B", 3kW	20.00	121.18	24.38	65.00	31.80	18.20	6.18	10.00	55.00	50.00	30.00	80.00	35.00	50.80	63.50	38.10	5.00	6.00	0.30	50, 20, 5	1/2	(*) OK
Design prop. "A", 2kW	20.00	121.20	40.00	60.00	21.20	18.80	21.20	10.00	50.00	40.00	30.00	70.00	30.00	50.80	63.50	38.10	5.00	4.00	0.30	50, 20, 5	M11	(*) OK
Design prop. "B", 2kW	20.00	121.20	35.00	65.00	21.20	16.34	18.66	10.00	55.00	37.54	32.46	70.00	32.54	50.80	63.50	38.10	5.00	4.00	0.30	50, 20, 5	M11	(*) OK
Design prop. "A", 1kW	20.00	121.20	50.60	60.00	10.60	29.00	21.60	10.00	50.00	39.60	25.40	65.00	34.60	50.80	63.50	38.10	5.00	2.00	0.30	50, 20, 5	M10	not tested
Design prop. "B", 1kW	20.00	121.20	45.60	65.00	10.60	34.00	11.60	10.00	55.00	44.60	25.40	70.00	39.60	50.80	63.50	38.10	5.00	2.00	0.30	50, 20, 5	M10	not tested
Design prop. "A", 3kW	25.00	83.75	13.00	38.95	31.80	13.00	0.00	19.50	19.45	44.80	20.20	65.00	18.75	51.00	51.00	40.00	5.00	6.00	0.30	50, 20, 5	M12	not tested
Design prop. "B", 3kW	25.00	83.75	15.00	36.95	31.80	13.00	2.00	18.50	18.45	44.80	20.20	65.00	16.75	51.00	51.00	40.00	5.00	6.00	0.30	50, 20, 5	M12	not tested
Design prop. "C", 3kW	25.00	83.75	11.43	40.53	31.80	11.43	0.00	19.88	20.65	43.23	21.78	65.0	18.75	51.00	51.00	40.00	5.00	6.00	0.30	50, 20, 5	M12	not tested
Design prop. "A", 2kW	25.00	83.75	20.00	42.55	21.20	18.80	1.20	21.30	21.25	40.00	25.00	65.00	17.55	51.00	51.00	40.00	5.00	4.00	0.30	50, 20, 5	M11	not tested
Design prop. "B", 2kW	25.00	83.75	22.03	40.53	21.20	17.00	5.03	19.88	20.65	38.20	21.80	60	18.73	51.00	51.00	40.00	5.00	4.00	0.30	50, 20, 5	M11	not tested
Design prop. "C", 2kW	25.00	83.75	20.00	42.55	21.20	15.00	5.00	21.30	21.25	36.20	23.80	60.00	18.75	51.00	51.00	40.00	5.00	4.00	0.30	50, 20, 5	M11	not tested
Design prop. "A", 2kW	25.00	84.70	33.00	41.10	10.60	24.00	9.00	20.50	20.60	34.60	20.40	55.00	20.70	51.00	51.00	40.00	5.00	2.00	0.30	50, 20, 5	M10	(*) OK
Design prop. "B", 2kW	25.00	84.70	33.00	41.10	10.60	28.00	5.00	20.50	20.60	38.60	21.40	60.00	19.70	51.00	51.00	40.00	5.00	2.00	0.30	50, 20, 5	M10	(*) OK
Ei-Nis, 1kW	25.00	84.70	33.00	38.50	13.20	20.00	13.00	19.00	19.50	33.20	21.80	55	16.70	51.00	51.00	40.00	6.35	2.00	0.25	50, 20, 5	M10	Very good
Ei-Nis, 500W	25.00	82.90	31.30	41.00	10.60	20.00	11.30	41.00	0.00	30.60	19.40	50	21.60	40.00	40.00	40.00	5.00	2.00	0.30	38, 15, 5	M8	(*) OK
Ei-Nis, 500W	25.00	82.80	31.30	41.00	10.50	20.00	11.30	41.00	0.00	30.50	14.50	45.00	26.50	40.00	40.00	40.00	5.00	2.00	0.25	38, 13, 5	M8	Very good
AVERAGE	23.06	98.37	28.70	48.89	20.78	19.34	9.36	18.39	30.50	40.12	23.77	65.38	25.13	49.70	54.84	39.26	5.08	3.89	0.29			
MIN	20.00	82.80	11.43	36.95	10.50	11.43	0.00	8.71	0.00	30.50	14.50	45.00	16.70	40.00	40.00	38.10	5.00	2.00	0.25			
MAX	25.00	121.20	50.60	65.00	32.28	34.00	21.60	41.00	55.00	50.00	32.46	80.00	39.60	51.00	63.50	40.00	6.35	6.00	0.30			
OPTIMUM										30/50	20/40	50/80	20/30						0.3			

Sheet8

MODEL (description)	Fr	L _{ax} [mm]	H _g [mm]	H _f [mm]	H _c [mm]	H _{B1}	H _{B2}	H _{F1}	H _{F2}	L _{BF}	L _{BL}	L _{ax} [mm]	X _F [mm]	D _B	D _{F1}	D _{F2}	Piezo. thick	N _c	Cont. foil	Piezo	Bolt (Inch), M/mm)	Comment
power [W]																						
Design prop. "A", 3kW	20.00	121.18	35.38	66.00	19.80	18.20	17.18	6.00	60.00	38.00	32.00	70.00	34.00	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop. "B", 3kW	20.00	121.18	35.00	66.38	19.80	13.34	21.67	8.71	57.67	33.14	31.87	65.00	34.52	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop. "C", 3kW	20.00	121.18	30.38	71.00	19.80	18.20	12.18	6.00	65.00	38.00	32.00	70.00	39.00	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop. "A", 2kW	20.00	121.20	44.00	64.00	13.20	18.80	25.20	6.00	58.00	32.00	33.00	65.00	31.00	50.80	63.50	38.10	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop. "B", 2kW	20.00	121.20	39.00	69.00	13.20	16.34	22.66	6.00	63.00	29.54	30.46	60.00	38.54	50.80	63.50	38.10	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop. "A", 1kW	20.00	121.20	52.60	62.00	6.60	29.00	23.60	6.00	56.00	35.60	29.40	65.00	32.60	50.80	63.50	38.10	3.00	2.00	0.30	50, 20, 3	M10	not tested
Design prop. "B", 1kW	20.00	121.20	47.60	67.00	6.60	34.00	13.60	6.00	61.00	40.60	19.40	60.00	47.60	50.80	63.50	38.10	3.00	2.00	0.30	50, 20, 3	M10	not tested
Design prop. "A", 3kW	25.00	83.75	19.00	44.95	19.80	13.00	6.00	19.50	25.45	32.80	22.20	55.00	22.75	51.00	51.00	40.00	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop. "B", 3kW	25.00	83.75	21.00	42.95	19.80	13.00	8.00	18.50	24.45	32.80	22.20	55.00	20.75	51.00	51.00	40.00	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop. "C", 3kW	25.00	83.75	17.43	46.53	19.80	11.43	6.00	19.88	26.65	31.23	23.78	55.00	22.75	51.00	51.00	40.00	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop. "A", 2kW	25.00	83.75	24.00	46.55	13.20	18.80	5.20	21.30	25.25	32.00	23.00	55.00	23.55	51.00	51.00	40.00	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop. "B", 2kW	25.00	83.75	26.03	44.53	13.20	17.00	9.03	19.88	24.65	30.20	24.80	55.00	19.73	51.00	51.00	40.00	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop. "C", 2kW	25.00	83.75	24.00	46.55	13.20	15.00	9.00	21.30	25.25	28.20	26.80	55.00	19.75	51.00	51.00	40.00	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop. "A", 1kW	25.00	84.70	35.00	43.10	6.60	24.00	11.00	20.50	22.60	30.60	19.40	50.00	23.70	51.00	51.00	40.00	3.00	2.00	0.30	50, 20, 3	M10	not tested
Design prop. "B", 1kW	25.00	84.70	35.00	43.10	6.60	28.00	7.00	20.50	22.60	34.60	20.40	55.00	22.70	51.00	51.00	40.00	3.00	2.00	0.30	50, 20, 3	M10	not tested
Design prop. 500W	25.00	82.90	33.30	43.00	6.60	20.00	13.30	41.00	2.00	26.60	18.40	45.00	24.60	40.00	40.00	40.00	3.00	2.00	0.30	38, 20, 3	M8	not tested
AVERAGE	22.81	100.20	32.42	54.16	13.61	19.26	13.16	15.44	38.72	32.87	25.57	58.44	28.60	50.23	55.78	39.17	3.00	4.13	0.30			
MIN	20.00	82.90	17.43	42.95	6.60	11.43	5.20	6.00	2.00	26.60	18.40	45.00	19.73	40.00	40.00	38.10	3.00	2.00	0.30			
MAX.	25.00	121.20	52.60	71.00	19.80	34.00	25.20	41.00	65.00	40.60	33.00	70.00	47.60	51.00	63.50	40.00	3.00	6.00	0.30			
OPTIMUM										30/45	20/35	45/70	20/60				3.00		0.3			

MODEL (description)	Fr	L _{ext} [mm]	H _{lg} [mm]	H _{fr}	H _z [mm]	H _{g1}	H _{g2}	H _{fr1}	H _{fr2}	L _{sf}	L _{sl}	L _{sf} [mm]	X _f [mm]	D _g	D _{f1}	D _{f2}	Piezo thick t _e [mm]	N _e (2,4,6)	Cont. foil	Piezo [mm]	Bolt (inch), [mm]	Comment
power [W]	20.00	121.18	29.38	60.00	31.80	18.20	11.18	10.00	50.00	50.00	30.00	80.00	30.00	50.80	63.50	38.10	5.00	6.00	0.30	50, 20, 5	1/2	(*) OK
Design prop., "A", 3kW	20.00	121.18	28.58	60.33	32.28	13.34	15.24	8.71	51.61	45.62	24.24	69.85	36.09	50.80	63.50	38.10	5.08	6.00	0.30	50.08 20.7,	1/2	Good, L _{sf} is too small
BRANSON, standard 3kW	20.00	121.18	24.38	65.00	31.80	18.20	6.18	10.00	55.00	50.00	30.00	80.00	35.00	50.80	63.50	38.10	5.00	6.00	0.30	50, 20, 5	1/2	(*) OK
Design prop., "B", 3kW	20.00	121.20	40.00	60.00	21.20	18.80	21.20	10.00	50.00	40.00	30.00	70.00	30.00	50.80	63.50	38.10	5.00	4.00	0.30	50, 20, 5	M11	(*) OK
Design prop. "A", 2kW	20.00	121.20	35.00	65.00	21.20	16.34	18.66	10.00	55.00	37.54	32.46	70.00	32.54	50.80	63.50	38.10	5.00	4.00	0.30	50, 20, 5	M11	(*) OK
Design prop. "B", 2kW	20.00	121.20	50.60	60.00	10.60	29.00	21.60	10.00	50.00	39.60	25.40	65.00	34.60	50.80	63.50	38.10	5.00	2.00	0.30	50, 20, 5	M10	not tested
Design prop. "A", 1kW	20.00	121.20	45.60	65.00	10.60	34.00	11.60	10.00	55.00	44.60	25.40	70.00	39.60	50.80	63.50	38.10	5.00	2.00	0.30	50, 20, 5	M10	not tested
Design prop. "B", 1kW	20.00	121.18	35.38	66.00	19.80	18.20	17.18	6.00	60.00	38.00	32.00	70.00	34.00	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop., "A", 3kW	20.00	121.18	35.00	66.38	19.80	13.34	21.67	8.71	57.67	33.14	31.87	65.00	34.52	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop., "B", 3kW	20.00	121.18	30.38	71.00	19.80	18.20	12.18	6.00	65.00	38.00	32.00	70.00	39.00	50.80	63.50	38.10	3.00	6.00	0.30	50, 20, 3	M12	not tested
Design prop., "C", 3kW	20.00	121.20	44.00	64.00	13.20	18.80	25.20	6.00	58.00	32.00	33.00	65.00	31.00	50.80	63.50	38.10	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop. "A", 2kW	20.00	121.20	39.00	69.00	13.20	16.34	22.66	6.00	63.00	29.54	30.46	60.00	38.54	50.80	63.50	38.10	3.00	4.00	0.30	50, 20, 3	M11	not tested
Design prop. "B", 2kW	20.00	121.20	52.60	62.00	6.60	29.00	23.60	6.00	56.00	35.60	29.40	65.00	32.60	50.80	63.50	38.10	3.00	2.00	0.30	50, 20, 3	M10	not tested
Design prop. "A", 1kW	20.00	121.20	47.60	67.00	6.60	34.00	13.60	6.00	61.00	40.60	19.40	60.00	47.60	50.80	63.50	38.10	3.00	2.00	0.30	50, 20, 3	M10	not tested
Design prop. "B", 1kW	20.00	121.19	38.39	64.34	18.46	21.13	17.27	8.10	56.23	39.59	28.97	68.46	35.36	50.80	63.50	38.10	4.01	4.29	0.30			
AVERAGE	20.00	121.18	24.38	60.00	6.60	13.34	6.18	6.00	50.00	29.54	19.40	60.00	30.00	50.80	63.50	38.10	3.00	2.00	0.30			
MIN	20.00	121.20	52.60	71.00	32.28	34.00	25.20	10.00	65.00	50.00	33.00	80.00	47.60	50.80	63.50	38.10	5.08	6.00	0.30			
MAX	20.00	121.20	52.60	71.00	32.28	34.00	25.20	10.00	65.00	50.00	33.00	80.00	47.60	50.80	63.50	38.10	5.08	6.00	0.30			
OPTIMUM	20.00									30/50	20/35	60/80	30/50						0.3			

Sheet9

MODEL (power [W])	Fr	L _{ax}	H _B	H _F	H _E	H _{B1}	H _{B2}	H _{F1}	H _{F2}	L _{BF}	L _{BL}	L _{BR}	X _E	D _B	D _{F1}	D _{F2}	Piezo. thick. L [mm]	N _z (2,4,6)	Cont. foil Piezo [mm]	Bolt, (Inch), M[mm]	Comment
Design prop. "A", 3kW	25.00	83.75	13.00	38.95	31.80	13.00	0.00	19.50	19.45	44.80	20.20	65.00	18.75	51.00	51.00	40.00	5.00	6.00	50, 20, 5	M12	not tested
Design prop. "B", 3kW	25.00	83.75	15.00	36.95	31.80	13.00	2.00	18.50	18.45	44.80	20.20	65.00	16.75	51.00	51.00	40.00	5.00	6.00	50, 20, 5	M12	not tested
Design prop. "C", 3kW	25.00	83.75	11.43	40.53	31.80	11.43	0.00	19.88	20.65	43.23	21.78	65.00	18.75	51.00	51.00	40.00	5.00	6.00	50, 20, 5	M12	not tested
Design prop. "A", 2kW	25.00	83.75	20.00	42.55	21.20	18.80	1.20	21.30	21.25	40.00	25.00	65.00	17.55	51.00	51.00	40.00	5.00	4.00	50, 20, 5	M11	not tested
Design prop. "B", 2kW	25.00	83.75	22.03	40.53	21.20	17.00	5.03	19.88	20.65	38.20	21.80	60	18.73	51.00	51.00	40.00	5.00	4.00	50, 20, 5	M11	not tested
Design prop. "C", 2kW	25.00	83.75	20.00	42.55	21.20	15.00	5.00	21.30	21.25	36.20	23.80	60.00	18.75	51.00	51.00	40.00	5.00	4.00	50, 20, 5	M11	not tested
Design prop. "A", 1kW	25.00	84.70	33.00	41.10	10.60	24.00	9.00	20.50	20.60	34.60	20.40	55.00	20.70	51.00	51.00	40.00	5.00	2.00	50, 20, 5	M10	(*) OK
Design prop. "B", 1kW	25.00	84.70	33.00	41.10	10.60	28.00	5.00	20.50	20.60	38.60	21.40	60.00	19.70	51.00	51.00	40.00	5.00	2.00	50, 20, 5	M10	(*) OK
Design prop. "C", 1kW	25.00	84.70	33.00	38.50	13.20	20.00	13.00	19.00	19.50	33.20	21.80	55	16.70	51.00	51.00	40.00	6.35	2.00	50, 20, 5	M10	Very good
Design prop. "A", 500W	25.00	82.90	31.30	41.00	10.60	20.00	11.30	41.00	0.00	30.60	19.40	50	21.60	40.00	40.00	40.00	5.00	2.00	38, 15, 5	M8	(*) OK
Design prop. "B", 500W	25.00	82.80	31.30	41.00	10.50	20.00	11.30	41.00	0.00	30.50	14.50	45.00	26.50	40.00	40.00	40.00	5.00	2.00	38, 13, 5	M8	Very good
Design prop. "C", 500W	25.00	83.75	19.00	44.95	19.80	13.00	6.00	19.50	25.45	32.80	22.20	55.00	22.75	51.00	51.00	40.00	3.00	6.00	50, 20, 3	M12	not tested
Design prop. "A", 3kW	25.00	83.75	21.00	42.95	19.80	13.00	8.00	18.50	24.45	32.80	22.20	55.00	20.75	51.00	51.00	40.00	3.00	6.00	50, 20, 3	M12	not tested
Design prop. "B", 3kW	25.00	83.75	17.43	46.53	19.80	11.43	6.00	19.88	26.65	31.23	23.78	55.00	22.75	51.00	51.00	40.00	3.00	6.00	50, 20, 3	M12	not tested
Design prop. "C", 3kW	25.00	83.75	24.00	46.55	13.20	18.80	5.20	21.30	25.25	32.00	23.00	55.00	23.55	51.00	51.00	40.00	3.00	4.00	50, 20, 3	M11	not tested
Design prop. "A", 2kW	25.00	83.75	26.03	44.53	13.20	17.00	9.03	19.88	24.65	30.20	24.80	55.00	19.73	51.00	51.00	40.00	3.00	4.00	50, 20, 3	M11	not tested
Design prop. "B", 2kW	25.00	83.75	24.00	46.55	13.20	15.00	9.00	21.30	25.25	28.20	26.80	55.00	19.75	51.00	51.00	40.00	3.00	4.00	50, 20, 3	M11	not tested
Design prop. "C", 2kW	25.00	84.70	35.00	43.10	6.60	24.00	11.00	20.50	22.60	30.60	19.40	50.00	23.70	51.00	51.00	40.00	3.00	2.00	50, 20, 3	M10	not tested
Design prop. "A", 1kW	25.00	84.70	35.00	43.10	6.60	28.00	7.00	20.50	22.60	34.60	20.40	55.00	22.70	51.00	51.00	40.00	3.00	2.00	50, 20, 3	M10	not tested
Design prop. "B", 1kW	25.00	82.90	33.30	43.00	6.60	20.00	13.30	41.00	2.00	26.60	18.40	45.00	24.60	40.00	40.00	40.00	3.00	2.00	38, 20, 3	M8	not tested
AVERAGE	25.00	83.86	24.89	42.30	16.67	18.02	6.87	23.24	19.06	34.69	21.56	55.94	20.74	49.35	49.35	40.00	4.17	3.80	0.30		
MIN	25.00	82.80	11.43	36.95	6.60	11.43	0.00	18.50	0.00	26.60	14.50	45.00	16.70	40.00	40.00	40.00	3.00	2.00	0.25		
MAX	25.00	84.70	35.00	46.55	31.80	28.00	13.30	41.00	26.65	44.80	26.80	65.00	26.50	51.00	51.00	40.00	6.35	6.00	0.30		
OPTIMUM	25									30/45	20/30	45/65	20/30					0.3			