PART ONE

SOUND PRESSURE/SOUND POWER CALCULATOR			
pascal	db SPL		
1	93.97940009	sound power	
1.002374467	94	2.511886432	mW

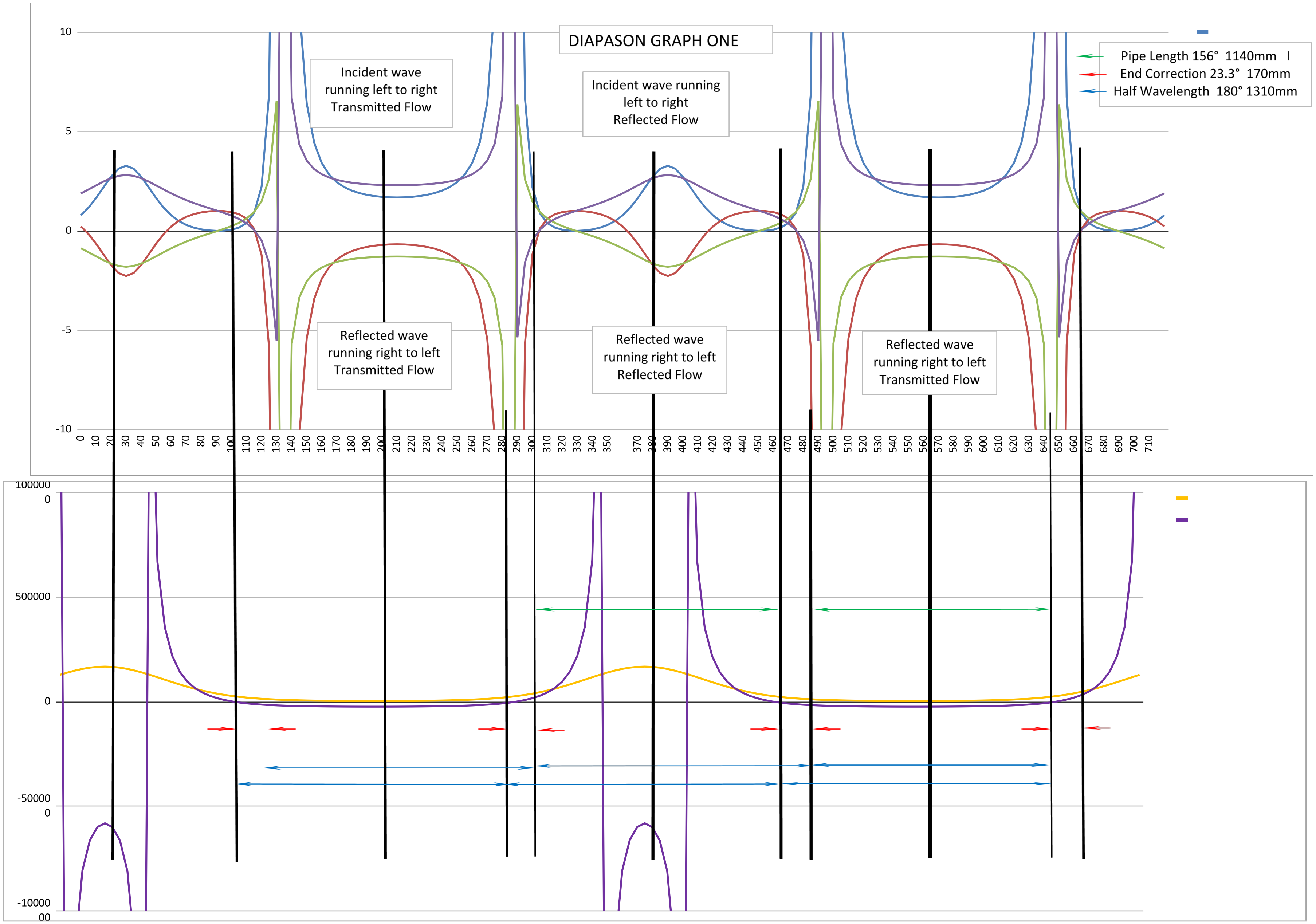
EQUATION NOMENCLATURE	
A: left to right standing wave sound pressure peak amplitude	*B:* right to left standing wave sound pressure peak amplitude
p: density of air	*λ*: wave length
ω: 2π	*ρ:* instantaneous pressure A' and B'
c: speed of sound	*v*: instantaneous particle volume flow
t: period of standing wave	*e*: base of natural logarithms (2.718)
k: wave number = 2π / λ	*S* : calculated pipe cross section area

ITEM	VALUES			UNITS	EXCEL FORMULAE	PHYSICS EQUATIONS
Measurement position relative to wavelength origin in cell E7.	DIAPASON	VIOLIN	STOPPED FLUTE	0		
Amplitude A left to right (incident wave)	1	1	1	pascal		
Amplitude B right to left (reflected wave)	1	1	1	pascal		
Instantaneous pressure at x=0 >> 1.160	0.8664427823	0.8664427823	0.8664427823	pascal	B9*SIN(EXP(-B31*%E$8)+(2*PI()*B35/1000)+$G$27)	ρ (x,t,θ) = A sin e[j(-kx+ωt + θ)]
Instantaneous particle acoustic flow >> U (x,t)	).00001258615297	000010384003	0000668320694	m^3/sec	(B43/10^6)*B11/(B32*B33)*SIN(EXP(-B31*$E$8)+(2*PI()*B35/1000)+$G$27)	U (x,t,θ) = (SA/pc)sin e[j(-kx+ωt+θ)]
Instantaneous pressure << p (x,t)	0.8664427823	0.8664427823	0.8664427823	pascal	B10*SIN(EXP(B31*$E$8)+(2*PI()*B35/1000)+$G$27)	ρ (x,t,θ) = B sin e[j(kx+ωt+θ)]
Instantaneous particle acoustic flow << U (x,t)	).00001258615297	000010384003	0000668320694	m^3/sec	(B43/10^6)*B13/(B32*B33)*SIN(EXP(B31*$E$8)+(2*PI()*B35/1000)+$G$27)	U (x,t,θ) = (SB/pc)sin e[j(kx+ωt+θ)]
Superposition (pressure) p (x,t) 8.16	2.162178958	2.162178958	2.162178958	pascal	B11*EXP((-B31*$E$8)+B13*EXP(B31*$E$8))*EXP(2*pi()*B35/1000)	p (x,t) = (Ae-jkx + Bejkx) e j(ωt)
Superposition (particle volume flow) U (x,t) 8.17	).00001684174758	000013895013	0000894291406	m^3/sec	(B43/10^6)/(B34*B33)*(B11*EXP((-B31*$E$8)-B13*EXP(B31*$E$8))*EXP(2*PI()*B35/1000))	U (x,t) = (S/pc) (Ae–jkx – Bejkx) ej(ωt)
ZL (x=L) p/U z1 8.18	128382.1021	1556082.653	241775.6608	kg/m^2*sec	B15/B16	ZL = ρ(L,t) / v(L,t)
ZL (x=L) p/U z1 8.18	-415.663293	-414.806554	-441.2978944	kg/m^2*sec	B11*EXP(-B31*B39/1000)+B13*EXP(B31*B39/1000)/(B11/(B33*B32)*EXP(-B31*B39/1000)-B13/(B32*B33)*EXP(B31*(B39/1000)))	ZL = (Ae -jkL + Be jkL) / (S/pc)e –jkL – (S/pc)e jkL)))
Characteristic Impedance of pipe Zo 8.19	59646.74803	722961.1325	112329.7693	kg/m^2*sec	B32*B33/B43/(10^6)	Zo = pc/S
Reflection Factor B/A 8.20	0.001569496419	000803622573	0.02283458563		EXP(-2*B31*B39/1000)*(B17-B19) /(B17+B19)	B/A = e -2jkL (ZL – Zo) / (ZL + Zo)
Input Impedance 1.168 Z0 Looking in z2 Characteristic Impedance	-821.9310295	-821.9057437	-821.9181039	kg/m^2*sec	B31*B32*(1+B19)/(1-B19)	
Input Impedance 8.23	2105416.806	1816626.245	67294.01637	kg/m^2*sec	B19*((B17*COS(B31*B39/1000)+B19*SIN(B31*B39/1000))/(B17*SIN(B31*B39/1000)+B19*COS(B31*B39/1000)))	ZIN = pc(ZL cos(kL) + (jpc) sin(kL) / jZL sin(kL) + pc cos(kL))
Input Z stopped (reactance) 8.24	n/a	n/a	-77.131	kg/m^2*sec	-D32*D33*1/TAN(B31*B39/1000)	ZIN closed end = -jpc 1/tan(kL)
Input Z open (reactance) 8.25	-33.839	-33.839	n/a	kg/m^2*sec	-D32*D33*TAN(B31*B39/1000)	ZIN open end = jpc tan(kL)
Reflected Power	0.7833	0.0060	0.3187		(B17-B22)^2/(B17+B22)^2	
Transmited Power	0.2167	0.9940	0.6813		4*B17*B22/(B17+B22)^2 Degrees	0
Reflected flow	-0.8851	-0.0773	0.5645		(B17-B22)/(B17+B22) Radians	0.00000
Transmitted flow	1.8851	1.0773	0.4355		2*B22/(B17+B22)	
Z load Z2- Z input Z1	1977035	260544	-174482		B22-B17	

PART TWO

wave number K	2.391	2.391	2.391	m	2*PI()/(B36/1000)	
Speed of Sound sea level and 20C	343.8	343.8	343.8	m/sec		
Dry Air Density at sea level and 20°C	1.204	1.204	1.204	kg/m^3		
True Frequency	**130.81**	130.81	130.81	Hz		
Calculated True Period T	7.64	7.64	7.64	msec	1/B34*1000	
Calculated True Wavelength	2628.24	2628.24	2628.24	mm	B32/B34*1000	
True Half Wavelength (*quarter wavelength*)	1314.12	1314.12	*657.06*	mm	B36/2 (4)	
True Half Wavelength Period (*quarterwave*)	3.82	3.82	*1.91*	msec	B35/2 (4)	
Measured Actual Pipe Length L	1140.00	1280.00	580.00	mm		7.30
Measured Actual Pipe Diameter	94.00	27.00	n/a	mm	mm	1241
Measured Actual Pipe Width	n/a	n/a	55.00	mm	Degrees	170
Measured Actual Pipe Depth	n/a	n/a	67.00	mm		
Calculated Cross Section Pipe Area	6939.78	572.56	3685	mm^2	pi()*(B40/2)^2 (D39*D40) 1mm = 0.137 degrees	0.137
Equivalent pipe diameter calculated from rectangular area.	n/a	n/a	68.50	mm	2*(SQRT(B43/PI()))	one degree = 0.021msec
Measured Mouth Width	64.70	15.22	54.68	mm	Degrees	179.47
Measured Mouth Cutup	20.05	11.76	28.74	mm	mm	1310
Calculated Mouth Area	1297.24	178.99	1571.50	mm^2	B45*B46	
Equivalent pipe diameter calculated from mouth area.	20.32	7.55	22.37	mm	SQRT(B47/PI()))	
Difference between true halfwave (*quarterwave*) pipe length and measured halfwave (*quarterwave*) pipe length.	174.12	34.12	*77.06*	mm	B37-B39	
Calculated frequency of measured actual pipe length.	150.79	134.30	148.19	Hz	B32/(B39/1000)/2 (4)	
Calculated period of frequency calculated from actual measured pipe length.	3.32	3.72	3.37	msec	1/(2 (4)*B50)*1000	
Difference between true pipe half wave (*quarterwave*) frequency and actual halfwave (*quarterwave*) frequency.	19.98	3.49	*17.38*	Hz	B50-B34	
Calculated Pipe end correction.	28.83	8.28	n/a	mm	0.6133*B40/2	
Calculated Mouth Correction	141.06	31.33	68.05	mm	2.3*(B40 (D42)/2)^2/SQRT(B45*B46)	
Alternative Calculated Mouth Correction	141.32	31.39	68.18	mm	1.3*(B43/B47)*B48	
Frequency with Calculated End Correction	147.07	133.43	n/a	Hz	B32/(2*(B53+B39)/1000)	
Frequency with Calculated Mouth Correction only	134.19	131.09	132.63	Hz	B32/(2*(4*)(B39+B54)*1000)	
Calculated wavelength based on pipe half wavelength with top end correction	2337.65	2576.56	n/a	mm	(B53+B39)*2	
Calculated wavelength based on pipe half wavelength (*quarter wavelength*) with mouth correction	2562.13	2622.66	***2592.22***	mm	(B54+B39)*2 (*4)	
Calculated wavelength based on pipe half wavelength with mouth & end correction	***2619.78***	***2639.22***	n/a	mm	(B54+B53+B39)*2	

Calculated frequency based on pipe half wavelength (*quarter wavelength*) with mouth and end correction.	***131.23***	***130.27***	***132.63***	Hz	B32*B60/2 *(D59)**1000
% error between true and calculated frequencies.	-0.32%	0.42%	-1.39%	%	1-(B61/B34)
% error between true and calculated actual pipe lengths.	0.32%	-0.42%	1.37%	%	1-(B60/B36)
Period difference between actual pipe length and end corrected pipe length.	422.61	75.16	n/a	usec	(B38-B67)*1000
Frequency reduction due to top end corrections only.	16.26	2.62	n/a	Hz	B56-B34
Frequency reduction due to mouth correction only.	3.38	0.28	1.82	Hz	B57-B34
Calculated halfwave period with End Correction only.	3.40	3.75	n/a	msec	1/B56*1000/2
Calculated halfwave period with Mouth Correction only.	3.73	3.81	3.77	msec	1/B57*1000/2
Calculated *quarter* wavelength period with mouth correction.	n/a	n/a	*3.77*	usec	1/D61*1000/2
Difference in period between actual pipe length and end corrected pipe length.	506.46	99.24	n/a	usec	(B38-B51)*1000
Actual pipe half wavelength (*quarter wavelength*) period	6.63	7.45	*3.37*	msec	1/B50*1000 *(/2)*


DIAPASON GRAPH ONE
Incident wave running left to right Transmitted Flow
Incident wave running left to right Reflected Flow
Reflected wave running right to left Transmitted Flow
Reflected wave running right to left Reflected Flow
Reflected wave running right to left Transmitted Flow
Pipe Length 156° 1140mm I
End Correction 23.3° 170mm
Half Wavelength 180° 1310mm
10
5
0
-5
-10
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570 580 590 600 610 620 630 640 650 660 670 680 690 700 710
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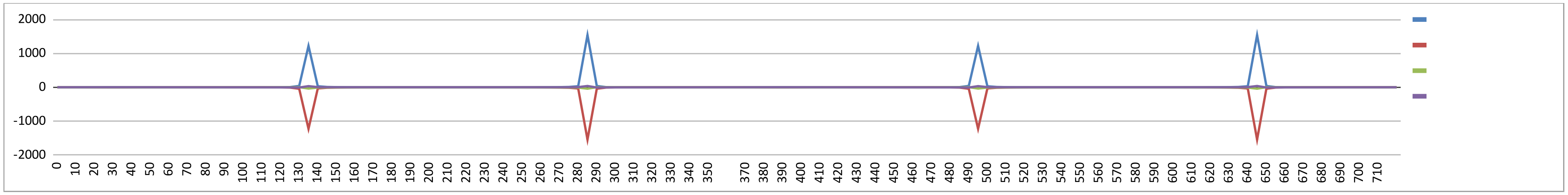
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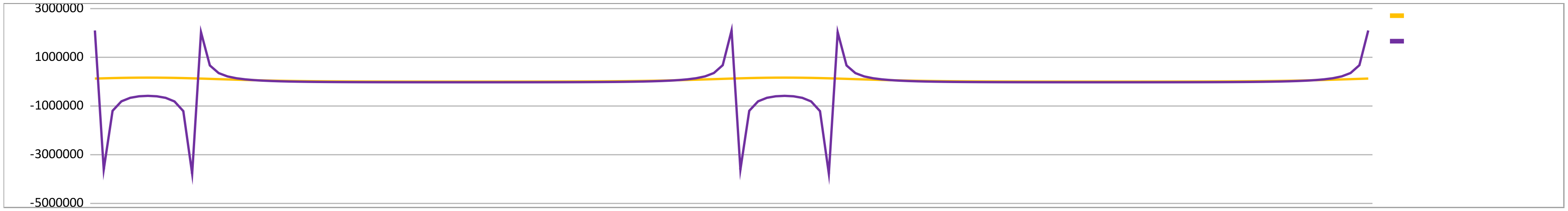
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