

# Ball Bearing의 주파수 분석데이터

1) Fundamental Train Frequency

$$N_m = 0.5 * N_i * (1 - (D_w * \cos \alpha) / d_m) + 0.5 * N_e * (1 + (D_w * \cos \alpha) / d_m)$$

2) Ball Pass Frequency Inner Ring

$$N_{im} = 0.5 * (N_i - N_e) * (1 + (D_w * \cos \alpha) / d_m)$$

3) Ball Pass Frequency Outer Ring

$$N_{em} = 0.5 * (N_e - N_i) * (1 - (D_w * \cos \alpha) / d_m)$$

4) Ball Spin Frequency

$$N_w = 0.5 * (d_m / D_w) * (N_e - N_i) * (1 - (D_w^2 * \cos^2 \alpha) / d_m^2)$$

$N_e$  : 외륜회전주파수(Hz)

$N_i$  : 내륜회전주파수(Hz)

$D_w$  : 볼의 지름(mm)

$D_i$  : 내륜의 궤도경(mm)

$d_e$  : 외륜의 궤도경(mm)

$d_m$  : 베어링의 피치원지름

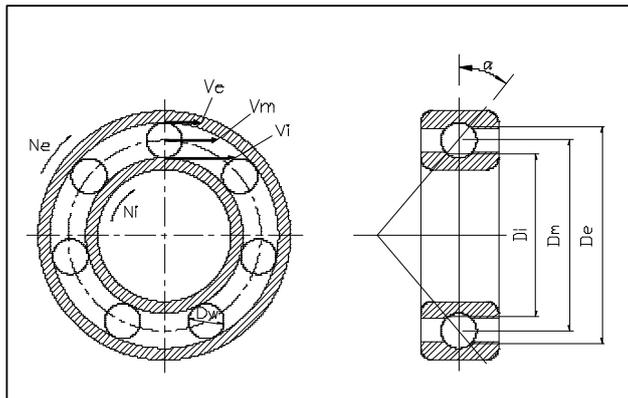
$\alpha$  : 접촉각

$Z$  : BALL 갯수

Ball BRG. 치수표

Item	dm	Dw	Ne	Ni	$\alpha$	Z	Nm	2*Nm	3*Nm	Z*Nim	Z*Nem	Nw	2*Nw
608	15	3.968	0	30	0	7	11.032	22.064	33.096	132.78	77.224	52.736	105.47
6000	18	4.7625	0	30	0	7	11.031	22.063	33.094	132.78	77.219	52.724	105.45
6001	20	4.7625	0	30	0	8	11.428	22.856	34.284	148.58	91.425	59.42	118.84
6004	31	6.35	0	30	0	9	11.927	23.855	35.782	162.65	107.35	70.156	140.31
6004	31	6.35	30	0	0	9	18.073	36.145	54.218	162.65	107.35	70.156	140.31
6005	35.5	6.35	0	30	0	10	12.317	24.634	36.951	176.83	123.17	81.175	162.35
6200	20.5	4.7625	0	30	0	8	11.515	23.03	34.546	147.88	92.122	61.082	122.16
6201	22	5.953	0	30	0	7	10.941	21.882	32.823	133.41	76.588	51.375	102.75
6202	25.5	5.953	0	30	0	8	11.498	22.996	34.495	148.01	91.986	60.752	121.5
6203	29	6.747	0	30	0	8	11.51	23.02	34.531	147.92	92.081	60.983	121.97
6204	34.5	7.9375	0	30	0	8	11.549	23.098	34.647	147.61	92.391	61.746	123.49
6205	39	7.9375	0	30	0	9	11.947	23.894	35.841	162.48	107.52	70.648	141.3
6303	33	8.73125	0	30	0	7	11.031	22.063	33.094	132.78	77.219	52.724	105.45
6303	33	8.73125	0	60	0	7	22.063	44.125	66.188	265.56	154.44	105.45	210.9
SDA9101	43	7.143	0	30	25	11	12.742	25.483	38.225	189.84	140.16	88.251	176.5
SDA0103	59	11.5	0	30	35	15	12.605	25.21	37.815	260.92	189.08	74.995	149.99
HBU1-002	56.5	11.906	0	30	40	14	12.579	25.157	37.736	243.9	176.1	69.328	138.66

\* Ball 또는 Cage의 공전 및 자전주파수( $N_m$ ,  $2*N_m$ ,  $3*N_m$ )은 spindle의 회전 주파수인 15Hz, 30Hz, 60Hz와 비교하여 가장 큰 차이가 생기는 주파수를 선택하여야함.



# Taper Roller Bearing의 주파수 분석데이터

1) Fundamental Train Frequency

$$N_m = 0.5 * N_i * (1 - (\tan \beta / \tan \alpha)) + 0.5 * N_e * (1 + (\tan \beta / \tan \alpha))$$

$N_e$  : 외륜회전주파수(Hz)

2) Roller Pass Frequency Inner Ring

$$N_{im} = 0.5 * (N_i - N_e) * (1 + (\tan \beta / \tan \alpha))$$

$N_i$  : 내륜회전주파수(Hz)

3) Roller Pass Frequency Outer Ring

$$N_{em} = 0.5 * (N_e - N_i) * (1 - (\tan \beta / \tan \alpha))$$

$Z$  : ROLLER의 갯수

$\alpha$  : (내륜과ROLLER의조립각도)/2

$\beta$  : (ROLLER의 각도)/2

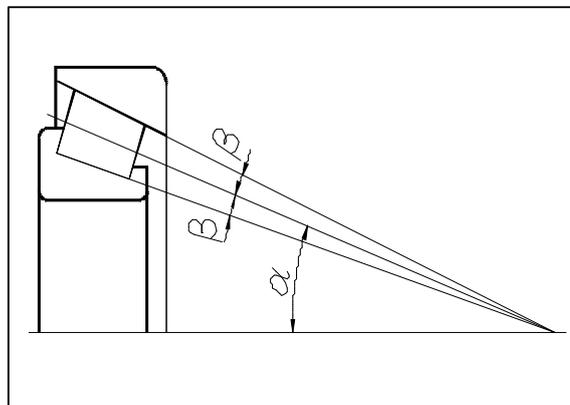
4) Roller Spin Frequency

$$N_w = 0.5 * (N_e - N_i) * (\tan \alpha / \tan \beta) * (1 - (\tan^2 \beta / \tan^2 \alpha))$$

Taper BRG. 치수표

Item	$\alpha$	$\beta$	$N_e$	$N_i$	$Z$	$N_m$	$2 * N_m$	$3 * N_m$	$Z * N_{im}$	$Z * N_{em}$	$N_w$	$2 * N_w$
38KW01CG	11.1667	1.3333	0	30	14	13.23	26.463	39.694	234.76	185.24	125.45	250.9
LM102949/10	10.3333	1.1667	0	30	23	13.32	26.649	39.974	383.53	306.47	132.62	265.24
LM11749/10	9.0833	1.7167	0	30	14	12.19	24.376	36.564	249.37	170.63	77.203	154.41
L507949g	13.4167	1.1333	0	30	29	13.76	27.512	41.268	471.07	398.93	179.63	359.26
32203J	9.75	2	0	30	13	11.95	23.903	35.855	234.63	155.37	70.761	141.52
JL69349g/10g	13.9583	1.542	0	30	22	13.38	26.751	40.126	365.74	294.26	136.87	273.75

\* Roller 또는 Cage의 공전 및 자전주파수( $N_m$ ,  $2 * N_m$ ,  $3 * N_m$ )은 spindle의 회전 주파수인 15Hz, 30Hz, 60Hz와 비교하여 가장 큰 차이가 생기는 주파수를 선택하여야함.



# NSK Bearing Frequency Analysis Data

## Deep Groove Ball Bearings

NSK assumes no liability with respect to errors or omissions.

(N=1800 rpm)

Bearing	Enter Bearing Speed Below		Characteristic Frequencies at Indicated Speed							
	Inner Ring (rpm)	Outer Ring (rpm)	Ball Pass Frequency Inner Ring		Ball Pass Frequency Outer Ring		Ball Defect Frequency		Fundamental Train Frequency	
			Hz	(CPM)	Hz	(CPM)	Hz	(CPM)	Hz	(CPM)
601X	1800	0	117.7	(7061)	62.31	(3739)	88.26	(5296)	10.39	(623.2)
602	1800	0	131.5	(7891)	78.48	(4709)	111.2	(6671)	11.21	(672.7)
602X	1800	0	117.2	(7033)	62.79	(3767)	90.12	(5407)	10.46	(627.8)
603	1800	0	113.8	(6829)	66.18	(3971)	105.4	(6325)	11.03	(661.9)
604	1800	0	133	(7978)	77.04	(4622)	104.7	(6280)	11	(660.2)
605	1800	0	131.3	(7879)	78.69	(4721)	112.2	(6730)	11.24	(674.5)
606	1800	0	117.9	(7072)	62.13	(3728)	87.57	(5254)	10.35	(621.2)
607	1800	0	115.2	(6912)	64.8	(3888)	98.73	(5924)	10.8	(648)
608	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
609	1800	0	130.3	(7816)	79.74	(4784)	117.5	(7051)	11.39	(683.5)
6000	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
6001	1800	0	148.6	(8914)	91.44	(5486)	118.9	(7132)	11.43	(685.8)
6002	1800	0	162.4	(9742)	107.6	(6458)	142	(8518)	11.96	(717.7)
6003	1800	0	177.5	(10650)	122.5	(7351)	158.3	(9499)	12.25	(735.1)
6004	1800	0	162.7	(9760)	107.3	(6440)	140.3	(8419)	11.93	(715.7)
60/22	1800	0	162	(9718)	108	(6482)	144.2	(8654)	12.01	(720.4)
6005	1800	0	176.8	(10610)	123.2	(7391)	162.4	(9742)	12.32	(739.1)
60/28	1800	0	176.8	(10610)	123.2	(7393)	162.6	(9758)	12.32	(739.3)
6006	1800	0	192.6	(11560)	137.4	(8244)	174.3	(10460)	12.49	(749.3)
60/32	1800	0	176.5	(10590)	123.5	(7412)	164.8	(9887)	12.35	(741.2)
6007	1800	0	192	(11520)	138	(8280)	178.4	(10700)	12.55	(752.8)
6008	1800	0	206.2	(12370)	153.8	(9227)	201.6	(12100)	12.82	(769)
6009	1800	0	222.9	(13370)	167.1	(10030)	205.3	(12320)	12.85	(771.1)
6010	1800	0	237.8	(14270)	182.2	(10930)	222.8	(13370)	13.02	(781)
6011	1800	0	222.8	(13370)	167.3	(10040)	206.5	(12390)	12.86	(771.8)
6012	1800	0	238	(14280)	182	(10920)	221.3	(13280)	13	(780.1)
6013	1800	0	253.1	(15190)	196.9	(11810)	236.1	(14170)	13.13	(787.5)
6014	1800	0	237.8	(14270)	182.2	(10930)	222.8	(13370)	13.02	(781)
6015	1800	0	253.2	(15190)	196.8	(11810)	235.6	(14140)	13.12	(787.1)
6016	1800	0	237.7	(14260)	182.3	(10940)	223.9	(13440)	13.03	(781.6)
6017	1800	0	253.2	(15190)	196.8	(11810)	235.2	(14110)	13.12	(787)
6018	1800	0	237.5	(14250)	182.5	(10950)	224.8	(13490)	13.03	(781.9)
6019	1800	0	252.9	(15180)	197.1	(11820)	238	(14280)	13.14	(788.2)
6020	1800	0	252.2	(15130)	197.9	(11870)	245	(14700)	13.19	(791.5)
6021	1800	0	252.9	(15170)	197.1	(11830)	238.4	(14300)	13.14	(788.4)
6022	1800	0	221.5	(13290)	168.5	(10110)	216.4	(12980)	12.96	(777.6)
6024	1800	0	236.7	(14200)	183.3	(11000)	232.4	(13940)	13.1	(785.7)
6026	1800	0	253.1	(15190)	196.9	(11810)	236.1	(14170)	13.13	(787.5)
6028	1800	0	268.3	(16100)	211.7	(12700)	250.9	(15050)	13.23	(793.8)
6030	1800	0	268.4	(16110)	211.6	(12690)	249.5	(14970)	13.22	(793.3)
6032	1800	0	251.8	(15110)	198.2	(11890)	248.4	(14900)	13.22	(792.9)
6034	1800	0	236.4	(14180)	183.6	(11020)	235.2	(14110)	13.12	(787)
6036	1800	0	220.6	(13230)	169.4	(10170)	224.8	(13490)	13.03	(781.9)
6038	1800	0	236.4	(14180)	183.6	(11020)	234.9	(14100)	13.12	(787)
6040	1800	0	220.5	(13230)	169.5	(10170)	225.5	(13530)	13.04	(782.3)
6044M	1800	0	220.4	(13230)	169.6	(10170)	226.1	(13570)	13.04	(782.6)
6048M	1800	0	235.6	(14130)	184.4	(11070)	242.9	(14570)	13.17	(790.4)
6052M	1800	0	236.3	(14180)	183.7	(11020)	236.1	(14170)	13.13	(787.5)
6056M	1800	0	251.5	(15090)	198.5	(11910)	250.9	(15050)	13.23	(793.8)
6060M	1800	0	236.3	(14180)	183.7	(11020)	235.6	(14140)	13.12	(787.1)

(N=1800 rpm)

Bearing	Enter Bearing Speed Below		Characteristic Frequencies at Indicated Speed							
	Inner Ring	Outer Ring	Ball Pass Frequency Inner Ring		Ball Pass Frequency Outer Ring		Ball Defect Frequency		Fundamental Train Frequency	
	(rpm)	(rpm)	Hz	(CPM)	Hz	(CPM)	Hz	(CPM)	Hz	(CPM)
6064M	1800	0	236.7	(14200)	183.3	(11000)	232.4	(13940)	13.1	(785.7)
6068M	1800	0	220.9	(13260)	169.1	(10140)	221.7	(13300)	13.01	(780.3)
6072M	1800	0	236.7	(14200)	183.3	(11000)	232.4	(13940)	13.1	(785.7)
6076M	1800	0	235.5	(14130)	184.5	(11070)	243.1	(14580)	13.18	(790.6)
6080M	1800	0	219.8	(13190)	170.3	(10220)	232.4	(13940)	13.1	(785.7)
6084M	1800	0	235.7	(14140)	184.4	(11060)	242	(14520)	13.17	(790)
6088M	1800	0	251.2	(15070)	198.8	(11930)	254	(15240)	13.25	(795.1)
6092M	1800	0	235.7	(14140)	184.3	(11060)	241.1	(14470)	13.16	(789.7)
6096M	1800	0	234.9	(14090)	185.1	(11110)	249.8	(14990)	13.22	(793.4)
60/500M	1800	0	250.8	(15050)	199.2	(11950)	258.5	(15510)	13.28	(796.9)
60/530M	1800	0	234.4	(14070)	185.6	(11130)	254.4	(15260)	13.25	(795.2)
60/560M	1800	0	266.3	(15980)	213.8	(12830)	270.9	(16260)	13.36	(801.5)
60/600M	1800	0	250.3	(15020)	199.7	(11980)	263.7	(15820)	13.31	(798.8)
60/630M	1800	0	280.1	(16800)	229.9	(13800)	302.1	(18130)	13.52	(811.4)
60/670M	1800	0	294.8	(17690)	245.2	(14710)	324	(19440)	13.62	(817.4)
623	1800	0	133.1	(7985)	76.92	(4615)	104.2	(6251)	10.99	(659.3)
624	1800	0	133.7	(8024)	76.26	(4576)	101.4	(6084)	10.9	(653.8)
625	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
626	1800	0	115.2	(6912)	64.8	(3888)	98.73	(5924)	10.8	(648)
627	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
628	1800	0	130.3	(7816)	79.74	(4784)	117.5	(7051)	11.39	(683.5)
629	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
6200	1800	0	147.9	(8872)	92.13	(5528)	122.2	(7331)	11.52	(691)
6201	1800	0	133.4	(8005)	76.59	(4595)	102.8	(6165)	10.94	(656.5)
6202	1800	0	148	(8881)	91.98	(5519)	121.5	(7290)	11.5	(689.9)
6202-10	1800	0	148	(8881)	91.98	(5519)	121.5	(7290)	11.5	(689.9)
6203	1800	0	147.9	(8876)	92.07	(5524)	122	(7319)	11.51	(690.7)
6203-625	1800	0	147.9	(8876)	92.07	(5524)	122	(7319)	11.51	(690.7)
6204	1800	0	148.4	(8906)	91.56	(5494)	119.5	(7169)	11.45	(686.7)
62/22	1800	0	146.1	(8766)	93.9	(5634)	131.4	(7886)	11.74	(704.3)
6205	1800	0	162.5	(9749)	107.5	(6451)	141.3	(8478)	11.95	(716.8)
62/28	1800	0	162.4	(9745)	107.6	(6455)	141.7	(8500)	11.96	(717.3)
6206	1800	0	162.7	(9760)	107.3	(6440)	140.3	(8419)	11.93	(715.7)
62/32	1800	0	145.5	(8732)	94.47	(5668)	134.6	(8077)	11.81	(708.5)
6207	1800	0	163.1	(9783)	107	(6417)	138.2	(8293)	11.88	(713)
6208	1800	0	161800	(9707000)	108200	(6493000)	145200	(8714000)	12020	(721400)
6209	1800	0	177.5	(10650)	122.5	(7351)	158.3	(9497)	12.25	(735.1)
6210	1800	0	177.2	(10630)	122.8	(7367)	159.9	(9594)	12.28	(736.7)
6211	1800	0	177.7	(10660)	122.3	(7340)	157.2	(9432)	12.23	(734)
6212	1800	0	177.5	(10650)	122.5	(7348)	158	(9477)	12.25	(734.8)
6213	1800	0	177	(10620)	123	(7378)	161.1	(9664)	12.3	(737.8)
6214	1800	0	176.9	(10610)	123.2	(7389)	162.1	(9727)	12.32	(738.9)
6215	1800	0	192.8	(11570)	137.2	(8230)	172.7	(10360)	12.47	(748.1)
6216	1800	0	176	(10560)	124	(7441)	168	(10080)	12.4	(744.1)
6217	1800	0	176.3	(10580)	123.7	(7420)	165.5	(9932)	12.37	(742)
6218	1800	0	176.7	(10600)	123.3	(7400)	163.4	(9803)	12.33	(740)
6219	1800	0	177	(10620)	123	(7382)	161.6	(9693)	12.3	(738.2)
6220	1800	0	177.1	(10630)	122.9	(7373)	160.5	(9632)	12.29	(737.3)
6221	1800	0	177.5	(10650)	122.6	(7353)	158.5	(9508)	12.26	(735.3)
6222	1800	0	177.7	(10660)	122.3	(7340)	157.2	(9432)	12.23	(734)
6224	1800	0	176.9	(10620)	123.1	(7384)	161.7	(9702)	12.31	(738.4)
6226	1800	0	176.5	(10590)	123.5	(7412)	164.8	(9887)	12.35	(741.2)
6228	1800	0	174.4	(10470)	125.6	(7535)	179.4	(10760)	12.56	(753.5)

(N=1800 rpm)

Bearing	Enter Bearing Speed Below		Characteristic Frequencies at Indicated Speed							
	Inner Ring	Outer Ring	Ball Pass Frequency Inner Ring		Ball Pass Frequency Outer Ring		Ball Defect Frequency		Fundamental Train Frequency	
	(rpm)	(rpm)	Hz	(CPM)	Hz	(CPM)	Hz	(CPM)	Hz	(CPM)
6230	1800	0	190	(11400)	140	(8402)	193.9	(11630)	12.73	(763.9)
6230M	1800	0	190	(11400)	140	(8402)	193.9	(11630)	12.73	(763.9)
6232	1800	0	205.4	(12320)	154.6	(9275)	208.4	(12500)	12.88	(772.9)
6234	1800	0	206.2	(12370)	153.8	(9229)	201.8	(12110)	12.82	(769)
6236	1800	0	190.1	(11410)	139.9	(8392)	192.3	(11540)	12.71	(762.8)
6238	1800	0	190.7	(11440)	139.3	(8357)	188	(11280)	12.66	(759.8)
6240	1800	0	206.5	(12390)	153.5	(9209)	199.1	(11940)	12.79	(767.3)
6244M	1800	0	190.4	(11420)	139.7	(8379)	190.7	(11440)	12.7	(761.8)
6248M	1800	0	189.7	(11380)	140.3	(8420)	196.3	(11780)	12.76	(765.5)
6252M	1800	0	190.5	(11430)	139.5	(8370)	189.6	(11380)	12.68	(761)
6256M	1800	0	189.2	(11350)	140.8	(8449)	200.3	(12020)	12.8	(768.1)
6260M	1800	0	190	(11400)	140	(8402)	193.9	(11630)	12.73	(763.9)
6264M	1800	0	190.6	(11440)	139.4	(8363)	188.6	(11320)	12.67	(760.3)
6268M	1800	0	189	(11340)	141	(8460)	201.8	(12110)	12.82	(769)
6272M	1800	0	204.9	(12290)	155.1	(9306)	212.7	(12760)	12.92	(775.4)
633	1800	0	133.7	(8024)	76.26	(4576)	101.4	(6084)	10.9	(653.8)
634	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
635	1800	0	115.2	(6912)	64.8	(3888)	98.73	(5924)	10.8	(648)
636	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
637	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
638	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
639	1800	0	147.9	(8872)	92.13	(5528)	122.2	(7331)	11.52	(691)
6300	1800	0	118.6	(7115)	61.41	(3685)	84.96	(5098)	10.24	(614.2)
6301	1800	0	119.2	(7150)	60.84	(3650)	82.86	(4972)	10.14	(608.4)
6302	1800	0	133.3	(7996)	76.74	(4604)	103.4	(6205)	10.97	(657.9)
6303	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
6304	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
63/22	1800	0	133	(7979)	77.01	(4621)	104.5	(6271)	11	(660.1)
6305	1800	0	147.8	(8870)	92.16	(5530)	122.4	(7346)	11.52	(691.4)
63/28	1800	0	132.8	(7967)	77.22	(4633)	105.5	(6327)	11.03	(661.9)
6306	1800	0	147.5	(8849)	92.52	(5551)	124.2	(7450)	11.57	(693.9)
63/32	1800	0	148	(8878)	92.04	(5522)	121.7	(7304)	11.51	(690.3)
6307	1800	0	147.9	(8876)	92.07	(5524)	122	(7319)	11.51	(690.7)
6308	1800	0	147.8	(8870)	92.16	(5530)	122.3	(7340)	11.52	(691.2)
6309	1800	0	148.1	(8887)	91.89	(5513)	121	(7259)	11.48	(689)
6310	1800	0	147.9	(8872)	92.13	(5528)	122.2	(7330)	11.51	(690.8)
6311	1800	0	148.3	(8897)	91.71	(5503)	120.1	(7207)	11.46	(687.8)
6312	1800	0	148.1	(8885)	91.92	(5515)	121.2	(7274)	11.49	(689.4)
6313	1800	0	147.9	(8872)	92.13	(5528)	122.2	(7330)	11.51	(690.8)
6314	1800	0	147.7	(8863)	92.28	(5537)	123	(7380)	11.54	(692.1)
6315	1800	0	147.6	(8854)	92.43	(5546)	123.7	(7423)	11.56	(693.4)
6316	1800	0	147.4	(8845)	92.58	(5555)	124.4	(7463)	11.57	(694.3)
6317	1800	0	147.3	(8840)	92.67	(5560)	125	(7497)	11.59	(695.2)
6318	1800	0	147.2	(8833)	92.79	(5567)	125.5	(7529)	11.6	(695.9)
6319	1800	0	147.1	(8827)	92.88	(5573)	125.9	(7556)	11.61	(696.6)
6320	1800	0	147.6	(8854)	92.43	(5546)	123.8	(7425)	11.56	(693.4)
6321	1800	0	147.7	(8863)	92.28	(5537)	123	(7380)	11.54	(692.1)
6322	1800	0	148	(8879)	92.01	(5521)	121.7	(7299)	11.5	(690.1)
6324	1800	0	146.1	(8764)	93.93	(5636)	131.6	(7895)	11.74	(704.5)
6326	1800	0	146	(8761)	93.99	(5639)	131.9	(7911)	11.75	(704.9)
6328	1800	0	146	(8759)	94.02	(5641)	132.1	(7925)	11.75	(705.2)
6330	1800	0	162.4	(9742)	107.6	(6458)	142	(8518)	11.96	(717.7)
6332	1800	0	144.4	(8663)	95.61	(5737)	141.5	(8492)	11.95	(717.1)
6332M	1800	0	144.4	(8663)	95.61	(5737)	141.5	(8492)	11.95	(717.1)
6334M	1800	0	145.9	(8753)	94.11	(5647)	132.6	(7958)	11.77	(706)