EMISSIONS REFERENCE SOURCE

Serial number: 9999

USER GUIDE

Issue 3 October 2003

LAPLACE INSTRUMENTS LTD

3B, Middlebrook Way
CROMER, Norfolk UK
Tel: 01263 51 51 60 Fax: 01263 51 25 32

INDEX

1.0 Check list

Items included with the shipment

Qty	Item
1	ERS main unit
1	Monopole antenna with BNC connector
1	Mains adaptor unit
1	Calibration sheets
1	Calibration data on CD ROM

Please check all items are present. If there are any discrepancies, please contact your supplier immediately.

2.0 INTRODUCTION

The standard technique specified for radiated emissions testing by most EMC standards is the measurement of radiated field strength, at a distance, on an Open Area Test Site (OATS).

It is well known that this technique suffers from high measurement uncertainty unless considerable investment is made in site preparation, configuration and calibration.

The ERS provides a means of substantially reducing this measurement uncertainty, even on very non-compliant test sites.

The ERS is a calibrated source of emissions. Its radiation at a distance of 3metres has been precisely measured by the leading test site in the UK , the National Physical Laboratory (NPL). By comparison between these results and results obtained on the user’s test site, the errors associated with the users test site can be largely quantified. If done rigorously, this technique can provide a traceable reference back to a national standard with a measurement uncertainty approaching that of accredited test houses.

Note that the primary function of the ERS is the quantifying of specific measurement error which involves checking a specific measurement against the standard. This will be found to be a more relevant requirement for practical testing.
The ERS can also be used to check the characteristics of a test site. This mode is particularly relevant for screened, non-anechoic chambers. Room resonances, nodes and anti-nodes can be readily identified and quantified.

Not only is the ERS a means of quantifying errors due to test site, the complete measurement system (site, product, antenna, receiver/analyser) is effectively included in the calibration loop. This allows the use of lower cost equipment without reducing the integrity of results.

3.0 ERS Description

The ERS main unit contains a 2MHz, crystal derived source signal. This is applied to the antenna via a highly stable fast switching circuit to produce a comb generator output with a spacing of 2MHz. The antenna is a standard top loaded monopole with characteristics designed to radiate useful energy up to 1GHz. The plane of the resultant radiation is parallel to the axis of the antenna stem.
Rechargeable batteries are included in the ERS and a separate mains charger is provided.
In order to prevent use of the ERS with batteries too low to provide the correct level of output, a monitor is built in which will switch the output off if the battery voltage drops below a pre-determined level.
For storage when not in use or during transit, the main unit features a convenient antenna storage bay to protect the vunerable stem. Magnetic pads retain the antenna in the bay until required.

4.0 Calibration

In order to provide a low priced, yet traceable unit, individual ERS units are calibrated against master ERS units in an anechoic chamber. The master ERS units are fully calibrated on the NPL (National Physical Laboratory, Teddington) standard test site. This site has become one of the ‘master’ sites in Europe and the calibration of the ERS involves the absolutely ‘correct’ procedures and the most accurate instrumentation standards.

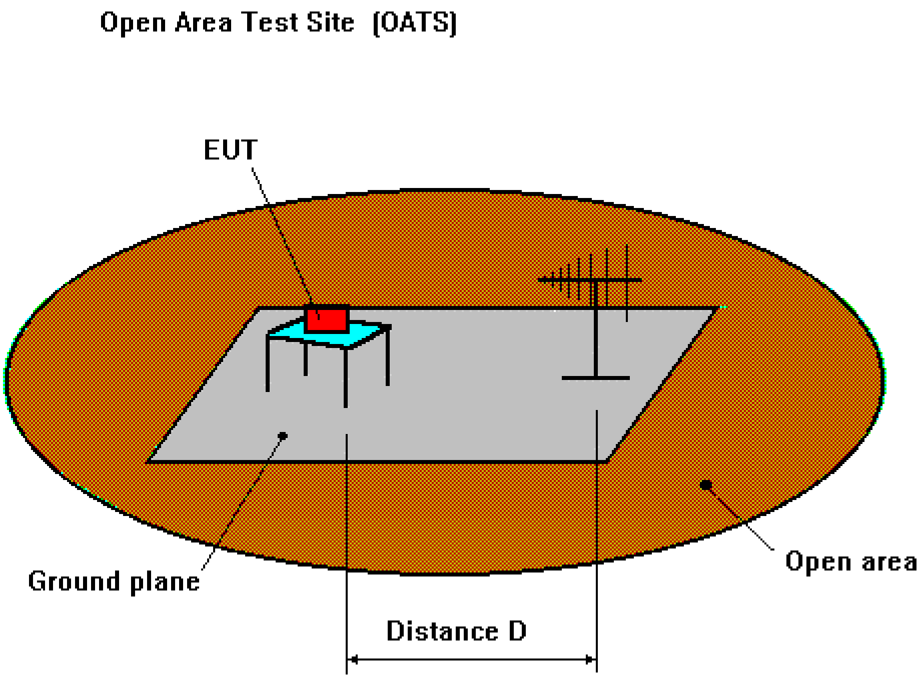
The conditions for the calibration are:
Antenna - source (ERS) distance = 3 metres
Measurement technique = height scanned antenna and peak hold resultant
ERS height = 0.8 metres
Polarisation = vertical and horizontal

Full details of the original calibration at NPL and the corrected calibration for your specific unit are enclosed at the rear of this guide in Appendix II

5.0 Background

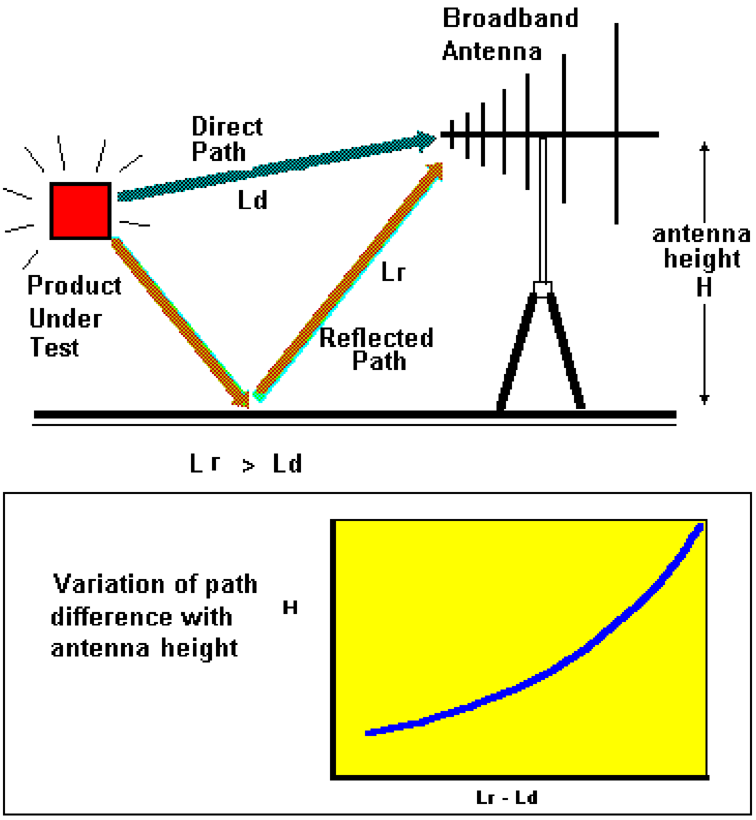
The EMC standards define an Open Area Test Site as basically an area free of potential RF reflections, with a metallic ground plane and with an antenna which can be height scanned over the range 1 to 4 metres

Fig 1



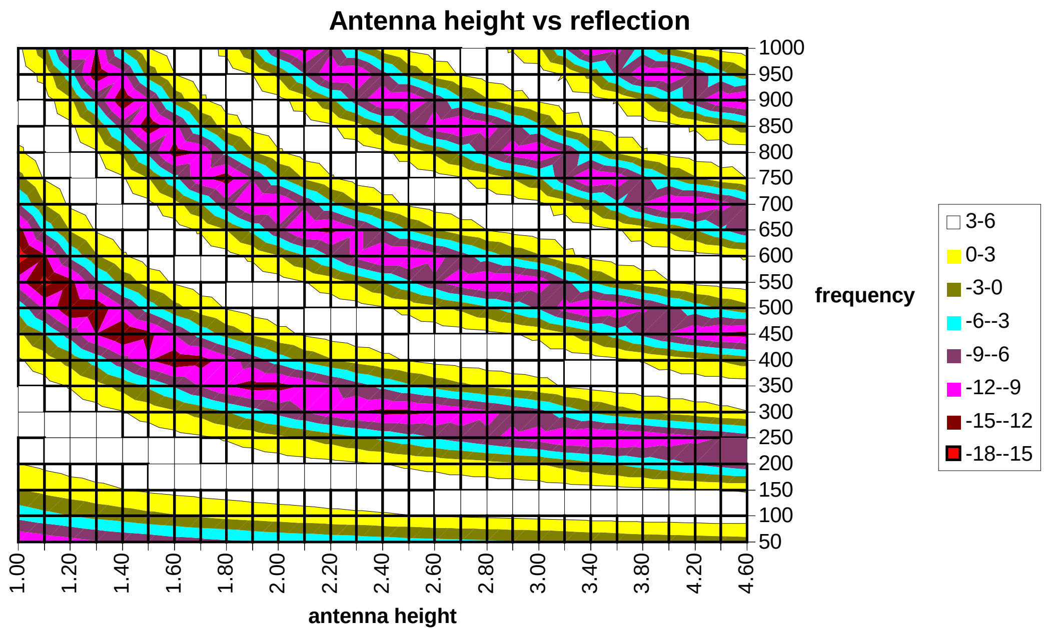
Under this arrangement, the only reflection will be from the ground plane. With a metallic ground plane, as specified by the standards, this reflection will be maximised and will interfere with the direct path reflection as shown in fig 2.

Fig 2



If the path length difference is ½ wavelength at a frequency of interest, the two signals will be 180º out of phase and will cancel. In fact the cancelation will not be total as the reflected wave, having travelled further, will have a lower amplitude than the direct path signal. However, on a 3 metre test site, the reduction in amplitude due to ground plane reflection will be over 15dB when Lr - Ld = ½ wavelength.

This effect is shown graphically in fig 3.



From this chart, it can be seen that, for instance, at 300MHz, if the antenna height is 2.5 metres, the measurement will be reading over 15dB low. At this frequency, the antenna height should be adjusted to 1 metre. Note that all the above applies to vertical polarisation only. With horizontal polarisation the reflection introduces an extra 180º phase shift which effectively 'inverts' the above chart. In order to overcome this problem of the 'interfering reflection', the standards specify that the antenna height (H) should be adjusted (or 'scanned') over a range of 1 to 4 metres whilst taking measurements and the peak levels recorded.

Bearing in mind the fact that this is all caused by just one reflector (the ground) the presence of other reflectors (nearby objects) would clearly cause considerable uncertainty! A worse case scenario would be a screened room. Resonances (standing waves) will be present in all 3 axes, creating hot and cold spots thoughout the chamber and making absolute measurement of emission level virtually impossible.

Other causes of measurement uncertainty are:

The presence of buildings, trees, bushes (almost anything) in the vicinity.
Variation of ground plane reflectivity
Antenna characteristics
Instrumentation error
Product configuration

If the test site is indoors, then nearby machinery, filing cabinets, metal tables, building structure, girders, RSJs, reinforcing rods, nearby staff, will all add to the equation.

Table 1 is an assessment of typical measurement uncertainties that may be encountered.

Table 1. Measurement uncertainties

Site	Test House	Own site	Own site	Own site
Equipment	**Top class**	**Top class**	**Low cost**	**Low cost**
Cost	**£100K**	**£30K**	**£4K**	**£5K**
Test site	**3**	**6**	**6**	**2**
Antenna	1.5	2	3	0
Analyser	1	1.5	4	4
Total (Instr)	**2.5**	**3.5**	**7**	**4**
Total (Site+Instr.)	**5.5**	**9.5**	**13**	**6**
Product configtn	**4**	**4**	**4**	**4**
Total overall	**9.5**	**13.5**	**17**	**10**
Note	**1**	**2**	**3**	**4**

Notes:
1. NAMAS accredited site
2. Uncalibrated test site (approximate OATS) and tuned receiver
3. Uncalibrated test site (approximate OATS) and spectrum analyser
4. As 3. With the addition of an emissions reference source.

General notes:
(a) Assume ground plane effect eliminated (by technique or absence)
(b) Test house figures and instrumentation figures derived from published figures.
(c) Product configuration and own test site errors will vary widely depending on product type and circumstances, and may be considerably larger.

The benefit of using the ERS becomes obvious. Note that the complete measurement system (test site + ground plane + reflections + antenna + instrumentation is all inside the calibration loop with the result that the total (Site + Instr.) error is dramatically reduced.

When used as described below, the ERS also takes into account the test site distortion due to any short term variables, such as weather conditions (outdoor sites) and room configuration for indoor sites.

6.0 Operating notes

6.1 Battery

Prior to using the ERS, ensure the batteries are fully charged. If in doubt, connect the battery charger to the charging socket and charge for 8 or more hours. The charging rate is set for trickle charging and so the charger may be left on for extended periods without damaging the battery.

Do not use the ERS with the battery charger connected.

Battery operating duration is 2.5 hours. Note that when new, the batteries will need charging and may need to be cycled 2 or 3 times before achieving full capacity. To maintain good battery capacity, observe good battery operation practices to avoid memory effect. (Ie always fully discharge before recharging)

6.2 Operation

To operate the ERS, first install the antenna. This is retained in storage by magnetic pads on the side of the unit and will simply pull away. Connect it to the BNC socket on the top of the unit.

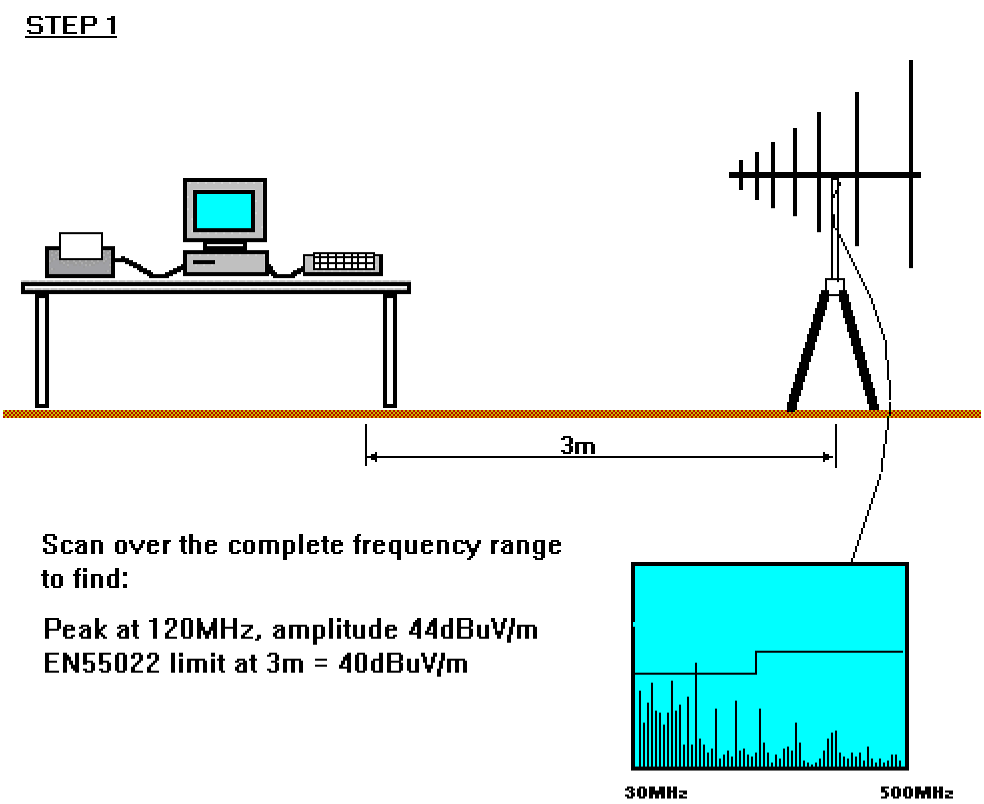
The output is switched on by pressing the push button switch to show a green indicator. Correct operation is confirmed by the green LED indicator.

If the green LED extinguishes whilst the switch is ON, the batteries have become discharged and the unit has automatically switched off.

7.0 Application

7.1 Measurement correlation

This technique checks the measurement error associated with a specific measurement. It provides the highest possible level of integrity .



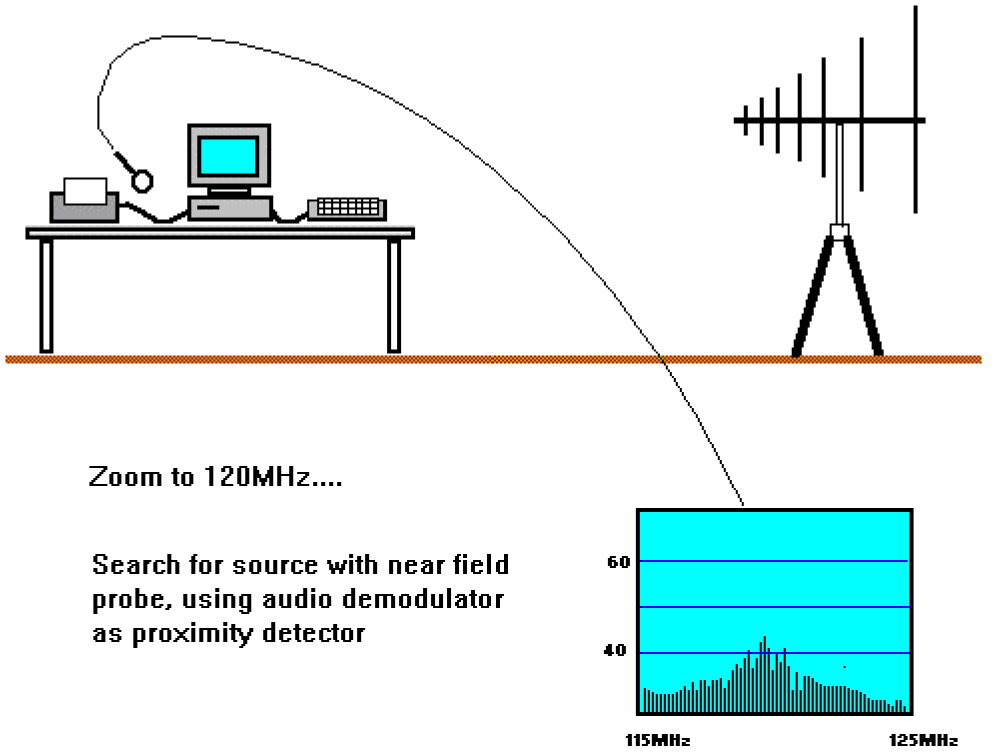
Prepare your test site and install the EUT. Use your measurement system as normal to detect any emissions from the EUT. The results are shown in STEP 1 as an example (assuming vertical polarisation)

As can be seen, an emission peak has been detected and measured.

However, at this stage we have no means of quantifying the accuracy or integrity of this measurement.

In order to gain an accurate check with the ERS, it must be located as close as possible to the source of the 120MHz signal. If the EUT is small and isolated, this next step will not be required.

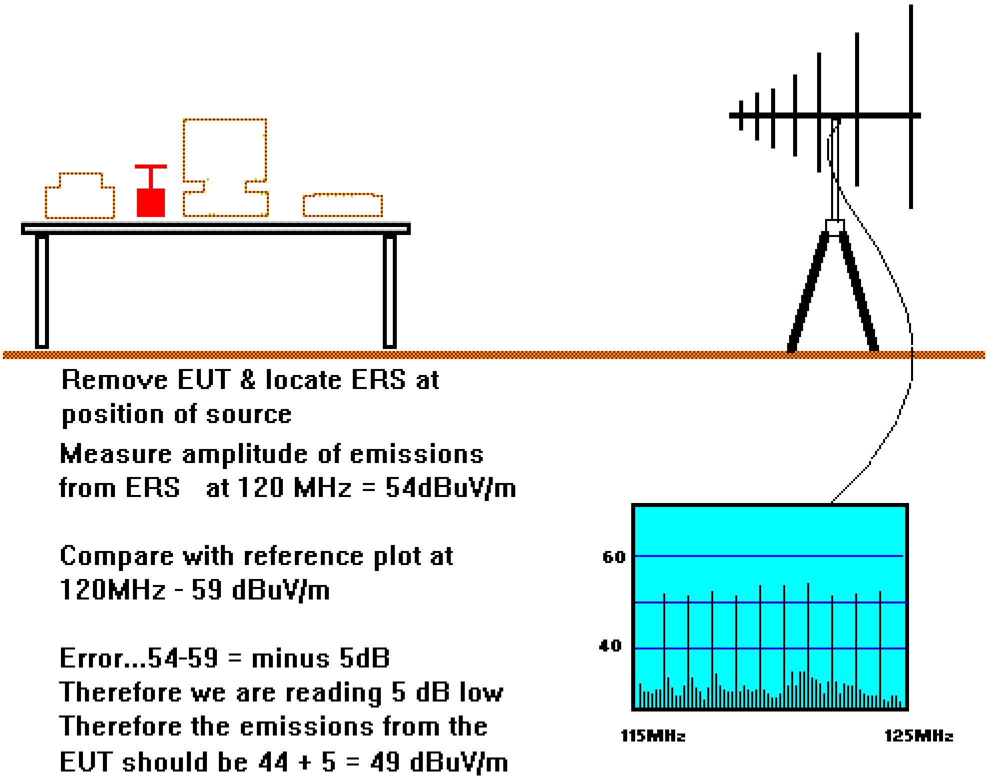
STEP 2



Locate the source as accurately as possible. Note that this may not correspond to the location of the highest readings from the near field probe. See Appendix 1 'Near field vs Far Field'.

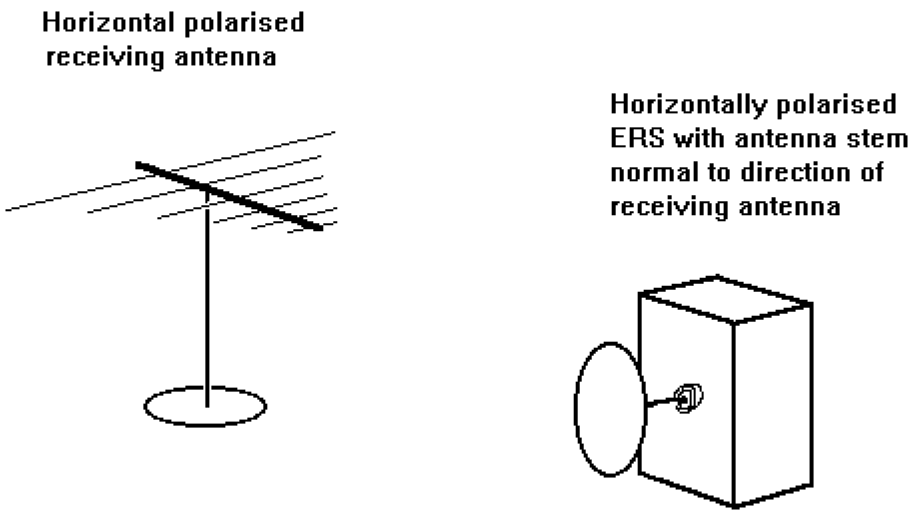
STEP 3

Remove the EUT and locate the ERS as close as possible to the position of the source. Position it with the antenna stem vertical for vertical polaristion
Switch the ERS on.



Measure the amplitude of the ERS emission line nearest the frequency under investigation. The lines are nominally 2MHz apart so the nearest one must be within 1MHz.
Compare the measured amplitude with the ERS reference plot or tabulated list (Appendix II) for the corresponding polarisation and frequency. If the site, antenna height, conditions, procedures and instrumentation were perfect, (ie matched the NPL site) the amplitude would match that on the reference plot. Generally there will be a discrepancy which will be due to these factors. This discrepancy is the correction factor to be applied to the original measurement. By applying this factor, the measurement is being 'normalised' to correlate with an NPL measurement.

Repeat for horizontal polarisation from step 1 but use the ERS on its side with the antenna stem horizontal and normal to the direction of the receiving antenna. Use the horizontal calibration plots in Appendix II



7.2 Test Site Calibration

This technique provides a complete overview of the characteristics of a test site ... antenna ... instrumentation installation. The result is a quantitative comparison between the users site and an ideal site (NPL).

Note that in the case of screened rooms (non-anechoic) the location of the ERS and the antenna will be critical. In small rooms slight movement of either could have significant effects on the results.
On open air sites, ground conditions may affect the site calibration, therefore calibration should be done each time the site is used.

1. Locate the ERS at the intended position of the EUT.
2. Measure the emissions from the ERS using your normal procedures.
3. By correlation of the ERS calibration plots and the plots obtained in step 2 a correction curve can be derived. This may be done by manual observation or by using a spreadsheet or similar in a PC (if the instrumentation allows this).

8.0 Direct Connection

An output can be taken from the ERS by directly connecting a BNC co-ax lead to the output socket. This will provide an uncalibrated output level from 2MHz to over 1GHz. This can be used, for instance, for insertion loss measurements.

Note that the output is not matched to 50ohm and therefore an impedance mismatch will occur when connected to 50 or 75ohm cables. This will result in strong peaks and dips in the output signal spectrum due to reflections. This direct output is not calibrated.

APPENDIX 1

Near field vs Far field

Take the case of an alternating current passing down a wire. This current will create a magnetic field round the wire, which must also alternate in direction. This continual reversal of magnetic fields consumes energy, the more times per second the field is reversed, the more energy is consumed. This energy ‘leaks’ away from the wire as an alternating magnetic field. If this field crossed a conductor, a voltage would be created along the conductor. In fact, if this field simply passed through space, a voltage is created in space. This voltage would depend on the impedance of ‘space’. This impedance is 377ohm (the impedance of free space) and results in a given voltage for a given magnetic field. Therefore, as the original magnetic field created by the alternating current disperses into space, it creates a matching voltage field and the radiation acquires a ‘free space’ form. This change occurs gradually but it is generally accepted that the nominal transition point occurs at about ½ wavelength. In free space, the energy alternates between magnetic and electric field components.

The standards require the measurement of interference at a distance. This is measurement of the far field radiation which be a function of two factors:

the source (S) = strength (power) of the source

the aerial (A) = efficiency of the aerial.

The aerial is the conductor which radiates the energy produced by the source.
Essentially, emission level = S * A
ie. The measured far field radiation level is related to S times A
The (very) near field level as measured by a near field probe is simply related to S.
So a strong source connected to a poor ‘aerial’ will generally not produce strong emissions, whilst a weak source connected to a ¼ wavelength conductor will radiate plenty.
For example, if the source is a microprocessor chip, the near field probe may pick up a very high 120MHz signal immediately adjacent to it. However, due to the small physical size of a chip, it is unlikely to be the ‘radiating’ element. To radiate energy, we need an aerial.
Aerials need a certain length in order to work effectively. Conventionally they need to be approaching ¼ wavelength long but measureable radiation may be emitted from conductors significantly shorter than this if the source is strong.
So if tracking the source of emissions, find a conductor (cable, PCB track, ribbon cable) that has evidence of the 120MHz signal on it. Even if the signal is weak, if the conductor is long, it is likely that the true source of the emissions is that conductor.

APPENDIX II

Reference data

The following information is enclosed:

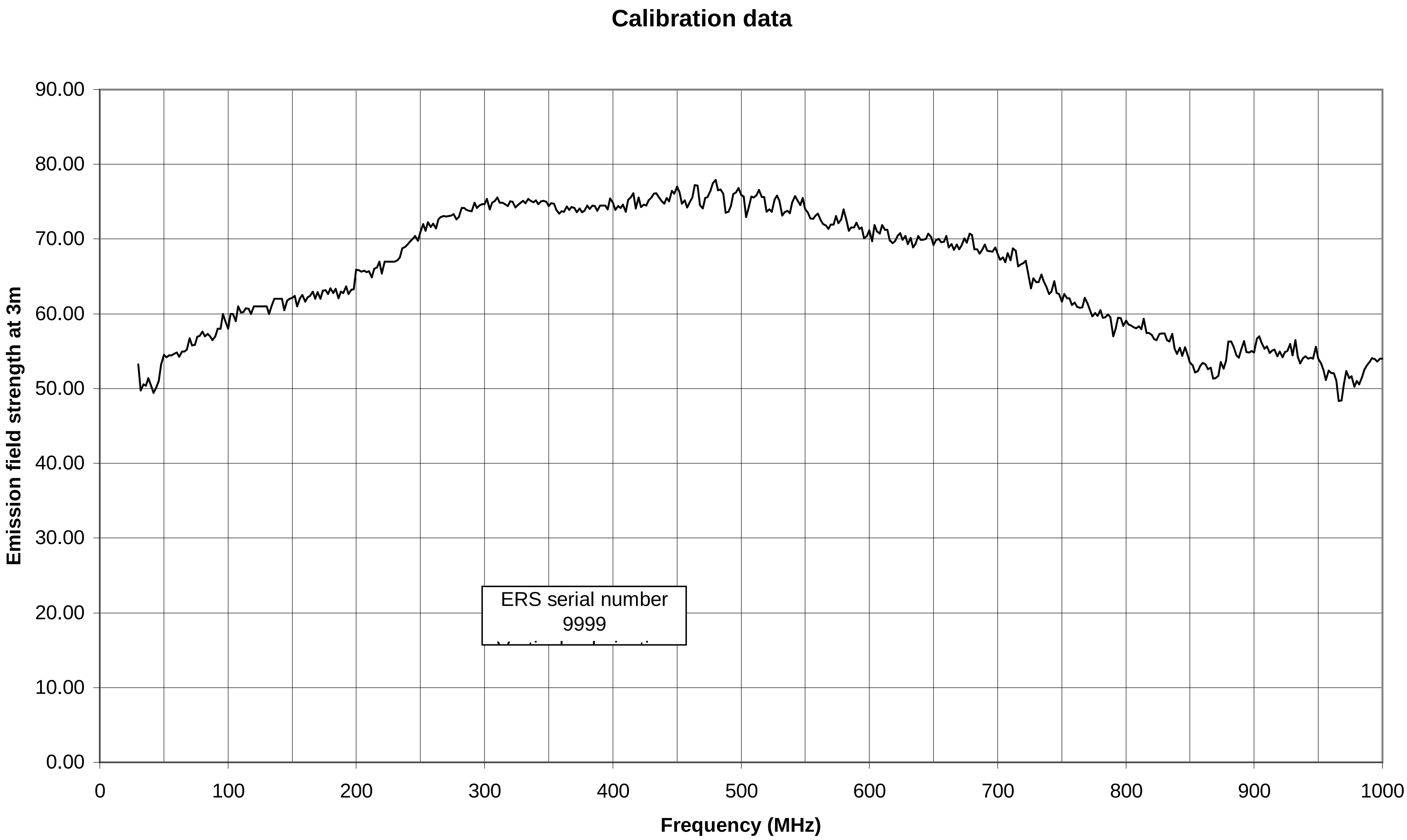
Calibration plots from NPL for the master ERS.
- (a) Vertical polarisation
- (b) Horizontal polarisation

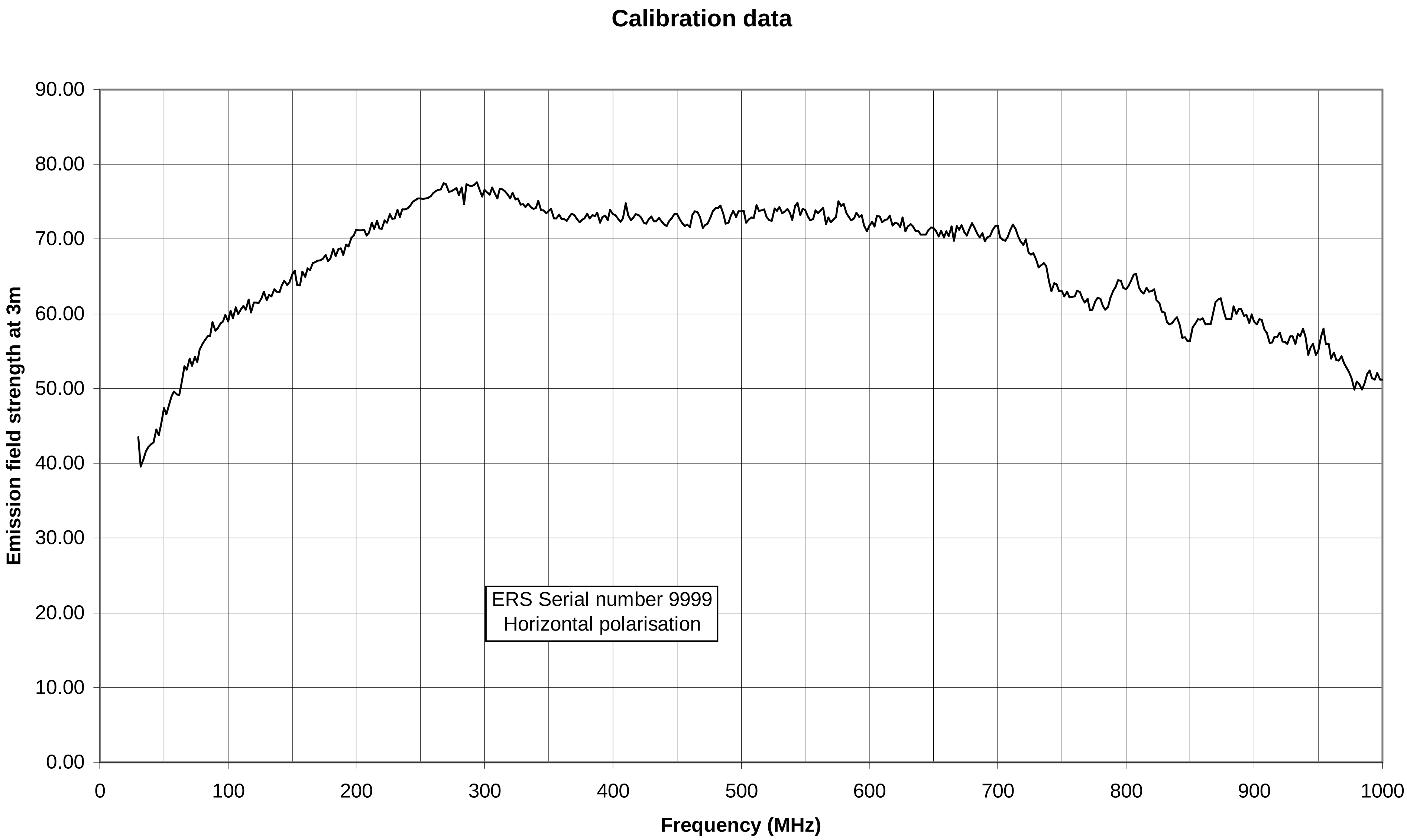
Calibration plots for your ERS
- (a) Vertical polarisation
- (b) Horizontal polarisation

Tabulated results for your ERS.
- (a) Vertical polarisation
- (b) Horizontal polarisation

All plots referenced to 3 metres antenna - ERS distance.

Note that a copy of the calibration data can be obtained on CD in SDF format (ASCII, comma delimited). Contact your supplier for ordering details.


Calibration data
ERS serial number
9999
Emission field strength at 3m
Frequency (MHz)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
100
200
300
400
500
600
700
800
900
1000


Calibration data
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Emission field strength at 3m
0
100
200
300
400
500
600
700
800
900
1000
Frequency (MHz)
ERS Serial number 9999
Horizontal polarisation

ERS calibration data

Serial number **9999**

Master serial number	1288
Master calibration date	19.10.2007

Calibration valid from

All data referred to 3m test distance

Frequency MHz	Horizontal dBuV/m	Vertical dBuV/m
30	43.53	53.26
32	39.56	49.76
34	40.58	50.59
36	41.59	50.39
38	42.16	51.36
40	42.57	50.37
42	42.83	49.45
44	44.55	50.15
46	43.77	51.00
48	45.21	53.26
50	47.38	54.50
52	46.54	54.21
54	47.87	54.46
56	49.00	54.43
58	49.62	54.67
60	49.20	54.80
62	49.13	54.25
64	51.10	54.96
66	53.00	54.94
68	52.55	55.19
70	53.99	56.77
72	53.04	55.76
74	54.25	55.83
76	53.59	56.91
78	55.22	57.06
80	55.97	57.62
82	56.45	57.00
84	57.01	57.30
86	57.08	57.00
88	58.92	56.47
90	57.75	57.00
92	58.08	58.00
94	58.71	58.00
96	58.94	60.00
98	59.83	59.00
100	58.98	58.00
102	60.40	60.00
104	59.41	60.00
106	60.84	59.00
108	60.00	61.00
110	60.63	60.14
112	61.08	60.23
114	60.58	60.77
116	61.88	60.67
118	60.20	60.00
120	61.50	61.00
122	61.50	61.00
124	61.44	61.00
126	62.06	61.00

128	63.00	61.00
130	61.85	61.00
132	62.54	60.00
134	62.35	61.00
136	63.30	62.00
138	63.00	62.00
140	62.89	62.00
142	63.87	62.00
144	64.41	60.50
146	63.88	61.77
148	64.22	62.02
150	65.29	62.17
152	65.79	62.37
154	63.85	61.00
156	63.82	62.08
158	65.62	62.50
160	64.93	61.65
162	66.11	62.20
164	65.80	62.40
166	66.79	63.00
168	66.91	62.00
170	67.10	62.87
172	67.15	62.00
174	67.34	63.09
176	67.87	63.16
178	67.05	62.62
180	67.41	63.43
182	68.71	62.78
184	67.76	63.36
186	68.72	62.08
188	68.73	62.95
190	67.84	62.79
192	69.29	63.65
194	69.00	62.63
196	70.13	63.20
198	70.45	63.30
200	71.22	65.87
202	71.17	65.82
204	71.15	65.66
206	71.22	65.74
208	70.50	65.60
210	70.84	65.72
212	72.17	64.89
214	71.39	66.05
216	72.47	66.19
218	71.45	67.00
220	71.35	65.38
222	72.51	67.00
224	72.18	67.00
226	73.32	67.00
228	72.68	67.00
230	72.74	66.96
232	73.90	67.16
234	72.93	67.57
236	73.94	68.74
238	73.97	68.95
240	74.12	69.24
242	74.51	69.73
244	75.00	70.06
246	75.18	70.43
248	75.42	69.79
250	75.43	70.92
252	75.40	72.01
254	75.41	71.12
256	75.51	72.25
258	75.77	71.61
260	76.15	72.06

262	76.44	71.42
264	76.61	72.64
266	76.64	72.93
268	77.49	73.05
270	77.34	73.04
272	76.31	73.07
274	76.39	73.12
276	76.60	73.33
278	76.81	72.65
280	75.89	72.97
282	76.88	74.18
284	74.68	74.15
286	77.36	73.93
288	77.15	73.77
290	77.12	73.74
292	77.28	74.89
294	77.57	74.19
296	76.71	74.48
298	75.71	74.68
300	76.56	74.66
302	76.25	75.38
304	75.94	73.95
306	76.88	74.85
308	76.10	75.14
310	75.45	75.58
312	76.70	74.87
314	76.62	74.85
316	76.38	74.70
318	75.97	74.44
320	75.44	75.08
322	76.17	75.00
324	75.28	74.22
326	75.45	74.56
328	74.59	74.87
330	74.69	75.14
332	74.30	74.83
334	74.76	75.40
336	74.29	75.10
338	74.04	74.94
340	74.18	75.19
342	75.09	74.66
344	73.87	75.05
346	73.84	75.13
348	73.47	74.97
350	73.79	74.41
352	74.02	74.82
354	72.74	74.71
356	72.78	73.92
358	73.25	73.38
360	72.67	73.74
362	72.70	73.67
364	72.44	74.38
366	72.96	73.88
368	73.42	74.32
370	73.21	74.17
372	72.67	73.56
374	72.24	74.13
376	72.58	73.57
378	72.79	73.81
380	73.41	74.48
382	72.78	74.01
384	73.21	74.48
386	73.11	74.42
388	73.52	73.80
390	72.20	74.50
392	72.98	74.46
394	73.15	74.46

396	72.52	73.96
398	73.90	75.42
400	73.32	74.88
402	73.23	73.89
404	72.72	74.44
406	72.32	74.14
408	72.76	74.61
410	74.78	73.68
412	73.20	75.24
414	72.49	75.60
416	72.90	76.13
418	73.33	74.13
420	73.23	75.58
422	72.89	74.30
424	72.20	74.60
426	72.04	74.50
428	72.66	75.16
430	73.00	75.56
432	72.38	76.05
434	72.39	76.11
436	72.83	75.56
438	72.37	75.13
440	71.93	74.71
442	71.77	75.48
444	72.35	75.05
446	72.83	76.46
448	73.36	76.09
450	73.35	77.00
452	72.70	76.28
454	72.22	74.76
456	71.72	75.18
458	71.94	74.24
460	71.65	74.99
462	73.19	75.58
464	73.74	77.19
466	73.59	77.17
468	72.95	74.54
470	71.46	74.09
472	71.90	75.51
474	72.05	75.65
476	72.92	76.48
478	73.71	77.48
480	74.15	77.93
482	74.18	76.51
484	74.48	76.64
486	73.40	76.08
488	72.06	73.53
490	72.22	73.68
492	73.12	74.43
494	73.81	75.99
496	72.98	76.23
498	73.73	76.84
500	73.74	75.89
502	73.81	75.67
504	72.21	72.97
506	72.66	74.35
508	72.89	75.69
510	72.81	75.56
512	74.54	75.90
514	73.79	76.56
516	73.83	75.65
518	74.00	75.65
520	72.97	73.63
522	72.50	73.98
524	72.42	73.65
526	74.11	75.32
528	73.79	75.82

530	74.28	75.14
532	73.46	73.14
534	73.67	73.58
536	74.02	73.76
538	73.53	73.46
540	72.57	74.90
542	74.44	75.76
544	74.89	75.16
546	73.24	74.57
548	74.06	75.48
550	73.93	74.04
552	73.00	73.52
554	72.48	72.76
556	72.67	72.72
558	73.83	73.17
560	73.49	73.37
562	73.82	72.54
564	74.18	71.97
566	71.98	71.82
568	72.87	71.37
570	72.28	71.92
572	72.66	71.96
574	72.98	73.07
576	75.07	72.12
578	74.41	72.66
580	74.73	74.00
582	73.49	72.50
584	72.98	71.09
586	72.51	71.53
588	72.79	71.57
590	73.54	72.16
592	72.98	71.39
594	73.22	71.54
596	71.78	70.11
598	71.02	70.42
600	71.77	71.19
602	72.33	69.73
604	71.68	71.89
606	73.10	71.06
608	73.03	70.74
610	72.24	71.87
612	72.60	71.22
614	72.62	71.25
616	73.16	69.85
618	71.80	69.44
620	72.18	69.74
622	72.07	70.47
624	71.63	70.81
626	72.90	69.92
628	71.03	70.40
630	71.68	69.31
632	72.00	70.17
634	71.68	68.89
636	71.09	69.35
638	71.11	70.38
640	70.61	69.91
642	70.60	69.93
644	70.62	70.02
646	71.17	70.71
648	71.54	70.30
650	71.46	69.20
652	71.11	69.85
654	70.36	70.01
656	71.10	69.59
658	70.20	69.63
660	71.04	70.41
662	70.44	68.90

664	71.71	69.33
666	69.75	68.54
668	71.76	69.29
670	71.22	68.60
672	71.90	69.16
674	70.94	70.07
676	70.49	69.49
678	71.40	70.75
680	72.10	70.55
682	71.58	68.64
684	70.71	68.66
686	70.22	68.04
688	70.82	68.64
690	69.73	69.26
692	70.23	68.44
694	70.43	68.39
696	71.19	68.33
698	71.74	68.86
700	71.83	68.02
702	70.22	67.23
704	69.88	67.54
706	69.77	66.90
708	70.28	68.12
710	71.29	67.15
712	71.94	68.73
714	71.31	68.44
716	70.35	66.35
718	69.72	66.58
720	69.23	66.76
722	69.97	67.11
724	68.21	65.04
726	67.92	63.41
728	68.11	64.73
730	67.22	64.23
732	66.19	64.26
734	66.51	65.26
736	66.79	64.31
738	66.38	63.69
740	64.29	62.68
742	63.01	63.00
744	64.11	64.39
746	63.90	62.75
748	63.03	62.68
750	63.01	61.63
752	62.34	62.66
754	62.95	62.06
756	62.22	62.06
758	62.24	61.18
760	62.33	61.48
762	63.10	60.94
764	62.93	60.82
766	62.08	60.87
768	61.51	62.17
770	62.04	61.39
772	60.46	60.47
774	60.53	59.63
776	61.66	60.08
778	62.14	59.71
780	62.03	60.48
782	61.04	59.44
784	60.56	59.56
786	60.93	59.91
788	62.11	59.51
790	63.11	56.97
792	63.62	57.99
794	64.52	59.44
796	64.46	59.40

798	63.46	58.40
800	63.26	59.10
802	63.73	58.61
804	64.35	58.47
806	65.25	58.19
808	65.33	58.08
810	63.52	58.30
812	62.96	57.93
814	62.71	59.34
816	63.45	57.45
818	62.94	57.43
820	63.05	57.17
822	63.30	56.60
824	61.83	56.46
826	61.47	57.30
828	60.27	57.40
830	60.16	57.38
832	58.90	56.47
834	58.55	56.31
836	58.80	57.28
838	59.19	55.35
840	59.51	54.64
842	58.44	55.44
844	56.79	54.36
846	56.89	55.51
848	56.36	54.60
850	56.38	53.49
852	58.17	53.10
854	58.62	52.17
856	59.25	52.37
858	59.21	53.06
860	59.38	53.41
862	58.56	53.22
864	58.67	52.61
866	58.65	52.77
868	60.08	51.30
870	61.54	51.42
872	61.98	51.69
874	62.08	53.55
876	60.43	52.66
878	59.35	53.71
880	59.27	56.26
882	59.28	56.26
884	60.99	55.57
886	59.99	54.45
888	60.71	54.10
890	60.61	55.18
892	59.72	56.33
894	59.85	54.92
896	58.77	54.80
898	59.94	55.00
900	58.98	54.85
902	58.58	56.66
904	59.29	57.02
906	59.19	56.11
908	57.86	55.32
910	57.45	55.67
912	56.07	54.75
914	56.14	55.08
916	56.93	55.18
918	56.90	54.29
920	57.47	54.96
922	56.27	54.19
924	56.20	54.87
926	56.00	55.00
928	57.00	56.00
930	57.00	54.46

932	56.00	56.50
934	57.29	54.28
936	57.00	53.39
938	58.00	54.06
940	57.00	54.29
942	54.50	53.97
944	55.50	54.10
946	56.00	54.00
948	54.50	55.56
950	55.00	54.00
952	57.00	53.38
954	58.00	52.49
956	56.00	51.16
958	56.00	52.39
960	54.00	52.07
962	54.81	52.00
964	53.80	51.09
966	53.74	48.37
968	54.29	48.43
970	53.44	50.65
972	52.83	52.35
974	52.16	51.40
976	51.37	51.67
978	49.89	50.27
980	50.95	51.03
982	50.64	50.55
984	49.85	51.51
986	50.64	52.56
988	51.96	53.16
990	52.42	53.56
992	51.39	54.04
994	51.23	53.91
996	52.10	53.62
998	51.21	54.02
1000	51.21	54.02
	9999.00	9999.00