The Radio Technology and Compatibility Group

Report No RTL458

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Investigation to Characterise Domestic Microwave Ovens for RA3/PN

22 Upper Ground
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Version 1.0

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1.0 Introduction

1.1 This project was sponsored by RA3/PN in connection with new frequency assignments in the microwave band allocated to Industrial Scientific and Medical (ISM) use in the United Kingdom.

1.2 Domestic microwave cookers have been in use in the United Kingdom market since the middle of the 1970s. This project is to look at typical emissions from these domestic microwave ovens to plot the frequency of operation over time, the spread of the RF signals created by the magnetron and the maximum erp radiated from a typical sample of domestic microwave cookers.

1.3 Frequency plots of the equipment were taken, see Annex 1.

1.4 Fifteen domestic microwave cookers were tested, six of which were from the RTCG's test stock and carried RTCG plant numbers and the remainder from staff at the RTCG. These were classified by make and model number and using the staff members initials.

1.5 The domestic microwave cookers were examined to discover what type of magnetron was used and the manufacturer of the magnetron.

2.0 Summary

2.1 The frequency measured from the domestic microwave cookers varied between approximately 1.87GHz and 2.93GHz (1060MHz).

2.2 Between 2.0GHz and 2.75GHz (750MHz) the RF signal emanating from the cooking chamber was approximately 10dB above the noise with the major signal peaks at between 2.4GHz and 2.5GHz (100MHz).

2.3 The RF power leaking from the all the domestic microwave cookers tested varied between 1549mW and 245mW which is a difference of 8dB.

2.4 Leakage from the doors of domestic microwave cookers is greater from cookers that at have been in constant use over a number of years.

3.0 Test Equipment Used

Equipment	Plant Number
Hewlett Packard 8566B Spectrum Analyser	1220
Hewlett Packard HP871B Signal Generator	1054
Century 20dB Horn 2.3 – 3.3GHz	1345
Q-Par Horn	481
Sucoflex cable	4321
Emco 1090 Turntable	2411

4.0 Measurement Method

4.0.1 The device under test (DUT) was placed on a non-conducting support at a height of 1.5 metres in a position closest to normal use (horizontal).

4.0.2 The output of a test antenna in the horizontal plane, at the carrier frequency of the DUT was connected to a Spectrum Analyser and the Spectrum Analyser was set to that part of the RF spectrum under investigation.

4.0.3 A load comprising 500ml of water in a non-metallic jug was placed in the DUT on the turntable offset from the centre.

4.0.4 The DUT was set to maximum power and turned on with a time setting of 10 minutes.

4.0.5 The DUT was then rotated through 360° until the maximum signal level from the DUT was received by the Spectrum Analyser. The maximum power level and frequency were recorded.

4.0.6 The DUT was then replaced by a substitution antenna that was connected to a calibrated Signal Generator.

4.0.7 The signal from the Signal Generator was increased until the level received by the Spectrum Analyser was the same as that received from the DUT.

4.0.8 The input level from the Signal Generator to the substitution antenna was recorded as the power level from the DUT.

4.0.9 The above test was repeated with the test antenna in the vertical plane and the results recorded.

4.1 Visual Inspection

4.1.1 The external top cover of the DUT was removed and a note of type and manufacturer of magnetron was noted.

4.1.2 The date of manufacture was noted.

5.0 Measurement Results

5.1 Domestic microwave cookers showing input and output powers specified by manufacturer.

Make	Model	Plant Number*	Input Power (kW)	Input Current (Amps)	Output Power (Watts)
Sharp	R-8200E	RIS	1400	5.0	600
Sanyo	EM9003T-2	DSW	1350	5.7	700
Toshiba	ER8730E	SL	1400	6.5	600
Philips	AVM702/PH	DSW	1100	4.8	500
Panasonic	NN5307B	100	1300	5.2	600
Matsui	150	FJM	950	4.0	500
Sharp	R-7780(B)M	1756	1300	5.5	660
Sharp	R5820	DSW	960	4.2	500
Sharp	MR-5A50(B)M	RDH	1350	5.7	700
Sharp	MR-5V10(W)M	AC	1350	5.7	700
Panasonic	NN8857	1754	1740	5.8	700
Matsui	M160	1406	1000	5.0	600
Sharp	R-V11(W)A	PLAB	960	4.2	600
Panasonic	NN6453B	2680	1400	6.7	600
Goldstar	MS-1707M	2682	1100	4.8	700

* see Section 1.4

5.2 Domestic microwave cookers by date of manufacturer.

Make	Model	Plant Number*	Year of Manufacture	Rated Power (Watts)	Magnetron Type
Sharp	R-8200E	RIS	7/1978	600	2M57-A(A)
Sanyo	EM9003T-2	DSW	1/1981	900	2M154K
Toshiba	ER8730E	SL	10/1985	600	2M172AH
Philips	AVM702/PH	DSW	12/1985	500	2M172AH(P)
Panasonic	NN5307B	100	4/1987	600	2M210-M
Matsui	150	FJM	1/1987	500	2M213
Sharp	R-7780(B)M	1756	5/1988	660	2M214
Sharp	R5820	DSW	8/1988	500	2M202
Sharp	MR-5A50(B)M	RDH	10/1988	700	2M214
Sharp	MR-5V10(W)M	AC	8/1989	700	2M214
Panasonic	NN8857	1754	9/1989	700	2M210-M1
Matsui	M160	1406	11/1990	600	2M238
Sharp	R-V11(W)A	PLAB	6/1991	600	2M216(G)
Panasonic	NN6453B	2680	4/1994	600	2M210-M1
Goldstar	MS-1707M	2682	11/1996	700	2M218J

* see Section 1.4

5.3 Domestic microwave cookers showing maximum RF power leaking from door area.

Make	Model	Plant Number*	Magnetron Type	Max Radiated Power (mW)
Sharp	R-8200E	RIS	2M57-A(A)	759
Sanyo	EM9003T-2	DSW	2M154K	977
Toshiba	ER8730E	SL	2M172AH	1175
Philips	AVM702/PH	DSW	2M172AH(P)	955
Panasonic	NN5307B	100	2M210-M	1549
Matsui	150	FJM	2M213	589
Sharp	R-7780(B)M	1756	2M214 [1]	380
Sharp	R5820	DSW	2M202	398
Sharp	MR-5A50(B)M	RDH	2M214	1000
Sharp	MR-5V10(W)M	AC	2M214	955
Panasonic	NN8857	1754	2M210-M1	513
Matsui	M160	1406	2M238	603
Sharp	R-V11(W)A	PLAB	2M216(G)	501
Panasonic	NN6453B	2680	2M210-M1	245
Goldstar	MS-1707M	2682	2M218J	309

* see Section 1.4

5.3.1 The domestic microwave cookers shaded in the above table are in regular use.

5.4 Manufacturer of the magnetrons.

Make	Model	Plant Number*	Magnetron Type	Magnetron Manufacturer
Sharp	R-8200E	RIS	2M57-A(A)	Sharp
Sanyo	EM9003T-2	DSW	2M154K	Sanyo
Toshiba	ER8730E	SL	2M172AH	Toshiba
Philips	AVM702/PH	DSW	2M172AH(P)	Toshiba
Panasonic	NN5307B	100	2M210-M	Matsushita
Matsui	150	FJM	2M213	Goldstar
Sharp	R-7780(B)M	1756	2M214	Sharp
Sharp	R5820	DSW	2M202	Sharp
Sharp	MR-5A50(B)M	RDH	2M214	Sharp
Sharp	MR-5V10(W)M	AC	2M214	Sharp
Panasonic	NN8857	1754	2M210-M1	Matsushita
Matsui	M160	1406	2M238	Hitachi
Sharp	R-V11(W)A	PLAB	2M216(G)	Toshiba
Panasonic	NN6453B	2680	2M210-M1	Panasonic
Goldstar	MS-1707M	2682	2M218J	Sanyo

* see Section 1.4

6.0 Observations

6.1 The frequency varied with load, a small load gave an initial instantaneous frequency that was different from that of an initial instantaneous frequency with a larger load (the DUT and the load were allowed to cool between tests). The small load comprised two tablespoons of water on the turntable and the large load comprised 1½ litres of water in non-metallic jugs. The DUT was turned on for 10 seconds for each test. See plot 17.

6.2 The frequency varied with the amount of time that the DUT had been in operation. As the load (500ml of water) warmed up the frequency of operation drifted LF. The cause was not examined

6.3 The emissions from the door during the cooking cycle were dependent on whether the load was at the front or rear of the cooking chamber. As the load was offset from the middle of the turntable, greatest emissions were measured with the load at the rear of the cooking chamber. As the load travelled round on the turntable to the front of the cooking chamber, the emissions through the door reduced in level.

6.4 No precise upper or lower frequency could be noted for any particular domestic microwave cooker, as there were many variables involved. The size and position of the load and the temperature of the load and also variations in the temperature of the magnetron with a possible consequential change in the voltage to the magnetron caused the frequency to change. Also the quantity of the water vapour in the cooking chamber could change the measurement results.

6.5 One of the domestic microwave cookers (PN100) raised the noise floor by 3dB to 4dB during the test.

7.0 Conclusions

7.1 The frequency measured from the domestic microwave cookers varied between approximately 1.87GHz and 2.93GHz (1060MHz).

7.2 Between 2.0GHz and 2.75GHz (750MHz) the RF signal emanating from the cooking chamber was approximately 10dB above the noise with the major signal peaks at between 2.4GHz and 2.5GHz (100MHz).

7.3 The RF power leaking from the all the domestic microwave cookers tested varied between 1549mW and 245mW which is a difference of 8dB.

7.4 Leakage from the doors of domestic microwave cookers is greater from cookers that at have been in constant use over a number of years.