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Data acquisition from X-band Microwave bench

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Abstract: The dielectric parameters of liquids and solids are measured by using X-band Microwave bench manually. Hence, personal computer (PC) based automatic measurement technique is used for accurate measurement of the dielectric parameters. PC based stepper motor moves the plunger in liquid cell or to the probe in slotted section of the microwave bench. X-band Microwave bench at 10.95GHz is used. The sampled signal is fed into the instrumentation amplifier . A 12-bit analog-to-digital converter, designed for use in an integrated technology This technique is used to give the maximum accuracy for the measurement of the position of standing wave voltage minima and determine the wave length of the electromagnetic wave in the wave guide filled with air(λ_g /2) or dielectric sample ($\lambda_{d/2}$). Further accuracy of this technique can be increased when the stepper motor is operated in micro stepping mode.

Keywords: - *ADC interfacing card, Instrumentation Amplifier, microwave bench, PC, stepper motor*

I: Introduction:

The dielectric parameters such as permittivity, permittivity loss, Loss tangent of Organic Liquids or mixtures were measured using Basic reflectometer techniques and Surber's technique [4,5,10,11,12] by using X-band Microwave bench . The liquid cell has movable short called as plunger displaces in liquid cell in proper direction by stepper motor [3].

To measure the reflected power from movable short analog to digital Converter implemented using 12 bit ADC interfacing card . The Resolution of an A/D converter is the number of output bits [2,13]. It provides use full information on how to configure the ADC registers . The Analog-to-Digital Converter (A/D Converter or ADC) has both analog and digital functions, it is a mixed-signal device. It can, however, be considered very simply to be the instrument that it is a device that provides an output that digitally represents the input voltage or current level . Most ADCs convert an input voltage to a digital word, but the true definition of an ADC does include the possibility of an input current. An ADC has an analog reference voltage or current against which the analog input is compared. The digital output word tells us what fraction of the reference voltage or current is the input voltage or current. So, basically, the ADC has the Input /Output transfer functions. This is because we generally consider this to be unity. However, **Dynalog** has introduced ADC PCL 812 with Instrumentation Amplifier PCLD 789D with different gains .

II: Experimental Details

The output signal from detector of X- band Microwave bench is low power signal range but the signal given to A/D card must be in the particular range and this signal must be noise free . Instrumentation amplifiers are precision gain blocks that have a differential input and an output that may be differential . These devices amplify the difference between two input signal voltages while rejecting any signals that are common to both inputs. It is widely used in many industrial, measurement, data acquisition and gain accuracy must be maintained within a noisy environment. **PCLD-789D** is one such versatile signal conditioning board of instrumentation amplifier [7] .The output channels of PCLD-789D are supported by the analog input channels of PCL 812 **.** It is connected to A/D card externally and it is a daughter board designed to expand the analog input channel of **PCL 812.** The gain of amplifier selected by the switch

PCL-812 [6] is a multifunction analog and digital I/O card that features A/D conversion, D/A conversion, digital input, digital output and counter/timer . In addition to all the features listed above, PCL-812 offers the convenience of programmable analog input ranges, where the analog input range can be switched by software commands instead of DIP switches. PCL-812 also delivers convenience and maximum resolution for applications that need different gains

Specifications: PCL-812 Analog Input:16 single-ended analog inputs,12-bit A/D converter, with up to 30 kHz sampling rate, Programmable gain, Resolution 12 bits, Input Range (V, software programmable)±10, ±5, ±2.5, ±1.25, ±0.625, ±0.3125,Accuracy 0.01% of reading ±1 LS Band Digital Output: Channels 16. Analog to digital conversation can be carried out inside the PC using Data Acquisition add-on-cards.

Automation technique consists of, personal computer , PCL812 interfacing card ,motor control/driver ,stepper motor and X-band microwave bench with liquid cell ,but automation technique moves the plunger in liquid cell [1,2,3] as shown in the **Fig.1 .** The PC is used to operate the stepper motor and by software program written in C++ language , the stepper motor displaces the plunger in liquid cell in proper direction [1,2,3,14,15,16].The microwave power from the detector with the distance covered by the plunger in liquid cell (in fraction of mm) of the microwave bench forward or backward direction are also displayed on the screen of monitor as standing wave voltage minima and maxima.

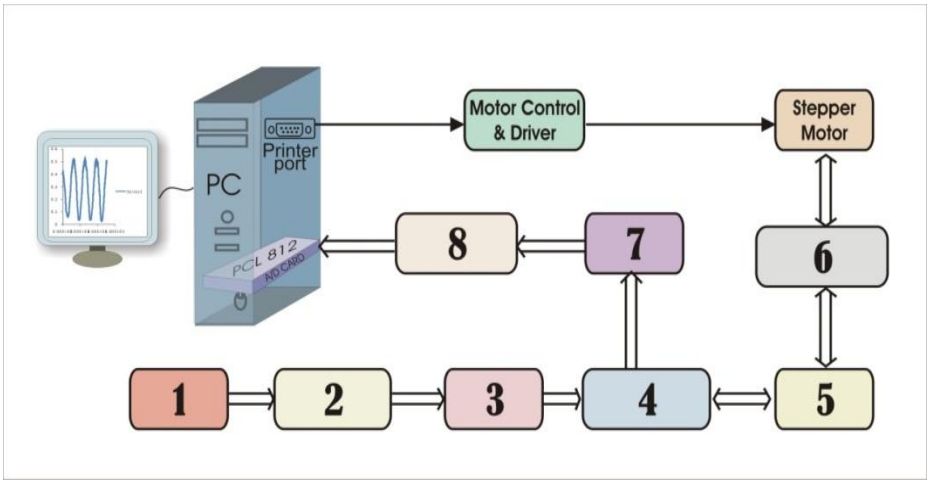

Fig.1: Functional Block Diagram: A Complete block diagram of Data acquisition from X-band Microwave bench **[1:**power supply , **2:** Microwave source ,**3:** Ferrite Isolator **4 :** Microwave Components (Frequency meter, Directional couplers, Isolator, slide screw tuners) , **5:** Liquid Cell **6:** The Plunger of Liquid Cell **7:** Crystal detector **8:** Instrumentation Amplifier PCLD 789D, **PC** :Personal Computer with A/D card PCL 812 **]**

III: Software:

The software programme is written in different programming language but we use **C++** language for it because this language works like low , middle and high level language [3,6-9].

The data acquisition in PC is possible with the help of PCL-812. The data acquisition programme is written in C++ because C++ supports input output instruction. The A/D conversion and data saving are performed as a foreground operation which means the CPU is fully occupied until the completion of all A/D conversion. If current scan range does not meet the next A/D conversion range required and it is set by using mux scan range function for different reading it requires simultaneous rotation of motor and which is also controlled through printer port of computer . The motor control and driver network controls the step sequence to rotate stepper motor in clockwise or anticlockwise direction. The RPM of the motor can also be increased or decreased by changing the time delays .Also in this language we can make executable files and It works as per flow chart as shown in **fig.2**

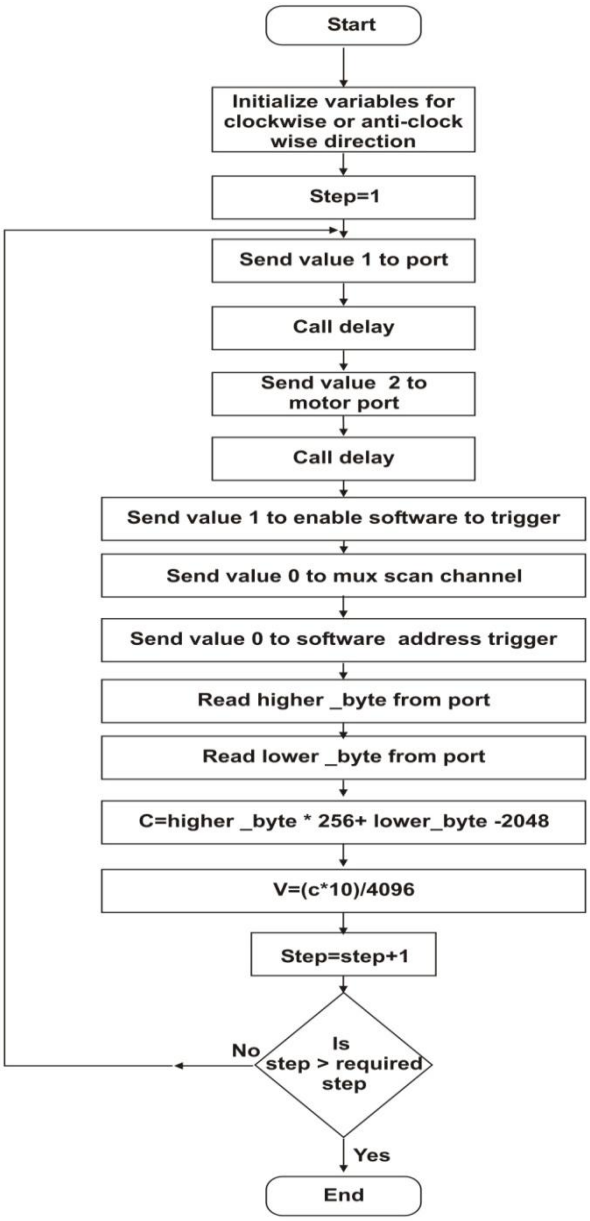

Fig. 2: Flow chart for C++ program

IV: Observations:

The liquid cell of X-band Microwave bench with no sample i.e. air filled liquid cell .The measurements of output power from detector are measured with different position in mm of the piston in liquid cell .Hence personal computer (PC) based automation measurement technique is used for accurate measurements. Read and record the position of standing wave voltage minima and determine the guide wave length $\lambda_g/2$ .Using data acquisition technique and Automation Technique for the Plunger in Liquid Cell of X-Band Microwave Bench Using Stepper Motor[3] ,the observations of position of the Plunger in Liquid Cell in mm and its corresponding microwave power are measured [4,5], as Shown in the **table .1**

Table-1: Observation table for readings of Lengths in mm v/s output power pages (4) to (9)

sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)
1	5.29E-02	0.412598	46	2.434167	0.270996	91	4.815418	8.30E-02	136	7.196661	0.100098
2	0.10583	0.402832	47	2.487084	0.283203	92	4.868334	0.078125	137	7.249578	0.107422
3	0.15875	0.415039	48	2.540001	0.256348	93	4.921251	7.57E-02	138	7.302495	0.109863
4	0.21167	0.400391	49	2.592917	0.266113	94	4.974167	7.57E-02	139	7.355411	0.109863
5	0.26458	0.410156	50	2.645834	0.249023	95	5.027084	7.32E-02	140	7.408328	0.12207
6	0.3175	0.400391	51	2.698751	0.261231	96	5.08	7.32E-02	141	7.461244	0.131836
7	0.37042	0.424805	52	2.751668	0.244141	97	5.132917	6.84E-02	142	7.514161	0.13916
8	0.42333	0.407715	53	2.804585	0.241699	98	5.185833	6.84E-02	143	7.567077	0.134277
9	0.47625	0.410156	54	2.857501	0.231934	99	5.23875	6.84E-02	144	7.619994	0.144043
10	0.52917	0.395508	55	2.910418	0.231934	100	5.291667	6.59E-02	145	7.67291	0.148926
11	0.58208	0.400391	56	2.963335	0.227051	101	5.344583	6.35E-02	146	7.725827	0.158691
12	0.635	0.395508	57	3.016252	0.20752	102	5.3975	6.10E-02	147	7.778743	0.15625
13	0.68792	0.385742	58	3.069168	0.217285	103	5.450416	6.10E-02	148	7.83166	0.163574
14	0.74083	0.390625	59	3.122085	0.195313	104	5.503333	6.10E-02	149	7.884576	0.163574
15	0.79375	0.378418	60	3.175002	0.195313	105	5.556249	6.35E-02	150	7.937493	0.175781
16	0.84667	0.385742	61	3.227919	0.180664	106	5.609166	6.35E-02	151	7.990409	0.175781
17	0.89958	0.371094	62	3.280835	0.185547	107	5.662082	6.10E-02	152	8.043326	0.178223
18	0.9525	0.375977	63	3.333752	0.17334	108	5.714999	5.37E-02	153	8.096243	0.19043
19	1.00542	0.368652	64	3.386669	0.166016	109	5.767915	5.62E-02	154	8.149159	0.195313
20	1.05833	0.380859	65	3.439586	0.15625	110	5.820832	5.62E-02	155	8.202076	0.195313
21	1.11125	0.36377	66	3.492502	0.15625	111	5.873748	6.10E-02	156	8.254992	0.205078
22	1.16417	0.371094	67	3.545419	0.148926	112	5.926665	5.86E-02	157	8.307909	0.212402
23	1.21708	0.358887	68	3.598336	0.13916	113	5.979581	5.62E-02	158	8.360826	0.214844
24	1.27	0.366211	69	3.651253	0.131836	114	6.032498	5.62E-02	159	8.413742	0.212402
25	1.32292	0.354004	70	3.70417	0.124512	115	6.085414	6.10E-02	160	8.466659	0.219727
26	1.37583	0.351563	71	3.757086	0.124512	116	6.138331	6.35E-02	161	8.519575	0.227051
27	1.42875	0.341797	72	3.810003	0.114746	117	6.191247	6.10E-02	162	8.572492	0.227051
28	1.48167	0.339356	73	3.86292	0.107422	118	6.244164	6.10E-02	163	8.625408	0.227051
29	1.53458	0.334473	74	3.915837	0.104981	119	6.297081	6.10E-02	164	8.678325	0.234375
30	1.5875	0.339356	75	3.968753	0.104981	120	6.349997	6.35E-02	165	8.731241	0.246582
31	1.64042	0.322266	76	4.02167	0.104981	121	6.402914	6.59E-02	166	8.784158	0.251465
32	1.69333	0.327148	77	4.074586	0.102539	122	6.45583	6.35E-02	167	8.837074	0.253906
33	1.74625	0.3125	78	4.127503	0.100098	123	6.508747	6.35E-02	168	8.889991	0.261231
34	1.79917	0.327148	79	4.180419	0.100098	124	6.561663	6.59E-02	169	8.942907	0.270996
35	1.85208	0.307617	80	4.233336	0.102539	125	6.61458	7.08E-02	170	8.995824	0.285645
36	1.905	0.317383	81	4.286252	9.52E-02	126	6.667496	7.08E-02	171	9.04874	0.280762
37	1.95792	0.300293	82	4.339169	9.03E-02	127	6.720413	7.08E-02	172	9.101657	0.292969
38	2.01083	0.317383	83	4.392086	9.28E-02	128	6.773329	7.57E-02	173	9.154573	0.300293
39	2.06375	0.297852	84	4.445002	9.03E-02	129	6.826246	7.57E-02	174	9.20749	0.3125
40	2.11667	0.302734	85	4.497919	9.28E-02	130	6.879162	7.57E-02	175	9.260406	0.310059
41	2.16958	0.292969	86	4.550835	9.28E-02	131	6.932079	0.078125	176	9.313323	0.324707

42	2.2225	0.292969	87	4.603752	8.79E-02	132	6.984995	8.54E-02	177	9.36624	0.324707
43	2.27542	0.290527	88	4.656668	8.30E-02	133	7.037912	9.03E-02	178	9.419156	0.349121
44	2.32833	0.280762	89	4.709585	8.54E-02	134	7.090828	8.79E-02	179	9.472073	0.349121
45	2.38125	0.280762	90	4.762501	8.30E-02	135	7.143745	9.28E-02	180	9.524989	0.351563

sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)
181	9.57791	0.358887	226	11.95915	0.490723	271	14.34039	0.432129	316	16.72165	0.148926
182	9.63082	0.368652	227	12.01207	0.510254	272	14.39331	0.427246	317	16.77457	0.144043
183	9.68374	0.36377	228	12.06498	0.493164	273	14.44623	0.422363	318	16.82748	0.148926
184	9.73666	0.390625	229	12.1179	0.515137	274	14.49914	0.422363	319	16.8804	0.144043
185	9.78957	0.380859	230	12.17082	0.498047	275	14.55206	0.412598	320	16.93332	0.136719
186	9.84249	0.395508	231	12.22373	0.522461	276	14.60498	0.422363	321	16.98624	0.134277
187	9.89541	0.393066	232	12.27665	0.500488	277	14.65789	0.407715	322	17.03915	0.126953
188	9.94832	0.402832	233	12.32957	0.522461	278	14.71081	0.419922	323	17.09207	0.131836
189	10.0012	0.410156	234	12.38248	0.50293	279	14.76373	0.402832	324	17.14499	0.117188
190	10.0542	0.397949	235	12.4354	0.512695	280	14.81664	0.415039	325	17.19791	0.112305
191	10.1071	0.412598	236	12.48831	0.50293	281	14.86956	0.393066	326	17.25082	0.102539
192	10.16	0.402832	237	12.54123	0.505371	282	14.92247	0.397949	327	17.30374	0.107422
193	10.2129	0.432129	238	12.59415	0.512695	283	14.97539	0.390625	328	17.35666	0.102539
194	10.2658	0.407715	239	12.64706	0.500488	284	15.02831	0.395508	329	17.40958	9.52E-02
195	10.3187	0.43457	240	12.69998	0.517578	285	15.08122	0.388184	330	17.46249	0.078125
196	10.3717	0.419922	241	12.7529	0.495606	286	15.13414	0.380859	331	17.51541	6.59E-02
197	10.4246	0.449219	242	12.80581	0.512695	287	15.18706	0.380859	332	17.56833	7.08E-02
198	10.4775	0.437012	243	12.85873	0.500488	288	15.23997	0.361328	333	17.62125	6.59E-02
199	10.5304	0.441895	244	12.91165	0.522461	289	15.29289	0.368652	334	17.67416	5.62E-02
200	10.5833	0.439453	245	12.96456	0.50293	290	15.34581	0.351563	335	17.72708	5.37E-02
201	10.6362	0.444336	246	13.01748	0.515137	291	15.39872	0.34668	336	17.78	5.13E-02
202	10.6892	0.45166	247	13.0704	0.500488	292	15.45164	0.34668	337	17.83292	5.86E-02
203	10.7421	0.43457	248	13.12331	0.510254	293	15.50456	0.336914	338	17.88583	5.13E-02
204	10.795	0.456543	249	13.17623	0.507813	294	15.55747	0.334473	339	17.93875	4.15E-02
205	10.8479	0.43457	250	13.22915	0.50293	295	15.61039	0.334473	340	17.99167	3.66E-02
206	10.9008	0.471191	251	13.28206	0.50293	296	15.66331	0.314941	341	18.04459	0.039063
207	10.9537	0.446777	252	13.33498	0.495606	297	15.71622	0.314941	342	18.0975	4.15E-02
208	11.0067	0.471191	253	13.3879	0.510254	298	15.76914	0.292969	343	18.15042	3.42E-02
209	11.0596	0.458984	254	13.44081	0.495606	299	15.82206	0.297852	344	18.20334	0.039063
210	11.1125	0.466309	255	13.49373	0.507813	300	15.87497	0.261231	345	18.25626	0.039063
211	11.1654	0.461426	256	13.54665	0.495606	301	15.92789	0.280762	346	18.30917	3.42E-02
212	11.2183	0.476074	257	13.59956	0.50293	302	15.98081	0.266113	347	18.36209	3.17E-02
213	11.2712	0.454102	258	13.65248	0.476074	303	16.03372	0.268555	348	18.41501	3.17E-02
214	11.3242	0.48584	259	13.70539	0.48584	304	16.08664	0.258789	349	18.46793	3.42E-02
215	11.3771	0.461426	260	13.75831	0.46875	305	16.13956	0.234375	350	18.52084	3.17E-02
216	11.43	0.498047	261	13.81123	0.480957	306	16.19247	0.234375	351	18.57376	3.17E-02
217	11.4829	0.473633	262	13.86414	0.471191	307	16.24539	0.212402	352	18.62668	3.17E-02
218	11.5358	0.498047	263	13.91706	0.473633	308	16.29831	0.219727	353	18.6796	3.42E-02

219	11.5887	0.483398	264	13.96998	0.466309	309	16.35123	0.197754	354	18.73251	3.42E-02
220	11.6417	0.507813	265	14.02289	0.471191	310	16.40414	0.197754	355	18.78543	3.17E-02
221	11.6946	0.490723	266	14.07581	0.454102	311	16.45706	0.183106	356	18.83835	2.93E-02
222	11.7475	0.498047	267	14.12873	0.471191	312	16.50998	0.187988	357	18.89127	3.17E-02
223	11.8004	0.495606	268	14.18164	0.444336	313	16.5629	0.17334	358	18.94418	3.42E-02
224	11.8533	0.495606	269	14.23456	0.45166	314	16.61581	0.163574	359	18.9971	3.42E-02
225	11.9062	0.507813	270	14.28748	0.439453	315	16.66873	0.153809	360	19.05002	3.42E-02

sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)
361	19.1029	3.66E-02	451	23.86551	0.449219	496	26.2468	0.512695	s	28.62808	0.32959
362	19.1559	0.039063	452	23.91843	0.446777	497	26.29971	0.493164	542	28.681	0.3125
363	19.2088	4.15E-02	453	23.97134	0.444336	498	26.35263	0.500488	543	28.73392	0.305176
364	19.2617	4.15E-02	454	24.02426	0.466309	499	26.40555	0.476074	544	28.78683	0.305176
365	19.3146	3.66E-02	455	24.07718	0.441895	500	26.45847	0.493164	545	28.83975	0.283203
366	19.3675	4.15E-02	456	24.1301	0.46875	501	26.51138	0.483398	546	28.89267	0.283203
367	19.4204	4.15E-02	457	24.18301	0.456543	502	26.5643	0.50293	547	28.94559	0.268555
368	19.4734	4.15E-02	458	24.23593	0.483398	503	26.61722	0.483398	548	28.9985	0.275879
369	19.5263	4.39E-02	459	24.28885	0.46875	504	26.67014	0.480957	549	29.05142	0.258789
370	19.5792	4.64E-02	460	24.34177	0.483398	505	26.72305	0.466309	550	29.10434	0.246582
371	19.6321	4.88E-02	461	24.39468	0.476074	506	26.77597	0.463867	551	29.15726	0.236816
372	19.685	4.64E-02	462	24.4476	0.483398	507	26.82889	0.463867	552	29.21017	0.236816
373	19.738	4.64E-02	463	24.50052	0.495606	508	26.88181	0.45166	553	29.26309	0.222168
374	19.7909	4.88E-02	464	24.55344	0.476074	509	26.93472	0.458984	554	29.31601	0.229492
375	19.8438	5.62E-02	465	24.60635	0.490723	510	26.98764	0.441895	555	29.36893	0.222168
376	19.8967	6.10E-02	466	24.65927	0.463867	511	27.04056	0.456543	556	29.42184	0.214844
377	19.9496	6.10E-02	467	24.71219	0.505371	512	27.09348	0.441895	557	29.47476	0.212402
378	20.0025	6.59E-02	468	24.76511	0.476074	513	27.14639	0.446777	558	29.52768	0.205078
379	20.0555	6.59E-02	469	24.81802	0.500488	514	27.19931	0.432129	559	29.5806	0.20752
380	20.1084	7.57E-02	470	24.87094	0.490723	515	27.25223	0.446777	560	29.63351	0.187988
381	20.1613	8.30E-02	471	24.92386	0.493164	516	27.30515	0.437012	561	29.68643	0.192871
382	20.2142	8.54E-02	472	24.97678	0.498047	517	27.35806	0.446777	562	29.73935	0.180664
383	20.2671	8.54E-02	473	25.02969	0.473633	518	27.41098	0.45166	563	29.79227	0.19043
384	20.32	9.28E-02	474	25.08261	0.505371	519	27.4639	0.437012	564	29.84518	0.175781
385	20.373	9.77E-02	475	25.13553	0.480957	520	27.51682	0.449219	565	29.8981	0.175781
386	20.4259	0.104981	476	25.18845	0.510254	521	27.56973	0.43457	566	29.95102	0.163574
387	20.4788	0.112305	477	25.24136	0.490723	522	27.62265	0.437012	567	30.00394	0.161133
388	20.5317	0.114746	478	25.29428	0.515137	523	27.67557	0.432129	568	30.05685	0.151367
389	20.5846	0.134277	479	25.3472	0.510254	524	27.72849	0.43457	569	30.10977	0.136719
390	20.6375	0.129395	480	25.40012	0.510254	525	27.7814	0.424805	570	30.16269	0.131836
391	20.6905	0.13916	481	25.45303	0.517578	526	27.83432	0.424805	571	30.21561	0.12207
392	20.7434	0.144043	482	25.50595	0.505371	527	27.88724	0.407715	572	30.26852	0.124512
393	20.7963	0.151367	483	25.55887	0.527344	528	27.94016	0.419922	573	30.32144	0.117188
394	20.8492	0.144043	484	25.61179	0.50293	529	27.99307	0.400391	574	30.37436	0.104981
395	20.9021	0.151367	485	25.6647	0.524902	530	28.04599	0.407715	575	30.42728	9.52E-02

396	20.9551	0.163574	486	25.71762	0.510254	531	28.09891	0.400391	576	30.48019	9.77E-02
397	21.008	0.168457	487	25.77054	0.534668	532	28.15182	0.368652	577	30.53311	9.28E-02
398	21.0609	0.17334	488	25.82346	0.512695	533	28.20474	0.371094	578	30.58603	8.30E-02
399	21.1138	0.170898	489	25.87637	0.510254	534	28.25766	0.36377	579	30.63895	0.078125
400	21.1667	0.180664	490	25.92929	0.507813	535	28.31058	0.366211	580	30.69186	7.08E-02
401	21.2196	0.180664	491	25.98221	0.500488	536	28.36349	0.349121	581	30.74478	6.59E-02
402	21.2726	0.19043	492	26.03513	0.507813	537	28.41641	0.366211	582	30.7977	6.35E-02
403	21.3255	0.185547	493	26.08804	0.48584	538	28.46933	0.336914	583	30.85062	5.86E-02
404	21.3784	0.192871	494	26.14096	0.50293	539	28.52225	0.34668	584	30.90353	5.62E-02
405	21.4313	0.200195	495	26.19388	0.488281	540	28.57516	0.32959	585	30.95645	4.88E-02

sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)
586	31.0094	4.64E-02	633	33.49649	0.100098	680	35.98361	0.344238	727	38.47073	0.48584
587	31.0623	4.64E-02	634	33.54941	9.28E-02	681	36.03653	0.344238	728	38.52365	0.517578
588	31.1152	4.39E-02	635	33.60233	0.109863	682	36.08945	0.349121	729	38.57657	0.495606
589	31.1681	4.15E-02	636	33.65524	0.109863	683	36.14236	0.358887	730	38.62949	0.524902
590	31.221	3.66E-02	637	33.70816	0.114746	684	36.19528	0.366211	731	38.6824	0.495606
591	31.274	3.66E-02	638	33.76108	0.112305	685	36.2482	0.356445	732	38.73532	0.515137
592	31.3269	3.66E-02	639	33.814	0.114746	686	36.30112	0.368652	733	38.78824	0.480957
593	31.3798	0.039063	640	33.86691	0.114746	687	36.35403	0.378418	734	38.84116	0.512695
594	31.4327	3.42E-02	641	33.91983	0.124512	688	36.40695	0.397949	735	38.89407	0.488281
595	31.4856	3.17E-02	642	33.97275	0.12207	689	36.45987	0.390625	736	38.94699	0.515137
596	31.5385	3.42E-02	643	34.02567	0.119629	690	36.51279	0.400391	737	38.99991	0.498047
597	31.5915	3.66E-02	644	34.07858	0.129395	691	36.5657	0.397949	738	39.05283	0.507813
598	31.6444	0.039063	645	34.1315	0.134277	692	36.61862	0.412598	739	39.10574	0.50293
599	31.6973	3.66E-02	646	34.18442	0.144043	693	36.67154	0.417481	740	39.15866	0.493164
600	31.7502	3.42E-02	647	34.23734	0.13916	694	36.72446	0.407715	741	39.21158	0.498047
601	31.8031	3.42E-02	648	34.29025	0.148926	695	36.77737	0.422363	742	39.2645	0.476074
602	31.8561	3.17E-02	649	34.34317	0.153809	696	36.83029	0.412598	743	39.31741	0.498047
603	31.909	3.42E-02	650	34.39609	0.161133	697	36.88321	0.441895	744	39.37033	0.476074
604	31.9619	3.66E-02	651	34.44901	0.166016	698	36.93613	0.429688	745	39.42325	0.50293
605	32.0148	0.039063	652	34.50192	0.17334	699	36.98904	0.446777	746	39.47617	0.48584
606	32.0677	3.66E-02	653	34.55484	0.178223	700	37.04196	0.43457	747	39.52908	0.505371
607	32.1206	3.42E-02	654	34.60776	0.178223	701	37.09488	0.473633	748	39.582	0.488281
608	32.1736	3.42E-02	655	34.66068	0.192871	702	37.1478	0.461426	749	39.63492	0.495606
609	32.2265	3.66E-02	656	34.71359	0.195313	703	37.20071	0.458984	750	39.68784	0.48584
610	32.2794	0.039063	657	34.76651	0.20752	704	37.25363	0.463867	751	39.74075	0.473633
611	32.3323	3.66E-02	658	34.81943	0.202637	705	37.30655	0.446777	752	39.79367	0.476074
612	32.3852	3.42E-02	659	34.87234	0.217285	706	37.35947	0.478516	753	39.84659	0.461426
613	32.4381	3.66E-02	660	34.92526	0.227051	707	37.41238	0.458984	754	39.89951	0.48584
614	32.4911	3.66E-02	661	34.97818	0.234375	708	37.4653	0.498047	755	39.95242	0.463867
615	32.544	4.15E-02	662	35.0311	0.236816	709	37.51822	0.473633	756	40.00534	0.478516
616	32.5969	4.15E-02	663	35.08401	0.241699	710	37.57114	0.493164	757	40.05826	0.466309
617	32.6498	4.15E-02	664	35.13693	0.258789	711	37.62405	0.480957	758	40.11118	0.48584

618	32.7027	4.39E-02	665	35.18985	0.261231	712	37.67697	0.48584	759	40.16409	0.471191
619	32.7557	4.88E-02	666	35.24277	0.275879	713	37.72989	0.495606	760	40.21701	0.498047
620	32.8086	5.13E-02	667	35.29568	0.270996	714	37.78281	0.476074	761	40.26993	0.483398
621	32.8615	5.37E-02	668	35.3486	0.285645	715	37.83572	0.495606	762	40.32285	0.493164
622	32.9144	5.37E-02	669	35.40152	0.288086	716	37.88864	0.46875	763	40.37576	0.466309
623	32.9673	6.10E-02	670	35.45444	0.297852	717	37.94156	0.505371	764	40.42868	0.493164
624	33.0202	6.59E-02	671	35.50735	0.292969	718	37.99448	0.498047	765	40.4816	0.476074
625	33.0732	6.59E-02	672	35.56027	0.300293	719	38.04739	0.512695	766	40.53452	0.473633
626	33.1261	7.08E-02	673	35.61319	0.314941	720	38.10031	0.495606	767	40.58743	0.466309
627	33.179	7.57E-02	674	35.66611	0.319824	721	38.15323	0.52002	768	40.64035	0.466309
628	33.2319	0.078125	675	35.71902	0.319824	722	38.20615	0.505371	769	40.69327	0.471191
629	33.2848	0.078125	676	35.77194	0.324707	723	38.25906	0.495606	770	40.74619	0.454102
630	33.3377	8.30E-02	677	35.82486	0.327148	724	38.31198	0.507813	771	40.7991	0.463867
631	33.3907	9.28E-02	678	35.87778	0.334473	725	38.3649	0.495606	772	40.85202	0.437012
632	33.4436	9.77E-02	679	35.93069	0.351563	726	38.41782	0.515137	773	40.90494	0.444336

sr,	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)	sr.	position	V(volt)
774	40.95786	0.4394531	820	43.39206	9.52E-02	866	45.82626	5.37E-02	912	48.26047	0.3076172
775	41.01077	0.4272461	821	43.44498	9.28E-02	867	45.87918	6.10E-02	913	48.31339	0.3027344
776	41.06369	0.4199219	822	43.49789	8.06E-02	868	45.9321	6.59E-02	914	48.3663	0.3198242
777	41.11661	0.402832	823	43.55081	7.57E-02	869	45.98502	6.59E-02	915	48.41922	0.3149414
778	41.16953	0.4003906	824	43.60373	6.84E-02	870	46.03793	6.84E-02	916	48.47214	0.3295898
779	41.22244	0.3857422	825	43.65665	6.35E-02	871	46.09085	7.32E-02	917	48.52505	0.3173828
780	41.27536	0.390625	826	43.70956	6.59E-02	872	46.14377	8.06E-02	918	48.57797	0.3295898
781	41.32828	0.3686523	827	43.76248	5.37E-02	873	46.19669	8.79E-02	919	48.63089	0.3295898
782	41.3812	0.3833008	828	43.8154	5.13E-02	874	46.2496	9.03E-02	920	48.68381	0.3393555
783	41.43411	0.3613281	829	43.86832	4.15E-02	875	46.30252	9.52E-02	921	48.73672	0.3393555
784	41.48703	0.3686523	830	43.92123	4.39E-02	876	46.35544	9.77E-02	922	48.78964	0.3466797
785	41.53995	0.3515625	831	43.97415	4.15E-02	877	46.40836	0.1025391	923	48.84256	0.3662109
786	41.59286	0.3417969	832	44.02707	3.66E-02	878	46.46127	0.1049805	924	48.89548	0.3588867
787	41.64578	0.3295898	833	44.07999	3.42E-02	879	46.51419	0.1049805	925	48.94839	0.3710938
788	41.6987	0.3344727	834	44.1329	3.17E-02	880	46.56711	0.1123047	926	49.00131	0.3613281
789	41.75162	0.3222656	835	44.18582	3.42E-02	881	46.62003	0.1147461	927	49.05423	0.3735352
790	41.80453	0.3100586	836	44.23874	3.42E-02	882	46.67294	0.1196289	928	49.10715	0.3808594
791	41.85745	0.300293	837	44.29166	3.17E-02	883	46.72586	0.1220703	929	49.16006	0.3833008
792	41.91037	0.2978516	838	44.34457	2.69E-02	884	46.77878	0.1196289	930	49.21298	0.378418
793	41.96329	0.2929688	839	44.39749	2.44E-02	885	46.8317	0.1269531	931	49.2659	0.3833008
794	42.0162	0.2807617	840	44.45041	2.93E-02	886	46.88461	0.1342773	932	49.31882	0.3955078
795	42.06912	0.2783203	841	44.50333	3.17E-02	887	46.93753	0.1391602	933	49.37173	0.3979492
796	42.12204	0.2636719	842	44.55624	2.93E-02	888	46.99045	0.144043	934	49.42465	0.3979492
797	42.17496	0.2758789	843	44.60916	2.69E-02	889	47.04337	0.144043	935	49.47757	0.3930664
798	42.22787	0.2563477	844	44.66208	2.69E-02	890	47.09628	0.1586914	936	49.53049	0.402832
799	42.28079	0.2563477	845	44.715	2.69E-02	891	47.1492	0.1660156	937	49.5834	0.4101563
800	42.33371	0.2539063	846	44.76791	3.17E-02	892	47.20212	0.1733398	938	49.63632	0.4199219

801	42.38663	0.2709961	847	44.82083	2.93E-02	893	47.25504	0.1733398	939	49.68924	0.4345703
802	42.43954	0.2587891	848	44.87375	2.44E-02	894	47.30795	0.1757813	940	49.74216	0.4272461
803	42.49246	0.2514648	849	44.92667	2.20E-02	895	47.36087	0.1855469	941	49.79507	0.4370117
804	42.54538	0.2441406	850	44.97958	2.69E-02	896	47.41379	0.1953125	942	49.84799	0.4394531
805	42.5983	0.2368164	851	45.0325	2.93E-02	897	47.46671	0.2026367	943	49.90091	0.4614258
806	42.65121	0.2392578	852	45.08542	2.69E-02	898	47.51962	0.2075195	944	49.95383	0.4614258
807	42.70413	0.2172852	853	45.13834	2.44E-02	899	47.57254	0.222168	945	50.00674	0.456543
808	42.75705	0.2075195	854	45.19125	2.44E-02	900	47.62546	0.222168	946	50.05966	0.4711914
809	42.80997	0.1855469	855	45.24417	2.69E-02	901	47.67838	0.2392578	947	50.11258	0.4663086
810	42.86288	0.1879883	856	45.29709	3.17E-02	902	47.73129	0.2319336	948	50.1655	0.4907227
811	42.9158	0.1733398	857	45.35001	3.17E-02	903	47.78421	0.246582	949	50.21841	0.4736328
812	42.96872	0.1586914	858	45.40292	2.93E-02	904	47.83713	0.2539063	950	50.27133	0.5053711
813	43.02164	0.1489258	859	45.45584	3.42E-02	905	47.89005	0.2612305	951	50.32425	0.4833984
814	43.07455	0.1489258	860	45.50876	3.42E-02	906	47.94296	0.2709961	952	50.37717	0.5078125
815	43.12747	0.1342773	861	45.56168	0.0390625	907	47.99588	0.2685547	953	50.43008	0.4956055
816	43.18039	0.1391602	862	45.61459	4.64E-02	908	48.0488	0.2929688	954	50.483	0.4980469
817	43.23331	0.1269531	863	45.66751	4.64E-02	909	48.10172	0.2880859	955	50.53592	0.5053711
818	43.28622	0.1147461	864	45.72043	4.64E-02	910	48.15463	0.2929688	956	50.58884	0.4956055
819	43.33914	0.1025391	865	45.77335	4.64E-02	911	48.20755	0.300293	957	50.64175	0.5175781

V: Result

The measurement of the position of standing wave voltage minima and determine the wave length of the electromagnetic wave in the wave guide filled with air ($\lambda_{g/2}$).The graph as shown in **fig.3** . The guide wave length is observed by the observation is $\lambda_{g/2}$ =13.49394 mm

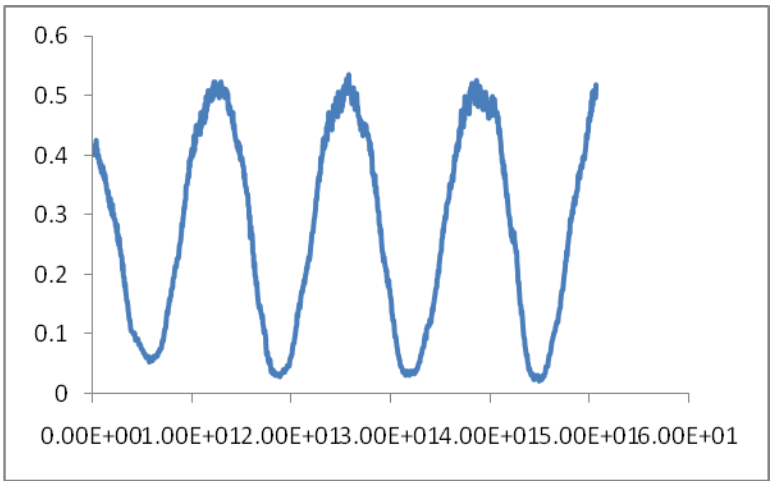

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Fig.3 : Graph of the position of standing wave voltage minima

VI: Conclusion

The measurement of microwave power against different length of liquid sample in the liquid cell ,is done manually. The micrometer is used to measure length of liquid sample in the liquid cell, as least count of micrometer is 0.01 mm , the accuracy of these measurement cannot be increased to high extent .

A Stepper Motor which divides a full rotation into a number of steps . A step motor rotates in discrete step angles. The Stepper Motors are manufactured with micro steps per revolution and Gear reducers may be

used to increase resolution of positioning and micro steps from 400 to 25600 per revolution can be used. The motor's position can be commanded to move and hold at one of these steps without any feedback sensor

The same method is used to measure the position of standing wave voltage minima and determine the wave length of the electromagnetic wave in the wave guide filled dielectric sample ($\lambda_{d/2}$). .The same measurement technique may be used to the probe in slotted section of the all types of bands such as C-band , K-band microwave bench.

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