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Solar Powered Microwave Bench

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Abstract: The demand for electrical energy is growing day by day while the available generation capacity is not matching the demand. With the gap between demand and supply widening power supply interruptions are becoming unavoidable. Further the increase in demand for electrical energy and the declining reserves of natural resources like coal, diesel, drew attention towards generation of electrical energy from non-conventional energy resources like wind, water and Sun. In this paper a scheme of using solar energy for supplying power to a X band microwave bench is discussed. The scheme would enable uninterrupted power supply and smooth conduction of laboratory work in an educational institution during power cut periods also. Further this also would help in saving diesel a fossil fuel used for generation of electricity

Keywords: Solar panel, Gunn diode, X band Microwave bench.

I. INTRODUCTION

William Brown[1] in 1973 has predicted a five fold increase in demand for electrical energy by 2000 and stressed the need for development of alternative energy resources. He has also suggested about free space transmission of power by microwave beam generated using solar energy, a basis for wireless power transmission[2] to cope up the increased demand.

In the present day power scenario demand for of electrical energy is increasing day by day. Unless the power generation capacity is increased to meet the demand power supply interruptions are unavoidable .Thus a wide gap is observed between demand for and supply of electrical energy leading to power interruptions. This forces the organizations or establishments to have their own diesel generating sets to meet their load demands. Further the conventional fuels used in power generation are limited in extent and are depleting. Thus to meet the growing energy demands and to give quality and pollution free supply attention has been directed towards exploring use of non conventional or renewable resources for power generation[3]. A renewable system converts the energy found in sunlight, wind, sea-waves, geothermal heat to electrical energy. Among the various alternatives solar power is best preferred since energy from Sun can never be exhausted.

In this paper a scheme to generate microwaves using solar power for Gunn diode bias is discussed. The requisite DC bias voltage to a X band Gunn diode is arranged using solar energy. The scheme can be extended to the entire microwave laboratory. This enables regular conduction of laboratory classes during power cut days, and also saves the diesel consumption for generator. The generation of microwaves using solar energy would also be a first step in study of wireless power transmission scheme.

II. METHODOLOGY

In a microwave bench with Gunn diode [4]as source the Gunn power supply provides a variable DC voltage 0-10V for the Gunn bias. This also has provision for providing output of square wave of 10V p-p amplitude and frequency varying from 800 Hz to 1200 Hz in internal mode of operation as supply to PIN modulator. In this generally 1KHz is used widely.

The Sun light is made to fall on a solar panel 63X27 cms consisting of 36 photo voltaic cells connected in series that develops d c voltage of 15 V maximum[5].This dc voltage is used to charge a 12V, 7.5 Ah battery through a charge controller. The charge controller used is model SCC 2a-c. The charge controller has two functions. The first is to prevent overcharging of battery and second is to prevent reverse current flow .

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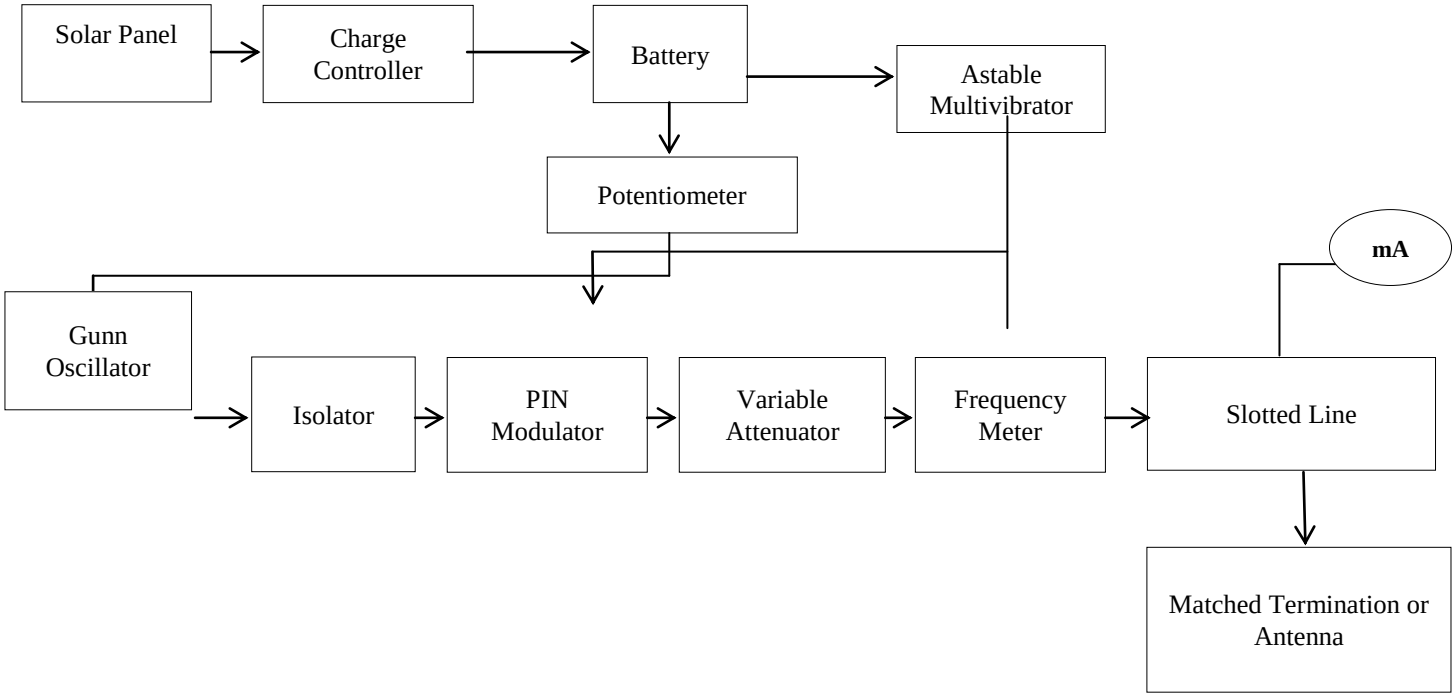

Figure 1:Block Schematic

It is observed that when voltage from solar panel crossed 13 Volts or the battery voltage reached 12V the controller automatically cut off the connection.

The DC voltage from battery is used to supply the bias voltage for GUNN diode. Further using the DC voltage as bias for NE 555 timer a 12 v p-p and 1.3 KHz frequency square wave is generated for the PIN modulator .The block schematic of proposed scheme is shown in figure1.The square wave generator using NE 555 is given in figure 2.

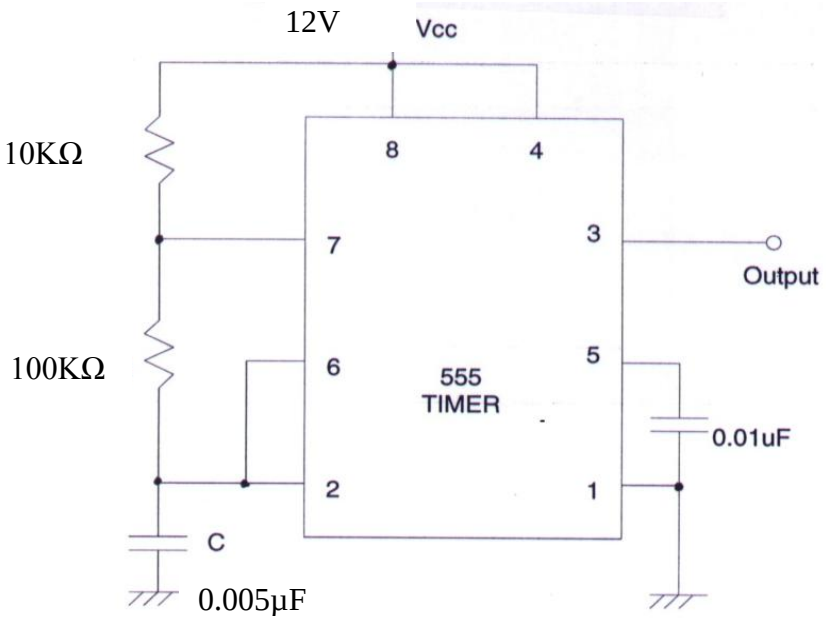

Figure 2: Astable Multivibrator using IC 555

With the Gunn power supply from Microlab model XB-8110 and battery charged through solar panel with proposed arrangement tests are carried out to find the IV characteristics of Gunn diode[6].

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The results are given in table I.

Using XB-8110Microlab Gunn power supply and Panel meters for recording			Using Battery charged through solar panel and CIE 123 Multimeters for recording	
V(Volts)	A(Amperes)		V(Volts)	A(milliAmperes)
0	0		0	0
0.19	0.020		0.08	6.9
0.53	0.047		0.42	36
1.28	0.099		1.27	97.5
1.87	0.131		1.76	125.3
2.48	0.157		2.37	152.7
3.09	0.172		2.95	169.2
3.71	0.177		3.83	173.4
3.99	0.176		3.71	172.7
4.33	0.170		4.83	158.2
4.76	0.161		5.19	154.7
5.13	0.157		5.66	150.1
5.91	0.151		6.08	148.1

Table I: I-V characteristics of Gunn diode

Further it is known that the crystal diode acts a square law device till crystal current does not exceed 20µA. Hence in the absence of power meter to make measurements proportional to power using ammeter the crystal output current is to be adjusted to less than or equal to 20µA . A suitable directional coupler can be used with crystal detector in auxiliary arm. . Alternately with the help of attenuator maximum current can be adjusted to 20µA.In such case to improve the accuracy of measurements at lower ranges an amplifier with suitable gain and a 1mA ammeter can be used. An op-amp based amplifier designed with gain 50 is used and the amplifier circuit is given in figure 3.

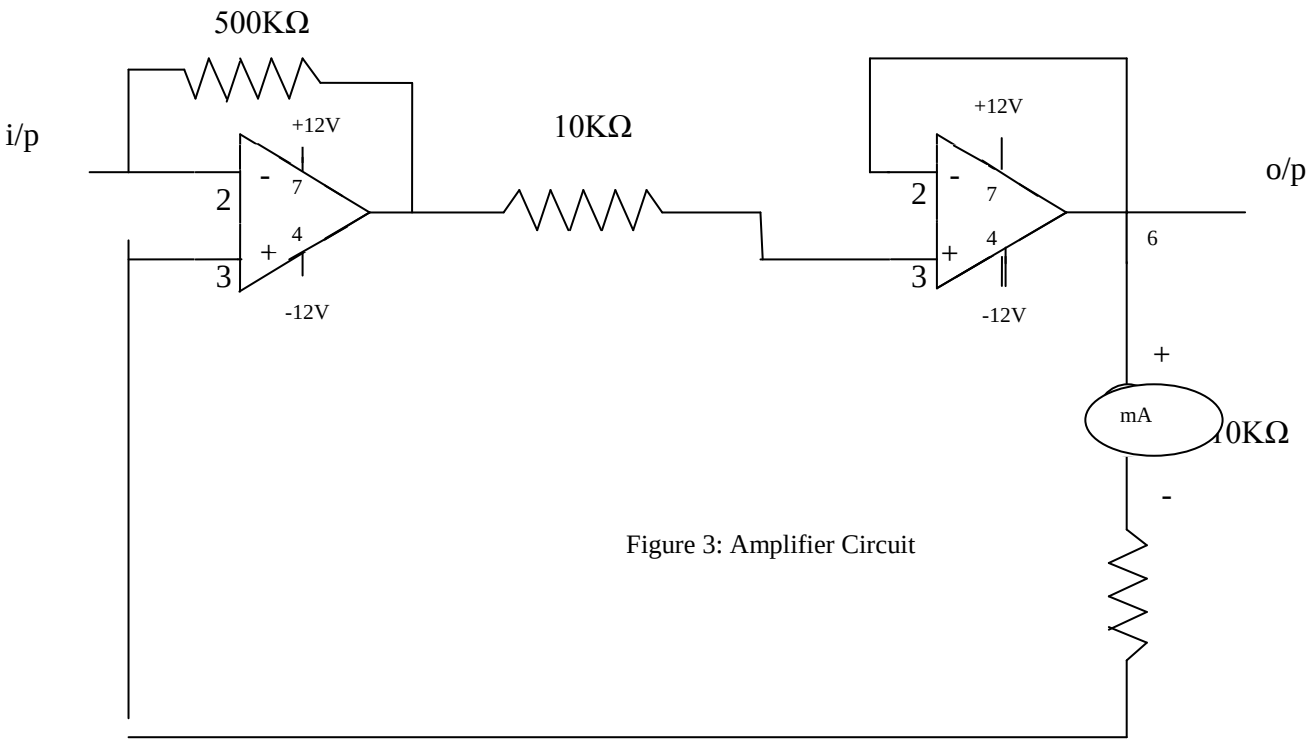

Figure 3: Amplifier Circuit

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In the present arrangement the rectified current from crystal is found to be about 80µA. Hence using a variable attenuator the maximum current is adjusted to 19.5µA. After verifying the square law behavior of crystal, using the CRO and amplifier arrangement the Standing wave ratios of Horn antennae and dish antenna are measured and the results are reported in table II.

	Using CRO		SWR=√(Imax/Imin)	Using Amplifier		SWR=√(Imax/Imin)
	I max	I min		I max	I min	
Horn antenna 18 dB	2.4	1.8	1.154	184.2	128.2	1.198
Horn antenna 21dB	0.8	0.6	1.15	192.7	115.3	1.29
Dish 21dB	2.8	1.6	1.322	245	94.1	1.613

Table II: SWR Measurements

III. RESULTS AND DISCUSSION

With the solar based arrangement it is observed that with a bias voltage of D C6.35 V microwave oscillations of higher amplitude are observed. The guide wave length measured is 3.26 cms. The cut off wave length is 4.6 cms and using relation [$1/\lambda_o^2 = 1/\lambda_g^2 + 1/\lambda_c^2$] the free space wave length λ_o and hence frequency are calculated . The calculated frequency is 11.28 GHz and the frequency meter reading was found to be 11GHz.

From table 1 it can be observed that there is good agreement in readings by both the methods. The small differences in some readings can be attributed to different sensitivities of the two meters used for recording. The negative resistance of Gunn diode is found to be 106 ohms.

From the readings of Table II one can conclude that the accuracy of measurement improves by using amplifier when crystal current is low.

IV. CONCLUSION

The use of solar energy for powering X band microwave bench is demonstrated. The Gunn bias current is found to be around 300 mA and the current drawn by astable circuit is 350mA. Thus the battery can power the bench for at least 9 hours sufficient to conduct the laboratory classes for whole day. The scheme can be extended to the entire microwave laboratory selecting proper solar panel and battery. This would avoid interruption to conduction of laboratory classes during power cut times. Also this would enable savings of quantity of diesel used for running the generator during power cut periods. The initial cost of the scheme may be high but the running cost or fuel cost is zero.

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