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Real Time Monitoring System For Electromagnetic Radiation Measurements Using Arm Processor For Cellular Base Stations

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Abstract:-The main purpose of real-time monitoring systems is monitoring the continuous exposure of electromagnetic fields that are radiated by cellular base station antennas and also mobile units and other RF sources of radiation levels. Monitoring and comparing with FCC and also ICNIRP levels are prescribed for general public.

An electromagnetically –coupled square microstrip patch antenna is designed and fabricated for deployment in the presented system. Antenna gain of 15 db and bandwidth from 500 MHz to 2500 MHz is achieved. The electromagnetically coupled antenna is connected to spectrum analyzer. Here the antenna is receiving multiple cell towers signals these signals are sent to frequency selector with spectrum analyzer; to select the particular cell base station or frequency is selected, these signal sent to multiplexed ADC. Which converts analog signal to digital signals? This digital signal is interface with 8255 to ARM circuit and compared with actual signals and FCC standard levels. Later all connected base stations power are calculated and this resultant signal is displayed on display device .once the FCC levels are exceeded, the GSM mode is activated and the exceeded data sent to the concerned person. The radiation levels are crossed the FCC given standards then the particular cellular base station power and timings are automatically stores. In any area According to IEEE standard the safe power density is 2 watts/m^2 when we want to establish new cellular base stations in that particular area. We have to take all parameters for electromagnetic radiation levels to be established.

Keywords: **-** FCC, ICNIRP, ARM, GSM

Fig.2.1 Elecrtomagnetic Radiation measurement setup.

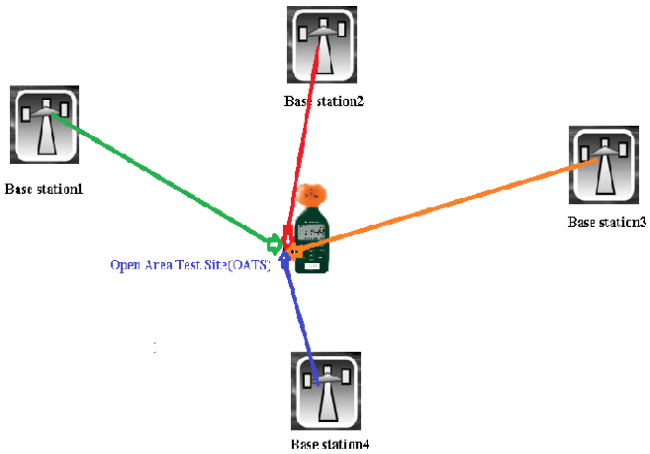

Fig2.2 EMR measurement at a point(OATS).

This system is Electromagnetic radiation measurements at a (Open Area Test Site (OATS)) measuring power density are the simplest equipment used for measurement. The equipment consist of a set of measuring antenna mounted on tripods connected to the spectrum analyzers which measure the base station signal and passes the data to a multiplexed analog to digital converter. The ADC to ARM processor interfacing these signals. The total exposure due to all radio signals acting together is calculated. Normally, the

measurements are made over the frequency range 30 MHz to 3000 MHz and the results include signals from radio, television as well as base stations. It is possible to break down the exposure quotient into proportions arising from different transmitters. Operators should calculate compliance distances in various directions from their antenna in order to define a boundary outside which the guidelines can never be exceeded.

III.Electromagnetic radiation monitor with advanced isotropic probe for ARM processor

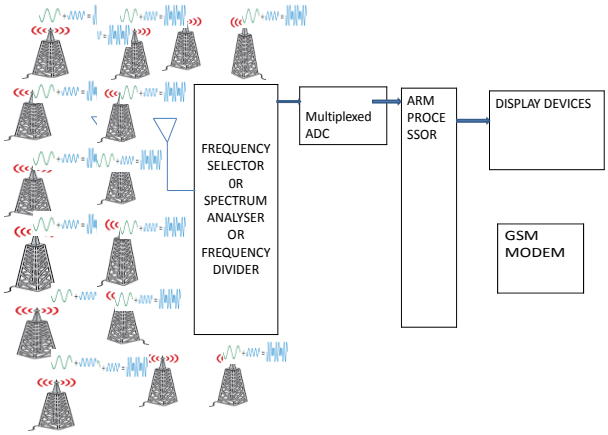

Fig3.2: Advanced isotropic probe for ARM 11processor block diagram.

The functioning of the block diagram. The ARM11 processor is connected to number of ports to support for measuring environment elements .The main operation of this processor is to measure different cellular network electromagnetic radiation levels. here the antenna is receiving multiple cell towers signals this signals are sent to frequency selector with spectrum analyzer here select the particular cell base station or frequency this signal sent to multiplexed ADC here which converts analog to digital data. This data is interface to ARM circuit and compared with actual signals and FCC standard levels. Later all connected base stations power are calculated and this resultant signals is displayed in display device .once the FCC levels are exceeded the GSM mode is activated and the exceeded data sent to the concerned person. The radiation level are cross for FCC given standards then automatically stores the particular cellular base station and also timings, the dipole antenna is alignment of free spaces impedance levels that frequency at which is measured fed to for advance isotropic probe that data is interfaced to ARM11 processor this information sent to display unit and sent to control unit. Area wise the electromagnetic radiation levels is 2 watts and is limited .for that area number of cellular base station are established but electromagnetic radiation levels are more that when we want to establish new cellular base stations in that area. we have to take all parameters for electromagnetic radiation levels to be establish.

Finally a broadband monitor for electromagnetic radiation has to be implemented. The electronic circuit and the tests of the monitor have to be presented. The system, called advanced isotropic probe for ARM processor, has acceptable isotropy and linearity. It measures the electromagnetic radiation with good accuracy as compare with other commercially available systems and can be used to monitor 24 hours a day. The massive production of the advanced isotropic probe for ARM processor combined with low cost and high reliability will allow the establishment of a broad network of measurement points resulting in continuous control of electromagnetic radiation and direct information flow to the public.

The establishment of a measuring network resulting in continuous control of electromagnetic radiation and direct information flow to the citizens. The general circuit of the proposed system may consist of a ARM11 processor, a USB controller and port, a flash memory, humidity and temperature sensors, a real time clock, a GSM modem and three DC amplifiers constitute the parts on the PCB of the system. The advance isotropic probe. It contains three mutually orthogonal dipoles, each one with the appropriate LNA, connected to the three DC amplifiers through a high resistance transmission line. The measured electromagnetic radiation power will be compared against time or in an analog or a digital indication gauge. Also, the last maximum value and the mean value of the electromagnetic radiation will be calculated. The measured incident electromagnetic radiation of the probe will be calculated by using the following form:

IV.Estimation of free space received power

The free space received power $PR=\mathbf{P_d A_e}$ **→(1)**

P_d is measured using the power density the one particular place

Where G_{ant}=received antenna gain

So $\mathbf{A_e}$**= (received antenna gain**$\times\lambda^2$**)/4**Π **→(2)**

$\mathbf{P_R=G_{ant}\times\lambda^2/4\Pi\times P_d}$ **→(3)**

$\mathbf{P_R=G_{ant}\times (3\times10^8\div (F\ (MHz)\times10^6))^2/\times Pd\div4\Pi}$

→(4)

Taking 10 log on both sides for only one network

$10\log 10\ PR=10\log G_{ant}\ |20\ \log 10(3\times10^2)|\ 10\ \log (P_d)\ 10\ \log (4\Pi)\ 20\ \log (F\ (MHz))$ →(5)

For n networks

$P_r(db)=10\times n\times\log\ g_{ant}+20\ \log\ (3\times10^2)+10\log(T_{otal})-10\times n\times\log\ (4\Pi)\ -20\log(F1(MHz))-20\ \log\ (F2(MHz))-20\ \log(Fn(MHz))$ →(6)

Where total power at a place is

$T_{otal}= (P_1^2+ P_2^2+ P_3^2+----------+P_n^2)^{1/2}$ →(7)

The isotropic behavior of the advanced isotropic probe and its comparison with other monitoring systems will be made at controlled environment and at the Open Area Test Site (OATS). The ARM architecture offers the great opportunity to use a standard, yet modern architecture. With mobile networking offerings based on ARM7 cores, customers can easily upgrade their existing 8- and 16-bit applications. Through this upgrade option, software algorithms do not become obsolete anymore and the associated development tools can be reused across future designs based on ARM7, ARM9 and the upcoming ARM Cortex implementations. A linearity test of the estimated equivalent radiation power density versus the transmitted power has to be made in different frequency bands.

The proposed system is for measuring electromagnetic radiation for cellular base station using ARM11 PROCESSOR,

The factors attributed to EMR radiation are:

- Frequency / wavelength of RF signal being transmitted;
- Operating power of transmitting stations;
- Radio Frequency Power radiated from the antenna;
- Time of Exposure of RF signal at a given distance from the antenna ;
- Exposure from other antennas located in the Area; Over powering of amplifier for better reception quality, signal strength and more coverage;
- Duration/ frequency of recurrent exposure ;
- Age, size and portion of the body and
- Temperature and humidity.

V. Results and discussions

The electromagnetic field strength measurement focusing on base stations was carried out at a particular point that means at a certain distance from more than two Base stations. The below shows the result of EMR at a chosen point from 4 different Base stations. The reference value (Standard limits) of 2 watts are in the frequency range of the target base stations, and the measured values are different as distance chosen is different from all Base stations, that means a common test point is chosen from all base stations as shown in Fig5.1(A plot of received power Vs distance is made at different frequency it is seen that radiation is of the magnitude of l0 watts near about 500 m to 1 KM) Therefore, by adding all field strengths to get the resultant field at that point. By observation it shows that the base stations can be considered to be complied with the reference level.

The total power of four base stations is as shown in figure 5.2(A plot of received power Vs distance is made at different frequency it is seen that radiation is of the magnitude of l4.64 watts near about 500 m to 1 KM)

```
>> pr1=Ae1.*pd1.*200
Base station power1 =   9.9630   2.4907   1.1070   0.6227
0.3985   0.2767   0.2033   0.1557   0.1230   0.0996
0.0823   0.0692   0.0590   0.0508   0.0443   0.03890.0345
0.0307
>> pr2=Ae2.*pd2.*200
 Base station power2 = 7.1094   1.7773   0.7899   0.4443
0.2844   0.1975   0.1451   0.1111   0.0878   0.0711
0.0588   0.0494   0.0421   0.0363   0.0316   0.0278   0.0246
0.0219
>> pr3=Ae3.*pd3.*200
Base station power3 =   5.7426   1.4357   0.6381   0.3589
0.2297   0.1595   0.1172   0.0897   0.0709   0.0574
0.0475   0.0399   0.0340   0.0293   0.0255   0.0224
0.0199   0.0177
>> pr4=Ae4.*pd4.*200
Base station powe4 =   9.4018   2.3504   1.0446   0.5876
0.3761   0.2612   0.1919   0.1469   0.1161   0.0940
0.0777   0.0653   0.0556   0.0480   0.0418   0.0367 0.0325
0.0290
Total four base station power =   14.6493   3.6623   1.6277
0.9156   0.5860   0.4069   0.2990   0.2289   0.1809
0.1465   0.1211   0.1017   0.0867   0.0747   0.0651
0.0572 0.0507   0.0452
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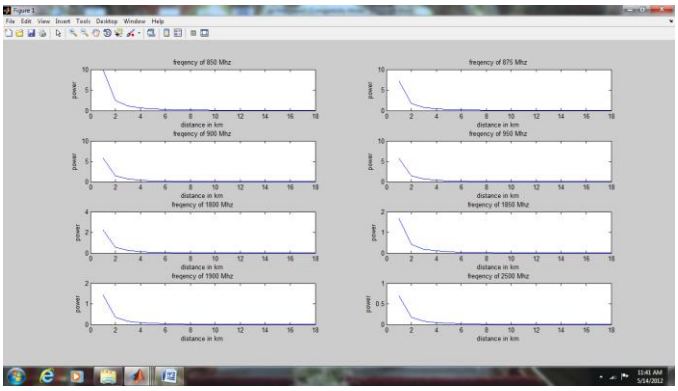

Figure: 5.1Received power levels over the distance

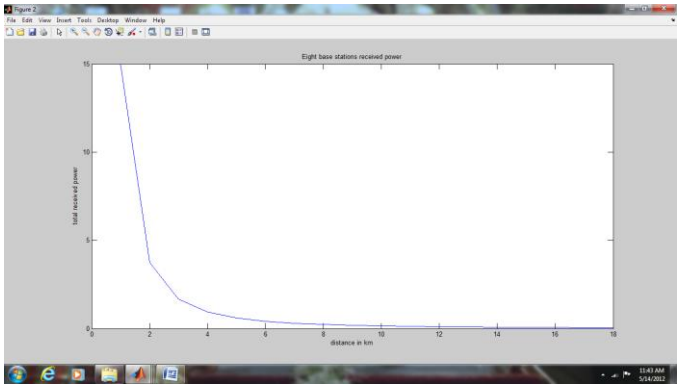

Fig: 5.2.Total four base station received power over distance

V. Conclusion:

This paper presents the total exposure due to all radio signals acting together at a specific point (Open Area Test Site (OATS)) from four base stations is calculated. The field strength of all the radio signals acting together at a chosen point is calculated. So by comparing reference level (Exposure limits) with the measured values shows that the geometrical location of the base stations are complied with the reference levels.

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