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# Remote Monitoring for Solar Photovoltaic Systems in Rural Application using GSM Voice Channel

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**Abstract**

The health of the Solar PV systems should be monitored continuously for their better performance and maintenance. For PV systems installed at rural locations, remote monitoring capabilities provide the information in advance when system performance is degraded or is likely to fail. Based on this information, preventive maintenance can be carried out to improve the performance and life of the system, thereby reducing the overall operating cost.

Advantages and disadvantages of several monitoring systems for rural application, based on the techniques of communication, such as, computer to computer communication (Ethernet), embedded system to computer (GSM) and embedded system to embedded system (GSM, GPRS) are discussed.

A new technique is proposed as a solution to overcome the limitations of other techniques. The proposed technique uses GSM voice channel for the communication of data, in the form of analog signal between transmitter and receiver. In order to study and evaluate the performance of proposed technique, various experiments have been performed and impact of parameters like shape (sine, square and triangular), frequency (50 - 4000Hz) and amplitude (0 – 6 V) of analog signal have been studied. It is observed that sine wave of frequency from 300 Hz to 3300 Hz with 4.5 V maximum amplitude can be sent on voice channel of GSM network with less than 1% error. This technique has low initial as well as operating cost. The GSM network is readily available in rural areas; this technique can be used easily.


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*Keywords:* preventice maintenance, analog signal, solar power plant,

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## 1. Introduction

Clean solar electricity can be generated by solar photovoltaic as well as by solar thermal technologies. The contribution of solar electricity in the world's total electricity generation is currently small percentage of total world energy production (0.2%) (Corresponding to 72 $GW_p$ capacity of solar plants as compare to 3600 $GW_p$ capacity of generated power plants) [1], but it is increasing at very high rate. During the last several years, the average annual growth rates of renewable energy capacity have been 70% [1]. In order to promote installation of solar power plants in India, the Government of India has also announced a national mission called Jawaharlal Nehru National Solar Mission (JNNSM) in 2010 [2].

As per the JNNSM, the set target is to install 20 $GW_p$ solar power capacity in India by year 2020 [2]. The planned capacity is nearly equally distributed among solar PV (SPV) and solar thermal technology. The JNNSM target includes installation of grid connected SPV systems as well as standalone or off-grid SPV systems. In this mission, the target is to install 18 $GW_p$ of grid connected solar power plants (including solar PV & solar thermal) and 2 $GW_p$ of standalone SPV systems.

Significant attention has been given to the installation of standalone SPV systems in JNNSM because standalone system is an immediate solution for the areas where the grid infrastructure is still absent or there is frequent power cuts, which is true for several parts of India. The SPV power systems are installed generally in remote rural areas. Since these power plants are away from the urban areas they are not easily approachable, therefore the repair and maintenance services in remote areas are expensive and time consuming. Due to above reason the standalone SPV systems installed in remote rural areas many times fails. For smooth, safe and optimum operation, SPV systems should be regularly monitored and evaluated. Also, due to distributed nature of installation of standalone SPV systems it will be very costly and tedious job to implement the remote monitoring & maintain the individual SPV system independently [4]. A centralized remote monitoring of SPV system will be more efficient and cost effective [3]. The remote monitoring system reduces the cost of system operation and maintenance by preventing the need of deployment of any trained technician or expert at the site. An off-grid SPV system consists of Solar modules, MPPT, batteries and inverter. In this system battery is a most week component. The batteries should be charged and discharged within its respective voltage levels. If they are not monitored and maintained timely, batteries are going to degrade at faster rates. This can be one of the sufficient reason for the system failure.

### *1.1. Remote Monitoring System*

In remote monitoring system, parameters of SPV system are measured by sensors, processed by signal processors and information is sent electronically to a central location where an operator can monitor and take appropriate action, if required. The basic remote monitoring system consists of two units; transmitter at remote location (where SPV system is installed) and receiver at central station (from where SPV system monitoring process is done). Transmitter and receiver can be small embedded system or can be computer based system. Based on type of system used at remote location and central station, remote monitoring system can be categorized in following ways:

- Computer (remote) to Computer (central) remote monitoring system [*5*]
- Embedded system (remote) to Computer (central) remote monitoring system [*3,6*]
- Embedded system (remote) to Embedded system (central) remote monitoring [*7*]

All remote monitoring systems use different communication techniques for data transmission, for example computer based remote monitoring system can use Ethernet network or dial-up network for the