Condition Monitoring of Voltage Source Inverter

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Abstract: **The aim of the work is to collect analog measured data and status information from the target Voltage Source Inverters (VSIs). Users can also control targets remotely from the same interface. Alarm messages also can be forwarded to users. All the measurements, alarms and events are real time. User can see target parameter through mobile phone(s).Typical remote monitored and controlled target is VSI. It doesn't mean that system is aimed for any specific applications. ARM processor can be used in almost any remote supervision application. System communicates bi-directionally with user. The measurements can be real time and stored (logged) into mass storage device. System can sends the information on request from user side. System sends immediately to indicate abnormal working of target. Alarm signals or Parameters reports can be forwarded to users through GSM phone. Analog inputs can be configured to measure the various physical parameters like battery voltage, VSI current and VSI voltage and ranges using various plug-in analog input modules. Analog inputs are verified by software routine encoded in ARM controller. Monitoring and controlling through wireless GSM is fast and easy. System does not require expensive communication wirings. GSM phones are used for remote monitoring and control. Valuable information is always available, no unnecessary and expensive on-site visits are required. The system is tested for real time applications and it is observed that it works reliably**.

Keywords: Voltage source inverter, Remote and local monitor system, USB based data storage.

I. INTRODUCTION

In today's advanced technical world, Voltage Source Inverters (VSIs) have become an integrated part of various industrial and household applications. The main aim of this project is the monitoring the output parameters of a VSI locally and remotely, and controlling the ON/OFF of VSI in the event of battery voltage falling below the specific low voltage. The system is targeted for the remote monitoring and controlling complex stand-alone VSI. In normal conditions, the system records and reports the overall performances of a VSI. Whereas, in case of incorrect or abnormal behaviors, it immediately informs the operators. In order to restore the system to the specific operating conditions, several means of communications and plant configurations were investigated. However, for more general, flexible and cost-effective implementation, GSM network is used for the remote communications and, in particular, on the short text message service. If the VSI battery voltage drops low then by sending SMS one can turn off the VSI. Where GSM module is out of coverage, in this area alternately USB facility can be explored. The parameter's value can be stored in the form of a text format, for further usage.

The literature survey pertaining to project theme is presented. Technological solution for parameter monitoring and controlling. Monitoring and controlling requires expensive control room server PC or operator workstation investment, any existing office or home desktop PC's with internet connection [1]. In monitoring and controlling system user cannot add more devices or features to the system. Such systems are not providing long term solutions. It doesn't base on mainstream technology. Developed system does not provide an easy to use and does not react to abnormal situations before it's too

late and also to increase productivity. Targets cannot be monitored and controlled remotely. It requires expensive and time consuming on site visit.

A brief overview of the technological solutions for monitoring the output parameters of VSI remotely and locally and controlling the ON/OFF of VSI in the event of battery voltage falling below the specific low voltage.

Monitoring and control of power converter systems is essential for consistent functioning and maximum yield of any solar electric system. The simplest VSI check (monitoring) can be performed by reading values on display (usually LCD). Most important VSI (or grid) related parameters are available on-line. [2]. The most common connection for local/remote control is RS232 for local monitoring, RS485 and power line for VSI interconnection. In some cases USB connection is also available. Additional services like satellite based monitoring (SPYCE) are also in use [3].

SCOUPS [4] is a real-time system for protect ting and monitoring à DC/AC converter has been designed and constructed. A notably successful project undertaken is made to monitor and control VSI parameter was NetMinder 121 [5] series communication adapter to design and implement a reliable system employed to integrate a controlled power UPS or lighting system into an Ethernet TCP/IP, MODBUS TCP or MODBUS RS485 network with a specific IP address. Different methods are proposed for fault diagnosis in [7]-[12]. These methods are based on first step of transformation like Park's Vector Transform, Fast Fourier Transform, Continuous Wavelet Transform, Discrete Wavelet Transform and Entropy. Second step is classifier based on If-Then rules, Fuzzy Interface System or Artificial Neural Network, Genetic Algoritham, etc.

Objective of this work is to develop a system to measure and collect the parameter status information from the target system, and design an interface to facilitate the user to monitor, control the system parameter remotely after receiving alarm messages to user mobile.

II. METHODOLOGY

The block schematic of the proposed setup is shown in figure 1.The user can send request for getting parameters of VSI through SMS. By sending message, user can put a VSI on or off. System will automatically send abnormal operation of VSI (low battery voltage). The current parameters of VSI can be stored in USB mass storage device and analyzed later if required. The following parameters are monitored locally and remotely.

1. Output Voltage of VSI.
2. Output Current of VSI.
3. Output Power of VSI.
4. Battery voltage.

A. Locally and Remotely Monitoring:

The above parameters are locally displayed and monitored by using 'LCD display'.

The above parameters are remotely monitored through GSM. The user can send the SMS to system with particular code (password). If code matches with ideal code which is stored in the system at the time of programming then the system will respond to the request by sending the values of the parameter, otherwise the system will send the message" There is error in request".

B. USB facilities:

The USB facilities are also provided to user. It demonstrates an USB Memory based on USB Mass Storage Class. The USB Memory is automatically recognized by the host PC running Windows which will load a generic Mass Storage driver. In this mass storage device, there is one text document which shows the current value of VSI parameters or which can also be stored.

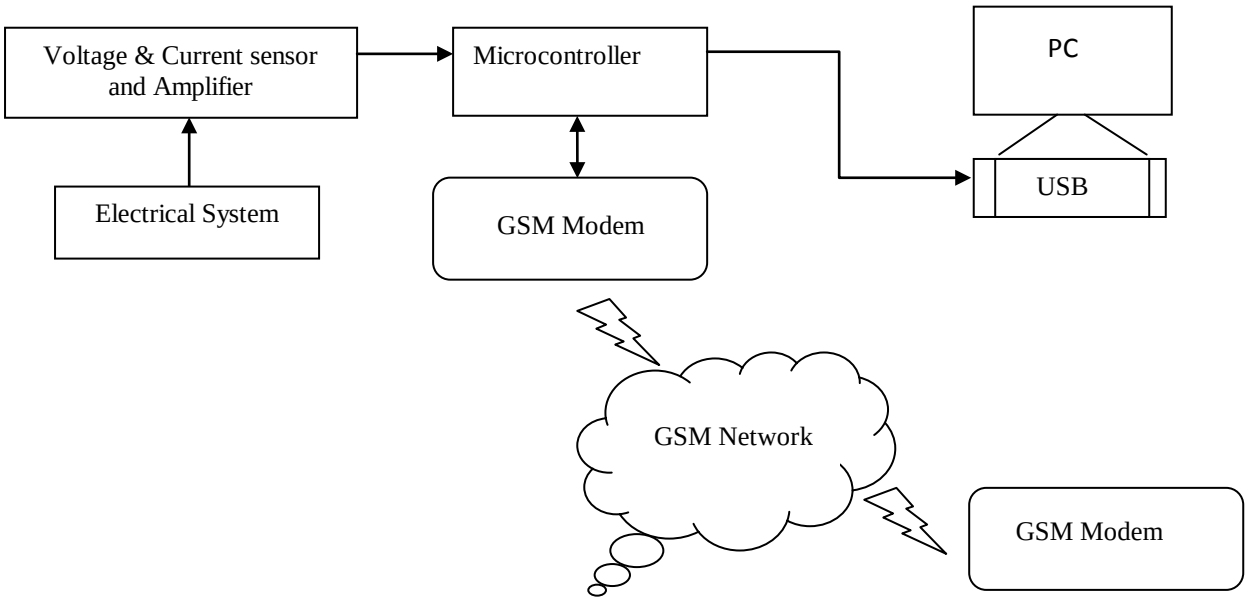

Fig. 1. Block diagram of proposed system

All the measurements, alarms and events are time-stamped. User can see VSIs parameter through mobile phone(s). A VSI going to be a target for monitor and control its parameter remotely. It doesn't mean that system is tied to any specific applications; using its modular I/O and freely programmed application of ARM controller it can be explained used in almost any remote supervision application.

System communicates bi-directionally with user. The measurements can be time-stamped and stored (logged) into mass storage device. System can send the data only when polled from the user. System immediately informs the user about abnormal working of target. Alarm messages or measurement reports are forwarded to users through GSM phone. Analog inputs have been calibrated using ARM controller. Monitoring and controlling through wireless GSM is fast & easy. System does not require expensive communication wirings. Control and monitoring is done remotely by using GSM phone.

VSI plays an important role in interfacing critical loads such as computers, communication systems, medical/life support systems, and industrial controls to the utility power grid. As mentioned in the section 1.3.1, there are some systems, in which monitoring is done by LCD display and transmitted via modem or Ethernet to the web or directly to other PC. But for remotely monitoring we will give GSM System and for data storage USB facility. Where USB is faster communication protocol .Through GSM, we can monitor and control by Short Message Services at reasonably low cost.

I. EXPERIMENTATION

GSM module communicates with controller only through UART interface. So UART port will be required for the interfacing GSM module with controller. LPC2148 which has two UART viz. UART0 and UART1. Also for storing the VSI parameters, we require USB connection and LPC2148 has USB ports. This justifies the selection of LPC2148. ADC is amongst the most widely used devices for the data acquisition system. Microcontroller works on binary values, but in physical world everything is analog. VSI output voltage, VSI output Current and Battery voltage are the example of physical quantities that are going to be displayed and monitored. We have selected LPC 2148 ARM Controller. The LPC 2148 contain two ADCs. These converters are single 10-bit successive approximation ADCs with eight multiplexed channels. So there is no need of external ADCs.

Algorithm for ADC:

- Initialize Pin Selection Register, Such that Pin 13, 14 and 15 will work as ADC pin.
- Initialize ADCR register, for ten bit digital output.

- Now set the bit for the Start of Conversion signal (SoC).
- If end of conversion signal is “1”, then go for next step. Else wait for EoC =”1”.
- Read digital output from ADDR register.
- For reading next data jump to step 3.

LM 016L, 16*2 LCD is used for display the data which is received from VSI. This module ascertains the working of the project and is useful for locally monitoring. GSM module is connected to Microcontroller by using UART Communication interface. TxD pin of GSM which is the data transmitter is connected to the RxD0 pin of LPC2148 controller. RxD pin of GSM which is the data receiver is connected to the TxD0 pin of LPC2148 controller.

The Message sent by GSM module can be observe on the HyperTerminal by using RS232 communication. But for further implementation message is encoded. When the GSM modem receives any message, Microcontroller will compare the message with the string which is stored in its flash memory. There are three Messages stored in the flash memory. These messages are:

A. Device On
B. Device Off
C. Status

A. Device On

If GSM Modem read the message “Device on” then it will send the message to controller through UART (i.e. Serial Communication) .Now controller will compare “Device on” string with the messages which are stored in Flash memory and if it matches then it will send high level to Port 0.11 of LPC2148.i.e.it will put on Device (VSI) ON connected at this port.

B. Device Off:

If GSM Modem read the message “Device Off” then it will send this message to controller through UART (i.e. Serial Communication) .Now controller will compare “Device Off” the string with the messages which are stored in Flash memory and if it matches then it will send logic low level to Port 0.11 of LPC2148.i.e. It will put on Device (VSI) OFF connected at this port.

C. Status:

If GSM Modem read the message “Status” then it will send this message to controller through UART (i.e. Serial Communication) .Now controller will compare “Status” string with the messages which are stored in Flash memory if it matches then GSM modem will respond to this message by sending status of device (VSI) i.e. current, Voltage and Battery Voltage to the user. The user number is stored in program.

System has another important application. When battery voltage drops below 8 Volt, then GSM module will send message "Battery Low” to the user. Experimental is shown in Figure. 2.

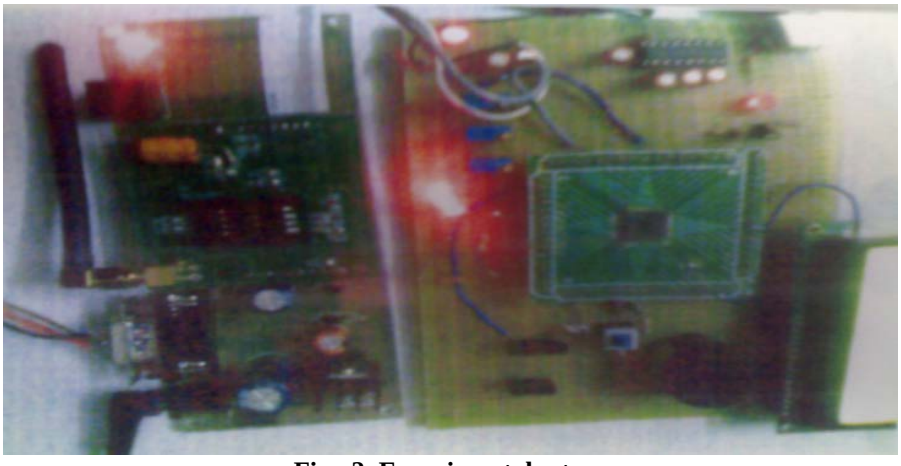

Fig. 2. Experimental setup.

I. RESULTS

To simulate change in values of VSI output Voltage, VSI output current and Battery voltage in the process of discharge three variable resistors (pot) at the input of ADC are connected. By varying the potentiometer the change in parameter values are created and they are displayed and monitored by "Local and Remote parameter monitoring and controlling system". The System tested thoroughly for good number of trill settings on site and it demonstrated successful functioning to display and monitor VSI output voltage, VSI output current and Battery voltage. It also gave appropriate alarm messages to user via GSM modem in the event of battery voltage dropping below 8 volt. For real time application, three variable resistors can be replaced by signal conditioning circuit. Signal conditioning circuit is used to convert VSI output parameters to reference voltage for ADC. Then system can be used on site and give appropriate alerts regarding controlling VSI performance. Some results are shown in Table I.

Table -1: Readings of the system

Resistor (KΩ)	VSI voltage (V)	Battery voltage (V)	VSI Current (mA)
1	230	13	10
2	184	10	9
3	161	9	8
4	138	7	7
5	115	6	6
6	92	4	5
7	69	3	4
8	46	2	3
9	23	1	1.5
10	0	0	0

The future work is to provide fault diagnosis for power converters used in solar energy as proposed in [13]-[14].

I. CONCLUSION

The system has the features like, the system designed can employed in real-time protection and monitoring of real time VSI performance. The system has in built battery protection unit for low voltage and VSI fail- safe operation. Use of a microcontroller unit renders flexibility in calculation algorithm for parameters of the VSI operation. The hardware architecture employed in design forms a low-cost and reliable control unit. GSM technology allows monitoring the parameter with wide range. Where network is not accessible the data can be kept stored in Mass Storage device.

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