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A Wireless Communication System for Data Transfer within Future Micro grids

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ABSTRACT:
A wireless data communication system for future micro grids (MGs) is presented in this paper. It is assumed that each MG has a central controller and each distributed generation unit in the MG has a local controller. The communication system is responsible for transmitting and receiving data amongst these controllers. This communication system is based on ZigBee technology, which is a low cost and low power consumption device. However, its main limitation is the low data transfer rate. To reduce the number of data transactions, a data management scheme is presented in this paper. The required data to be transferred are defined and a suitable coding is proposed. Finally, the number of transmitted symbols and the processing time of the proposed data management scheme are numerically analyzed. In addition, the dynamic operation of an MG is evaluated considering the delays that are imposed by this communication system.As an extension doing the project on mutiple Microgrids.

Index Terms:
Communication system, data management scheme, data transmission delay, microgrids (MGs), ZigBee.

I. INTRODUCTION:
The Increasing number of renewable energy resources such as photovoltaic, wind, and micro-hydro are leading to a substantial amount of electric energy generation in the form of distributed generation (DG) units within the electric networks. Integration of the DGs will benefit the electric networks by reducing the network expansion costs, minimizing the power losses in long feeders and increasing the reliability of the network. It may also be helpful to achieve faster recovery following a fault in the network [1]. Microgrid (MG) is a cluster of loads, DGs and energy storages interconnected by a network of feeders and located in the same geographical area. It can act as an independent power system whenever needed. In the presence of a utility grid, an MG can operate either in grid-connected mode or in autonomous mode.

In grid-connected mode, the network voltage and frequency are dictated by the grid; hence the DGs are controlled such that the desired amount of power (based on maximum power point tracking or economic power dispatch) is supplied by each DG. Hence, any power mismatch between the power generated by the DGs and the load requirement will be met by the grid. In autonomous mode, the DGs are not only required to supply the MG load demand but should also regulate the feeder voltage and frequency within acceptable limits. Therefore, for proper operation and control of DGs within an MG, each DG should be updated with the information about the MG operating mode. This information is required to be transferred from the MG main circuit breaker (CB) that connects the MG and the grid (see Fig. 1), to all the DGs.

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Additionally, the MG requires the real-time power measurement of the grid, loads and DGs as well as the state of charge (SoC) of the available energy storage devices. Similarly, the root mean square (RMS) value, phase angle, and frequency of voltage as well as the active/reactive power at certain specific points in the MG are required to be monitored and given as inputs to the DG control systems. Furthermore, instantaneous values of voltages at the terminals of DGs and the feeder are needed for synchronizing a new DG with the MG. Fig. 1 shows a sample MG network along with the different data which need to be monitored and transmitted to the respective controllers.The wired technologies have a higher data transfer bandwidth and are more reliable; however, their installation cost is relatively high. On the other hand, the wireless technologies have lower installation costs and are more suitable for remote areas. At the same time, they are more flexible for future expansions [10]. A comparison among different wireless technologies that can be considered for MG applications is presented in Table II.

Due to the growing number of meters, sensors, and actuators which needs to be monitored and controlled continuously within an MG, utilizing wired technologies leads to a significant installation cost. Therefore, the wireless technologies are a better candidate for MG applications. However, it is to be noted that they have a lower data transmission rate and may also be vulnerable to interferences with other signals [7]. In this paper, a ZigBee-based communication technology is proposed for data transfer in MGs. ZigBee has been widely considered for data transmission in power systems. In [14], ZigBee is used for data monitoring of all subsystems of a dc MG system. It is also used for real-time measurement and data transfer in a power system application in [15], where an algorithm is proposed for compressing the data. The reliability of ZigBee technology in power system applications, including the number of good and bad data packets transmitted under impulsive high power transients, are evaluated in [16].

In addition, an encryption code is developed for ZigBee in [9] to increase the security of the transmitted data. Since the data transfer rate for ZigBee is low, to reduce the need for high data transfer by such a device. Implementation of ZigBee as a wireless sensor network is proposed in [21], in which a WiFi-ZigBee message delivery scheme is developed to reduce the power consumption of the wireless devices. Also, an algorithm is developed in [22] to avoid interference between ZigBee and WiFi signals,

II.BLOCK DIAGRAM

SECTION1:

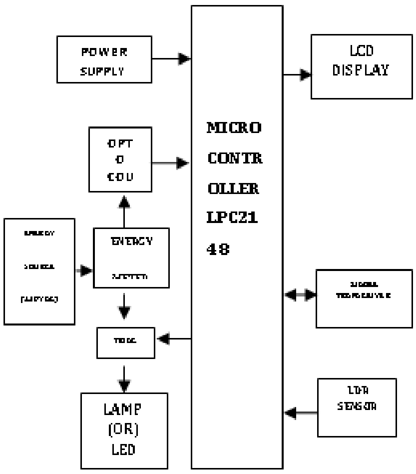

Fig 1: Block diagram

SECTION2:

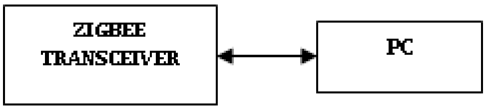

Fig 2: Monitoring section

II. BLOCK DIAGRAM DESCRIPTION:

Power Supply:

This section is meant for supplying Power to all the sections mentioned above.It basically consists of a Transformer to step down the 230V ac to 9V ac followed by diodes. Here diodes are used to rectify the ac to dc. After rectification the obtained rippled dc is filtered using a capacitor Filter. A positive voltage regulator is used to regulate the obtained dc voltage.

Microcontroller:

This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

MAX 232:

The microcontroller can communicate with the serial devices using its single Serial Port. The logic levels at which this serial port operates is TTL logics. But some of the serial devices operate at RS 232 Logic levels. For example PC and GSM etc. So in order to communicate the Microcontroller with either GSM modem or PC, a mismatch between the Logic levels occurs. In order to avoid this mismatch, in other words to match the Logic levels, a Serial driver is used. And MAX 232 is a Serial Line Driver used to establish communication between microcontroller and PC (or GSM)

LCD Display:

This section is basically meant to show up the status of the project. This project makes use of Liquid Crystal Display to display / prompt for necessary information.

ZIGBEE:

Zigbee is new wireless technology guided by IEEE 802.15.4 Personal Area Network standard. It is primarily designed for the wide ranging controlling applications and to replace the existing non-standard technologies. It currently operates in 868MHz band at a data rate of 20Kbps in Europe, 914MHz band at 40kbps in USA, and the 2.4GHz ISM bands Worldwide at a maximum data-rate of 250kbp

LDR:

The LDR is used to measure the light intensity.

PC Section:

This section basically contains a PC with Serial communication associated hardware. Apart from this, the web cam is also connected to the PC. The serial communication associated hardware circuitry includes the bus (DB 9) connector from PC to Microcontroller.

Optocoupler:

Where small size, higher speed and greater reliability are important, a much better alternative is to use an Optocoupler. These use a beam of light to transmit the signals or data across an electrical barrier, and achieve excellent isolation. Optocoupler typically come in a small 6-pin or 8-pin IC package, but are essentially a combination of two distinct devices.

Energy meter:

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic readings of electric meters establish billing cycles and energy used during a cycle.

III. HARDWARE COMPONENTS:

LPC2148 CONTROLLER

ARM7 LPC2148 is ARM7TDMI-S Core Board Microcontroller that uses 16/32-Bit 64 Pin (LQFP) Microcontroller No.LPC2148 from Philips (NXP). All resources inside LPC2148 is quite perfect, so it is the most suitable to learn and study because if user can learn and understand the applications of all resources inside MCU well, it makes user can modify, apply and develop many excellent applications in the future. Because Hardware system of LPC2148 includes the necessary devices within only one MCU such as USB, ADC, DAC, Timer/Counter, PWM, Capture, I2C, SPI, UART, and etc. The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface

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and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

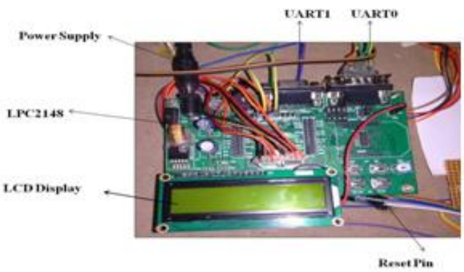

Fig 3: LPC2148 Board

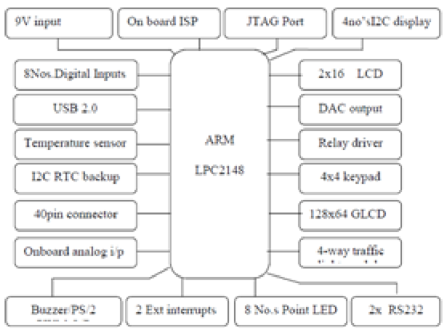

Fig4: General block diagram of ARM7 LPC2148

FEATURES:

- Processor: LPC2148
- 2xserial ports (one for ISP and other for Serial Communication)
- 12.00 MHz precious stone
- On board Reset Circuit with a switch.
- Dual Power supply (either through USB or utilizing outer force connector).
- Power on LED supply.
- Three ready for controllers 1.8v, 3.3v and 5v with up to 800ma current
- Extension headers for µc ports.
- Graphic LDC showcases interfacing port.
- USB Ports.
- CAN controller interfacing.
- MMC/SD card interfacing.
- 8 Bit LED interfacing.
- EEPROM Interfacing
- Onboard UART

Arm Construction:

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty.

Fig 5: LPC2148 Pin Diagram

V. ZIGBEE TECHNOLOGY:

The explosion in wireless technology has seen the emergence of many standards, especially in the industrial, scientific and medical (ISM) radio band. Need for a widely accepted standard for communication between sensors in low data rate wireless networks was felt.

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As an answer to this dilemma, many companies forged an alliance to create a standard which would be accepted worldwide. It was this Zigbee Alliance that created Zigbee. Bluetooth and Wi-Fi should not be confused with Zigbee. Both Bluetooth and Wi-Fi have been developed for communication of large amount of data with complex structure like the media files, software etc.

Fig 6: ZigBee Module

Zigbee is a low power spin off of Wi-Fi. It is a specification for small, low power radios based on IEEE 802.15.4 – 2003 Wireless Personal Area Networks standard. The specification was accepted and ratified by the Zigbee alliance in December 2004. Zigbee Alliance is a group of more than 300 companies including industry majors like Philips, Mitsubishi Electric, Epson, Atmel, Texas Instruments etc. which are committed towards developing and promoting this standard. The alliance is responsible for publishing and maintaining the Zigbee specification and has updated it time and again after making it public for the first time in 2005. Many years ago, when Bluetooth technology was introduced, it was thought that Bluetooth would make Wi-Fi redundant. But the two coexist quite well today, so do many other Wireless standards like Wireless HART and ISA100.11a. Then why would we need another WPAN standard like Zigbee? The answer is, the application focus of Zigbee Alliance - low cost and low power for energy efficient and cost effective intelligent devices. Moreover, Zigbee and Bluetooth have different application focus.

Zigbee Networks:

Zigbee devices can form networks with Mesh, Star and Generic Mesh topologies among themselves. The network can be expanded as a cluster of smaller networks.

A Zigbee network can have three types of nodes: Zigbee Coordinator (ZBC), Zigbee router (ZBR) and Zigbee End Device (ZBE) each having some unique property.

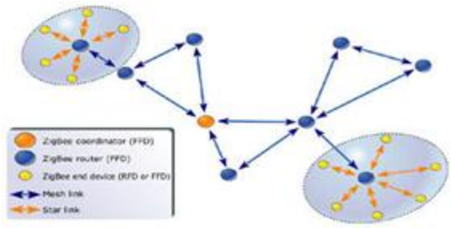

Fig 7: Structure of Zigbee Network

Zigbee understand through a typical usage scenario in a home automation system. There can be only one ZBC in a network, the one that initiates the network in the first place and stores the information about the network. This would be the main control panel or remote control in the living room of each storey. All the devices in the network communicate with this ZBC. In a network, data traffic can be periodic, intermittent or repetitive. When data is periodic, the application determines the rate of transfer. Intermittent data needs optimum power savings and hence the data rate is stimulus dependent.

Technical specifications of zigbee:

- Frequency band2.400 — 2.483 GHz
- Number of channels16
- Data rate250 kbps
- Supply voltage1.8 – 3.6 V
- Flash memory128 kB
- RAM8 kB
- EEPROM4 Kb Operating
- Temperature-40 — +85 °C

OPTO COUPLERS:

There are many situations where signals and data need to be transferred from one system to another within a piece of electronics equipment, or from one piece of equipment to another, without making a direct electrical connection. Often this is because the source and destination are (or may be at times) at very different voltage levels, like a microcontroller which is operating from 5V DC but being used to control a triac

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which is switching 230V AC. In such situations the link between the two must be an isolated one, to protect the microprocessor from over voltage damage. Relays can of course provide this kind of isolation, but even small relays tend to be fairly bulky compared with ICs and many of today's other miniature circuit components. Because they are electro-mechanical, relays are also not as reliable ó and only capable of relatively low speed operation. Where small size, higher speed and greater reliability are important, a much better alternative is to use an Optocoupler. These use a beam of light to transmit the signals or data across an electrical barrier, and achieve excellent isolation.

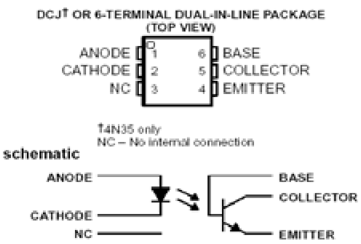

Fig 8: Working of optocoupler

Optocoupler typically come in a small 6-pin or 8-pin IC package, but are essentially a combination of two distinct devices: an optical transmitter, typically a gallium arsenide LED (light-emitting diode) and an optical receiver such as a phototransistor or light-triggered diac. The two are separated by a transparent barrier which blocks any electrical current flow between the two, but does allow the passage of light. The basic idea is shown in Fig.1, along with the usual circuit symbol for an Optocoupler. Usually electrical connections to the LED section are brought out to the pins on one side of the package and those for the phototransistor or diac to the other side, to physically separate them as much as possible. This usually allows optocouplers to withstand voltages of anywhere between 500V and 7500V between input and output. Optocouplers are essentially digital or switching devices, so they are best for transferring either on-off control signals or digital data.

Analog signals can be transferred by means of frequency or pulse-width modulation.

VI. SOFTWARE TOOLS:

INTRODUCTION TO KEIL SOFTWARE:

Keil compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.

PROLOAD:

Proload is software which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller placed in the programmer kit and this is done by the Proload. Programmer kit contains a microcontroller on it other than the one which is to be programmed. This microcontroller has a program in it written in such a way that it accepts the hex file from the keil compiler and dumps this hex file into the microcontroller which is to be programmed. As this programmer kit requires power supply to be operated, this power supply is given from the power supply circuit designed above. It should be noted that this programmer kit contains a power supply section in the board itself but in order to switch on that power supply, a source is required. Thus this is accomplished from the power supply board with an output of 12volts or from an adapter connected to 230 V AC.

VII. EXPERIMENTAL RESULTS:

Fig 9: Hardware kit

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Fig 10: Observing units in LCD

Fig 11: Observing output percentage in LCD

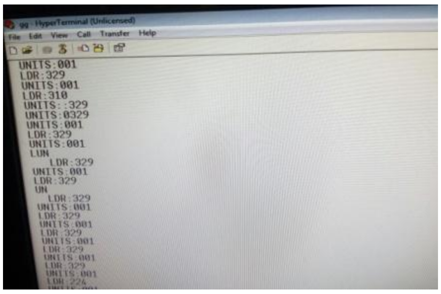

Fig 12: Observing the output inHyper terminal Appication

VIII. CONCLUSION:

The project "A WIRELESS COMMUNICATION SYSTEM FOR DATA TRANSFER WITHIN FUTURE MICROGRIDS" has been successfully designed and tested. Integrating features of all the hardware components used have developed it. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

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He has 11.5years teaching experience in the stream of engineering education. He has 16 Published in International Journals and National Conferences and also 1 International conference. He has attended many workshops, FDP and Seminars. He has been awarded as 'Academic Excellence' in 2011 in SVPCET. His research areas are Low Power VLSI, Digital IC Design, Signal processing, image processing and communications systems.