

Universal Detector with GSM Interface

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Abstract- Adding automation to an existing fully functional (manual) system has always been a challenge for engineers. The most common problems may include installation of distribution boards, selection of different hardware for different load ratings, etc. Often, a potential user avoids going for such systems as installations want major modification, are quite expensive & cumbersome. There's nothing simpler than connecting an automation system simply by bypassing the existing system and also using the same system irrespective of the voltage rating. To add basic level of automation i.e. detection of any switching of a device, we have come up with a device called 'Universal Detector' with added communication feature. This concept is presented by the use of an external GSM modem which acts as a communication interface between the user and the device. Universal Detector is a retrofit-able device with the key feature being its low cost and wide voltage range literally making it "Universal".

I. INTRODUCTION

Presently, automation is highly application specific and is often termed as a luxury. Simple switching ('on' to 'off' or 'off' to 'on') detection can be the basic building block of any automation system. Universal detector can find application in home as well as building automation.

Universal Detector with GSM is capable of detecting the presence or absence of any voltage in the wide range of 3V-240V, 50/60Hz. It aims at augmenting automation to an existing installation without the need to reinstall the application's entire setup. We used an Atmel 89C51 microcontroller based universal detector i.e. the input can be AC or DC voltage. It makes use of UART communication protocol to transmit messages from the device to the respective user. Currently we have integrated a GSM modem which is communicating with the user. An android powered [4] smart phone application is created which converts the trigger of text message into a user friendly pre-saved message. This pre-saved message comes as a pop-up alert whenever the state of the device connected at the respective port changes. The application also includes mode selection and change of phone number facility.

One can also choose to replace the GSM modem with his personal computer or any other application specific device which can accept data serially.

II. DESCRIPTION

1. INPUT INTERFACE

Each input port is connected to a bridge rectifier which converts AC to DC (and DC input remains unaffected). The

rectified voltage is then passed through a RC-filter (3 resistors with $R=4.7$ ohms/2W connected in series and $C=10\mu\text{F}$, 415V) to moderate the ripples. The range of DC at the output of the rectifier would be in the range of approximately 3V to 240V depending upon the input. This voltage is now given to the input of the opto-coupler (ps2502-1). The output side of the opto-coupler consists of a Darlington pair whose collector is connected to 5V DC (via pull-up resistor of value 1kohms/0.25W) with emitter grounded. The output for the controller is directly taken from the collector.

The above can be summed up as: If there is voltage at the input port, the output of the opto-coupler gives approximately zero volts (TTL logic 0); and in the absence of voltage at the input port, the output of the opto-coupler gives approximately five volts (TTL logic 1). Hence by this interface a wide range of voltages has been narrowed-down to a simple TTL logic. By connecting opto-coupler, it helps us isolate the high/low voltage grounds of the input side from the microcontroller interface-which is working at constant 5V DC. Also each of the ports can be connected to loads operating at different voltages in the range specified above.

The voltage and power values of the components such as resistors and capacitors in the input interface have been designed and simulated on the software Cadence Allegro.

2. MICROCONTROLLER INTERFACE

The outputs (TTL level) from the opto-coupler are given to Ports 2.0, 2.1, 2.2, 2.3 of the microcontroller Atmel 89C51. An indicator LED for every port is taken as output from Ports 0.0, 0.1, 0.2, 0.3 respectively [2]. A crystal of frequency 11.0592 kHz provides clock pulses to the microcontroller. Power-on LED and Reset facility is also provided. Ports 3.1 and 3.2 are transmitter (Tx) and receiver (Rx) pins respectively. These pins are connected to the max232 IC which converts TTL level to UART level. A UART cable is used to connect this circuit to the GSM modem.

The entire microcontroller interface is simulated on the software Proteus (ISIS) and the C code [1] [3] is written on the software Keil.

III. BLOCK DIAGRAM

Fig1. Shows the block diagram of Universal Detector. The block diagram consists of the following major blocks:

A. *Rectifier with filter*: used to accept convert AC voltage to DC voltage. In case DC is applied, it passes through the rectifier unaffected.

B. *Filter*: used to reduce the ripples in the full wave rectified output from the rectifier

C. *Opto-coupler*: It acts as an isolator and isolates the grounds of the ports and the processing circuit. It detects voltages between 3V to 240V. If voltage is present at its input it produces 0 volt output, as soon as the input voltage is reduced to 0 it gives a 5V DC output.

D. *Microcontroller (AT89C51)*: receives the inputs at TTL level from various ports and processes them. It then actuates the respective LED/s and also sends the desired command/s to the GSM modem which in turn sends SMS/s to the user.

E. *MAX232*: converts TTL level signals received from the microcontroller to UART level which is understood by the GSM modem.

Mode 1: Detects “on to off” switching.
Mode 2: Detects “off to on” switching.

When both the modes are selected both “on to off” and “off to on” switching are detected.

Consider a Miniature Circuit Breaker (MCB) connected across Port A as shown in Fig 2. It is seen that the Universal Detector is simply connected at the output side (load side) of the MCB. Let Port A be configured in Mode 1 operation. Hence the input from Port A is at logic low to the controller (at port 2.0). Now due to some reason (e.g. Overload or Short Circuit) at the load end the MCB trips, the voltage across Port A falls to zero. This will cause logic high to appear at the controller (at port 2.0). This triggers the controller to send AT commands [5] to the GSM modem such that an “A” is transmitted as a text message to the user’s mobile phone. This is then interpreted by the phone application as a pre-saved message as chosen by the user.

IV. WORKING

The overall application can be divided into two modes (selected by the phone application):

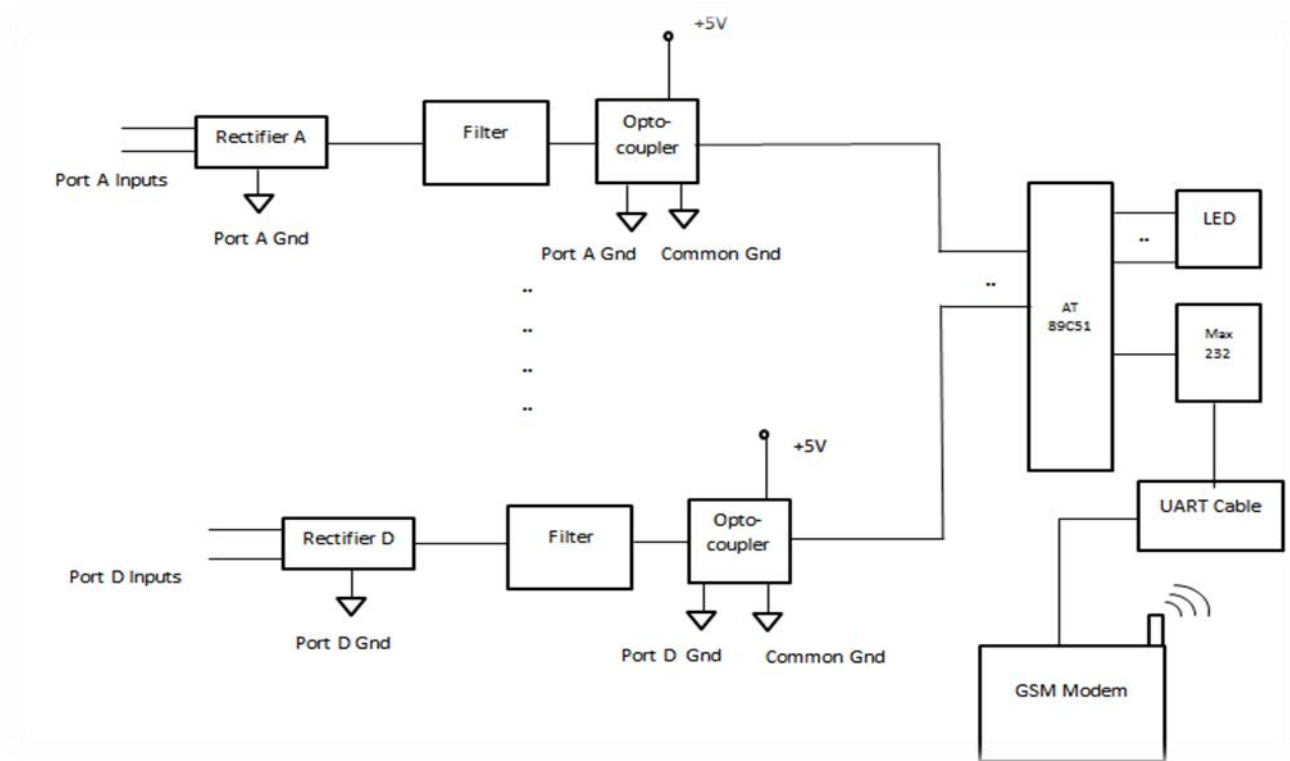


Fig.1Block Diagram

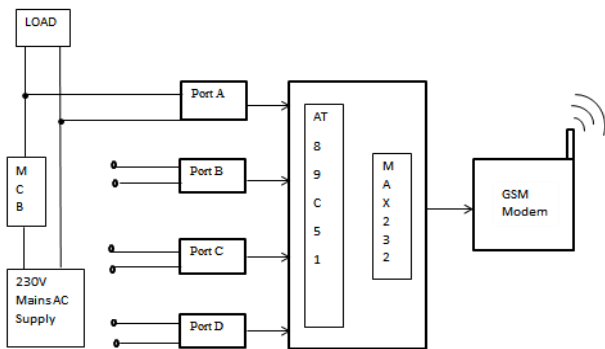


Fig.2 Universal Detector Connected Across Load

V. MOBILE APPLICATION

The application opens with an Authorization window which asks for username and password to ensure only the authorized user is granted access (Fig 3). After authorization, a menu driven window (Admin) opens which giving options of “Add Description” and “Change of Phone number” (Fig 4).

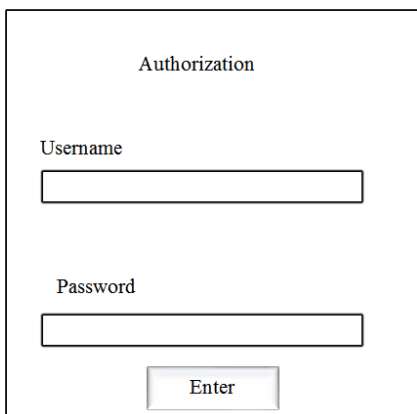


Fig.3 Authorization Window

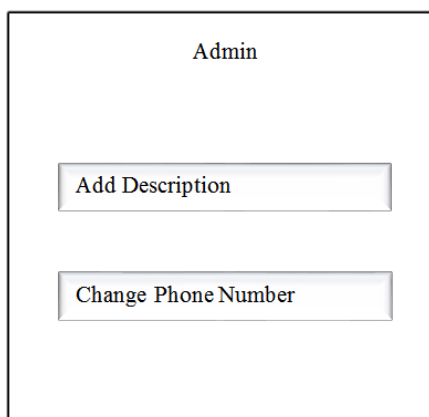


Fig.4 Admin Window

1. Add Description :

When the user selects this option, the window as shown in Fig. 5 appears. This allows the user to name each and every port the way he wants it to appear in the pop-up. This enables the overall concept to be more open and user-friendly.

E.g. Port A is given the name “MCB 1” and its operation in Mode 1 is selected.

Port	Add Description	Mode 1	Mode 2
Port A	“MCB 1”	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Port B		<input type="checkbox"/>	<input type="checkbox"/>
Port C		<input type="checkbox"/>	<input type="checkbox"/>
Port D		<input type="checkbox"/>	<input type="checkbox"/>

Fig.5 Add Description Window

Four ports (A to D) are provided by default, and by selecting the option “Add Port” the user can add more ports, (provided the hardware supports-maximum limit up to 25 ports). The last option on the same window is “Save” which as the name suggests, saves the above changes. Now, if a text message of “A” arrives, a pop-up of “MCB 1” is displayed by the application.

2. Change of phone number:

When the user selects this option, the window as shown in Fig 6 appears. This allows the user to change the phone numbers for the preceding messages. The new phone number is entered in the “New Number” box shown and “send” is pressed. This sends the new phone number to the controller which responds by sending a 5-digit confirmation code (on the new number). The user then needs to type this number in the “Confirmation Code” space as shown in the Fig. 6, and then click “send”. This will change the number within the microcontroller memory. Now, all the preceding messages will be sent on the new number.

Changing Phone Number

New Number

Send

Confirmation Code

Send

Fig.6 Change Phone Number Window

VI. APPLICATIONS

Universal Detector can be used in a variety of applications such as follows:

- i. Home Automation: Indicates when a MCB trips.
- ii. Medical: Detecting tripping/non-functioning of critical equipments.
- iii. Fire Detection: in conjunction with a fire/smoke. Detector (by simply bypassing its power LED).
- iv. Security Systems in banks.
- v. Detectors in pressure and flow regulations.
- vi. Any other application where presence or absence of voltage needs to be detected.

VII. COST

Universal Detector with four input ports costs approximately Rs 230. Every additional port adds a cost of Rs 35 to the device.

VIII. RECOMMENDATIONS

- i. We can further increase the voltage range from 3V to 415V so that it can be used with 3 phase supply also.
- ii. We can also make it RoHS (Restriction of Hazardous Substances) compliant by using Lead free solder, wires with acceptable grade pigments & hexa-chrome plating on the metallic enclosure.

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