AUTO CONTROL OF A STANDBY TRANSFORMER USING MICROCONTROLLER

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ABSTRACT

The main aim of the research work is to provide un-interrupted power supply to the energy consumers. For this purpose two similar types of distribution transformers are used so that, if any one transformer is failed, then immediately another transformer is brought into the circuit during over loading, over temperatures, input voltage variations and provides conventional 230V supply to the consumers without burning of transformers.

Keywords: *un-interrupted power supply, distribution transformers, over loading*

INTRODUCTION

Transformer is the vital component in the electric power transmission and distribution. Transformers failure reduction and providing un-interrupted supply to the consumers is essential for smooth functioning of transformers. Burning of transformers is due to overloads, voltage variations and over temperatures. It takes lot of time to repair and involves lot of expenditure. Distribution transformers account for the majority of losses in an electric power network. Of these losses, core heating accounts for the substantial portion. They can be considered constant so long as a transformer is in service. By contrast, winding losses are only significant under higher loadconditions.

For monitoring the load current continuously, current transformer is used and the output of current transformer is fed to micro-controller through A-D converter. Similarly for monitoring transformer body temperature or oil temperature operational amplifiers are used with suitable temperature transducer. For over voltage parameter monitoring, the input voltage to the transformer primary is fed through autotransformer and the over voltage is checked. Normally the single phase transformer primary it is designed to operate at 230V AC. If the input voltage is more than 250V AC continuously, then there is a chance that the primary winding may burn due to over voltage. To protect from this, supply to the primary is provided through a relay contact, so that, relay energizes and disconnects the supply to the transformer primary. The outputs of the over load, over temperature, over voltage parameters are converted into digital pulses usingA – D converters and the digital information are fed to micro-controller for necessary action.

This paper describes design and development of a demonstration unit for "Auto Control of a standby transformer using micro-controller".

PROPOSED SYSTEM BLOCK DIAGRAM

For the demonstration purpose two separate similar types of lower rating step-down transformers are used and are treated as distribution transformers. The idea of using additional transformer is to protect the existing transformer burning due to the overloads and over temperature. This additional transformer is known as standby transformer. The combination of both the transformers is designed in such a way that, if any one transformer is over loaded, automatically the other transformer shares the load and reduces the burden of firsttransformer.

The load sharing must be carried out at on load, so that un-interrupted supply can be provided to the consumers. The individual blocks of the system illustrated in fig.1 are:

(1) Line voltage Monitoring and controlcircuit
(2) Temperature Monitoring and controlcircuit
(3) Load Sensingcircuit
(4) Analog to DigitalConverter
(5) Clock generator
(6) Micro-controller

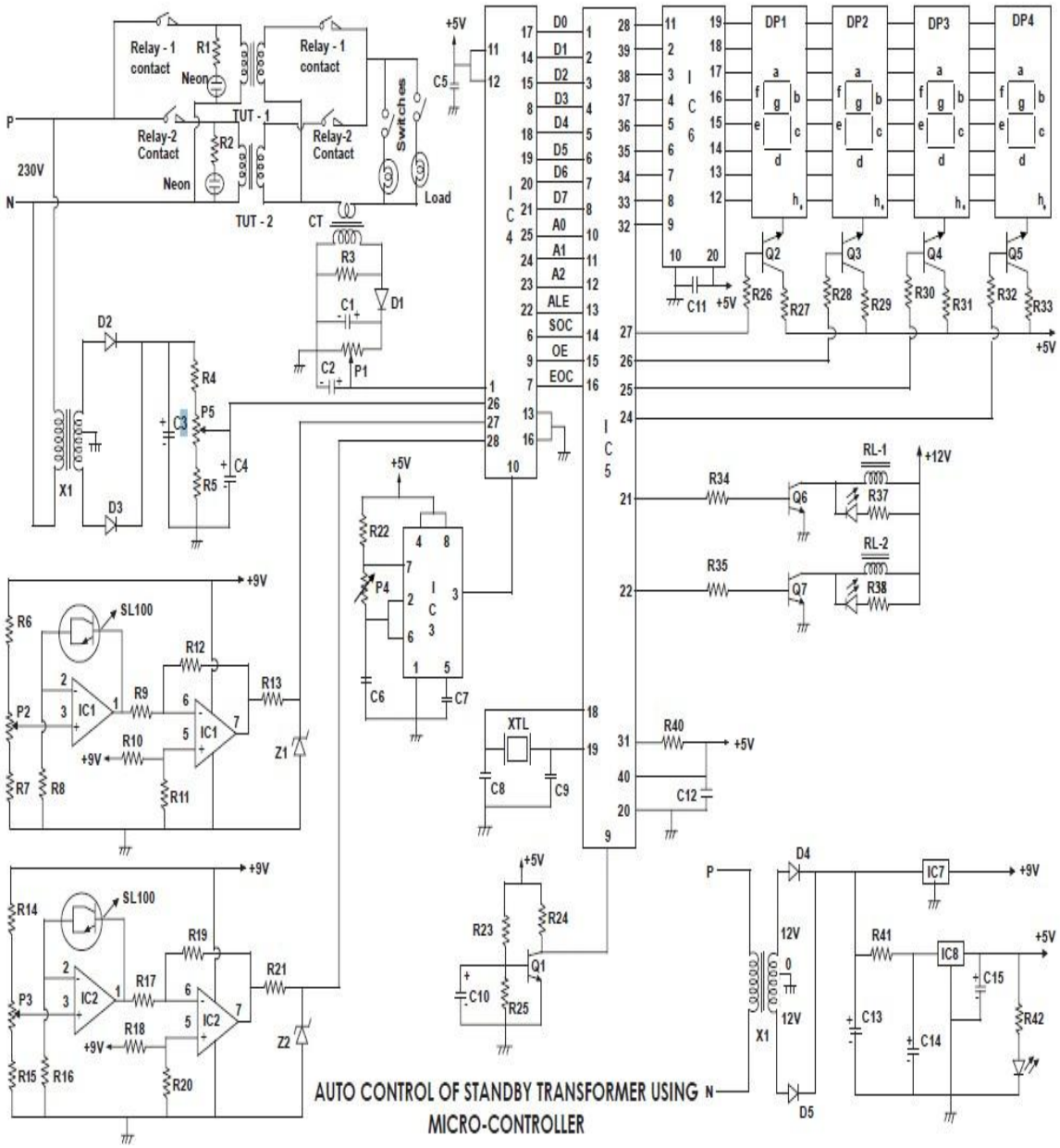


Fig.1 Proposed system block diagram

LINE VOLTAGE MONITORING AND CONTROL

The stand by transformer (TUT-2) used should be exactly similar to the main distribution transformer (TUT-1), so that voltage variations at the output can be minimized. The outputs (secondary) of both the transformers are connected parallel to each other, where as inputs (primary) are separated by the relay contacts. When the main transformer is over loaded, both the transformers primaries are connected parallel to each other through the relay contacts, so that the load is distributed equally to both the transformers as illustrated in fig.2.

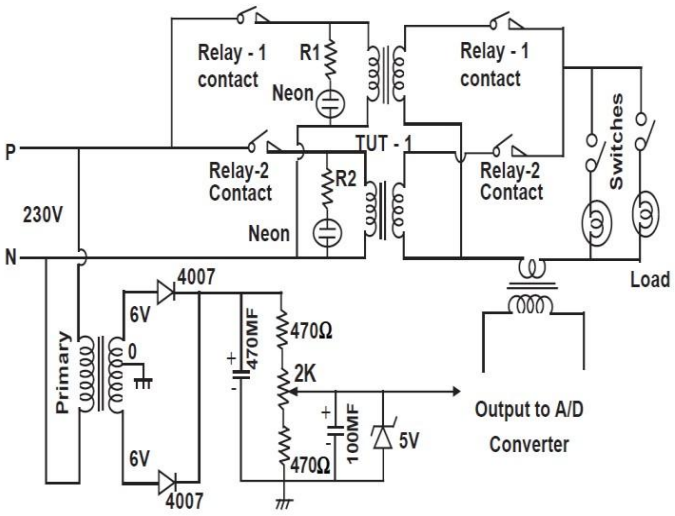


Fig.2 Line voltage Monitoring and control circuit

To protect the transformers burning due to over voltage, the output of the line voltage sensing circuit is fed to micro-controller unit through the A/D converter, so that according to the received digital information from the ADC, the micro-controller energizes relay-1 and Relay-2. These relay contacts are used to break the supply to the transformers primary by which both the transformers are protected from high input voltage.

TEMPERATURE MONITORING AND CONTROL

The circuit design consists of a basic transducer, which converts temperature in to equivalent voltage. For this, transistor „SL100" is used as a sensor. The transistor junction (Base & emitter or Base & collector) characteristics depend upon the temperature. For a transistor, the maximum average power that it can dissipate is limited by the temperature that collector - base junction can with stand.Therefore, maximum allowable junction temperature should not be exceeded. The average power dissipated in collector circuit is given by the average of the product of the collector current and collector base voltage. At any other temperature the de-rating curves are supplied by the manufacturer to calculate maximum allowable power (Pj). Where TC is case temperature, Tj is junction temperature and Qj is the thermal resistance.The entire circuit design of the temperature sensing circuit is illustrated in Fig.3.With the help of 2K preset (variable resistor) connected at the input of first stage, the initial room temperature corresponding output voltage can be adjusted for the easy calibration. The output of the second stage is clamped with 5V zener and the same output is fed to the A/D converter.

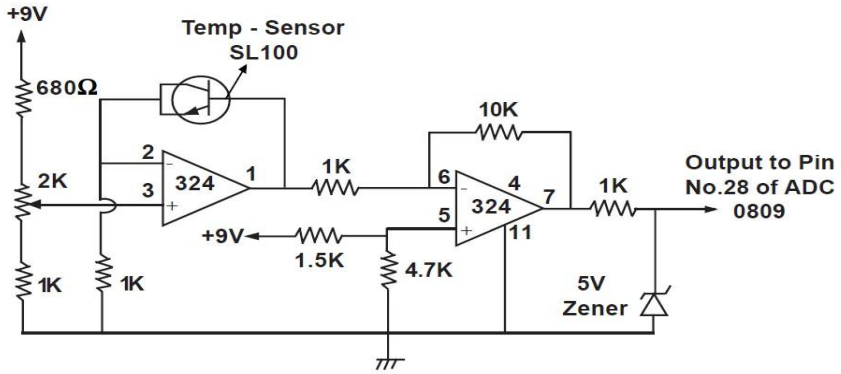


Fig.3 Temperature Monitoring and control circuit

LOAD SENSING AND CONTROL

In fig.4 if the load is more than 1Amp, then the micro-controller energizes the relay – 3. This is a 2 change over relay, i.e., it is having 2 sets of change over contacts. Once the relay is energized, normally closed contact gets opened and open contact gets closed, by which both the transformer primaries are connected parallel to each other and the load is distributed equally on both the transformers primary. The current flowing through the CT primary can be measured, for this purpose, digital display is provided at the output of the Micro-controller Chip. With the help of a 470ohm resistor connected across the CT secondary, the ripple can be suppressed and real value can be obtained at the output of CT. This voltage can be adjusted to the required level, for this purpose 2K variable resistor is used and the final output is taken from its mid point.

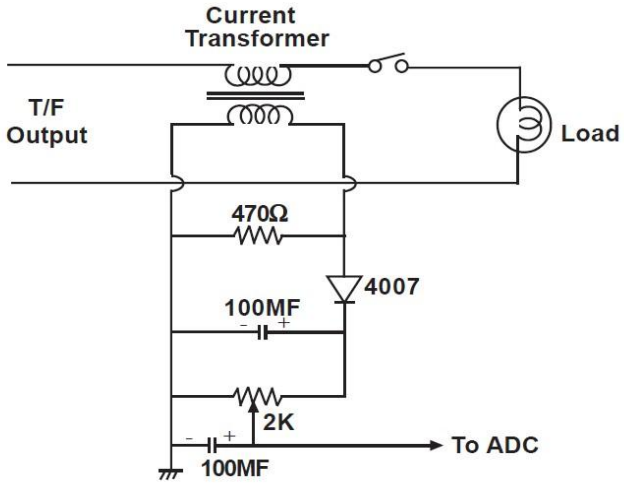


Fig.4 Load sensing and control circuit

ANALOG TO DIGITAL CONVERTER

As the peripheral signals usually are substantially different from the ones that micro-controller can understand (zero and one), they have to be converted into a pattern which can be comprehended by a micro-controller. This task is performed by a block for analog to digital conversion or by an ADC. This block(fig.5) is responsible for converting an information about some analog value to a binary number and for follow it through to a CPU block so that CPU block can further process it. This analog to digital converter (ADC) converts a continuous analog input signal, into an n-bit binary number, which is easily acceptable to acomputer

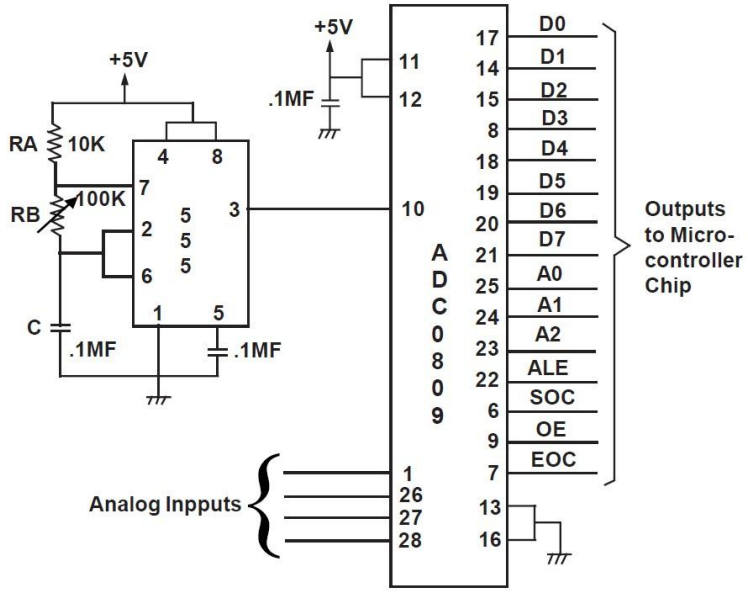
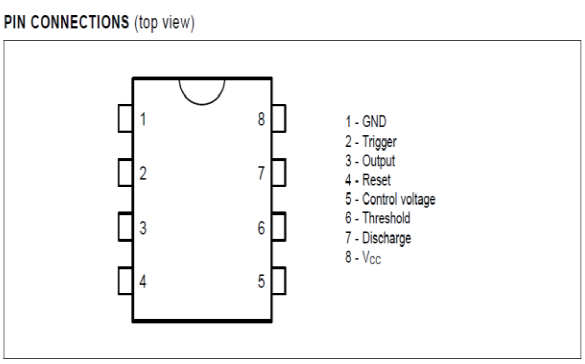


Fig.5 Analog to Digital converter

ADC 0809 (8 Bit A/D converter) is used to convert an analog voltage of Instrumentation amplifier output in to an output binary word that can be used by a computer.

CLOCK GENERATOR

The clock generator circuit is designed using 555 Timer IC(fig.6,fig.7). This IC is configured in Astable Mode of operation (free running oscillator). The frequency can be adjusted using external resistor and capacitor. The required frequency is more than 100KHz. The output of this IC is fed to the A - D converter.



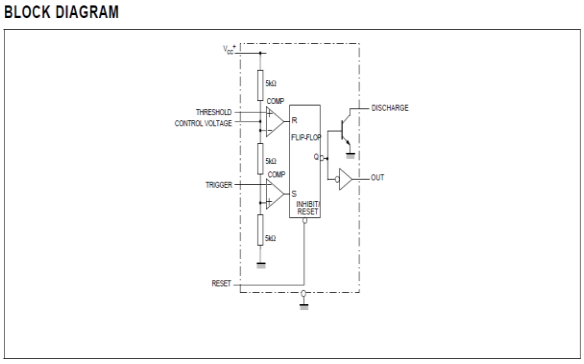


Fig.6 Clock Generatorpin connections

Fig.7 Clock Generator blockdiagram

MICROCONTROLLER

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer(fig.8,fig.9)with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufacturedusingAtmel‟shigh-densitynonvolatilememorytechnologyandiscompatiblewith the industry-standard MCS-51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded controlapplications.

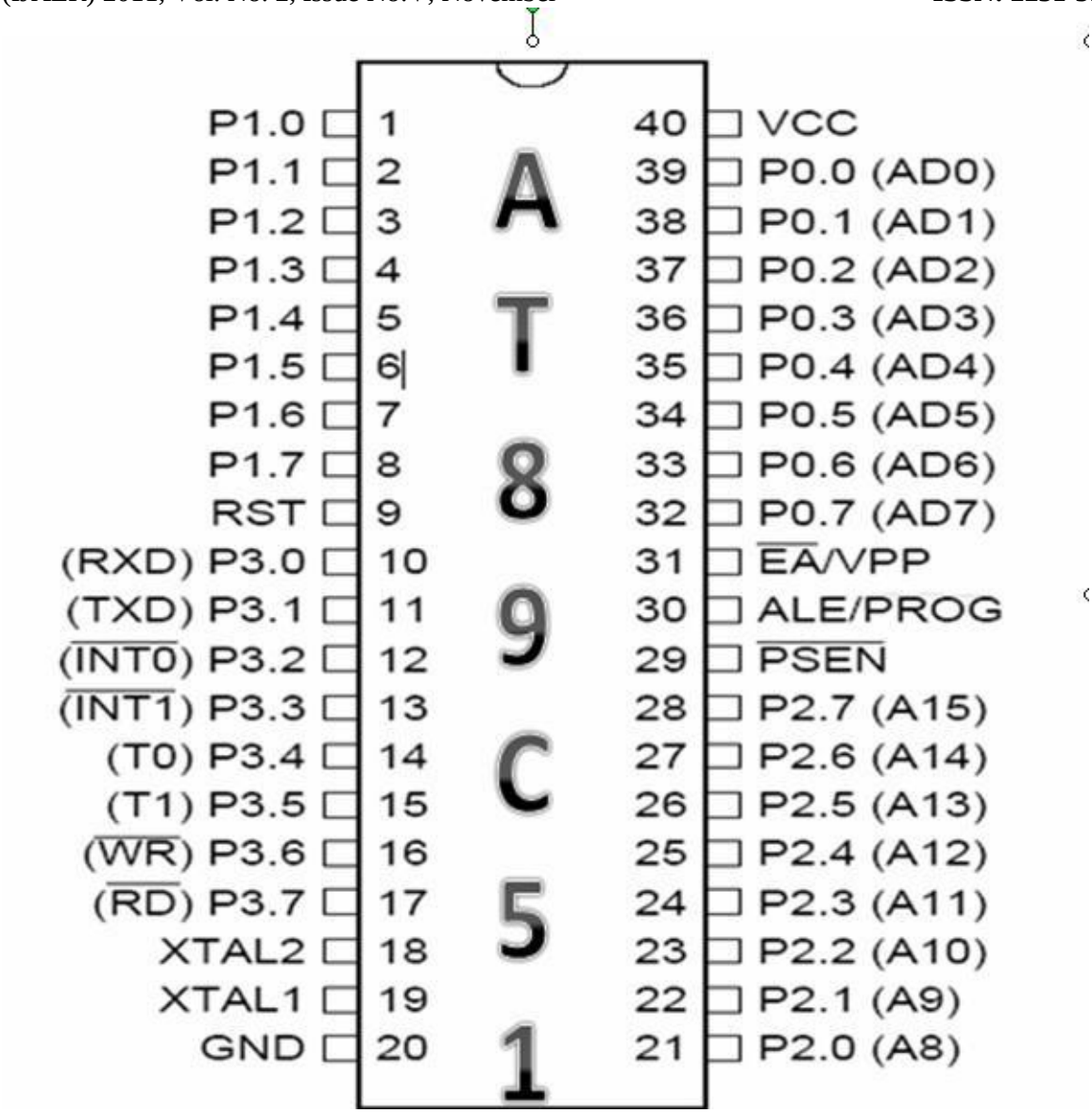


Fig.8 Microcontroller pin diagram

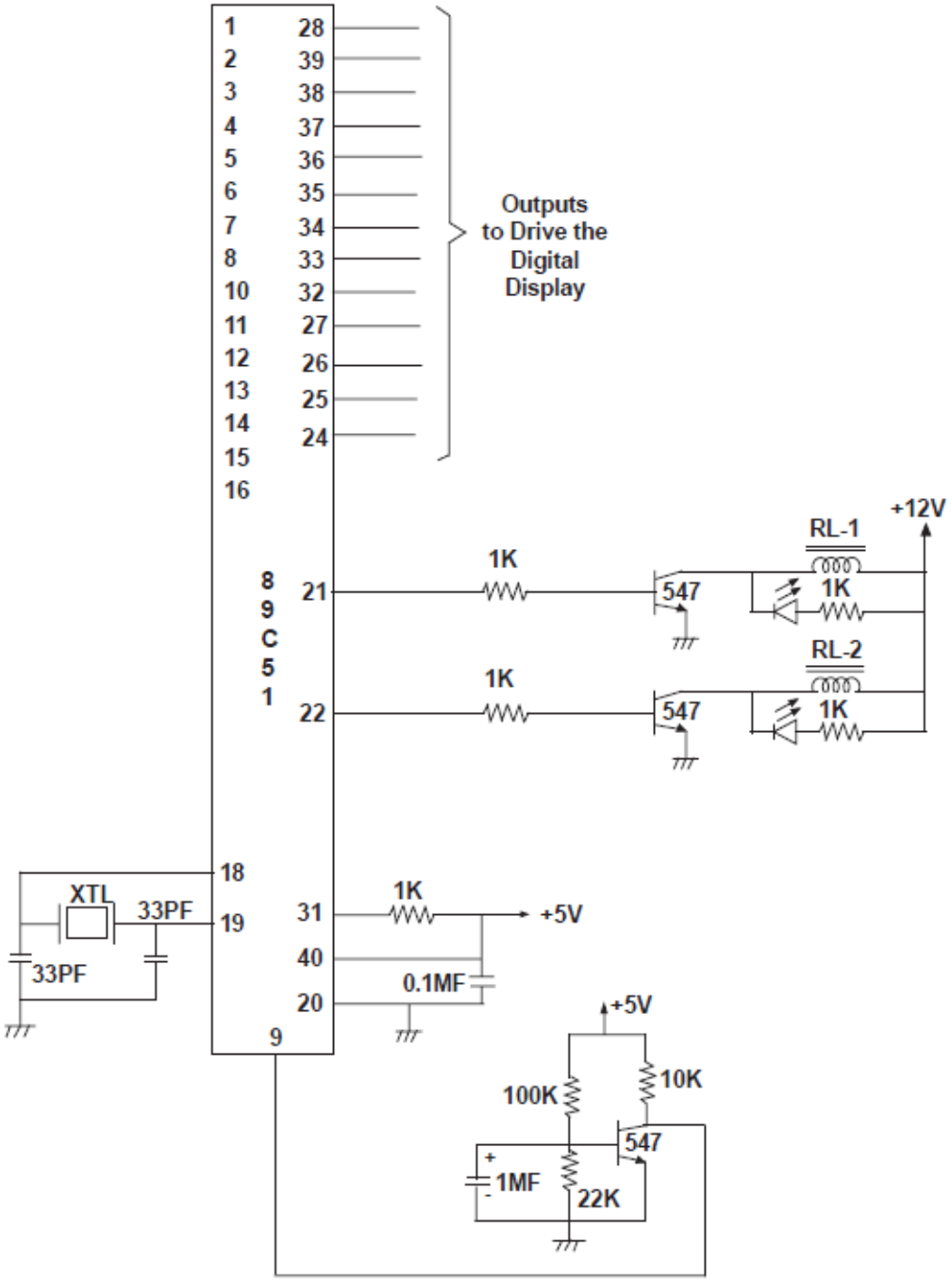


Fig.9 Microcontroller circuit diagram

CONCLUSIONS

The research work on "Auto Control of Standby Transformer Using Microcontroller" is successfully designed, tested and a demo unit is fabricated to monitor and control three important

parameters, load current, temperature and high input voltage, for distribution transformers protection and to provide un-interrupted power supply to consumers. Apart from these three parameters, various other parameters, such as line frequency, power factor, power leakage, Energy measurement can also be incorporated with minor modifications.

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