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Detection and Prevention of Phase Fault and Overheating for 3-Phase Load with Smart Notification

K. Vamshikrishna[1], B. Shiva Krishna[2], Mr. P. Kamalakar[3] and Ms. K.Chetaswi[4]

[1, 2] Final Year B.Tech, Department of Electrical and Electronics Engineering, Malla Reddy Engineering College (A), India.

[3, 4] Assistant Professor, Department of Electrical and Electronics Engineering, Malla Reddy Engineering College (A), India.

E-Mail: kamaleee209@gmail.com

Abstract - ***The project is been conceptualized to solve the issues and damages occur in operating the 3-phase loads in industries. Therefore there are many solutions and protection in the market, but our idea proposes the best and smart technology of protecting the 3-phase system. The proposed system uses three-phase power supply where in three single-phase transformers are connected to it. The system has a set of AC712 used as current sensor. A thermostat is connected to the motor body to sense the temperature of the motor. The motor is operated by switching the main relay, which is operated by other set of relays by sensing single phasing and over temperature conditions.***

Keywords – Detection, Prevention, Fault, Overheating

I. INTRODUCTION

This project develops an automatic tripping mechanism for the three phase supply system. The project output resets automatically after a brief interruption in the event temporary fault while it remains in tripped condition in case of permanent fault. The electrical substation which supply the power to the consumers, have failures due to some faults which can be temporary or permanent. These faults lead to substantial damage to the power system equipment. In India it is common, the faults might be LG (Line to Ground), LL (Line to Line), 3L (Three lines) in the supply systems and these faults in three phase supply system can affect the power system. To overcome this problem a system is built, which can sense these faults and automatically disconnects the supply to avoid large scale damage to the control gears in the grid sub-stations. This system is built using three single phase transformers which are wired in star input and star output, and 3 transformers are connected in delta connections, having input 220 volt and output at 12 volt. This concept low voltage testing of fault conditions is followed as it is not advisable to create on mains line. 555 timers are used for handling short duration and long duration fault conditions. A set of switches are used to create the LL, LG and 3L fault in low voltage side, for activating the tripping mechanism. Short duration fault returns the supply to the load immediately called as temporary trip while long duration shall result in permanent trip.

Various studies have shown that anywhere from 70%, to as high as 90%, of faults on most overhead lines are transient. A transient fault, such as an insulator flashover, is a fault which is cleared by the immediate tripping of one or more circuit breakers to isolate the fault, and which does not recur when the line is re-energized. Faults tend to be less transient (near the 80% range) at lower, distribution voltages and more transient (near the90% range) at higher, sub transmission and transmission voltages. Lightning is the most common cause of transient faults, partially resulting from insulator flashover from the high transient voltages induced by the lightning.

Thus, transient faults can be cleared by momentarily reenergizing the line, in order to allow the fault to clear. Auto reclosing can then restore service to the line. The remaining 10 - 30% of faults are semi permanent or permanent in nature. A small branch falling onto the line can cause a semi-permanent fault. In this case, however, an immediate de-energizing of the line and subsequent auto reclosing does not clear the fault. Instead, a coordinated time-delayed trip would allow the branch to be burned away without damage to the system.

II. WORKING PRINCIPLE

1. speed when the 3 phase stator winding is energized from a 3 phase supply, a rotating magnetic field is produced which rotates around the stator at synchronous.
2. The rotating magnetic field cuts the rotor conductors, which as yet, are stationary. Due to this flux cutting, EMFs are induced in the rotor conductors. As rotor circuit is short circuited, therefore, currents start flowing in it.
3. Now, as per Lenz's law , "the direction of induced current will be such that it opposes the very cause that produced it" .
4. Here, the cause of EMF induction is the relative motion between the rotating field and the stationary rotor conductors. Hence, to reduce this relative motion, the rotor starts rotating in the same direction as that of the stator field and tries to catch it but, can never catch it due to friction and windage and therefore EMF induction continues and motor keeps rotating.

Thus, principle of 3 phase induction motor also explains why rotor rotates in same direction as the rotating field and why induction motor is self starting. When rotor winding is short-circuited with no resistance in series, it is called a squirrel cage induction motor and when rotor winding is shorted through a resistance in series, it is called slip ring induction motor. The three-phase induction motor has a very wide range of applications in both industrial and commercial settings. The following are just a few examples of its applications:

- Air conditioners / heat pumps
- Compressors
- Fans / air-handling units
- Pumps
- Industrial machinery

Given their wide range of applications, it is critical to protect induction motors adequately. Operating an induction motor safely requires protection against a wide range of conditions and events.

A. Fault Protection

An electrical fault occurs whenever there is an abnormally high electric current. Some of the most common causes of fault currents are:

- Short circuits
- Line-to-ground faults

B. Overload Protection

An overload is a condition in which currents above the rated value are present, but unlike fault current, overloads may be of just a few amperes over the rated current. Nevertheless, overloads can cause irreversible damage due to the amount of heat released

C. Features

1. Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz.
2. Memory:
   - 32 KB instruction RAM
   - 32 KB instruction cache RAM
   - 80 KB user-data RAM
   - 16 KB ETS system-data RAM
3. External QSPI flash: up to 16 MB is supported (512 KB to 4 MB typically included).
4. IEEE 802.11 b/g/n Wi-Fi.
5. Integrated TR switch, balun, LNA, power amplifier and matching network.
6. WEP or WPA/WPA2 authentication, or open networks.
7. 16 GPIO pins.

8. SPI.
9. I²C (software implementation) .
10. I²S interfaces with DMA (sharing pins with GPIO).
11. UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2.
12. 10-bit ADC (successive approximation ADC).

III. SYSTEM OVERVIEW

The CP2102 is a highly-integrated USB-to-UART Bridge Controller providing a simple solution for updating RS-232 designs to USB using a minimum of components and PCB space. The CP2102 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, EEPROM, and asynchronous serial data bus (UART) with full modem control signals in a compact 5 x 5 mm MLP-28 package. No other external USB components are required. The on-chip EEPROM may be used to customize the USB Vendor ID, Product ID, Product Description String, Power Descriptor, Device Release Number, and Device Serial Number as desired for OEM applications. The EEPROM is programmed on-board via the USB allowing the programming step to be easily integrated into the product manufacturing and testing process. Royalty-free Virtual COM Port (VCP) device drivers provided by Silicon Laboratories allow a CP2102-based product to appear as a COM port to PC applications. The CP2102 UART interface implements all RS-232 signals, including control and handshaking signals, so existing system firmware does not need to be modified. In many existing RS-232 designs, all that is required to update the design from RS-232 to USB is to replace the RS-232 level-translator with the CP2102. An evaluation kit for the CP2102 (Part Number: CP2102EK) is available. It includes a CP2102-based USB-to UART/RS-232 evaluation board, a complete set of VCP device drivers, USB and RS-232 cables, and full documentation. Contact a Silicon Labs' sales representatives or go to www.silabs.com to order the CP2102 Evaluation Kit.

A. Description

The AllegroACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and over-current fault protection.

The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized Bi CMOS Hall IC, which is programmed for accuracy after packaging.

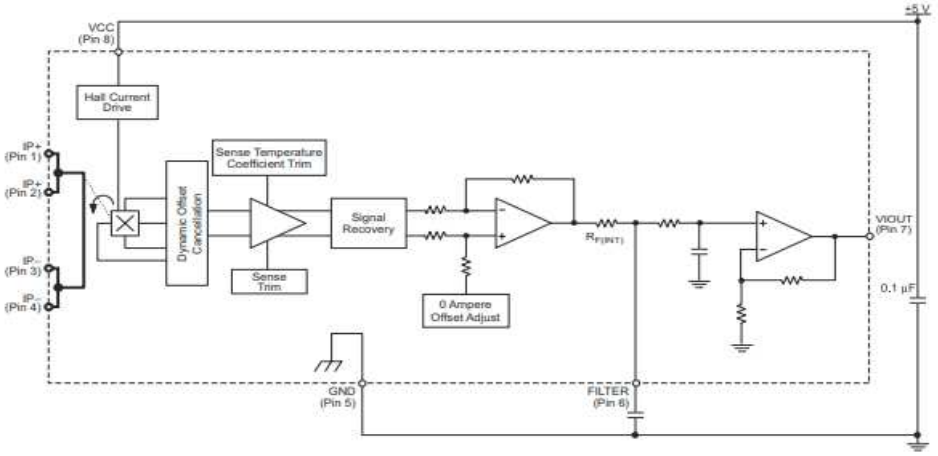

Fig. 4.1: Functional Diagram

The output of the device has a positive slope (>VIOUT(Q)) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× over current conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 5 through 8). This allows the ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators.

IV. WORKING OF 3-PHASE PROTECTION

A. *Software*

1. Set ssid and password of your WI-FI internet.
2. Set pins for indicator/alarm.
3. Preset the current sensor and thermostat value.
4. Link it through MQTT viaadafruit.
5. Through IFTTT link your medium of contact(gmail/facebook/whatsapp) and adafruit.

B. *Hardware*

1. When the current exceed the preset value of current sensor termed as over current, then the sensor transmit signal to the nodeMCU and from mcu it is transmitted to the relay and the relay get opened and the load is protected.
2. When the temperature exceed the preset value of thermostat termed as overheating, then the sensor transmit signal to the nodeMCU and from mcu it is transmitted to the relay and the relay get opened and the load is protected.
3. At the same time the alert and indicator turned on and a notification is send to your gadget .
4. Same mechanism is used for other two phase connection.

C. *Application*

- More Advance In Features Compare To Old One.
- More Consistent.
- Cost Efficient.
- Protection Feature Is Very Much Advanced.
- Construction Is Easy.
- Easy To Handle.

V. CONCLUSION

The technology boosts the protection in 3-phase system with

- Single phase protection over 3-phase.
- and overheating over the system and load.

Therefore the technology short outs the immediate alerts which might resolve the faults and issues as soon as possible.

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