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PROTECTION AND MONITORING OF THREE PHASE INDUCTION MOTORS

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Abstract -*Protection of induction motors is important because most industrial applications use induction motors from the market due to their high robustness, reliability, low cost and maintenance and high efficiency. They are also critical components in many commercially available equipments and industrial processes. The reason for presenting the paper is to provide safety to industrial motors, lift motors , pumps and so on. The principal motivation behind the paper is to provide protection to induction motors from faults, for example, Overcurrent, Stalled rotor, Unbalanced load, Undervoltage, winding temperature protection and Internal Ground fault. For analyzing the defects and to enhance its protection system a SIMOCODE module is used which is connected to the motor.*

Key Words: **over current, stalled rotor, unbalanced load , SIMOCODE PRO, Ground fault, trip time, trip current, Winding Temperature, Undervoltage.**

1.INTRODUCTION

In earlier system of protection of Induction Motors Microcontrollers were used which uses different modules like Temperature sensors, Analog to digital Converters [1]. These type of proposed systems required large Hardware implementation and also produces erroneous results. To overcome these problems a SIMOCODE module is used in this paper that provide full protection of induction motor with simulation on a PC where parameters can be controlled from the control center to avoid system breakdown[3]. SIMOCODE pro is the flexible and modular motor control system for low-voltage motors. It can easily and directly be connected to automation systems via PROFIBUS or PROFINET and covers all functional requirements between the motor starter and the automation system – including the fail-safe disconnection of motors. Here all parameters like overcurrent ,stalled rotor ,unbalanced load , Ground fault, undervoltage protection are controlled and simulated via SIMOCODE

1.1 PROPOSED SYSTEM

In the System three phase supply is given to the 4 pole contactor which is connected to Relay through Relay drivers. The infeed contactors signal are fed to the SIMOCODE PRO V module. The contactors are connected to a switching block which is then connected to three phase Induction motor. The contactor control is fed to the SIMOCODE module from the switching block. The SIMOCODE module is connected to the Automation system via PROFIBUS. These Automation System receives signals from different process sensors provided in the Module.

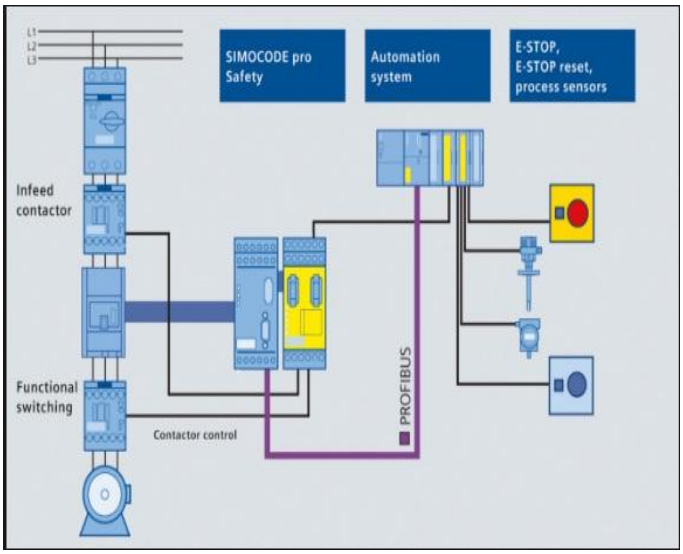

Fig-1:Proposed system block

2. MOTOR PARAMETERS AND REFERENCES

The Parameters that are taken for protection of three phase Induction Motor are overcurrent protection, Stalled Rotor protection, protection from Unbalanced load, Ground Fault Protection , Undervoltage protection and Temperature Protection.

Motor reference values have been taken to be Voltage=415V Frequency=50Hz, Rated Current(Is)=11A, RPM=1449, Power Factor=0.83, Rated Power=5.5KW

2.1 Overcurrent Protection

Over-current protection is that protection in which the relay picks up when the magnitude of current exceeds the pickup level. The main element in over-current protection is an over-current relay. The over-current relays are connected to the system, normally by means of CT's, for small power motors direct to supply line[2].
Cooling down Period of Motor- 60-300s
Signal Warn- for I>115% of Is

Table-1: Overcurrent Protection time analysis

Imax(% of Is)	I(L1)% of Is	I(L2)% of Is	I(L3)% of Is	Last Trip Time
120	121	121	120	88s
149	149	149	149	35s
170	169	169	169	16s
180	180	180	180	7s

Induction Motor should be protected from Overcurrent if the current increases greater than 115%of Rated current(Is).The above time analysis shows that as the rated current increases above 115%of Is, the trip time of motor decreases ,larger the current is, more frequently the trip time decreases to shut the motor and the motor is protected .For large current i.e. 180% of Is the trip time of motor is least.

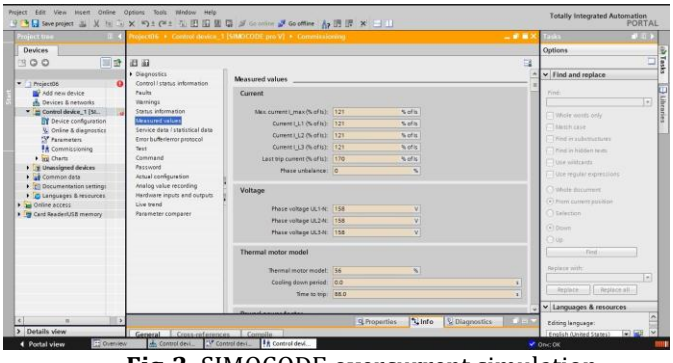

Fig-2: SIMOCODE overcurrent simulation

2.2 Unbalance Protection

The extent of phase unbalance can be monitored and transmitted to the control system. If a specified limit value is violated a defined and delayable response can be initiated. If the phase unbalance is greater than 50%, the tripping time is also automatically reduced in accordance with the overload characteristic since the heat generation of motor increases in asymmetrical condition.

The phase unbalance can be calculated from the following equation:

Phase Unbalance= max([Imax-Iavg]; [Imin-Iavg])/ Iavg

where Iavg= I1+I2+I3/3

The response to SIMOCODE phase unbalance can be : signaling, warning, tripping.

The unbalance level must be exceeded for the period of set delay time before SIMOCODE pro executes the desired response.

Setting Range: 0 - 25.5s

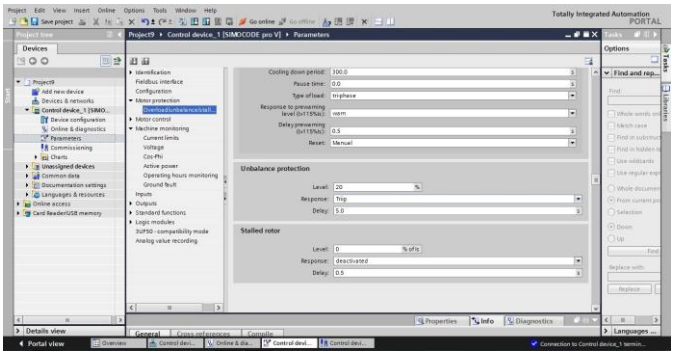

Fig-3: SIMOCODE phase unbalance simulation

Here the unbalance level is set to be 20% for a trip response in a delay of 5sec.

2.3 Protection from Stalled Rotor

Stalling is a condition at which a motor stops rotating even when there is sufficient voltage at its terminals. This condition occurs when the torque required by the load is more than the maximum torque (Breakdown torque) that can be generated by the motor. At this condition, the motor drains the maximum current and the speed comes zero. Here the response level of stalled rotor condition is taken to be 200% of Is i.e. if the current increases beyond 200% , tripping of motor will take place in a delay of 5sec.

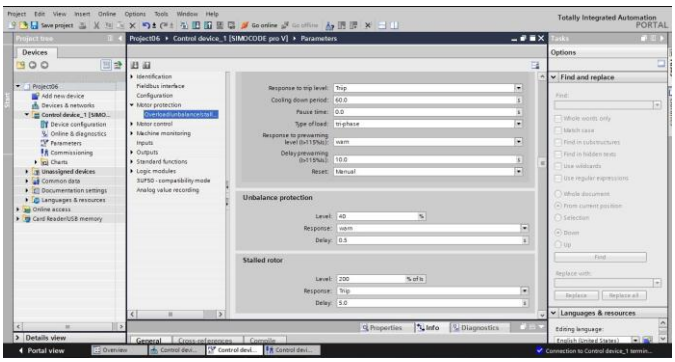

Fig-4: stalled rotor level and response

If the current increases beyond 200% of rated current , a trip time of motor would get induced as per the strength of

current flowing , greater the current and lesser would be the trip time .For a current of 265% of Is the trip time is 16sec

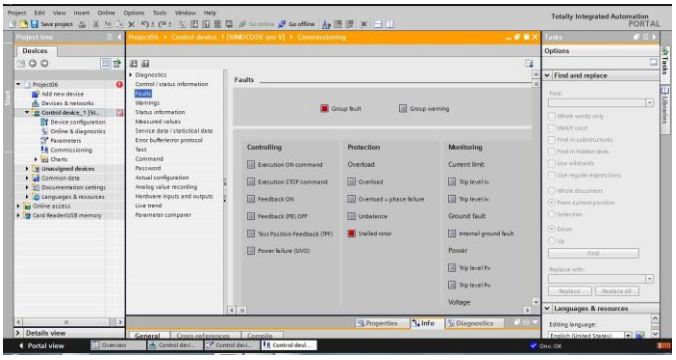

Fig-5: Group Fault of Stalled rotor shown

2.4 Internal Ground fault Protection

An Earth Fault is a fault that creates a path for current to flow from one of the phases directly to the neutral through the earth bypassing the load. Earth Fault in motor occurs when its phase conductor insulation is damaged. An earth fault module can be attached to the SIMOCODE pro V basic unit. Using a summation current transformer, it is possible to configure a more accurate external earth fault monitoring circuit. The advantage: A summation current transformer used with SIMOCODE-DP can remain in the main circuit and can still be operated with SIMOCODE pro.

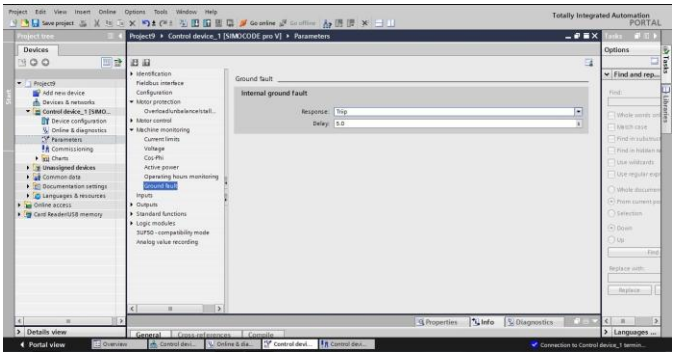

Fig-6: Internal Ground Fault

For internal Ground Fault to occur a trip response is set for a delay of 5sec as per convenience.

2.5 Undervoltage Protection

In under voltage protection of three phase induction motor feeds the protection from the under voltage. When supply system has low voltage than the certain rated of induction motor then under voltage protection section
n of protection supply is provided to the motor It has similar concept as over voltage it also has comparator which compare two voltage one from supply and other from the voltage drop. The comparator function is carried out by the SIMOCODE module where the voltage references are set by the user below which if the voltage drop occurs a warning is generated and motor is tripped after a specific time delay.

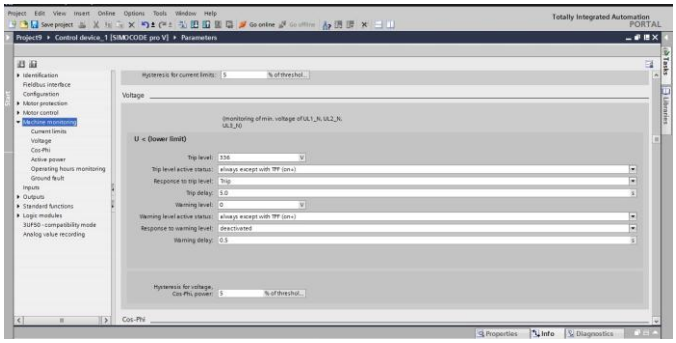

Fig-7: Undervoltage Response Reference

Here the response level set by the user is trip at voltage reference of 336Volt below which if the voltage drop occurs the motor will trip with a trip delay time of 5sec as per convenience.

2.6 Winding Temperature protection

Winding Temperature is monitored by Thermistor which consists of PTC temperature sensors installed. These sensors are incorporated in the motor windings thus measuring the motor heat directly. This direct temperature measurement enables the thermistor motor protection relays to evaluate various motor conditions such as overheating, overload and insufficient cooling. The main features of thermistor protection are Dynamic Interrupted Wire detection, Short Circuit Monitoring of Sensor Circuit, Non-Volatile Fault Storage etc.

3. CONCLUSION

Protection and monitoring of three phase induction motor from over current, unbalance load, undervoltage, Internal Ground Fault and winding Temperature provides non- stop running of motor. Civilize its lifetime and efficiency. Also monitoring of various protection parameters can be done by the use of SIMOCODE Automation system and also threshold can be set for each parameter for smart monitoring and uninterrupted running of motors.

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BIOGRAPHY

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