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Page: 10-17

Design and Implementation of Automatic Power Transfer and Load Shed Controller

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Abstract: *The automatic power transfer and load shed controller (APTLSC) make the new levels of standby power plants. Programmable logic controller (PLC), adjustable interlocks and counters with time delay can improve switchgear, generator, and engine economics and extend power plants life. Electronic counting timers for loading, unloading or transferring are adjustable from 0.1 seconds to 132 minutes. PLC provides a wide range of logic controls (about 4000 nos. of Rungs). In this paper, PLC DVP SS series controller have used. The APTSLC combined with electronic load shed control and emergency generators or standby power plants. If there is Auto synchronizing base load mode in the Gen-set, the emergency system is started and synchronized with the utility. The APTLC is activated by an auxiliary contact of voltage monitoring relay (VMR). The output contacts in the APTLC to initiate separation and shutdown of the standby system. There are two standby power plants or generators. If utility (normal source) fails, one power plant starts to load basis (peak or non-peak hour).*

Keywords: *Programmable Logic Controller, Voltage Monitoring Relay, Switch Gear*

1 Introduction

A few years ago, the system functioned with a manual transfer switch. When the power goes out, we need to start our generator and connect it to the transfer switch. When the utility power is restored we need to turn off our generator and switch our house or office to utility power. Nowadays it functioned with an ordinary automatic transfer switch, everything is fully automatic. When the utility power goes out, the transfer switch connects the load to generator. When the utility power is restored, generator is shut off and the transfer switch reconnects our home or business to the utility.

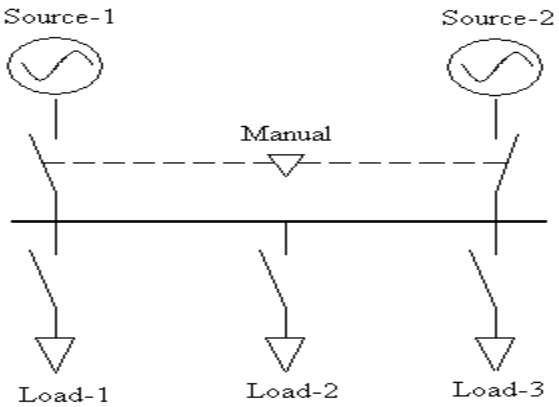


Fig. 1: Ordinary manual transfer switch

AJSTEME

Academic Journal on Science, Technology, Engineering & Mathematics Education (AJSTEME)

Volume 4, Issue 1, February 2024

Page: 10-17

There are some problems of ordinary manual system. The most commonly used manual transfer switch transfers load to optional standby systems which mechanically interlocks only two breakers or switches. But we may need to use several power sources. Since the loss of power occurs during the night or normal working hours, an operator drives unnecessary equipment and lighting. Operator must require for Manual Transfer. This system require operator intervention to first open the normal (utility) source breaker or switch and then close the alternate (generator) breaker or switch. Operator may not safely get to the equipment. If operator forgets to turn off the alternator, a large quantity of economical loss occurs due to fuel consumptions. In this model everything is installed as per users' requirements.

Proposed System Model

The APTLSC used in conjunction with a standby generator, provides a safe, convenient, robust way to maintain power in a home or industrial during a utility outage. The system senses when utility power is lost, triggers a permanent generator to start, and transfers selected plant-1 or plant-2 according to peak hour and priority assigned at installation.

Transfer switches are used to protect critical electrical equipments and appliances against the loss of utility power. The normal power source of appliances is the utility, backed up by a generator power source. The transfer switch is connected to both the utility and generator sources and supplies the appliance with power from either the normal or secondary sources. In the event that the power is lost from the normal source (utility), the transfer switch system transfers the load to the plant-1 (second source) for peak hour (9 AM to 9 PM) or to the plant-2 (third source) for non-peak hour (9 PM to 9 AM). If the priority is set for plant-1, plant-1 is repaired with ready to start first. If Plant-1 fails to start, then Plant-2 will start after a few seconds. When voltage, all phases and frequency get of plant-1 normal, immediately plant-2 transfers the load back to plant-1 and plant-2 is stopped (Shamim, 2022).

The functional block diagram of APTLS is shown in fig. 2. The utility power fails or drops below the low phase voltage level (175 volts), exceeds the high phase voltage level (260 volts) or any phase fails, the VMR activates. The VMR-1 sends a utility fail signal to PLC by input X0. PLC check by its counter T0 whether it is brownout (momentary failed) or blackout (failed for a long). If counter timed out or passed the set value, it decides Utility failed confirmed by internal memory (M1). If utility returns within counting period, it resets.

Functions of different Inputs and Outputs are following:

X0	Input signal from utility voltage monitoring relay (VMR1) to PLC.	Switch is closed when VMR1 found the power source of utility is normal. It is a safety device which checks any phase failure, under voltage, over voltage etc.
X1	Input signal from Plant#1 voltage monitoring relay (VMR2) to PLC.	Switch is closed if VMR2 found voltage of Plant#1 is normal. It is a safety device which checks phase failure, under voltage, over voltage etc.
X2	Input signal from utility switchgear auxiliary contact to PLC.	This signal is activated when utility is disconnected from load. It is opened if utility is loaded.
X3	Input signal from Plant#1 switchgear auxiliary contact to PLC.	This signal is activated when Plant#1 is disconnected from load. It is opened if Plant#1 is loaded.
X4	Input signal from Plant#2 switchgear auxiliary contact to PLC.	This signal is activated when Plant#2 is disconnected from load. It is opened if Plant#2 is loaded.

AJSTEME

Academic Journal on Science, Technology, Engineering & Mathematics Education (AJSTEME)

Volume 4, Issue 1, February 2024

Page: 10-17

X5	Input signal from Plant#2 voltage monitoring relay (VMR3) to PLC.	Switch is closed if VMR3 found voltage of Plant#2 is normal. It is a safety device which checks phase failure, under voltage, over voltage etc.
X6	Input signal from clock module to PLC.	It gives On/Off signal in pick hour (night) or normal hour (day).
Y0	Output signal from PLC to utility switchgear relay.	This output performs the On/Off control the utility (main) switchgear.
Y1	Output signal from PLC to Plant#1 start/stop relay.	This output gives the signal, which controls the remote starting and stopping of Plant#1.
Y2	Output signal from PLC to Plant#1 switchgear relay.	This output performs the On/Off control the Plant#1 switchgear.
Y3	Output signal from PLC to Plant#2 start/stop relay.	This output gives the signal, which controls the remote starting and stopping of Plant#2.
Y4	Output signal from PLC to Plant#2 switchgear relay.	This output performs the On/Off control the Plant#2 switchgear.

As demand increases at peak hour on higher-priority circuits but running in lower capacity of Plant, the system turns-off less important circuits. This allows a larger number of loads to be supported without nuisance tripping of the generator. In this situation the load dump control of Intelligent Load Management feature is activated and saves from over loading trips. Once utility power is restored, the transfer switch transfers the load back to the normal source, and initiates generator engine cool-down and then shutdown.

A clock module has connected for detect the peak or non-peak hour to PLC input X6. For peak hour, signal sends to Plant-1 remote control section. The remote start signal is produced by PLC output Y1. The generator of plant-1 is started, the VMR-2 monitors the safe level of voltage buildup or not. If it is found everything normal, send the signal to PLC input X1. PLC proceeds to close (on) the plant-1 switchgear. Before the closing of switchgear it checks the interlocks. Interlocks ensure that the utility switch gear (X2) and plant-2 switch gear (X4) is off. Finally PLC commands the Plant-1 to close through output Y2.

The Plant-1 remote control gets the stop signal; it waits and holds to allow the generator to cool-down (approx. 3 minutes). After that the signal sends to removes the Y1 start signal. If VMR-2 of X1 activates, it also sends the stop signal to second priority generator (plant-2 remote control). The system will automatically transfer loads according to priorities which programmed in PLC. If VMR-2 (X1) does not activate or generator do not ready for a certain time, it sends the start signal to X6. Second priority generator (non-peak hour operator generator) has as emergency basis. For best results, electronic equipment such as computers, clocks, security systems and phone systems should be connected to an uninterruptible power system (UPS) to ensure no data is lost until transfer of power occurs. The utility power is available or restored; the generator will continue to run the selected loads for approximately 60 seconds to be sure the utility power is stabilized and to cool down the engine. PLC checked by its counter T1 whether it is stabilized (brown-in). If counter timed out or passed the set value, it decides utility restored and confirms by internal memory (M2). The VMR-1 of utility founds everything normal; sends the signal to PLC input X0. PLC proceeds to close (on) the utility switchgear. Before the closing of switchgear it checks the interlocks. Interlocks ensure that the Plant-1 switch gear (X3) and Plant-2 switch gear (X4) is switched off. There is a delay (T2-2 sec) to wait for stabilized the power and Finally, PLC commands the utility switch gear to close (on) via output Y0.

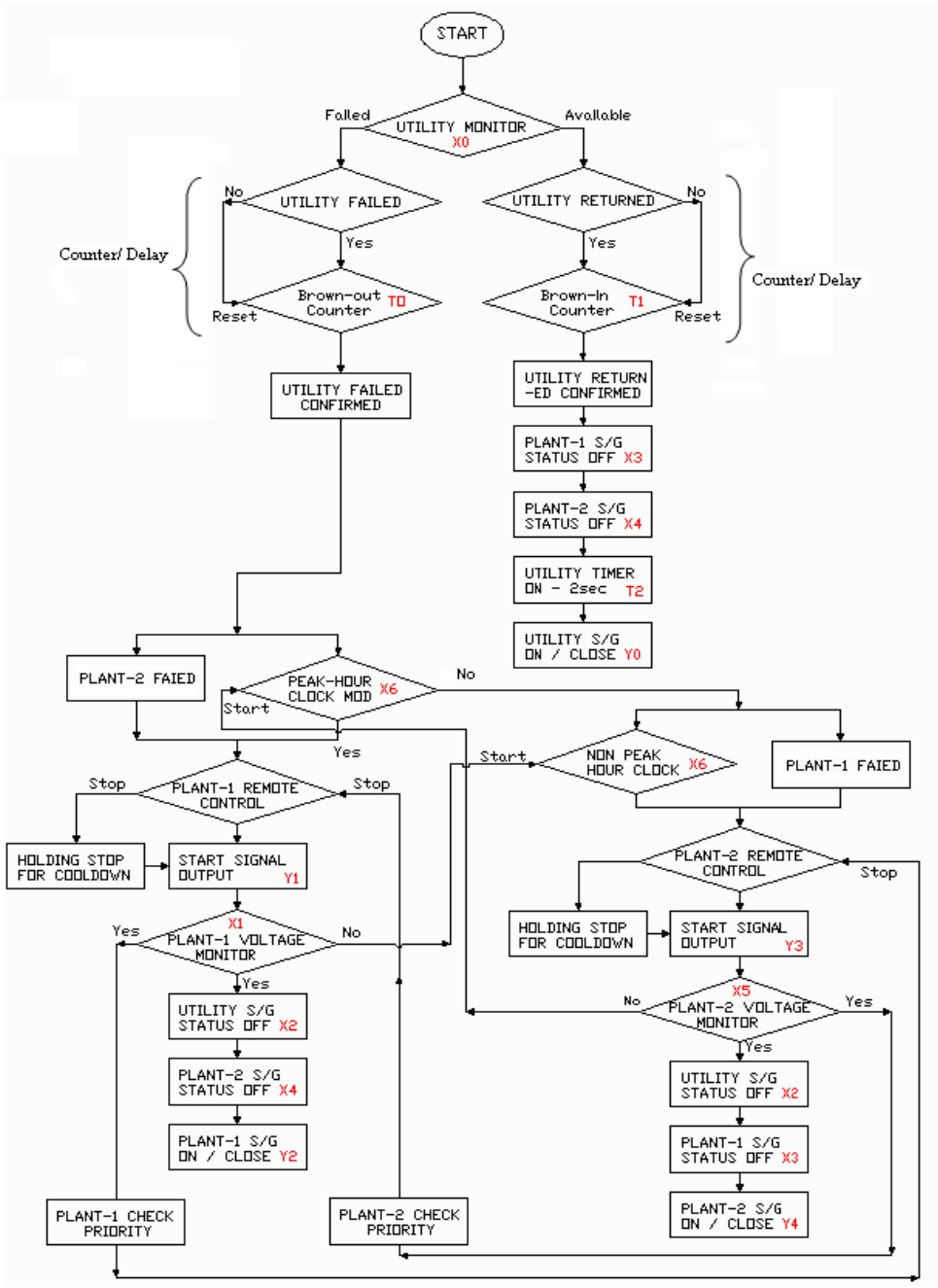
AJSTEME

Academic Journal on Science, Technology, Engineering & Mathematics Education (AJSTEME)

Volume 4, Issue 1, February 2024

Page: 10-17

Fig. 2: PLC Program Flow Chart



AJSTEME

Academic Journal on Science, Technology, Engineering & Mathematics Education (AJSTEME)

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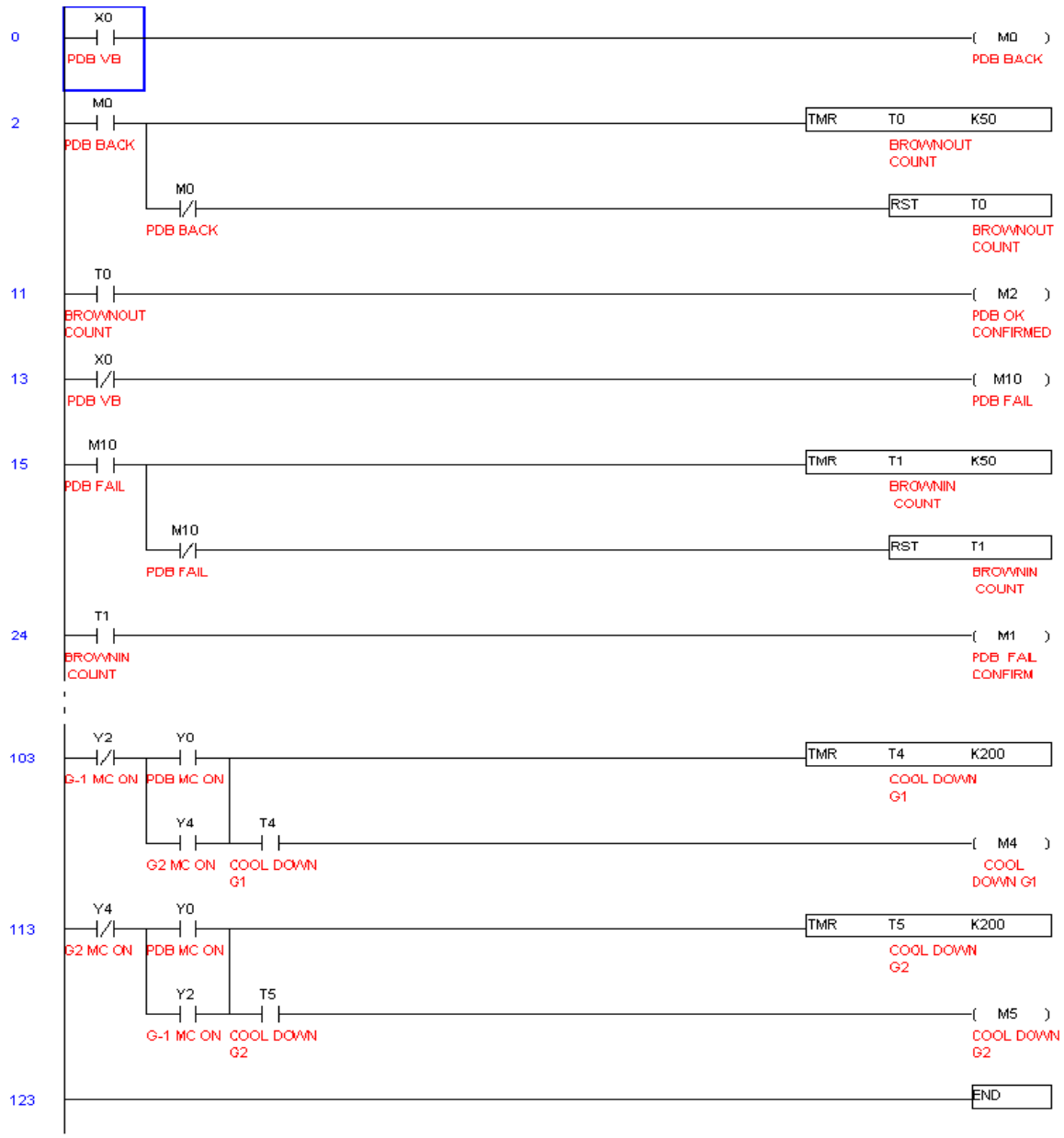
Page: 10-17



AJSTEME

Academic Journal on Science, Technology, Engineering & Mathematics Education (AJSTEME)

Volume 4, Issue 1, February 2024

Page: 10-17

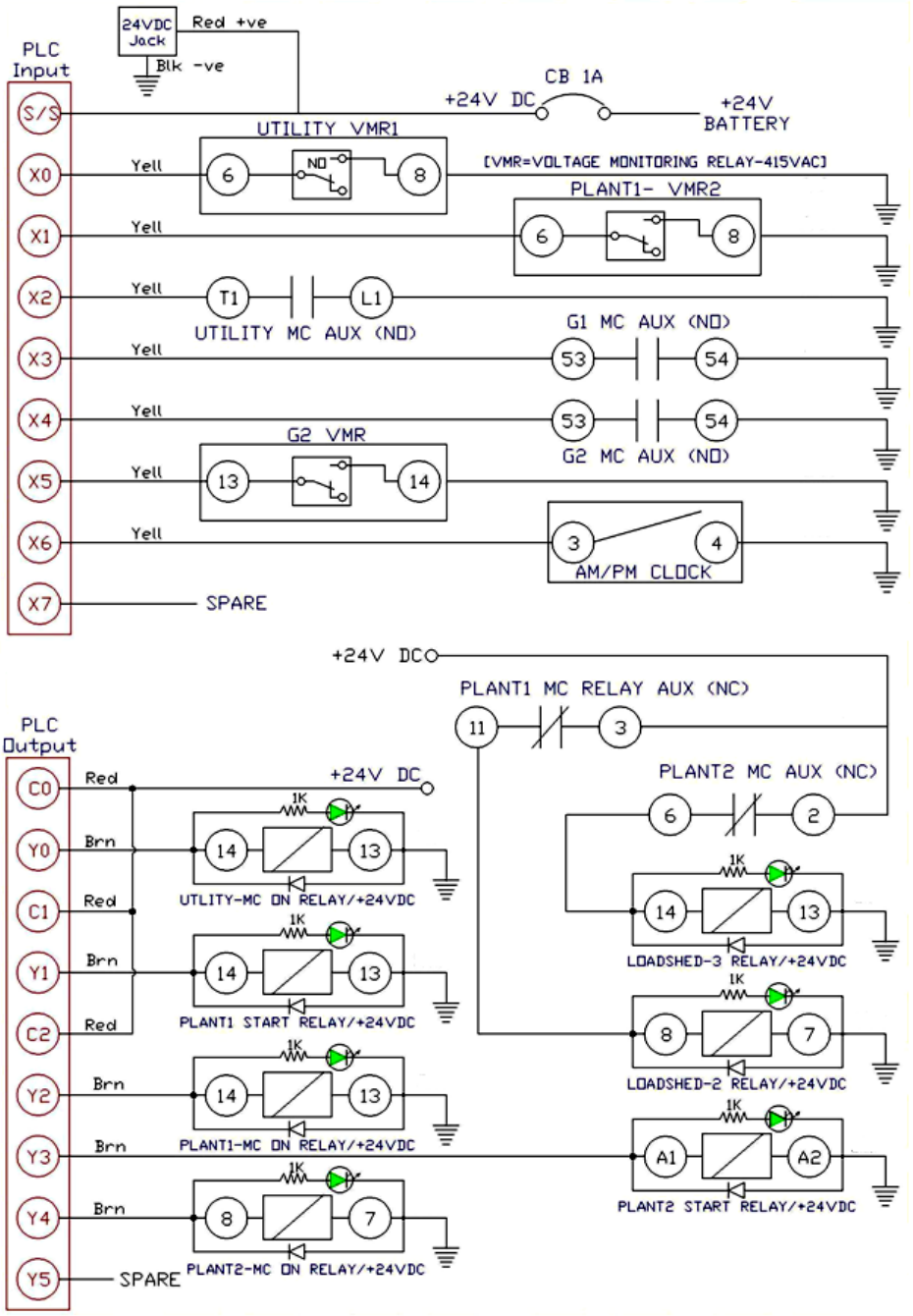


Fig. 4: Electrical Schematic Diagram

AJSTEME

Academic Journal on Science, Technology, Engineering & Mathematics Education (AJSTEME)

Volume 4, Issue 1, February 2024

Page: 10-17

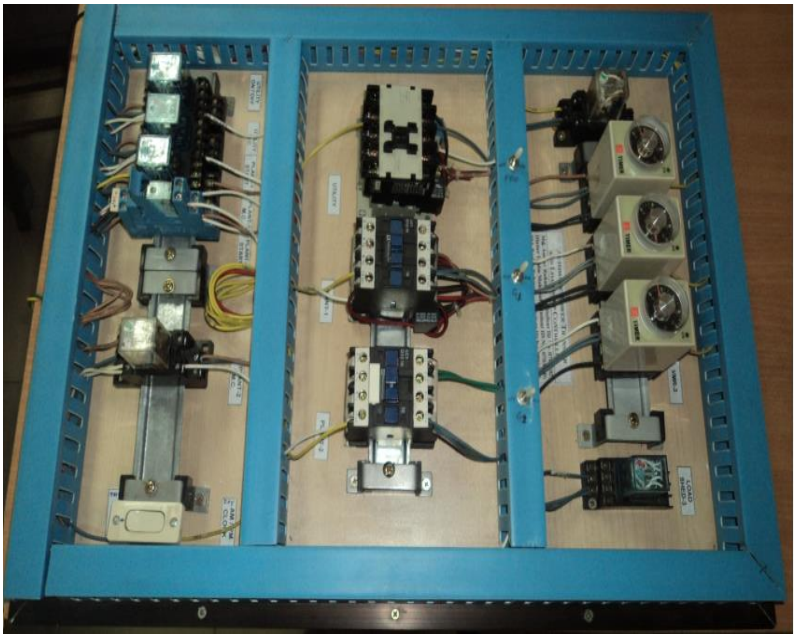


Fig. 4: Electrical Schematic Diagram

2 Conclusion

The proposed system is very flexible, offer many performance enhancing options and are easily adaptable to power systems with more than three sources. As per users requirements this system can include different control or programming logic, customer provided logics and other electrical interlocking to ensure proper transfer. It allows manual, automatic, locked and by passed transfer modes of operation. The scheme assistance robust over current protection, high fault current interruption capability as well as the largest operating cycle lifetime of any automatic transfer solution.

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