

Star Delta Starter Motor System in Allen-Bradley PLC

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Abstract—

Practically there is no point in leave usage of Star/Delta Starter control circuits in situations that include different various types of motors due to its importance to start working for specific motors at least loss of current. Nevertheless, carry out of Star/Delta Starter control circuit on synchronous and induction generally need much more work and efforts and it is not easy to implement in general commercial workstations or remote fields. On the contrary, applied to Star/Delta Starter control circuit in the Programmable Logic Control (PLC) is proposed way to be applied and identify of its components of this work that regard as peripherals to the Programmable Logic Control (PLC). Pico type of PLC will be employed for this purpose. Simplify of programming circuit written codes caused by ladder language and applied by software name's Picosoft version 6 for this project case. Many developing countries began using PLC in its industrial field in a jiffy. In this article, there is a providing for simulation, circuit diagram and communication for Star/Delta Starter control circuit by PLC and its result on board separately.

Key word; Star/Delta Starter, PLC, RS-232 and Picosoft Software

نظام التشغيل الذاتي ستار/دلتا للمحركات في جهاز المسيطر المنطقي المبرمج - آلن برادلي

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الخلاصة

بصوره عمليه لاجدوى من الابتعاد عن استخدام نظام التشغيل الذاتي ستار/دلتا في المحطات التي تحتوي على انواع مختلفة ومتعدده من المحركات نظرا لاهميتها في بدء تشغيل المحركات ضمن اقل قيمه ممكنه في خساره للتيار. تنفيذ دائرة نظام التشغيل الذاتي ستار/دلتا للمحركات عامة والمحركات الحثيه لو المحركات المتزامنة بصورة

خاصة تحتاج الى جهد وعمل جدا كبير وهي ليست سهلة التنفيذ في محطات العمل العامة التجارية والحقول الانتاجية الطرفية. ولكن على العكس تطبيق واستعمال دائرة تشغيل نظام التشغيل الذاتي ستار/دلتا في جهاز المسيطر المنطقي المبرمج (PLC) هي دائره والنموذج المقترح في هذا البحث من حيث التنفيذ و ممثالة المكونات التي تعتبر كوحدات ملحقه بالجهاز السيطر المنطقي. النوع البيكو ضمن المسيطر المنطقي المبرمج سوف يوضف لتنفيذ هذا الغرض. تبسيط كتابة شفرة الدائره البرمجية بسبب لغة السلم والسوفت وير المستخدم هو بيكوسوفت الاصدار السادس . لذلك الكثير من الدول المتطورة بدئت باستخدام جهاز المسيطر المنطقي المبرمج في الحقول الصناعية في فترة سريعة جدا. في هذه المقالة نحن سوف نجهر محاكاة - الرسم البياني للدائرة وجهاة الاتصال في دائرة تشغيل الخط المباشر ودائرة تشغيل معكوس الاتجاه ونواتجها عمليا بصوره منفصلة.

الكلمات المفتاحية : نظام التشغيل الذاتي ستار/دلتا ؛ جهاز المسيطر المنطقي المبرمج (PLC)؛ نقطة الاتصال المتسلسل-٢٣٢ ؛ السوفت وير بيكوسوفت.

I. INTRODUCTION

Diverse starting techniques are engaged for beginning induction and synchronous drives since these drives pull more beginning current throughout the beginning. To avoid loss to the windings owing to the great beginning current stream, there is an engagement for diverse kinds of beginners. The humble procedure of the drive beginner for the induction and synchronous driver is the Star/Delta Starter beginner. Star/Delta Starter is to find out the best dependable and useful start process which has the least influence worth difficulties. These three simple start techniques which diverge in their individual cabling joining are the best, most appropriate and commonly used start technique in the manufacturing region owing to its financial details [1].

The Star delta starter is preferred with induction/synchronous motor due to following reasons:

- Starting current is reduced 3-4 times of the direct current due to which voltage drops and

hence it causes less losses.

- Star delta starter circuit comes with circuit first during starting of the motor, which reduces voltage 3 times, that is why current also reduces up to 3 times and hence less motor burning is caused.
- In addition, starting torque is increased and it prevents the damage of motor winding.

Circuit theory of Star/Delta Starter [1, 2]. PLC dependable usages [3-7], description of circuit components with details [8-14], there is a description of the mechanism of interfacing between PC and PLC as well as Star/Delta Starter implementation in Picosost and finally download this code to PLC.

In this paper, firstly the illustration of the Star/Delta Starter in general. Then programming mentioned circuit at PLC. Finally, the evaluation of viable and feasible mode is done by PLC.

II. CONCEPT OF STAR/DELTA STARTER

This is a starting method that reduces the starting current and starting torque. Star delta starter design normally consists of three contactors, an overload relay and a timer for setting the time in the star-position (starting position). For the star delta starter, a motor must be in delta connected during a normal run and the main purpose is to be able to use star delta starter. Star delta starter received the starting current is about 30 % of the starting current during direct on line start and the starting torque is reduced to about 25 % of the torque available at a Direct On Line (D.O.L) start. Star delta starter only works when the application is light loaded during the start. If the motor is too heavily loaded, there will not be enough torque to accelerate the motor up to speed before switching over to the delta position [1].

The basic function is to enable the motor to start and the motor windings are configured in a star formation to the supply voltage. The voltage applied for star delta starter to the individual motor winding is therefore reduced by a factor of $1/\sqrt{3} = 0.58$ this connection amounts to approximately 30% of the delta values. The starting current is reduced to one third of the direct starting current.

Due to the reduced starting torque, the star-delta-connection is suitable for drives with a high inertia

mass, but a resistance torque which is low or only increases with increased speed. It is preferably used for applications where the drive is only put under a load after run-up. After a motor run-up, in most cases an automatic timing relay controls the switch-over from star to delta. The run-up using star connection should last until the motor has reached the approximate operational speed. So that after switching to delta, as little post acceleration as possible is required. Post-acceleration in delta connection will instigate high currents as seen with direct on-line starting [2].

III. PROGRAMMABLE LOGIC CONTROLLER (PLC) PRACTICE

There is a settled in a rule of automation at its water usage situations. Originally built on hard logic units, the knowledge used was upgraded, upgraded and improved in the late seventies by the liberal and wide use of Programmable Logical Controllers (PLC). The drinking water creation of the wasted area of Paris (1 million dwellers) has been completely automatic (with around 100 PLCs), and unmanned next hours [3]. The refinement of water for internal drinking includes numerous steps of dealing with the raw water which are essential to eliminate postponed objects, color and bacteria previously being supplied to the water delivery system. The viability of automating the control and cleaning of the filters through the request of a suitable PLC founded plan [4]. The skills of Bechtel Water Technology, Engineering, in the request of Programmable Logic Controllers to schemes which were considered and built on behalf of a main water & unused water value [5].

A method for development of such system network using the potentials of programmable logic controller (PLC) is a getaway [6]. Nevertheless, carry out of the DOL and its reverse on synchronous and induction generally need much more work and efforts and it is not easy to implement in general commercial workstations or remote fields. On the contrary, applied of a Direct On Line (DOL) and a Reverse- Direct On Line (R-DOL) in PLC is proposed way to be applied and identify of its components of this work that regard as peripherals to PLC [7]. Obviously there are almost control fields that PLCs endure and employ

in it, like Home Automation Control [8]. Recently it's used for Regulation of power production in power plants for turbine and generator [9] etc.

IV. EXECUTION CIRCUITS COMPONENTS DESCRIPTION

A programmable logic controller (PLC) or programmable controller is a digital computer employed for automation of normally engineering, electro-mechanical procedures, like regulator of equipment on factory gathering outlines, enjoyable rides, or light matches. PLCs are employed in numerous machineries, in numerous businesses. PLCs are planned for several engagements of digital and analog inputs and outputs, lengthy temperature varieties, immunity to electrical noise, and resistance to shaking and impact. Plans to control engine process are naturally kept in battery-backed-up or non-volatile memory. A PLC is a sample of a "hard" real-time system due to output effects have to be created in reply to input situations within a restricted period; else unplanned process would outcome [10, 11, 12].

A relay is an electrically activated key. Numerous relays employ an electromagnet to mechanically activate a key, but extra working values are also employed, like solid-state relays. Relays are employed when there is essential to control a circuit by a low-power signal (with whole electrical isolation between control and controlled circuits), or where numerous circuits must be controlled by a lone signal. The first relays were employed in the long expanse telegraph circuits as amplifiers: they regular the signal coming from one circuit and re-transmitted it on another circuit. Relays were employed widely in receiver contacts and quick processors to achieve logical processes. [13].

A Normally Open (NO) Impulse Key is an impulse key that, in its evasion public, creates no electrical contact with the circuit. Just if the key is pushed down, it does make electrical contact with the circuit. If the key is pressed down, the key makes electrical contact and the circuit is now locked. Thus, electricity can now stream to the new portion of the circuit joining to the push key and make the device turn or power on the respective portion. Normally Open Impulse keys are the greatest public kind of push keys used in devices and circuits. A Normally Closed (NC) Impulse Key

is an impulse key that, in its evasion national, makes electrical contact with the circuit. When the key is pushed down, the key no longer makes electrical contact and the circuit is now open. Thus, electricity has no longer stream to the added portion of the circuit to turn or power on the respective portion of the circuit the key was made to switch. Normally Closed Push keys are not the greatest public kind of push key used; Normally Open Push Keys are. Nevertheless, they still have general use and request in several strategies [14, 15].

RS-232 stands for Recommend Standard number 232 and C is the latest revision of the standard. The serial ports on most computers use a subset of the RS-232C standard. The full RS-232C standard specifies a 25-pin "D" connector of which 22 pins are used. Most of these pins are not needed for normal PC communications, and indeed, most new PCs are equipped with male D type connectors having only 9 pins [16].

V. PLC TO PC CONNECTION AND INTERFACING

The period logic is employed since the programming is mainly concerned with applying logic and changing processes. Input devices such as switches, and output devices such as drives, being controlled are connected to the PLC and then the controller displays the inputs and outputs agreeing to the machine or process. Originally PLCs were planned as an extra for hard-wired relay and timer logic control systems. (Hard-wiring means that all of the components were manually connected by wires). PLC contains of two parts, i.e. the PLC hardware and programming [17].

The proposed device using is Programmable Logic Control (PLC) from Rock Well Allen-Bradly, its specific model is (Pico 1760-L12 AWA-ND) as displayed in Fig.1



Fig.1 PLC / Pico 1760-L12 AWA-ND

Firstly, there are two usages groups of bush button like normally open (N.O) in green color and normally close (N.C) in red color, and it is represented by an input signal. Where these push buttons are wired to PLC inputs. PLC Allen - Bradley from Rockwell is working on 220 v directly so that it is employed for this function properly. The proposed circuit panel also contains 220 v relay coil that is wiring also to PLC output, this is a control circuit on the output. There are three color Signal light bulbs and it represents to output and it is connected to power circuit on output as displayed in Fig.2

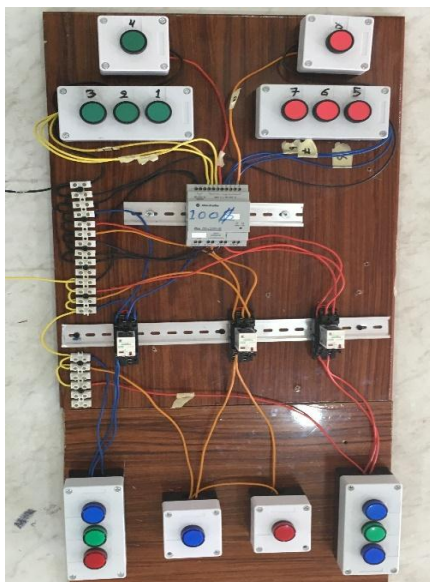


Fig.2 Electrical Control Panel

Next, the proposed software used is Picosoft vision 6 that lets us to program PLC by using Ladder Language due to it is specific software for this version of PLC/Pico. RS 232 connector and its cable are to make Simulink and download connection between PC and PLC. Finally the connection between PLC and PC is done by using serial port and RS 232 cable physically.

VI. EXECUTION PROPOSED OF STAR/DELTA STARTER CIRCUIT LOGICALLY

The ladder language has done a good job of it obviously since it did not interested in difficulty of the diagram but it makes them easier more and more. By the sound of it there is no point in leave ladder language and it's not bound to any limit. By using ladder language, it has been accomplished the programming the Star/Delta Starter circuit. Explain circuit diagram is consisting of 2 logical switches.

Logical Switch number 2 at Picosoft Software is normally open (N.O) and it is used to start working in the circuit to let it start accounting for Star connection. Whereas it is N.O so as to it does not let power through it directly as soon as it has not the power signal from the outside switch that connect to position 2 in the PLC. On the contrary, when this logical switch gets signal power from position 2 in PLC it would get circuit on.

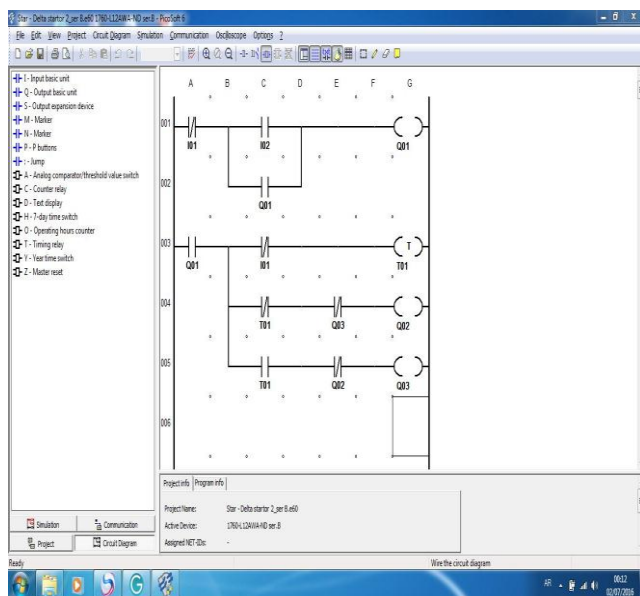
Logical Switch number 1 at Picosoft Software is normally close (N.C) is used for re-set the circuit to let it start over again. Whereas it is N.C so as not to let power through it directly as soon as it get signal power from position 1 in the PLC. On the contrary, this logical switch lets the signal power to throw at it when there is no signal power from the output switch that connected in position 1 in the PLC.

Due to logical output number 1 at Picosoft Software is connected to logical switch number 2 in parallel connection to let the power to throw at it when logic switches numbered 2 is cut it off and has ability of continuation to output as Displayed in Fig.3

Obviously the Logical output of Picosoft Software is three outputs of the proposed system and it is employed as a control output logical address. The Second of these outputs is providing an output signal to Star power circuit at first five second and then will cut off, Third of these outputs is providing an output signal to a Delta power

circuit at the end of five second and then will power on to infinity. First of output is providing timer Delay output that would be working on two cases Star period and Delta period.

Timing delay is an on-delayed timer type and it employed for the purpose of the delay period between star and delta. And there is only one logic timer used in Picosoft software. It is a timer on type that give power for delay period and cut power off after a delay period. Delay period used is five second only. Actually, there is only one timer delay, but it is employed for several used. One time is used as normally close (N.C) and connect it in star timer output circuit, it lets the power to throw at it and give power to a Star timer so that Star output is working for first five second. Second time is used as normally open (N.O) and connect it in Delta timer output circuit, it doesn't let the power to throw at it at first five second and then give power to Delta timer so that Delta Output is work for end five second or after five second as Displayed in Fig.3.



Afterwards, the same worker press push button number 2 on electrical panel lets signal input power make a timer to Delta accounting after 5 seconds on the other hand, after end of star time as well as it represents the secondary part working and working motor in the Delta circuit after the end of the 5 second period of infinite time as displayed in Fig.6.

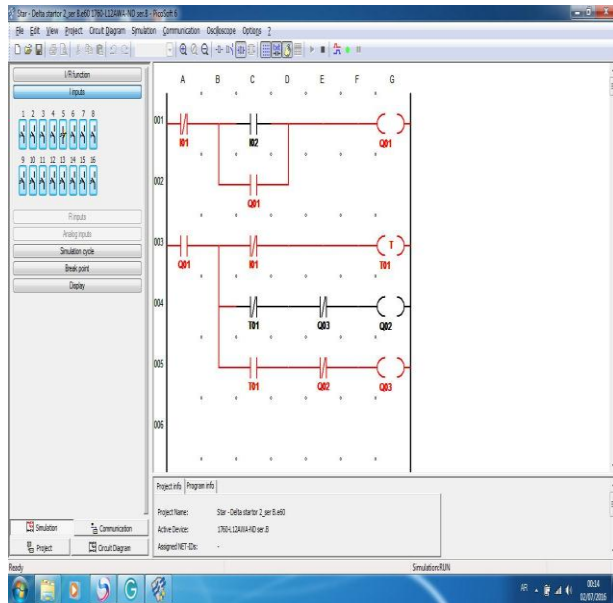


Fig.6 operation simulation with Delta power signal output

At Picosoft software, Logical switch normally close has address number 1 is connected to electrical panel with push button normally open has address number 1 due to it is connected to position 1 in the PLC. Thus, when the worker press push button number 1 on the electrical panel, it lets the power to be cut off instantaneously and reset the circuit as displayed in Fig. 5 now the worker can return the circuit operation again and can make a reset and return circuit for all operations as the worker need.

As illustrated before, the timer address in Picosoft software has to divided into two categories; one of these logical addresses is put it on normally close (N.C) logical switch made a let the power signal pass through at first 5 seconds, when the timer is accounting for star connection circuit . Then second logical addresses is putting it on normally open (N.O) logical switch made to let the power signal pass through after finish 5 second (period of Star connection), when the timer is finished accounted for Star circuit to make Delta connection circuit work on

Moreover, in this study, There has making a

security mode by use 2 logical switch normally close put it before output at Picosoft software. First one has the address of output 2 and it has a name of Delta circuit so as to be cut power off on output 1 when output 2 is working on. On contrary second one has the address of output 1 and it has name of Star circuit so as to be cut power off on output 2 when output 1 is working on, as displayed in Fig.5.

VII. RESULT AND DISCUSSION

There is an important alarm checking for a created connection properly between PLC and PC and check the right code downloaded throw it with a note blink yellow bulb at the middle of the PLC. When the worker starts power on, the motor is standing by, in safety mode and don't rotate. Whereas the worker can notice bulb for first output and the second output is signaling and indicating to power off, as displayed in Fig.7.

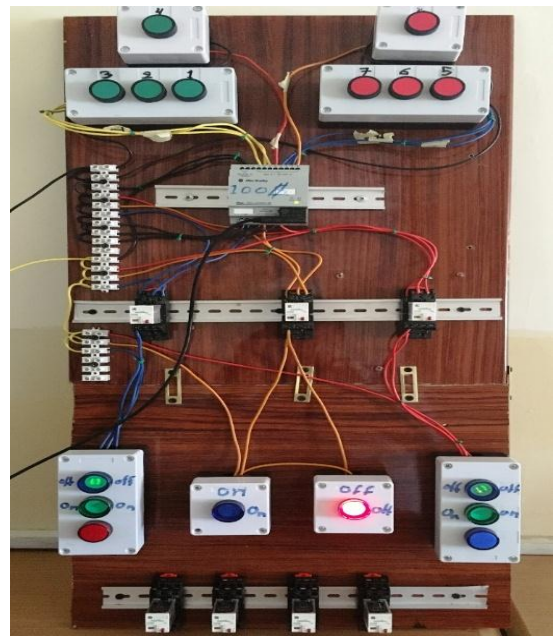


Fig.7 electrical control panel interfacing at safety mode

When the worker press push button 2 on the electrical panel, the motor is start rotation and working on a Star connection. Whereas the worker can notice bulb for timer delay signal is indicating to power on and bulb for first output is signaling to power on and bulb for second output is signaling to power off, as displayed in Fig.8

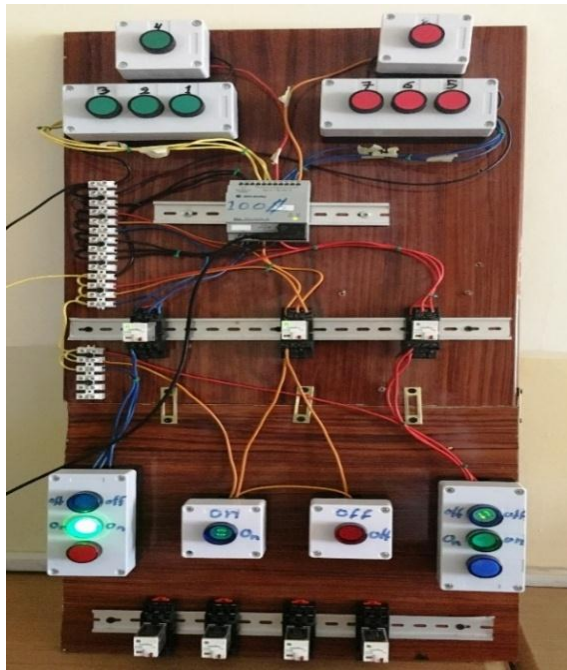


Fig.8 Star power signal output

The previous period represents Star connection. Now the period represents for delta connection circuit where it's done without press any push button. When the timer delay is finish accounting, the circuit is converted to the Delta connection automatically. Whereas anyone can notice bulb for timer delay signal is indicating to power on and bulb for first output is signaling to power off due to Star connection time has been finished and bulb for second output is signaling to power on due to Delta connection time has been started to work, as displayed in Fig.9

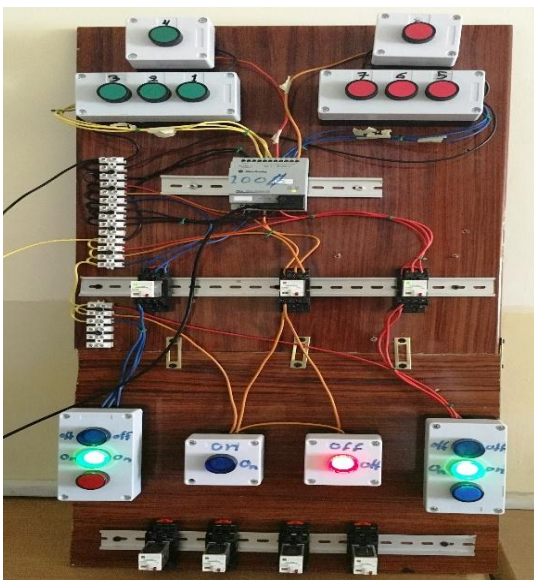


Fig.9 Delta power signal output

Then, the worker press push button 1 to reset circuit, as displayed in Fig.7 and then returns the previous operation respectively as the worker need.

In general Star/Delta starter needs a lot of expensive components such as coils, conductor, gear box and overload, etc. this means its circuits would be exorbitant as well as have a time and more effort to finish but not with the proposed circuit by PLC. Whereas it just needs software and little cheap components to finish.

VIII. CONCLUSION

In the past and up to now Star/Delta Starter control circuit was used for starter induction and synchronous drive. The implementation is done obviously and if it compares with Direct On Line (D.O.L) circuit, it will be satisfactory due to there is no load and loss of current at beginning start. Therefor ones have to look forward to using this method and this theory to get rid of this loss of current. General components that employed to carry out control and power circuit is on the cheaper range to any factory. PLC results for Star/Delta Starter experiment are much too worth. Picosoft software usually works on all windows versions and gives amazing results. It is executed logic language like ladder easily. By the sound of it, there is no point in leaving PLC applications for future works.

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