MANTECH Publications

Recent Trends in Electrical Machines and Drives

Volume 2, Issue 1, January- April 2017

Development of Test Jig for PLC and Programming of Commonly Used Blocks

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Abstract

Automation is basic requirement in industrial development. Programmable logic controller (PLC) plays an important role in development of industrial automation. PLC has many input-output pins that can use for controlling various applications. There are some expandable module in PLC for controlling applications. To develop test jig for flexi logic PLC series is the main objective. By designing and developing Automatic Test Equipment (ATE) for PLC, it is possible to minimize and reduce human intervention. This can provide faster and efficient testing of equipment.

Keywords: *PLC, Test jig, Flexi logic series FL-010.*

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INTRODUCTION

It is necessary to develop automatic test equipment (ATE) for PLC to reduce and remove human interference. It also provides efficient and faster testing of equipment. As industry needs to provide efficient and accurate devices to be manufacture, the testing must be capable to avoid malfunctions of component.

The recent development is to make testing of devices automatically by less human interferences. Appraisal of test results is again done physically it compares result with pre-established value or used its conclusion.
Control of the test sequence is also done by the operator, usually following a written test sequence. The switching of connections, the test equipment and unit under test (UUT) is done by manually operated pre-wired switch box.

Presently, most of the testing of ele tronics components, sub-assemblies, modules, and systems are still done manually. Switching, control, evaluation and recording are usually done by operator.

It is essential to go for automatic testing because manual system is time consuming and less accurate. In manual testing there will be more chances to skip any test. These days modular test may help to reduce capital equipment costs and system size without sacrificing performance hence it is necessary to design and develop a system to increase efficiency, accuracy and quality of present industrialized devices.

II. RELATED WORKS

The RAE SYSTEM company provides AutoRAE2 product for Automatic Test and Calibration for gas monitor. The AutoRAE 2 is a flexible, modular system which provides calibration effectively and efficiently. [5]

D. Ahuja et al. [1] introduced “Programmable Logic Controllers”. This paper states that PLC is a digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions by implementing specific functions such as logic sequencing, timing, counting, and arithmetic to control, through digital or analog input/output modules, various types of machines or processes. It is an easily understood programming language .It can hold data for a long time i.e. for an indefinite time but requires

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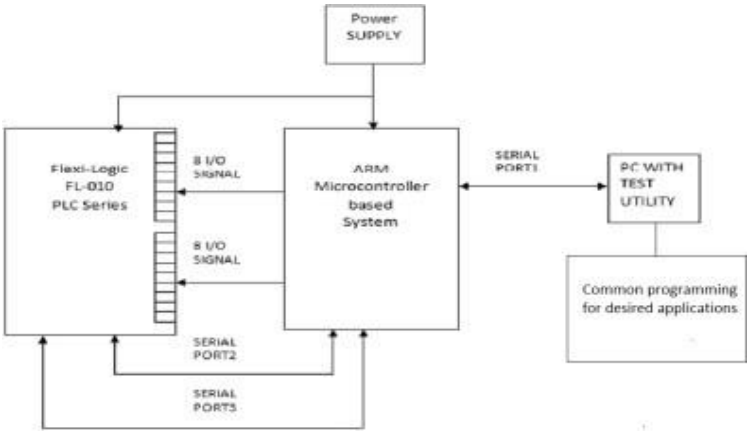
excessive work in connecting wires. PLCs are used in many industries and machines.

Dimitri Bohlender et al. [2] introduced "Concolic Test Generation for PLC Programs using Coverage Metrics" This paper presents a technique for fully automated generation of test cases for PLC programs adhering to the IEC 61131-3 standard. While previous methods strive for completeness and therefore struggle with the state explosion we pursue a symbolic execution based approach, dropping completeness but nevertheless achieving similar or even better results in practice.

Nilesh Bhandare [3] introduced "ARM microcontroller based automated system for calibration and testing of industrial analog modules" in which by designing and developing Automatic Test Equipment (ATE), it is possible to minimize and remove the human intervention. This can provide efficient and faster testing of equipment. Most of the test functions are done automatically under control of computers because Computers operate at very high speeds, with individual program steps taking typically less than two microseconds. Even though it may take a large number of these steps to perform a control or conversion operation, such

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Fig.1 Proposed Block Diagram



operations can often be completed in few milliseconds.

Vishal Kumar Alok et al. [4] have proposed "To study the different industrial applications of PLC through ladder diagrams" In this paper about the important concept of PLC and its application has been discussed. Early PLCs were designed to replace relay logic systems. These PLCs were programmed in "ladder logic", which strongly resembles a schematic diagram of relay logic. The main difference from other computers is that PLCs are armored for severe conditions and have the facility for extensive input/output (I/O) arrangements.

III. SYSTEM DESCRIPTION

Fig.1 shows connection setup for ARM microcontroller based system which requires 24V supply, FL-010 PLC, communication ports. The main purpose of ARM microcontroller based system is for auto testing of PLC parameters such as input power, digital inputs and outputs, high speed input and outputs, communication channels. ARM microcontroller based system communicates with PC through serial port.

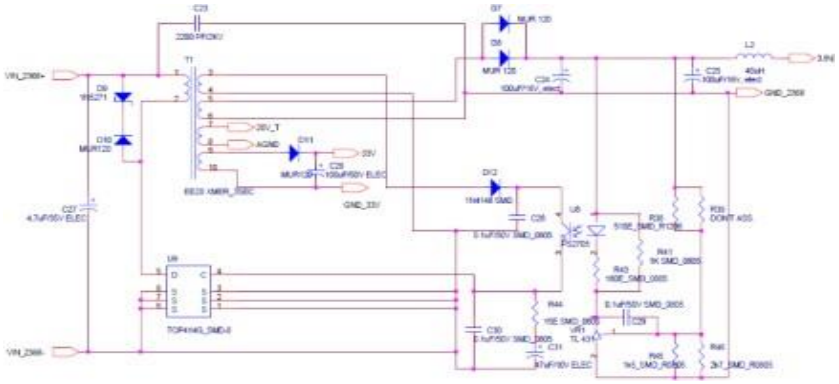
PC with test utility is a GUI which shows the result. In GUI parameters will test automatically. Jig tests the parameters as well as detects the faults present in PLC. If any fault present in PLC then ARM givesthe signal PLC is not connected. PLC to PLC communication also implement using MOD bus RTU. Test jig tests digital parameters but in the system analog testing method also included

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because jig must be act as flexible model to users.

Fig. 2 shows 24V 500 mA switch mode power supply. Which has high current limit. EE20 core will saturate during start up. Zener diode clamp circuit used to clamp leakage inductance spikes to fixed maximum voltage.C27 provides local decoupling of DC input. Tantalum capacitor C24 and C25 provides low profile and small outline for secondary capacitance.

1. 24V power supply:



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L2 filters high frequency switching noise from pie filter with output capacitor. Control loop gain set by R43 and stability influenced by R44, C24, C25, R38.R48 sets dc regulation point and shunt regulator TL 481 along with bypass capacitor C29 provide drive for optocoupler. TL 418 along with bypass capacitor C28 provides drive for optocoupler U8. Any remaining switches noise in the system is filtered by ceramic capacitor C25. R44 and C31 part of control pin feedback circuit. C30 used to slowly decouple high frequency noise on control pin. Circuit diagram shown in fig. 2 is referred from datasheet of Top414/412 IC.

2. Processor pin diagram LPC2368

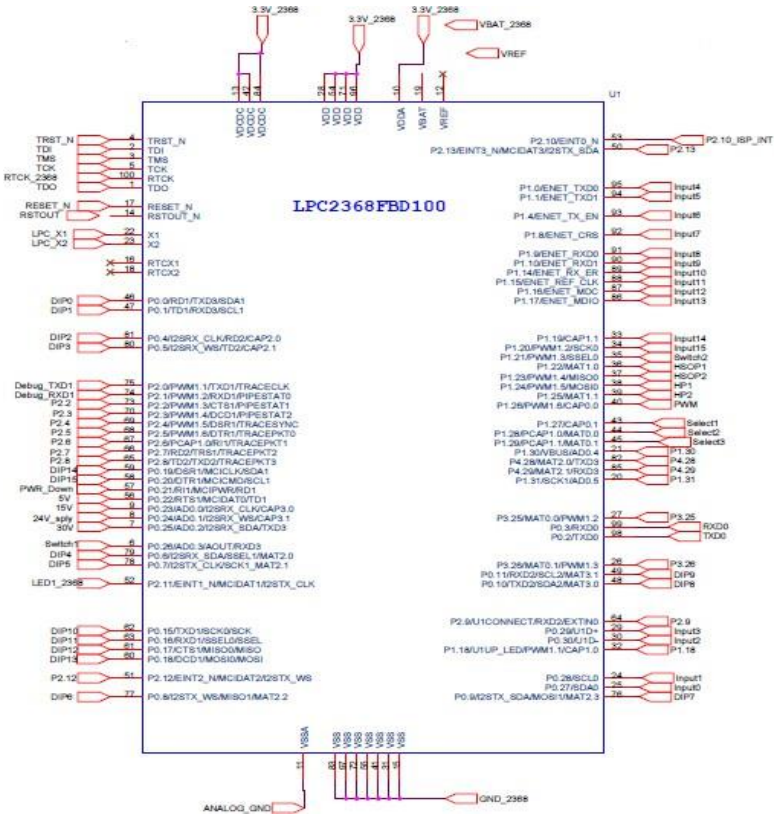


Fig.3 pin diagram of LPC2368

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Fig. 3 shows pin diagram of LPC23xx series these series are ARM-based microcontrollers for applications requiring serial communications for a variety of purposes. These microcontrollers typically incorporate a 10/100 Ethernet MAC, USB 2.0 Full Speed interface, four UARTs, two CAN channels, an SPI interface, two Synchronous Serial Ports (SSP), three I2C interfaces, an I2S interface, and a MiniBus (8-bit data/16-bit address parallel bus).

Baud Rate Calculations:

Required B.R= 16* desired B.R. = 16*9600= 153600

Peripheral clock =72MHz

CPU frequency= 72MHz/4=18 MHz DLL and DLM =18MHz/153600= 117.18

DLL (Divisor Latch LSB) =117 DLM (Divisor Latch MSB) =0

1. Common ladder programming

To develop common ladder network which is frequently used in the industrial application so customer can get readymade ladder for testing, only uncommon part will be added by customer.

To develop ladder network for frequently used blocks in PLC applications are mentioned below

1. Motor drive
2. Relay circuit
3. Indicating ON/OFF LED
4. Conveyer drive

IV. SYSTEM FLOW CHART

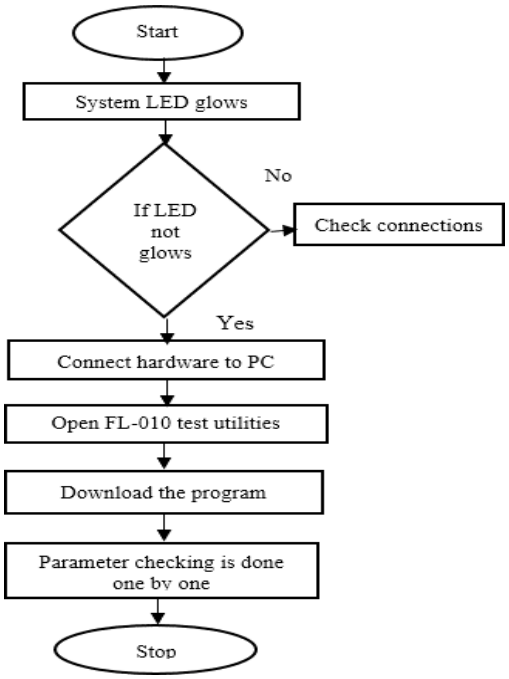


Fig.4 how system works step by step process

V.RESULTS

A. Input/output testing using Flexisoft software

Flexisoft software contains various registers e.g. Y register for output YW for output coil. By setting value in particular register ON/OFF operation of particular LED takes place. Due to this flexi soft software user can identify PLC's I/O's are working or not.

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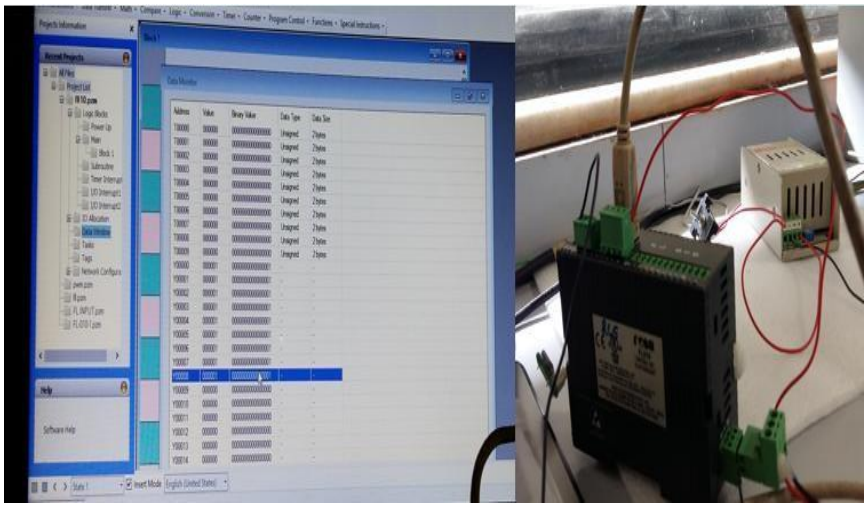


Fig.5 Input testing setup for FL-010

Fig.5 shows the result of input channel testing of FL-010. By applying 24V supply to particular channel X0-X7 input tag address filled 1 automatically in corresponding register.

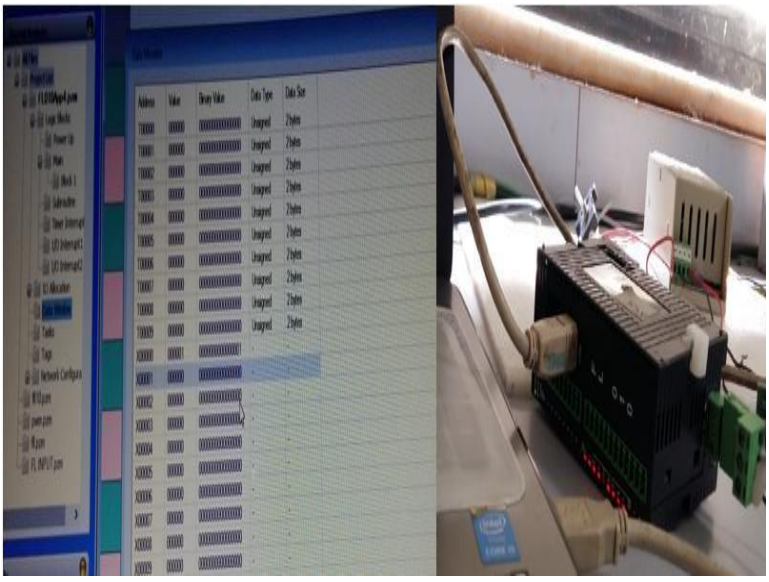


Fig.6 Result of FL-010 output on Flexisoft

Fig.6 shows output channel result of FL-010. If 24V supply is applied to Y0-Y7 on FL-010 particular channel will be energized output signal generated by PLC by activating switching device

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i.e. relay.

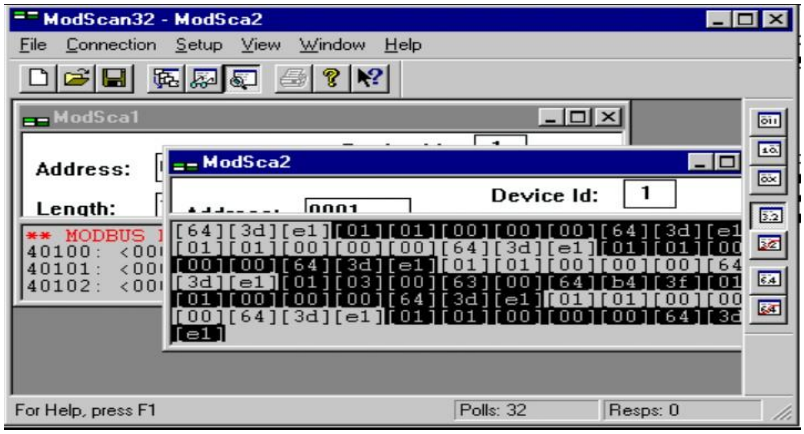


Fig.7 Result on Modscan software

As shown in fig. 7 modscan software shows the result of transmitted string. Following frame shows the Modbus frame structure.

Start	1	2	3	4	5	6	7	8	Par	Stop



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Fig.8 Test Jig

As shown in fig. 8 this test jig contains hardware of power supply, communication ports, and LPC2368 processor.

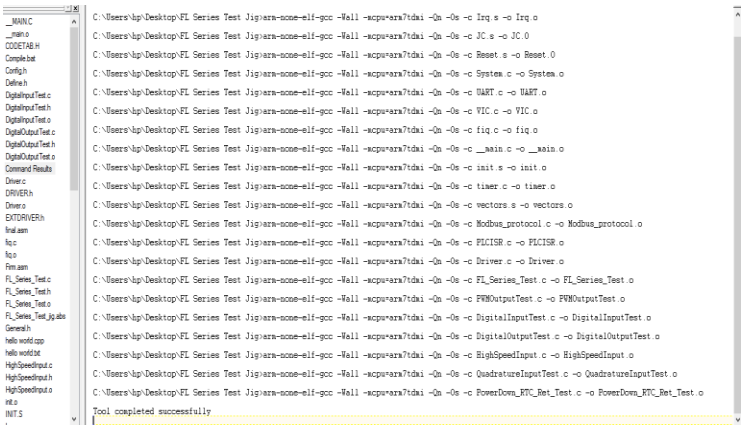


Fig.9 Textpad simulation

Textpad software is text editor it is not IDE. Simulated result as shown in fig. 9 shows only tool completed successfully message after compiling the program.

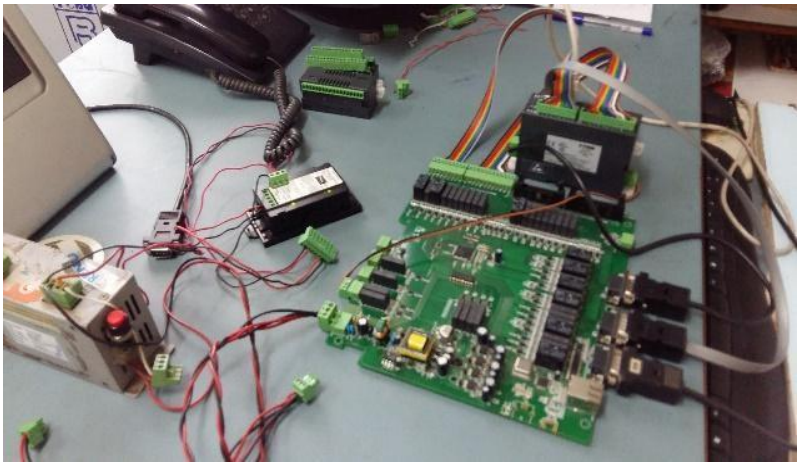


Fig.10 Connection setup of jig with PLC FL-010

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Fig. 10 shows PLC FL-010 connected to the jig via connectors, power supply and communication cables to PC.



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Fig.11 (a) Result with test utility



Fig.11 (b) Result with test utility

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Fig. 11(a) and 11(b) shows the result on GUI which contains test utilities which declares the result of input channels, output channels, high speed inputs, pwm outputs, expansion slots etc. If all tests are ok then message will display on screen tests completed successfully. This process completed within 3 to 5 minutes only hence called process is time consuming than the manual test.

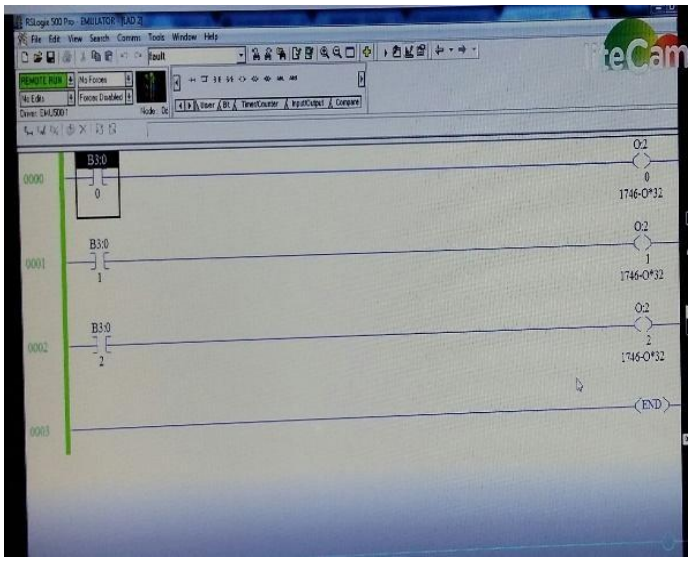


Fig.12 (a) Common ladder network

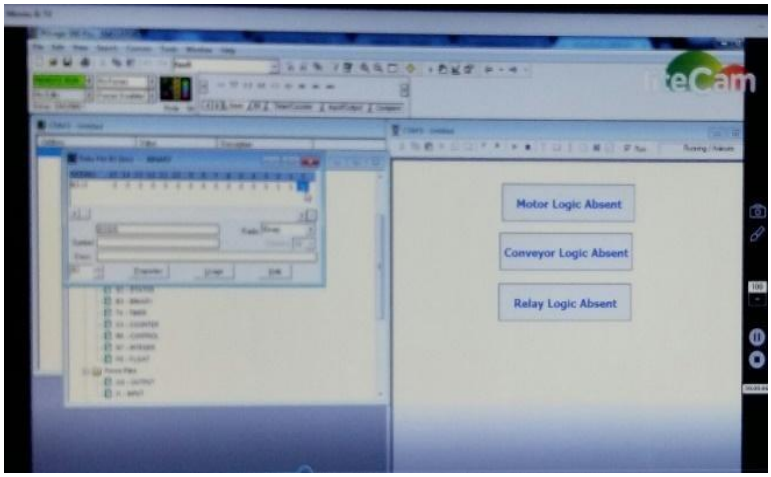


Fig.12 (b) GUI for ladder network

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Fig. 12(a) and 12(b) shows the result of commonly used ladder network. RS-500 logic software is used for simulation. Absent logic in PLC is displayed on the screen.

CONCLUSIONS

This system is test jig to test PLC FL-010. Test jig is nothing but combine hardware including ARM 7 (LPC2368) processor. For accurate reading of project PLC have to satisfy the I/O conditions using flexisoft software. By performing the mentioned results PLC FL-010 is in working condition. Textpad software compiles the program and gives the simulation result. This test jig is controlled through pc with serial communication. The implemented work performed in Renu Electronics Pvt. Ltd. Pune.

ACKNOWLEDGEMENT

I take pleasure in presenting my work done in development of test jig for PLC. I would like to express my deep sense of gratitude to my guide Dr.S.A.Pardeshi for his valuable suggestions.

I am deeply indebted to him for giving me chance to do this innovative project providing constant guidance throughout this work. I acknowledge with thanks, the assistance provided by department staff, electronics faculty staff. And the last but not least special thanks to Mr.Santoshshinde and Mr.Gopal Ambike from Renu electronics Pvt.Ltd. Pune for permitting to do the implementation the work.

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4) Automatic Test and Calibration http://www.raesystems.com/products /autorae-2

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