SECTION 8. SYSTEM TESTING
PC-700/900 PROGRAMMABLE CONTROLLERS

8-1. GENERAL DESCRIPTION

The PC-700 or PC-900 system is tested after field wiring is complete and all I/O modules are installed. All system components, except the analog inputs, are tested using the Monitor and Force functions of the program loader. The analog input circuits require an additional test circuit (see Fig. 8-1) to complete testing.

The procedures of this section assume that the user is familiar with the system, program loader, and related peripherals. If this is not the case, the user should study all related system, program loader, and peripheral documentation before proceeding with these test procedures.

The PC-700 or PC-900 system is tested by using the following four tests (dependent on the actual system's configuration):

- I/O Module testing (See paragraph 8-2.)

- Remote I/O testing (See paragraph 8-3.)

- Interprocessor testing (See paragraph 8-4.)

- Peripheral testing (See paragraph 8-5.)

8-2. I/O MODULE TESTING

Use the following step-by-step procedure to test the PC-700 or PC-900 system's I/O modules.

1. Initialize the processor per the procedures given in Section 7:

    - Use paragraph 7-7 for PC-700 processors.

    - Use paragraph 7-8 for PC-900 processors.

2. After initialization is complete, place the respective processor's keyswitch in the **Run** or **Run/Program Protect** position.

3. This test procedure uses the **Monitor mode**, which is described in the appropriate program loader's programming manual.

4. Using the Monitor mode, activate each discrete input. Observe that the loader Monitor function is active and that the LED on the corresponding discrete input module lights.

Note

If the user energizes an input in this test, he should check to see that the processor is reporting only that input ON. If he displays all input groups in binary format on the CRT, racks that are improperly addressed or have more than one switch ON in any group of four (vertical racks) or a shorted I/O cable can cause several inputs to appear ON, or the wrong input to turn ON.

To isolate the problem, disconnect the other racks, one at a time, until the problem disappears. This will localize the problem to the offending rack or module. If all other racks are disconnected and the rack and module under test are proven good, the I/O cable may be bad and should be changed.

For additional trouble-shooting information, see Section 9.

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5. Ensure that all inputs are turned OFF when discrete input testing is completed.

6. Remain in the **Monitor mode** and apply thumbwheel input (or other suitable input) to each **input register**. Observe that the loader Monitor function indicates that the processor receives the data sent.

7. Ensure that all register inputs are in their pretest states when register input testing is complete.

8. The **discrete outputs** of a system are tested by using the **Force function** of the Monitor mode.

WARNING

THE USER'S OPERATOR PERSONNEL ARE RESPONSIBLE FOR ENSURING THAT NO DANGER TO PERSONNEL OR DAMAGE TO EQUIP-MENT RESULTS FROM THE ENERGIZATION OF AN EXTERNAL DEVICE THROUGH THE USE OF THE FORCE FUNCTION.

9. Ensure that the devices controlled by the outputs to be tested are properly disabled or in a safe operating condition.

10. Force each discrete output to an ON state. Observe that the LED on the corresponding discrete output module lights, that no other output is ON, and that the controlled device is properly operating. In the case of disabled devices, check to see that the proper operating potential is being applied to the device from the output under test.

11. Ensure that the output under test is forced OFF when each discrete output's test is complete. Also ensure that all forced conditions are deleted after all outputs are tested.

12. **Analog and register output** testing is accomplished by loading numerical data in the associated register and checking that the external result is correct.

13. To test the **single-point register** outputs (NL-753) or **multiplexed register** outputs (NL-754), load numerical data (via the program loader's Register function) into the register under test. Observe that the corresponding instrumentation or readouts obtain the proper readings.

14. Ensure that all register outputs are returned to pretest states after register output testing is completed.

15. To test the **analog outputs**, connect a multimeter across the analog output module terminals under test. After the meter is connected and the proper voltage range is selected, load the numerical data into the corresponding output register via the program loader's Register function. Observe that the analog output reading on the meter is appropriate and that the controlled instrumentation device (if one exists) operates properly.

Example: When an output register is connected to an NL-750 analog output, it provides a numerical range of 0 through 4095. The analog outputs produced by this numerical range vary, depending on module type. In the case where an output register is applied to the top channel of an NL-750 analog output module, the result of this module's digital-to-analog conversion (for each type) is shown in Table 8-1.

16. Ensure that all analog outputs are returned to the pretest states and that the meter is disconnected after analog output testing is completed.

17. To test the **analog input**, a battery test circuit is connected across the analog input module terminals to simulate an analog input. This test circuit consists of a battery (within the nominal voltage rating of the analog modules) and connecting leads.

Example: Figure 8-1 shows this test circuit for an NL-740 A through C module. The battery is shown connected to the analog input module's top channel (T5/T6).

TABLE 8-1. NL-750 D/A CONVERSION

NL-750 Module Type	Output Register Decimal Value	T5/T6 Measured Voltage
A	2048	2.5 V
B	2048	5 V
C	2048	5 V
A	4095	5 V
B	4095	10 V
C	4095	10 V

CAUTION

These analog output readings vary directly with the precision and tolerance of the multimeter. This test should be used to test the analog output module's function and not module accuracy.

18. After the battery test circuit is connected, monitor the corresponding input register contents for the result of the analog input module's analog-to-digital conversion. This register is monitored by using the program loader's Register function. The result of this conversion can be calculated for each type of NL-740 module as follows:

- **NL-740A** Anticipated Value = $$\frac{(\text{Battery Voltage}) \times 4095}{5}$$

- **NL-740B** Anticipated Value = $$\frac{(\text{Battery Voltage}) \times 4095}{10}$$

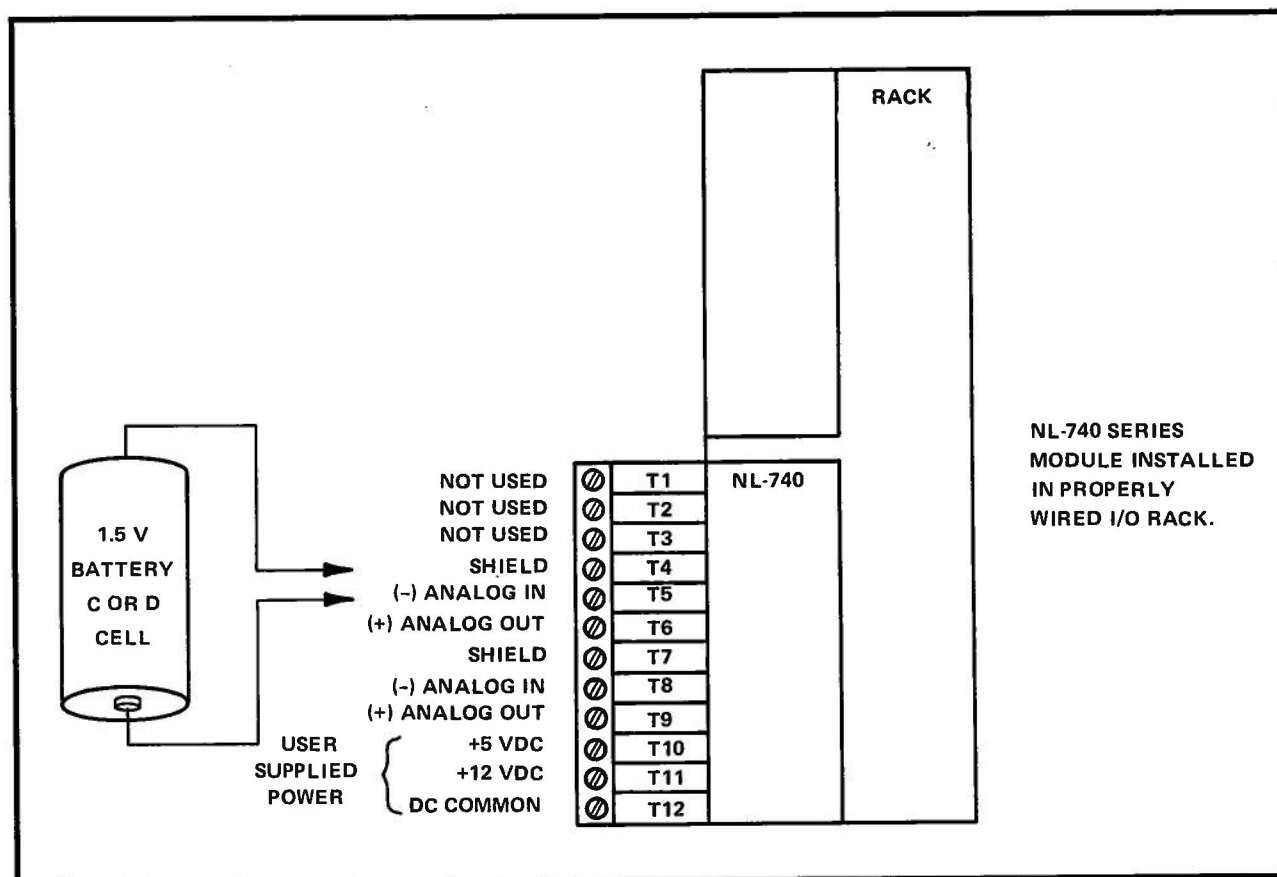- **NL-740C** Anticipated Value = $$\frac{(\text{Battery Voltage} - 1) \times 4095}{4}$$

Figure 8-1. Analog Input Test Circuit

Example: Using the 1.5 Vdc C or D cell shown in Figure 8-1, the following results should be calculated and monitored:

- NL-740A — 1000 through 1400

- NL-740B — 500 through 700

- NL-740C — 400 through 600

CAUTION

This analog input testing indicates that the analog-to-digital conversion is functional. This test does not measure conversion accuracy.

19. Ensure that the battery test circuit is removed and that all analog inputs are deactivated after analog input testing is completed.

CAUTION

When all I/O module testing is complete, ensure that all inputs are deactivated, that all outputs are forced OFF, and that all Force function commands are deleted.

8-3. REMOTE I/O TESTING

Remote I/O operation and remotely located I/O modules are tested in the same manner as the discrete I/O and register modules. (See paragraph 8-2.)

Prior to testing the remote I/O, ensure that the local/remote unit pair (NL-771 and NL-772, respectively) and the I/O expander power supply (NLE-770) are set up in accordance with their respective documentation. Also, ensure that the

LINK OK light is present on both the local and remote units when the processor is initialized and running.

After verifying the remote I/O structure and operation, proceed with the step-by-step procedure of paragraph 8-2. During remote I/O testing, observe all **WARNINGS** and **CAUTIONS** associated with the Monitor mode operations.
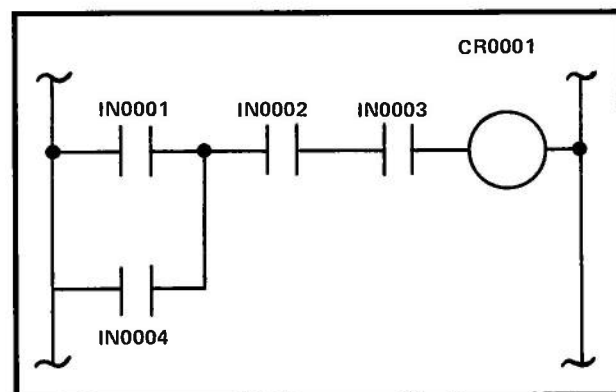
8-4. INTERPROCESSOR TESTING

Interprocessor operation is tested by checking to see that the two NL-771 local units (operating as a pair) are correctly set up. Also, ensure that the **Link OK** lights on both units are present when the processors are initialized and running.

After verifying interprocessor operation, proceed with the step-by-step procedure of paragraph 8-2 to test each discrete I/O and register I/O module to be transmitted across the link under test. Again, during testing, observe all **WARNINGS** and **CAUTIONS** associated with the Monitor mode operations.

8-5. PERIPHERAL TESTING

8-6. TAPE LOADER

Using the program loader, enter the test program of Figure 8-2 into the processor. Refer to the appropriate program loader's programming manual for instructions on programming this line of logic.

Figure 8-2. Peripheral Test Program

After this test program is entered, perform the following test sequence:

1. Record this test program on tape by using the appropriate program loader manual.

Note

This program is recorded on the NLTL-783 Tape Loader when the NLPL-780(P) Program Loader is used, and on an audio cassette recorder when the NLPL-789 Mini Loader is used.

2. After the test program is recorded, rewind the tape and re-enter the program into the processor from the tape loader or audio cassette recorder.

3. Using the program loader's Monitor mode, verify that the program presently in the processor is the same as that originally entered (see Fig. 8-2).

This test verifies that the system can write to and read from the tape loader or audio cassette recorder.

8-7. PRINTER

The NLPL-789 Mini Loader and the NLPL-780 version of the CRT program loader **do not** support the Print function. To test printer operation, use the NLPL-780P version of the CRT program loader and print the test program entered during the tape loader test. Refer to this program loader's programming manual for print instructions. After the program is completely printed, verify that it is the same as that originally entered (see Fig. 8-2).

8-8. PROGRAM VERIFICATION

The successful completion of these tests only indicates that the system under test is wired properly and that the system components tested are operational. **These tests do not verify that the user program installed in the processor functions correctly.** It is the user's responsibility to load the control program and to determine if the system has been correctly programmed for specific user applications.

8-9. TEST FAILURES

If any failures are detected during these tests, recheck the system wiring and installation by using Section 7 and the system drawings. If the wiring and installation are correct, refer to Section 9 or to the documentation of the suspected systems component. If problems continue after these steps are taken, contact your Westinghouse Service Representative.