Westinghouse

numa-logic

REGISTER INPUT MODULE

(16 bit)

Catalog No. NL-743

PERFORMANCE DATA

Circuits per Module	16
I/O Rack Positions Req'd.	2
TTL Input Voltage Range	-0.3 to +5.7 VDC min. and max.
Current Sink Req'd.	0.37 mA @ 5.7 VDC typical
ON Input Voltage Level	2.0 to 5 VDC
OFF Input Voltage Level	0 to 1.4 VDC
Input Loading	0.37 mA
Input Response Time	3 ms ON 6 ms OFF
Input Impedance	15K ohms
Power Requirement	3 units, Logic Power Supply 1 external power supply
Terminal Ratings	300 V
Opto Isolation	2500 V
Temperature Rating	0° to 60°C 32° to 140°F
Humidity Rating	0 to 95% noncondensing
Wire Size	AWG No. 14 max.
Keying Slots	Between pins: 9 and 11 27 and 29

INTRODUCTION

The function of the 16-bit Register Input Module is to convert TTL type input signals to logic levels that are then made available to the Processor for update acquisition in registers and eventual use by the user program. Input data may be either BCD or binary in form. (BCD-to-binary or binary-to-BCD conversions can be done in the Processor, as necessary.) The Module's 16 inputs are separate but share a single ground connection (signal return).

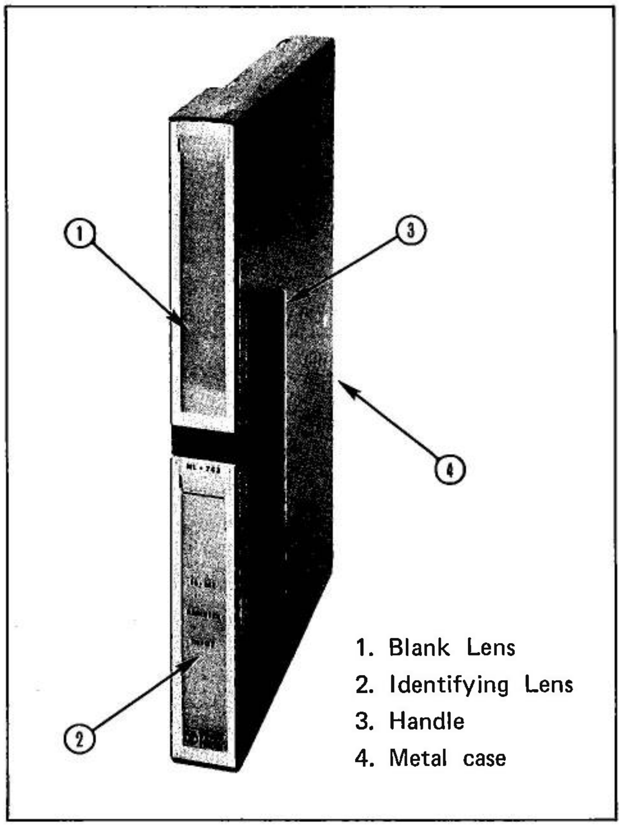


Figure 1 — 16-bit Register Input Module

The Module is a "double height" type that accepts up to sixteen 5 VDC TTL data signals from such external devices as 4-digit BCD thumbwheels. Field wiring to the Module is through terminals on the I/O Rack. Each circuit uses 3 terminals:

- +5.7 VDC, or external power supply input
- D1 thru D16, or TTL compatible inputs
- DC COM, or signal return for the device and supply

Although the Module is basically a TTL input unit, it is designed to be used with many other logic families, including LP TTL, LS TTL, HTL and B series CMOS. The Module is provided with high/true logic, but a user-installed jumper quickly changes it to low/true, thereby eliminating the need for external inverters.

+5.7V (400 mA)	T1	+5.7V
Do not use	T2	
Do not use	T3	
Do not use	T4	
Bit 1	T5	D1
Bit 2	T6	D2
Bit 3	T7	D3
Bit 4	T8	D4
Bit 5	T9	D5
Bit 6	T10	D6
Bit 7	T11	D7
Bit 8	T12	D8
Bit 9	T13	D9
Bit 10	T14	D10
Bit 11	T15	D11
Bit 12	T16	D12
Bit 13	T17	D13
Bit 14	T18	D14
Bit 15	T19	D15
Bit 16	T20	D16
Do not use	T21	
Optional low/true select terminal	T22	H/L SEL
Do not use	T23	
DC COM (for power and signal lines	T24	COM

Figure 2 – Terminal Identification

For proper operation of the Module, an external power supply is required. (See Application Note 2.)

The Module includes 2 pictorial Lenses; the upper is blank, the lower identifies the Module.

Also supplied with the Module are 2 user Terminal Identification Strips, which are to be filled in with wire numbers and applied to the I/O Rack next to the terminals. (See Figure 2.)

INSTALLATION

Proper Sequence – This installation procedure is divided into two distinct parts. First, connect field wiring to the I/O Rack but **do not** install the Module. Second, after AC power can **safely** be applied to the whole system, voltage measurements must be taken **before** installing the 16-bit Register Input and Output Modules. (This phase can be part of the start-up procedures.)

> CAUTION
>
> Install the Register Modules **only** after AC line power can be **safely** applied to the entire system and after the electrical measurements, described here, have been made. Equipment damage can result if this sequence is not followed.

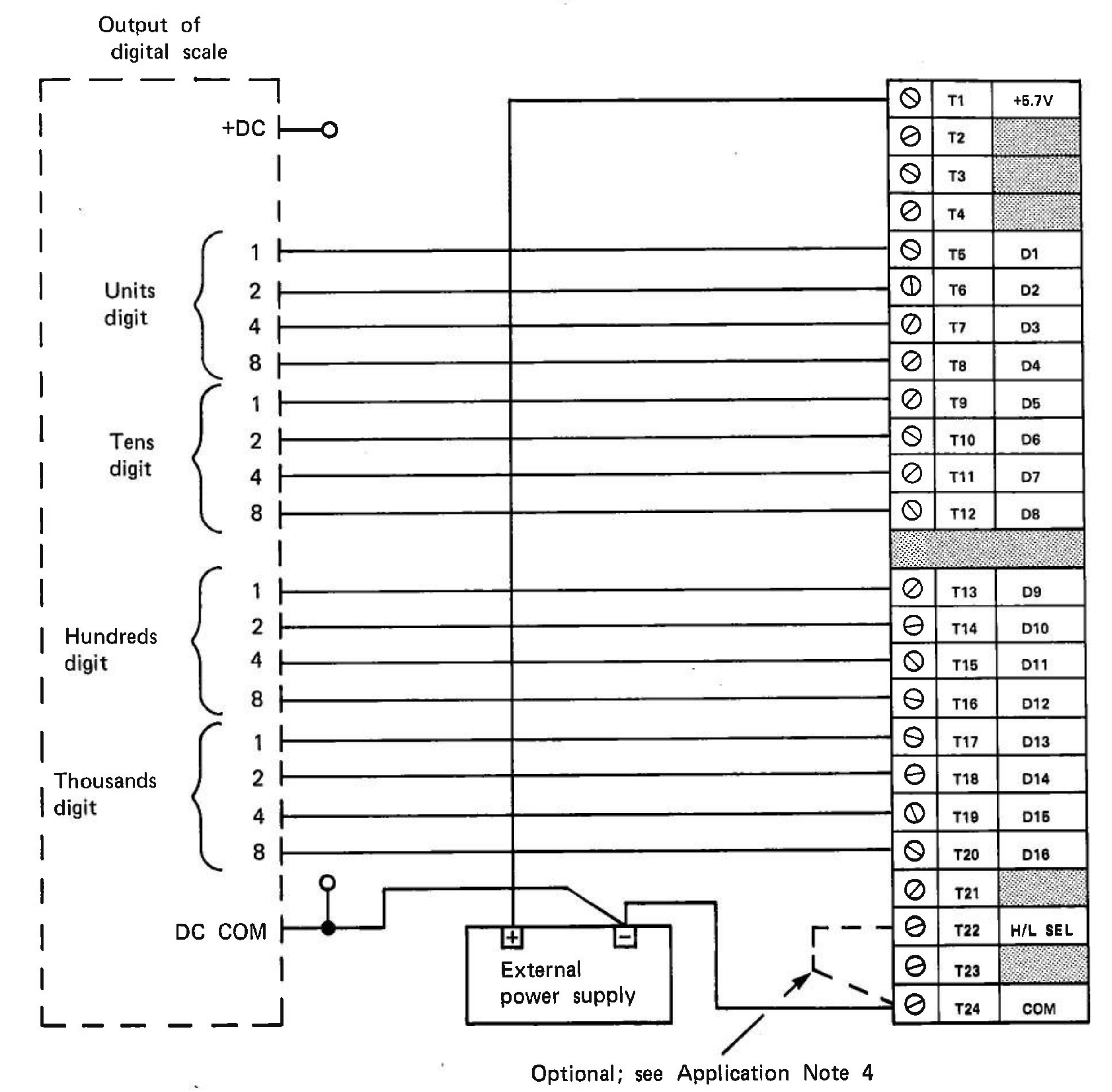
Wiring – Connect the field wiring to the I/O Rack terminals according to the application's wiring diagrams. In most cases it will be necessary to use twisted conductors. In some cases it may be necessary to use shielded cable and provide a ground connection. Follow the techniques noted in the typical connection diagrams in Figure 3.

The DC COM (T24) terminal functions as the signal return for the 16 input terminals **and** the external power supply. Thus the external power supply's DC common terminal and the negative terminal of the supply powering the external device **must** be connected. (See Figure 3.)

It may be necessary to place a jumper between the H/L SEL (input polarity select) terminal and the DC COM terminals. (If used, the system wiring diagrams should show it.) Use an insulated wire at least AWG No. 22 but smaller than No. 14.

Physical Placement – Only after AC line power can safely be applied to the entire application should preparations be made to install the Register Input Module(s) in the I/O Rack. It is a simple process, but certain electrical measurements must be made first. A voltmeter is required.

Step 1 – Apply AC power to the entire application, and verify that the voltage between the +5.7 VDC terminal (+) and the DC COM (-) terminal is +5.7 VDC (±0.25 V). Measure at all I/O Rack terminals used for Register Input and Output Modules.



a) for 4-digit BCD instrument's TTL compatible output

Figure 3 – Connection Diagram (typical)

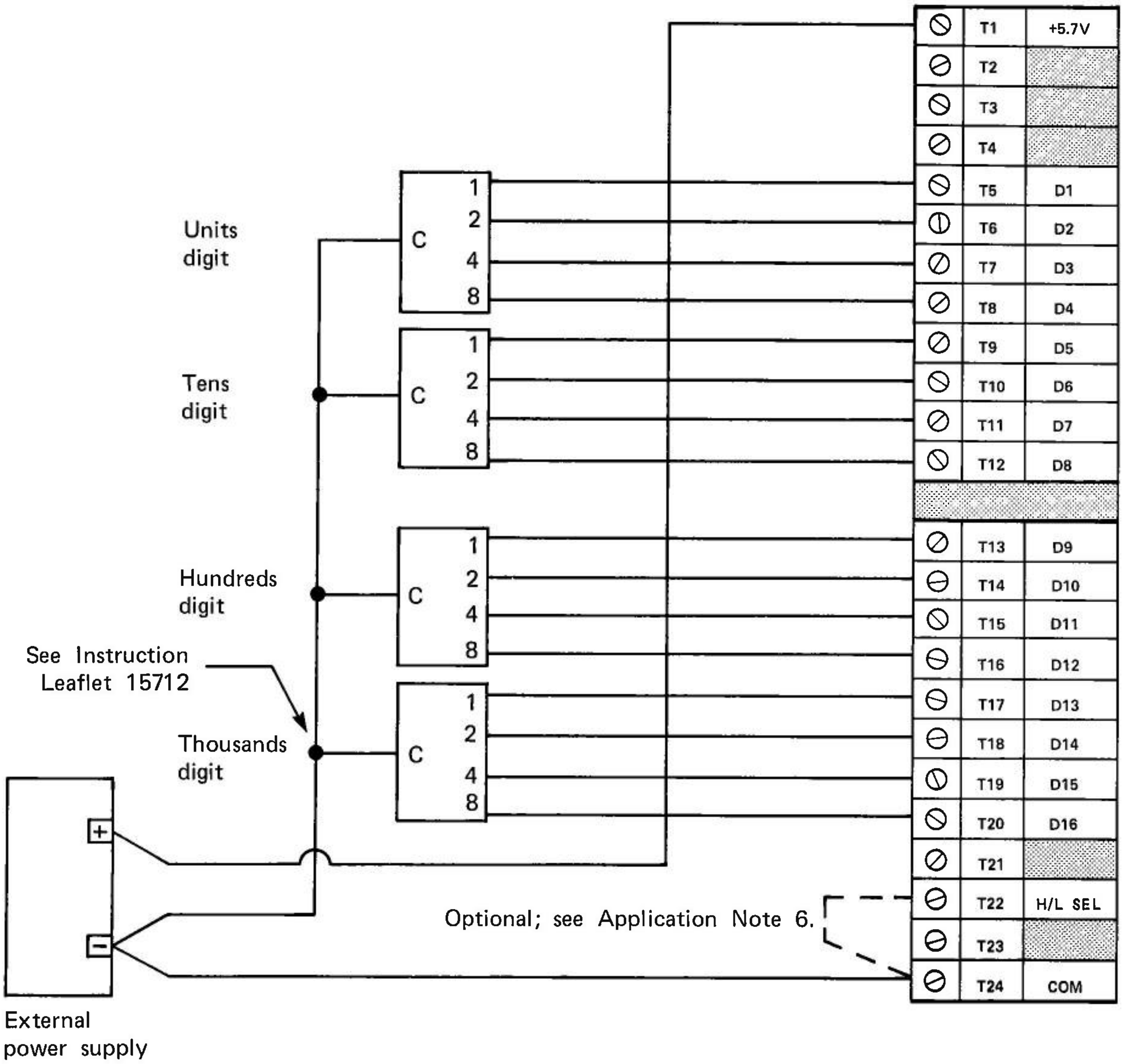
Step 2 – If necessary, adjust the external power supply's output to the required voltage.

Step 3 – Remove AC power from the application.

Step 4 – Refer to system drawings and determine which I/O Rack and which Position in the Rack the Module is to be placed. (Although a Module can be placed in either the upper 2 Positions or the lower 2 Positions, it may not straddle Positions B and C. See Figure 5.) It is important that it be placed according to the user program Reference Number scheme.

Step 5 – Move the Locking Bar on the I/O Rack's built-in terminal block to the left in order to uncover the guide slots on the block. (See Figure 4.)

Step 6 – Align all of the Module's guide pins with corresponding slots on the I/O Rack. Gently press the Module into the edge connector on the Rack. Make sure the edge



b) for 4-digit BCD thumbwheel

Figure 3 — (cont'd.)

pins on the Module align and mate with the Rack connector.

Step 7 — When the Module is properly seated, snap the Rack's Locking Bar over the Module's guide pins in order to hold it in place.

Step 8 — Write the wire number, or other identifying information, on the Terminal Identification Strip for subsequent use. Wiring practices to the terminals on the I/O Rack are described in the PC-900 and PC-700 Application Manuals.

Switch Settings — In order to complete installation of the Register Input Module, it is necessary to physically set individual rocker switches on the I/O Rack. Their combined function is to electrically identify each terminal in the Rack with a Reference Number required for programming. This explanation is detailed only to the

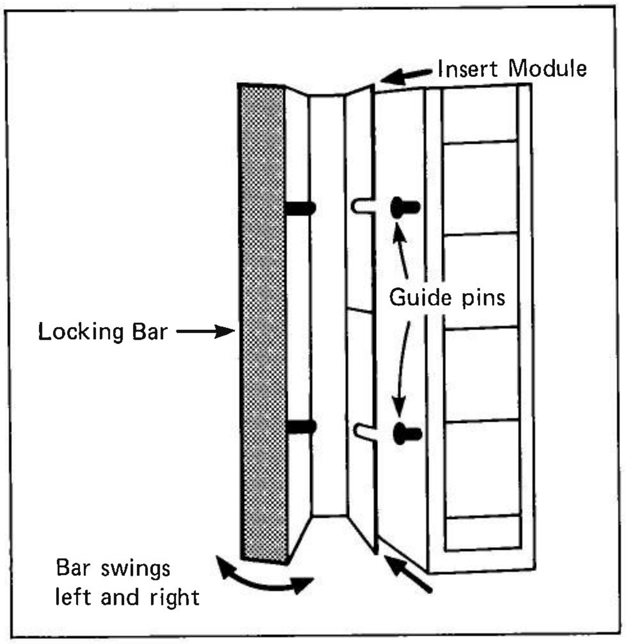


Figure 4 — Guide Slots

level required by the installation team. (For further details, see the PC-700 and PC-900 Application Manuals and, also, Instruction Leaflet 15718.)

Step 1 — Locate the list that relates wire numbers at each terminal with directly corresponding Reference Numbers. The system drawings should show them. If not, contact the design engineer or programmer. The switches **cannot** be set correctly without a list.

Step 2 — Locate the first-used Register Input Module on the system drawings and on the I/O Rack. This may be anywhere in the layout and will probably be grouped together with other Input Modules of the same type.

Step 3 — Identify the Reference Number for the first input terminal on **that** Module. It will be a number like IR0001.

Step 4 — At the top right-hand side of **that** I/O Rack, locate the Rack Switch assembly. (See Figure 5.) Note that it is divided into 3 groups of 4 rocker switches each. Locate those that make up the GSEL area.

It is necessary to set 1 of the 4 switches to the ON position according to the specific Reference Number. Relate the Number to Table A for the first Module and for all other Register Input Modules of this type in subsequent I/O Racks.

Step 5 — As indicated on Table A's right column, set the proper switch to the ON position.

Step 6 — Set the remaining 3 switches in GSEL to the OFF position. (The 4 switches may be thought of as a type of selector switch.)

Step 7 — Set 1 of the 8 rocker switches in the TOP and BOTT areas to ON. To determine which to press, locate the Reference Number of the top input terminal (fifth down) on the Module. (Use the list described earlier in this publication.) For example: IR0001. Relate this Number to Table B and read across.

Step 8 — As indicated in Table B's center column, set the proper switch to ON.

Example: What are the proper settings for a Register Input Module placed in Position CD if it has a first

Table A

RACK SWITCH GSEL SETTING

If the Reference Number is:	Press ON GSEL Switch:
IR0001 thru 0008	1
IR0009 thru 0016	2
IR0017 thru 0024	3
IR0025 thru 0032	4

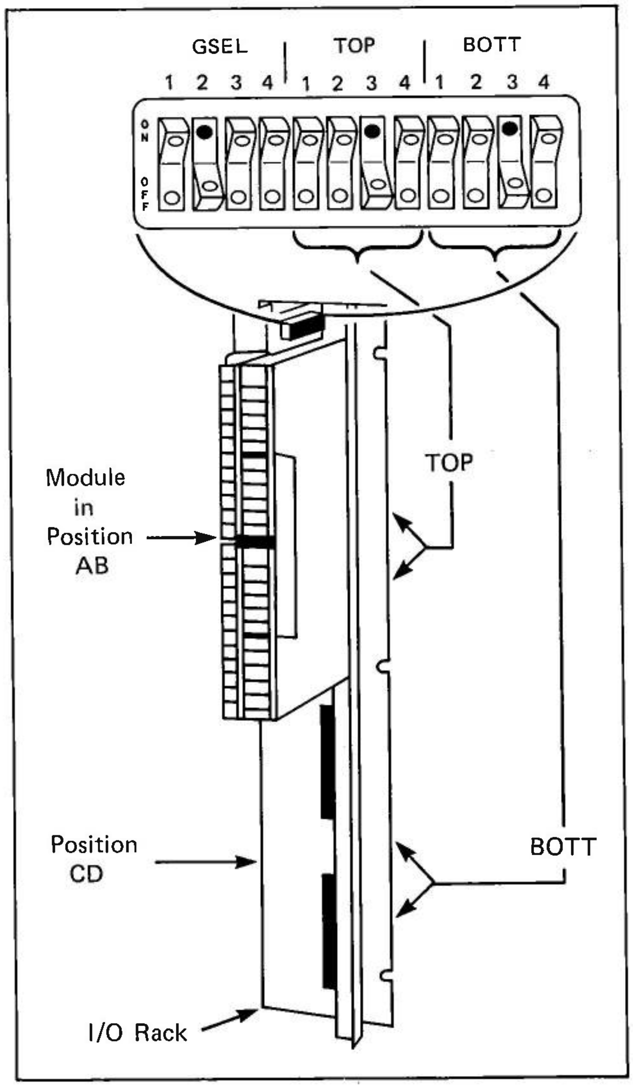


Figure 5 — Rack Switch Location

Terminal Reference Number of IR0008? Answer: GSEL 1 and BOTT 4 are set ON.

Step 9 – Place all remaining 10 switches in the OFF position. (As an aid to future troubleshooting, mark the rocker switch settings on a piece of tape and place it near the assembly.)

Table B

RACK SWITCH TOP/BOTT SETTINGS ①

If the Reference Number is:	Press ON: Group	Press ON: Switch	Affects Position:
IR0001, 0009, 0017, 0025	TOP	1	AB
IR0002, 0010, 0018, 0026	BOTT	1	CD
IR0003, 0011, 0019, 0027	TOP	2	AB
IR0004, 0012, 0020, 0028	BOTT	2	CD
IR0005, 0013, 0021, 0029	TOP	3	AB
IR0006, 0014, 0022, 0030	BOTT	3	CD
IR0007, 0015, 0023, 0031	TOP	4	AB
IR0008, 0016, 0024, 0032	BOTT	4	CD

① In a correctly written program the Reference Numbers will be related to the Positions as shown here. (Thus IR0002 will never be Position AB.)

Step 10 – Apply AC power to the application and again measure the voltage at the same terminals noted in Step 1. Measure at all I/O Rack Positions used for Register Input Modules. Under these load conditions the level should be +5.7 VDC (±0.25 V).

Step 11 – If necessary, readjust the power supply's output to the required voltage.

Step 12 – Apply the self-adhesive Terminal Identification Strip, supplied with the Module, to the terminal block's face.

APPLICATION NOTES

1. If the length of the wire run between the external TTL-compatible device and the Register Input Module does not exceed 100 ft (30 m), use insulated, twisted conductor wires not larger than AWG No. 14 nor smaller than No. 22. For runs over 100 ft, it may be necessary to use a twisted conductor, shielded cable. Choose the specific type according to the number of input signal lines required. Ground the shield **only** at the Module end. Use the I/O Rack mounting bolt for the ground connection.

2. An external DC power supply is required to operate the Register Input Module. The Catalog No. NLPS-315, rated at 1.5 amperes, is acceptable and able to power 3 Modules. (For larger loads the -330 and -360 supplies provide 3 and 6 amperes, respectively.) It must be connected to the **same** AC power line as the Processor. The DC supply must be capable of providing 5.7 VDC (±0.25 V) and a current of 450 mA.

3. If the external 5.7 VDC power supply voltage to the Module is lost while the Processor continues to operate, all the bits of the Processor's input register associated with this Module assume an OFF state.

4. The logic of the Module must be set according to the logic of the external device's output. The Module is factory-shipped as a high/true device. Users may optionally change the logic to low/true by means of a jumper placed between I/O Rack terminals marked H/L SEL (input polarity select) and DC COM. (See Figure 3.)

When high/true logic is selected, a high-level input having a voltage between 2.0 and 5 VDC is considered an ON state. When low/true logic is selected, a low-level input having a voltage between 0 and 1.4 VDC is considered an ON state. A summary of the state relationships is shown in Table C.

Table C

LOGIC STATES RELATIONSHIPS

Selected Logic	Signal State	Data Terminal (VDC)	Register Bit State
High/ true	high	5	"1"
	low	0	"0"
Low/ true	high	5	"0"
	low	0	"1"

5. An unused or unconnected data input terminal assumes a high-voltage level automatically.

6. Since there are no status Indicators, in order to determine the status of an input, measure the voltage at the I/O Rack's terminals or monitor the input register with a Program Panel.

7. The TTL device (which is frequently a transistor) that drives the input terminals must be capable of sinking a continuous current of 0.37 mA to ground.

PROGRAMMING NOTES

1. In order to assure that the input data will correctly appear in the Processor's input register, it must be present and stable for a given time. This factor is the elapsed time between a change of voltage level at an input terminal and a bit's corresponding change of state in a register, which is, to a certain extent, a variable. To determine this time, it is necessary to add the maximum

input converter response time to the time required by the Processor to make 1 scan.

A typical Processor scan time is about 10 ms for each 1000 words.

To determine the time factor, estimate the program scan time and the Module's response time.

2. Each data input contains an input delay circuit that increases the Module's noise immunity. The exact delay time varies among components, and thus an input register's bits may, for an intermediate period of 1 scan, at once contain older **and** updated data. Assuming no further input changes are made, all the data in the register is updated only at the next scan.

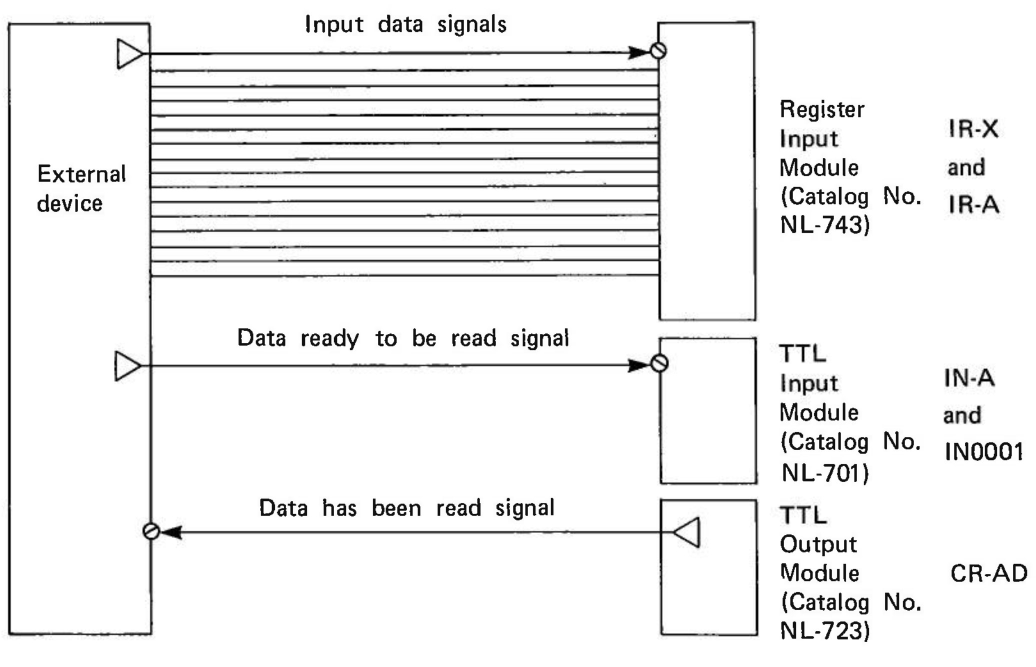
Normally this does not present a problem, yet there are applications where non-synchronized inputting may cause difficulty. If so, a form of "synchronizing signal" must be implemented either through hardware or the user program. Its function is to assure that the intermediate bit states would be ignored until the entire register is updated.

Handshaking functions for data synchronization are not provided by the Module. However see Notes 3 and 4 for equivalent hardware solution and typical program solutions.

3. One form of synchronization of input data is the use of additional hardware in the system. As shown in Figure 6(a), a TTL Input and a TTL Output Module (Catalog No. NL-701 and -723, respectively) are added to the I/O Rack. Here the external device outputs a signal to the discrete TTL Input Module to indicate that new data is ready/being transmitted. This triggering signal is sensed by the user program, which waits 1 scan before accessing the register which now contains the completely updated data. The program can then output a signal to the external device, through a discrete TTL Output Module, that the data has been read. (See Figure 6(b).)

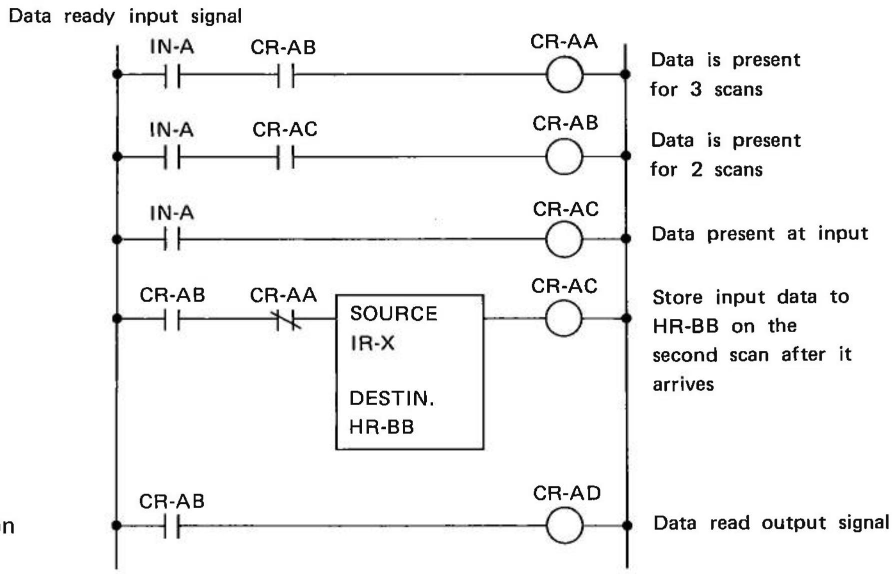
A variation is possible on this program. Note that the Processor reads all the discrete inputs **before** it reads register inputs. Thus there is a delay of between 1.5 to 4.8 ms to update all 256 I/O points. The delay may be used to assure that the new data has settled—that is, is completely updated in the register. See the typical timing diagram in Figure 6(c). Here the "data ready to be read" signal is connected to the discrete TTL Input Module at IN0001. It is available to the Processor—but **not** necessarily read by it—just earlier than, or at the same time as, the data input to registers. In this way the register data can be read off the "leading edge" of the data ready signal, as represented by the timing diagram.

A typical program for this arrangement is shown in Figure 6(d). Note that it requires that the data ready signal be OFF for at least 1 scan. The external device can use the "trailing edge" of the data-has-been-read output signal to indicate that the Processor is ready to read the next register data update. (Trailing edge here refers to the timing diagram representation.)

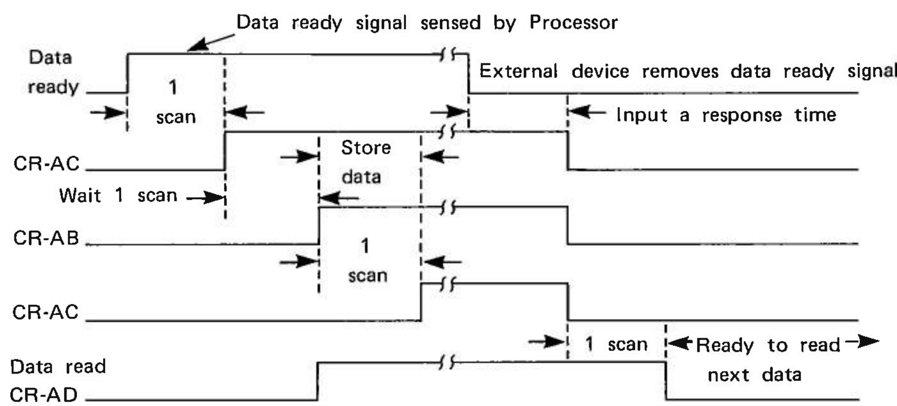


a) hardware

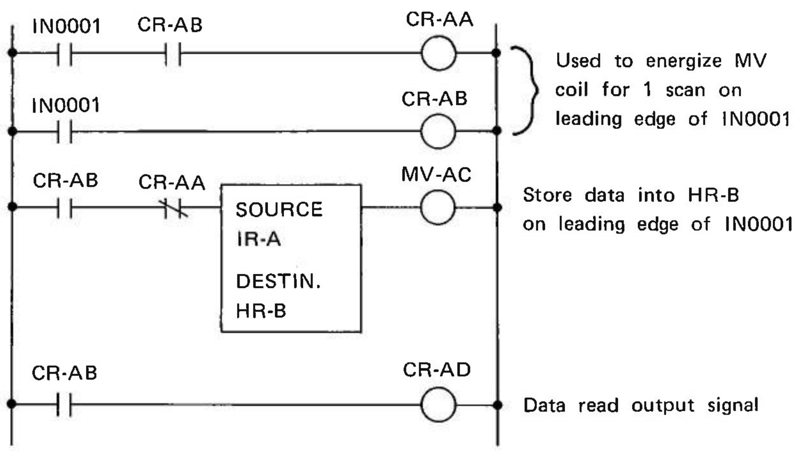
Figure 6 — Synchronizing Solutions



b) program solution



c) timing diagram



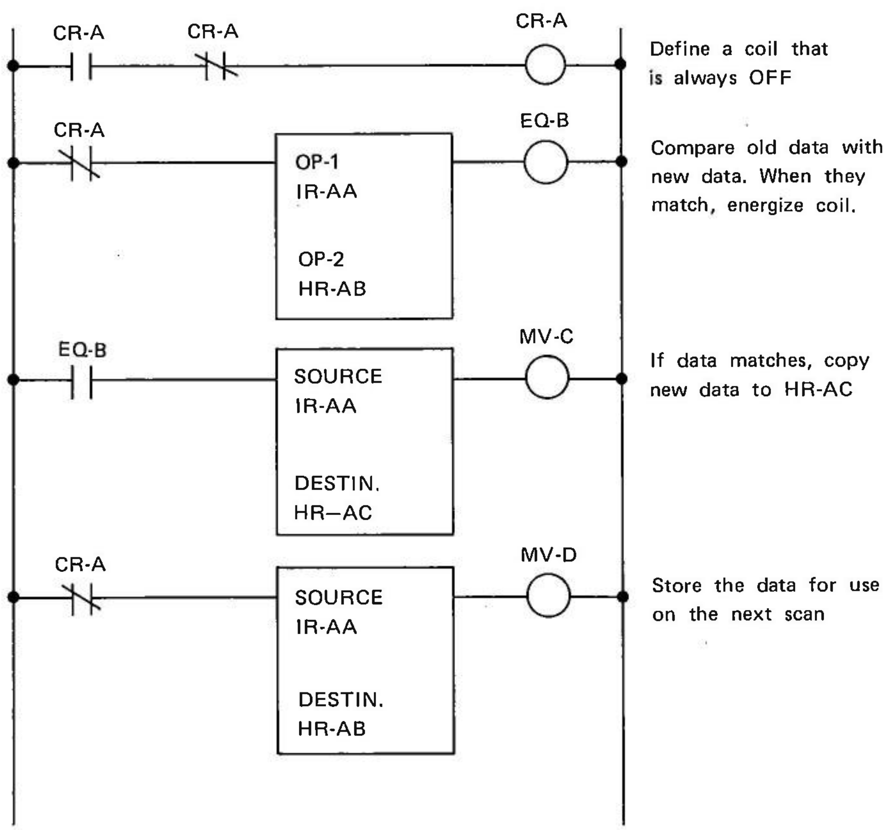
d) 1 scan delay program

Figure 6 — (cont'd.)

4. Another form of "synchronization" is through the user program in which rungs are written to assure that the new input data within a register has stabilized for 2 scans **before** it is made available to other Processor functions. A typical program is shown in Figure 7. (Note that if the EQ000X coil is de-energized for more than 1 scan, assume that input data is changing more rapidly than the Processor can accept.)

5. A typical connection diagram for a 4-digit BCD TTL-compatible device is shown in Figure 3(a). Note that the BCD data must be converted to binary form before it can be used by other Processor special function coils such as add, subtract, etc. (Use a DB function.) Also note that the DC common side of the device's output must be connected to the DC common side of the external power supply.

6. A typical connection diagram for a 4-digit BCD thumbwheel device is shown in Figure 3(b). Note that the BCD data must be converted to binary before it can be used by other Processor special function coils such as add, subtract, etc. (Use a DB function.) For most BCD thumbwheels such as the Catalog No. NLT-714, select low/true logic, and place a jumper between Terminals 22 and 24. For BCD complement thumbwheels in which the output signal is inverted within the device, maintain high/true logic by leaving Terminal 22 unconnected.



IR-AA = Input register assigned to the NL-743 Module. It contains the current data read from the Module.

HR-AB = Holding register that contains the data read from the Module last scan.

HR-AC = Holding register that always contains valid data. Contents are updated only when the old and new data match.

Figure 7 — Stabilizing Program (typical)

7. A typical connection diagram for any open collector or open drain output device (rated at 5 VDC) is shown in Figure 8. Typical connections for TTL, LP TTL, Series B CMOS with totem pole or resistor pull-ups operating at 5 VDC are shown in Figure 9. Devices that operate at more than 5 VDC are shown in Figure 10.

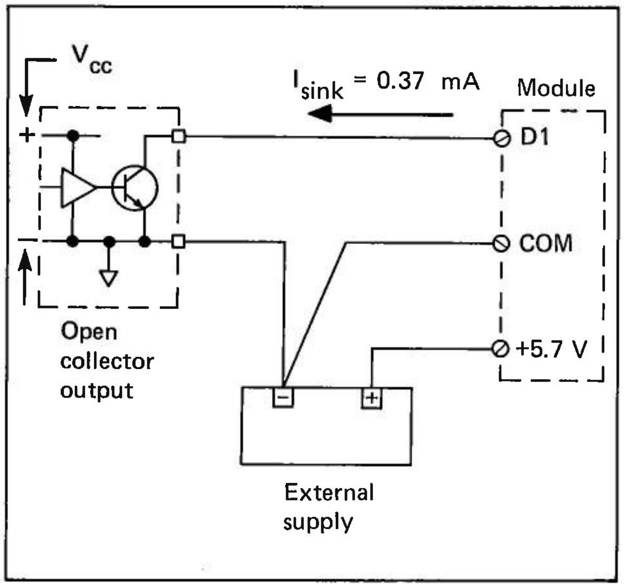


Figure 8 — Open Collector or Open Drain Connections

Note that in all 3 Figures the DC common side of the device's output must be connected to the DC common side of the external power supply. The logic of the input must correspond to the logic of the device's output. (Use a jumper for low/true logic, if necessary.) In Figure 10, note that the diode prevents high-level input voltages greater than 5.2 VDC from damaging the input circuitry

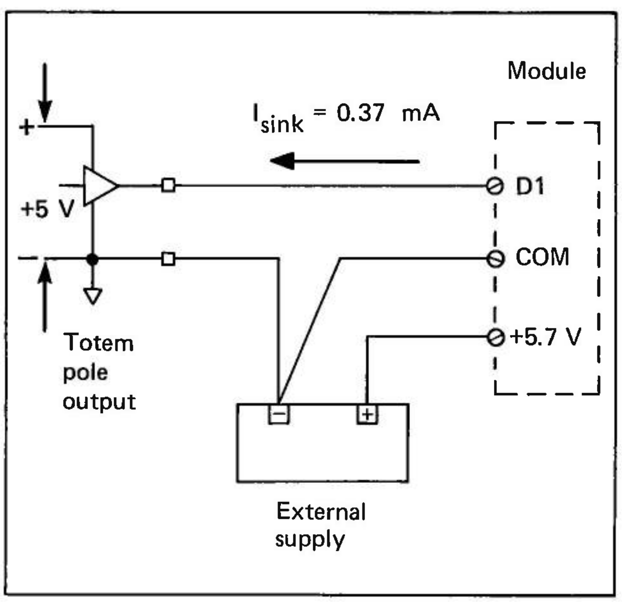


Figure 9 — LP TTL, LS TTL, Series B CMOS 5 VDC

while still allowing the signals to pass in a low-level state. (If, however, the output device is clamped at 5.2 VDC, or less, the diode is **not** needed.)

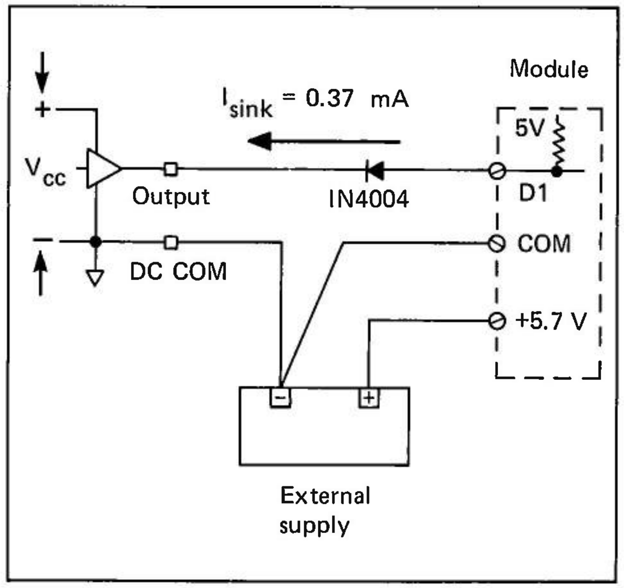


Figure 10 — Higher than 5 VDC Connections

CIRCUIT DESCRIPTION

This description provides a quick overview of the Module's major circuit components and their functions. It is **not** necessary to read this information in order to install or use the unit.

A highly simplified circuit of a single data input is shown in Figure 11. The response times are controlled by the R-C time constant: 3 ms ON, 5.5 OFF, nominal. The 15K ohm pull-up resistor causes an unconnected or unused input to "float" high.

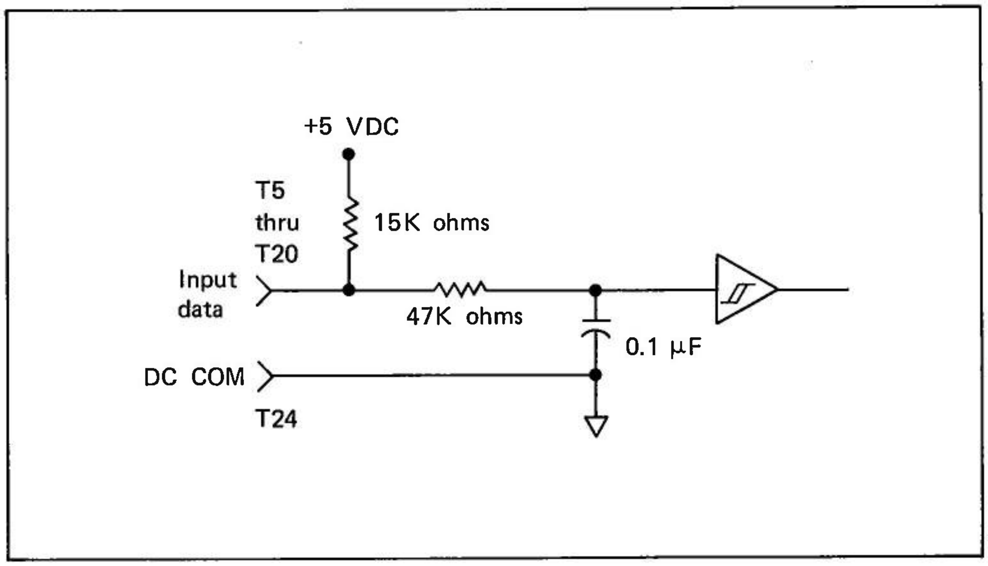


Figure 11 — Input Circuit Schematic (simplified)

Instruction Leaflet 15652
July, 1982

Westinghouse Electric Corporation
Automation Division
200 Beta Drive
Pittsburgh, PA 15238