Westinghouse

numa·logic

MULTIPLEXED REGISTER INPUT MODULE

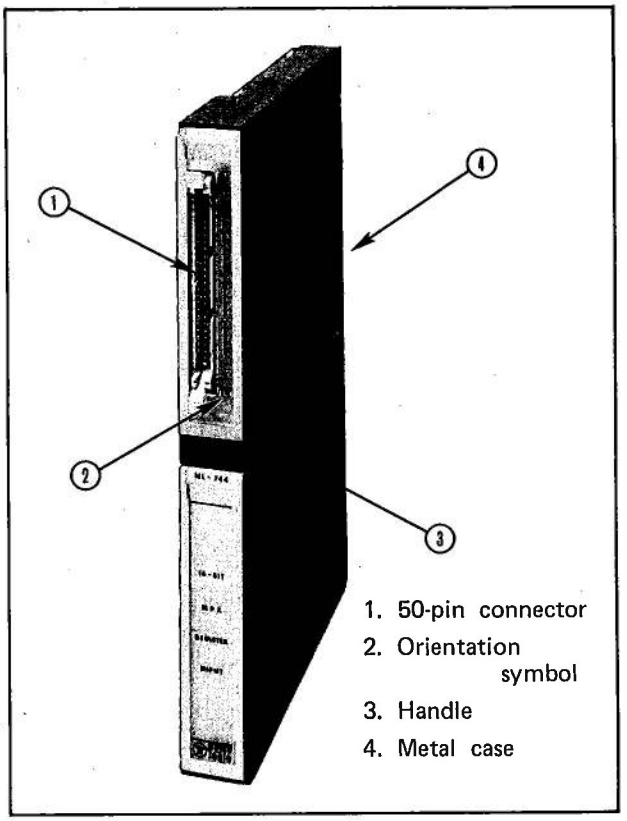
Catalog No. NL-744

PERFORMANCE DATA

Circuits per Module	8 or 16 (switch selectable)
I/O Rack Positions Req'd.	2
Data Inputs	TTL compatible (fan in of 1)
Input Voltage Range	-0.5 to +5.5 VDC
Input OFF Voltage (max.)	+3.5 to +5.0 VDC
Input ON Voltage	0 to +1.5 VDC
Select Outputs	TTL compatible low/true logic (fan out of 10)
Output Voltage Range (max.)	-0.5 to +5.5 VDC
Output OFF Voltage	+2.4 to +5.0 VDC
Output ON Voltage	0 to 0.8 VDC
Input Multiplexing Scan Time	200 msec (max.) for 16 inputs
Power Requirement	165 units (max.), Logic Power Supply (120 units typical) 0 units, Output Power Supply 1 external power supply
Opto Isolation	2500 V
Temperature Rating	0° to 60°C 32° to 140°F
Humidity Rating	0 to 95% noncondensing
Keying Slots	Between pins: 9 and 11 29 and 31

INTRODUCTION

The 16-bit Multiplexed Register Input Module is a microprocessor-based, multiplexing, 4-digit BCD device capable of accepting signals from 16 separate



1. 50-pin connector
2. Orientation symbol
3. Handle
4. Metal case

Figure 1 — Multiplexed Register Input Module

TTL-compatible field devices, each of which may use 16 lines, or "bits," to transmit data over a single data bus. These devices may be compatible types of thumbwheel switches, digital voltmeters, electronic counters and gauging instrumentation. After reading each of the 16, or fewer, field devices separately, the Module converts the input BCD data into binary data and sends this information to the Processor where it is used to update the related input registers. Each input device is sampled at least 5 times per second.

The 16 data inputs are TTL-compatible, low/true, fan in of 1. Together they form a 16-bit data input bus that carries the BCD data.

The Module also provides selection output signals that determine which of the field devices is to transmit on the data bus at a given time. The 16 select outputs

(SEL1 thru 16) are TTL-compatible, low/true, fan out of 10.

All inputs and outputs are optically isolated from the Processor.

The Module is a "double height" type. Recommended field wiring to it is by means of a cable/connector assembly available from Westinghouse. Also available are Thumbwheels, a quick-connect Distribution Panel and an external power supply. Together, these units offer fast installation without labor-intensive procedures. See Table A for more information and refer to Figure 2 where all of these devices are shown in relation to each other. (Alternately, users may wire to the Module, but proper procedures must be followed and restrictions must be observed.)

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

Since connection is made directly on the Module, no Terminal Identification Strips are supplied. The Module's Lenses are supplied without symbols.

INSTALLATION

Proper Sequence — This installation procedure is divided into two distinct parts. First, install, connect or wire all external field devices, but do not make a connection at the Module's 50-pin male connector. Second, after AC power can safely be applied to the whole system, voltage measurements must be taken before connecting to the Multiplexed Input Module. (This phase can be part of the start-up procedures.)

CAUTION

Make connections with the Multiplexed Input Module **only** after the electrical measurements, described later, have been made. Equipment damage can result if this sequence is not followed.

Wiring — These procedures assume that all the items available from Westinghouse and listed in Table A are being used in conjunction with the Module. If users choose to select other devices, they are responsible for making up their own installation procedures. Use the steps listed here when and if they apply. Refer also to Direct Connections later in this publication.

Note also that the following installation steps assume that all other devices that make up the multiplexing system are already installed. Follow procedures detailed in Instruction Leaflets supplied with each Westinghouse device.

Step 1 — Refer to the system drawings and determine the exact I/O Rack Positions in which the Module will be placed. (See Figure 4 for an explanation of "position.") Use a screwdriver to remove the terminal block adjacent to the top half of the Module. (It cannot be installed if the block remains in place. See Figure 3.)

Step 2 — Confirm the exact Positions the Module will occupy in the I/O Rack. (Although the Module can be placed in either the upper 2 Positions or the lower 2 Positions, it may not straddle Positions B and C. See

Table A

OPTIONAL RELATED DEVICES ①

Device	Catalog No.	Length (ft/m)	Publication ②
Thumbwheel Switch (plug-in type only)	NLT-715	-	15712
Thumbwheel Interface Board/Cable	NLTB-717A NLTB-717B	5/1.5 10/3	15713
Distribution Panel	NLDP-708 NLDP-716	-	15658
Distribution Panel Cable	NLC-10DP NLC-20DP NLC-30DP NLC-40DP	10/3 20/6 30/9 40/12	15717

① This listing represents all optional items Westinghouse offers to complete a multiplexing input system.

② These numbers identify Instruction Leaflets that explain each device.

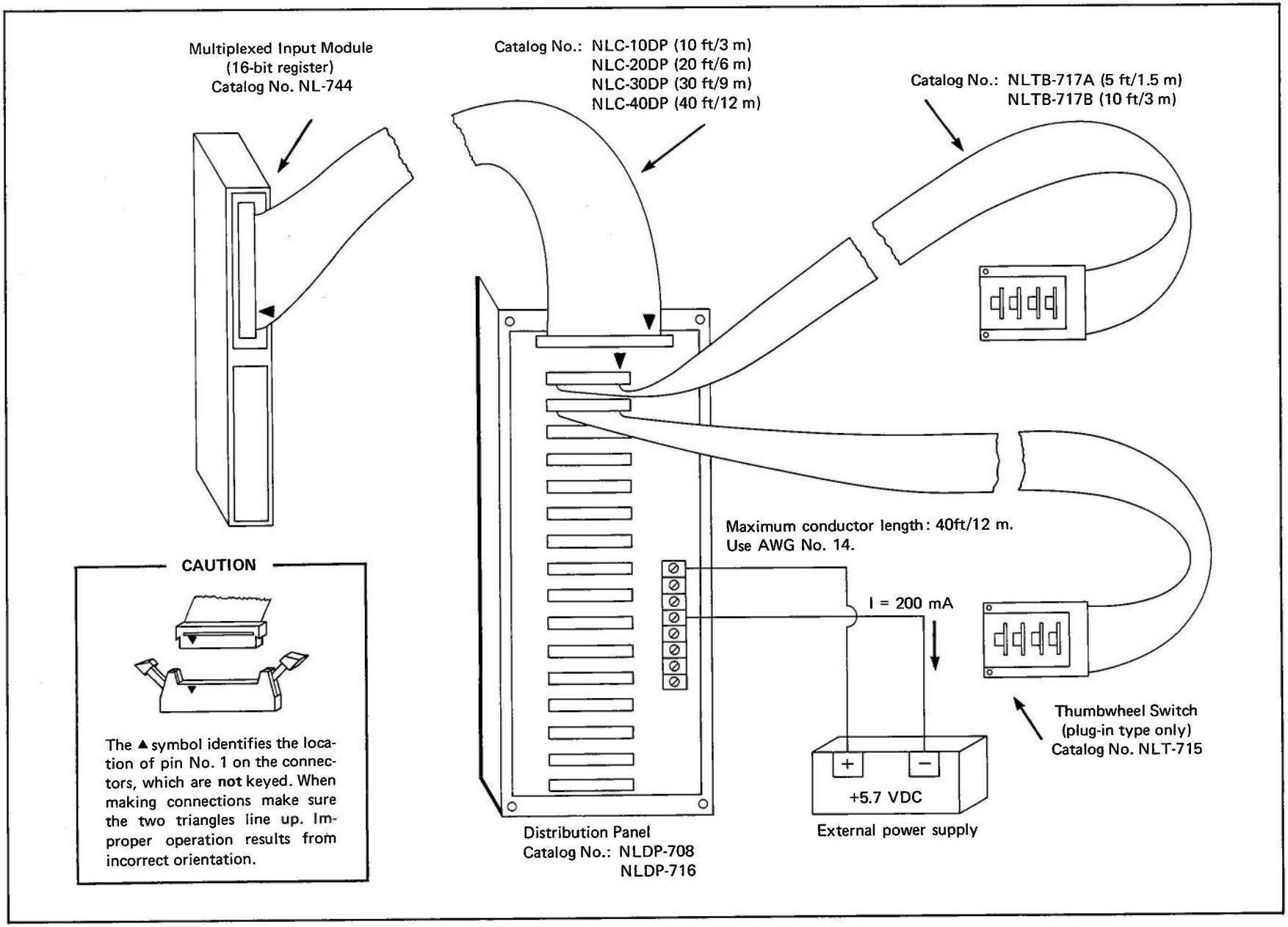


Figure 2 — Overall Relations of Devices

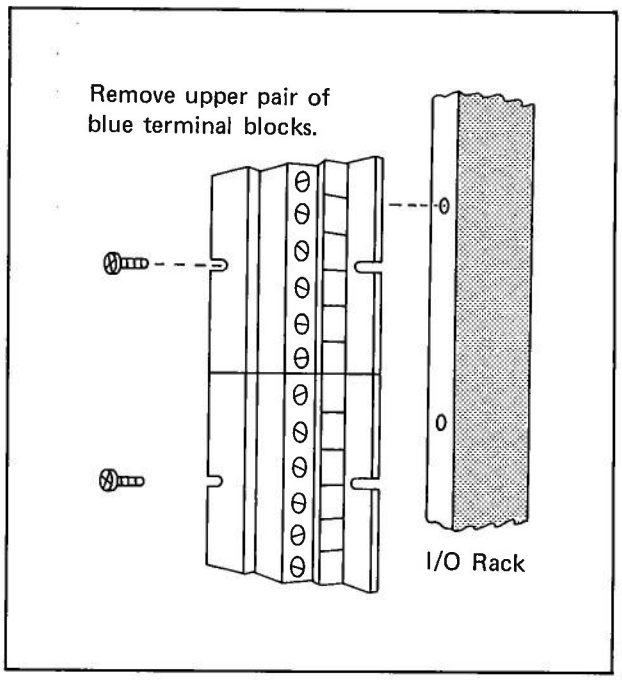


Figure 3 — Terminal Block Removal

Figure 4.) It is important that it be placed according to the user program Reference Number scheme.

Step 3 — 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 5.)

Step 4 — 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 pins on the Module align and mate with the Rack connector.

Step 5 — 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.

Switch Settings — In order to complete the installation of the Module, it is necessary to physically set individual rocker switches on the I/O Rack and the Module. Their combined function is to electronically identify each field device's input with a Reference Number required for programming. This explanation is detailed only to the level required by the installation team. (For further details, see the PC-700 and PC-900 Application Manuals and, also, Instruction Leaflet 15718.)

Step 6 — On the I/O Rack in which the Module is placed, locate the Rack Switch assembly. It is located at the top right-hand side. (See Figure 4.)

Step 7 — Place all 10 of the rocker switches on the assembly in the OFF position. (This setting assumes that **only** Multiplexed Modules are in the Rack. If other types of Modules are used in the remaining positions, see Application Note 1.)

Step 8 — Another rocker switch assembly is located near the rear edge of the Module. (See Figure 6.) It may be necessary to remove the Module from the Rack to see it.

It is necessary to set these switches according to input registers associated with this Module. Note that the Module can be set to accept up to 8 or up to 16 field device inputs.

Step 9 — Locate a list that relates field devices with directly corresponding Reference Numbers. The system drawings should show them. If not, contact the design engineer or programmer. The switches cannot be set without the list.

Step 10 — Identify all the Reference Numbers used with the Module. Relate these to Table B. Determine which switches are to be set to the OPEN/OFF position.

Step 11 — Set the Module Switches as indicated in the Table.

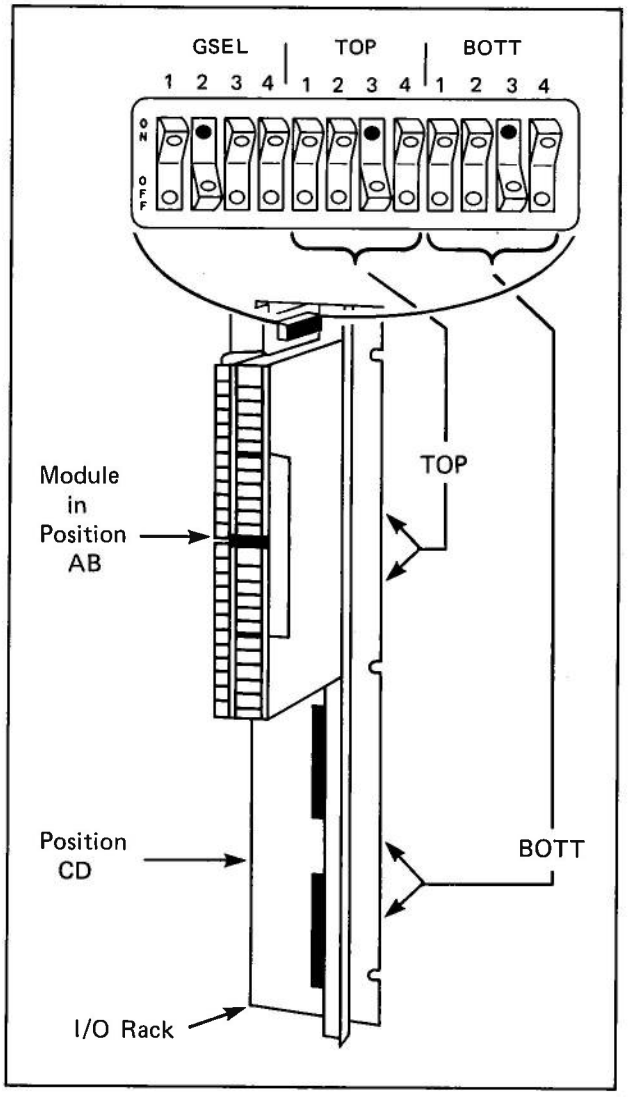


Figure 4 — Rack Switch Location

Note that the Module Switch assembly is not marked ON/OFF. The OFF position is marked OPEN on the top of the assembly. The CLOSED/ON position is nearer the printed circuit board.

Example: Input registers IR0009 thru 0016 are assigned to a given Multiplexed Input Module. What switch or switches should be set? Answer: put switch 2 in the OPEN/up position. (All other switches are to be in the CLOSED/down position.)

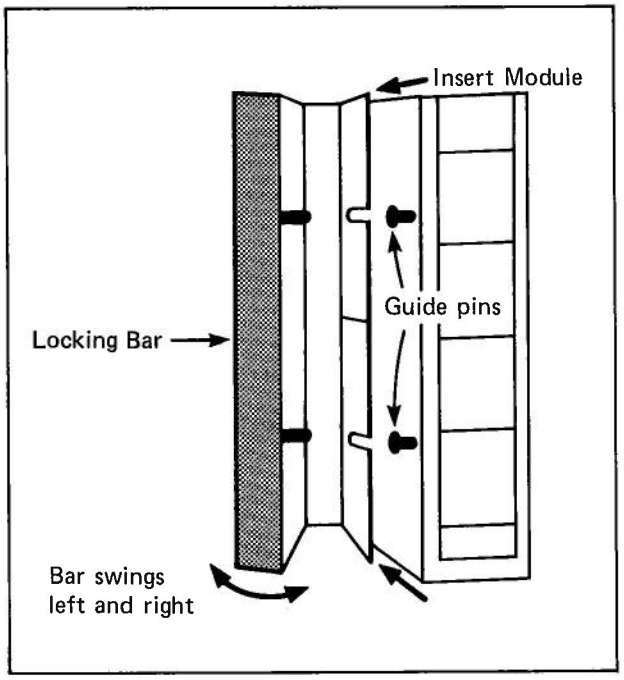


Figure 5 — Guide Slots

Voltage Measurements — Once the AC line power can be safely applied to the system, a number of voltage measurements must be taken to assure that the external power supply is outputting within a range that is acceptable to the Module. A digital voltmeter is required.

CAUTION

Do not connect the Distribution Panel Cable to the Module at this time. Damage could occur due to improper voltage levels.

Step 12 — Locate pin 2 (+5.7 VDC) and pin 16 (COM) on the connector of the Distribution Panel Cable. (See Figure 7.) Use a digital voltmeter to adjust the external power supply output voltage for +5.7 VDC (±0.05 V). Pin 16 should be negative with respect to pin 2.

Step 13 — De-energize the system, including the external power supply.

Step 14 — Connect the Distribution Panel Cable with the 50-pin male connector on the Module. Orientation is important! Be sure the molded plastic triangles on the connector and on the Module's Lens line up. (See Figure 8.)

Table B

MODULE SWITCH ASSEMBLY SETTINGS

Use:	If the Reference Numbers are:	Press OPEN ① Module Switch(es) ②
For up to 8 field devices	IR0001 thru 0008 IR0009 thru 0016 IR0017 thru 0024 IR0025 thru 0032	1 2 3 4
For up to 16 field devices	IR0001 thru 0016 IR0017 thru 0032	1,2 3,4

① Switch assembly is marked CLOSED; opposite position is OPEN = OFF.

② Any other settings are illegal. If such are used, the Processor ignores the Module's data.

Step 15 — Energize the system and measure the voltage between terminals 1 (Vcc) and 4 (GND) on TB1 of the Distribution Panel. (See Figure 9.) Terminal 1 should be positive with respect to terminal 4.

Step 16 — Adjust the output voltage to +6.06 VDC (±0.02 V). This level is sufficient to compensate for the voltage drop in the circuit, but it will not damage the Module, assuming the circuit uses the items noted in Table A.

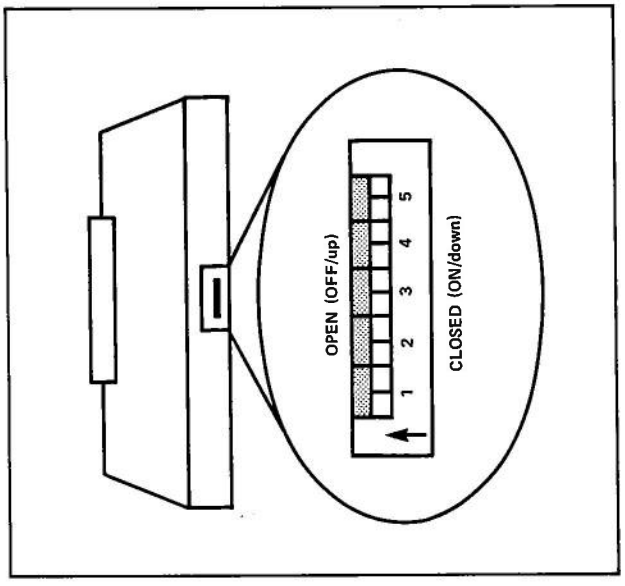


Figure 6 — Module Switches

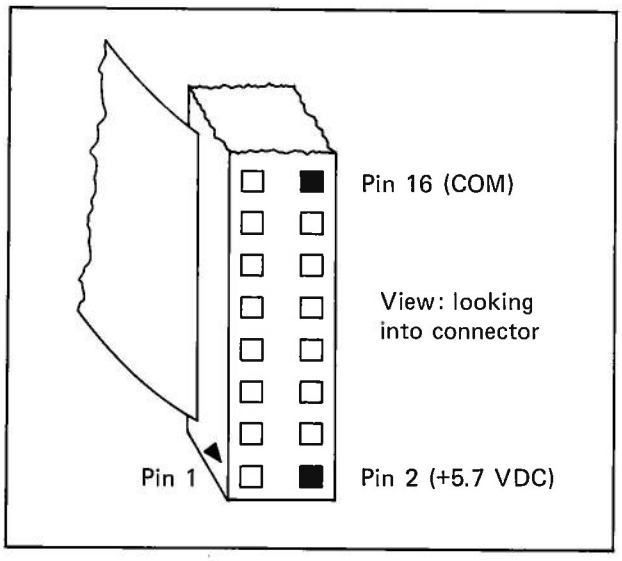


Figure 7 — 50-pin Female Connector on Cable

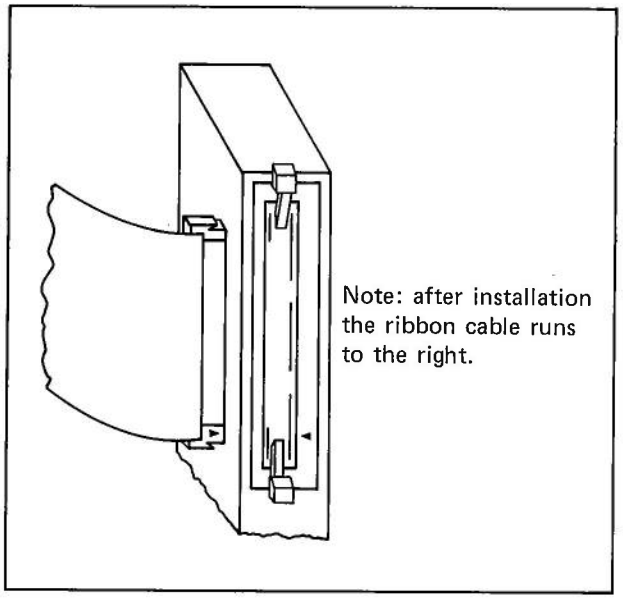


Figure 8 — Proper Connector Orientation

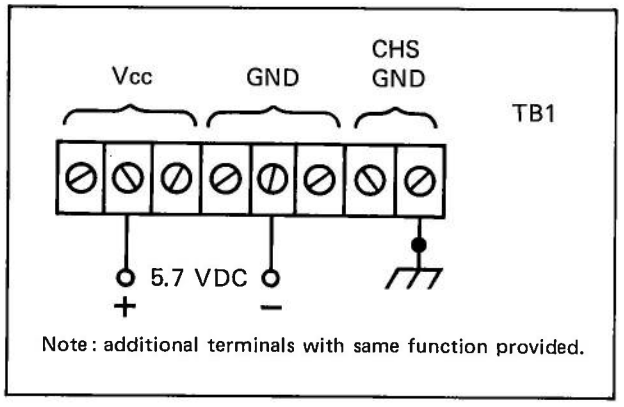


Figure 9 — Distribution Panel, TB1

DIRECT CONNECTIONS

It is possible to use the Multiplexed Input Module without the optional devices listed in Table A. However, the user assumes the responsibility for proper choice of equipment, wiring practices and overall caution. To assist with this process, a number of very general guidelines are listed here.

Guideline 1 — Read the installation steps listed earlier in this publication and use them as the basis of new procedures.

Guideline 2 — Although the 50-pin male connector could be used for direct connection, it is strongly recommended that the proper socket (connector) be purchased to make a trouble-free connection. The proper 50-conductor shielded cable is also recommended. (See Table C.)

Table C

PARTS LIST

Item Used:	Manufacturer	Part No.
Connector ("header") on Module	3M	3433-1022
Connector ("socket") on Cable	3M	3425-6000
50-conductor ribbon Cable	3M	3476/50

Guideline 3 — If a Westinghouse Thumbwheel assembly is to be used without other optional equipment listed in Table A, order a Catalog No. NLT-714 extended-pin type. (Its design allows for easier connection of user-provided diodes and individual conductors than the -715 unit.)

Guideline 4 — Follow the typical connection diagram shown in Figures 10 and 11. Also follow Figure 12 for connection at the Module end.

Guideline 5 — Use an A115A type diode on each signal line output from a thumbwheel in order to isolate one set from another. (See Figure 10.)

Guideline 6 — The signal conductors must be shielded. Connect the shield to pin 50 of the male connector on the Module. (See Figure 12.)

Guideline 7 — See Application Note 2 for power supply requirements. Observe Application Notes 4 thru 9 when selecting non-Westinghouse devices.

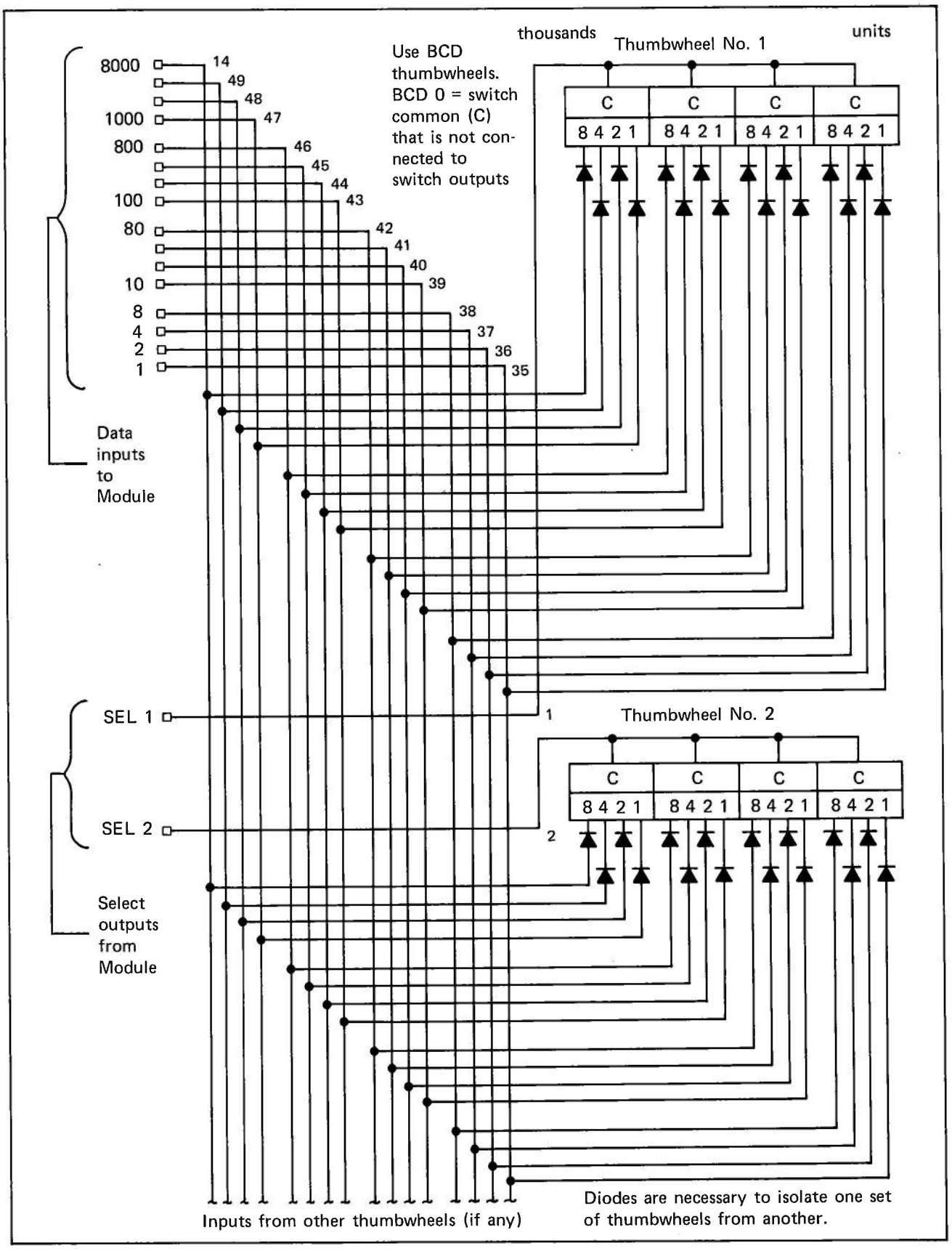


Figure 10 – Typical Thumbwheel Connection Diagram

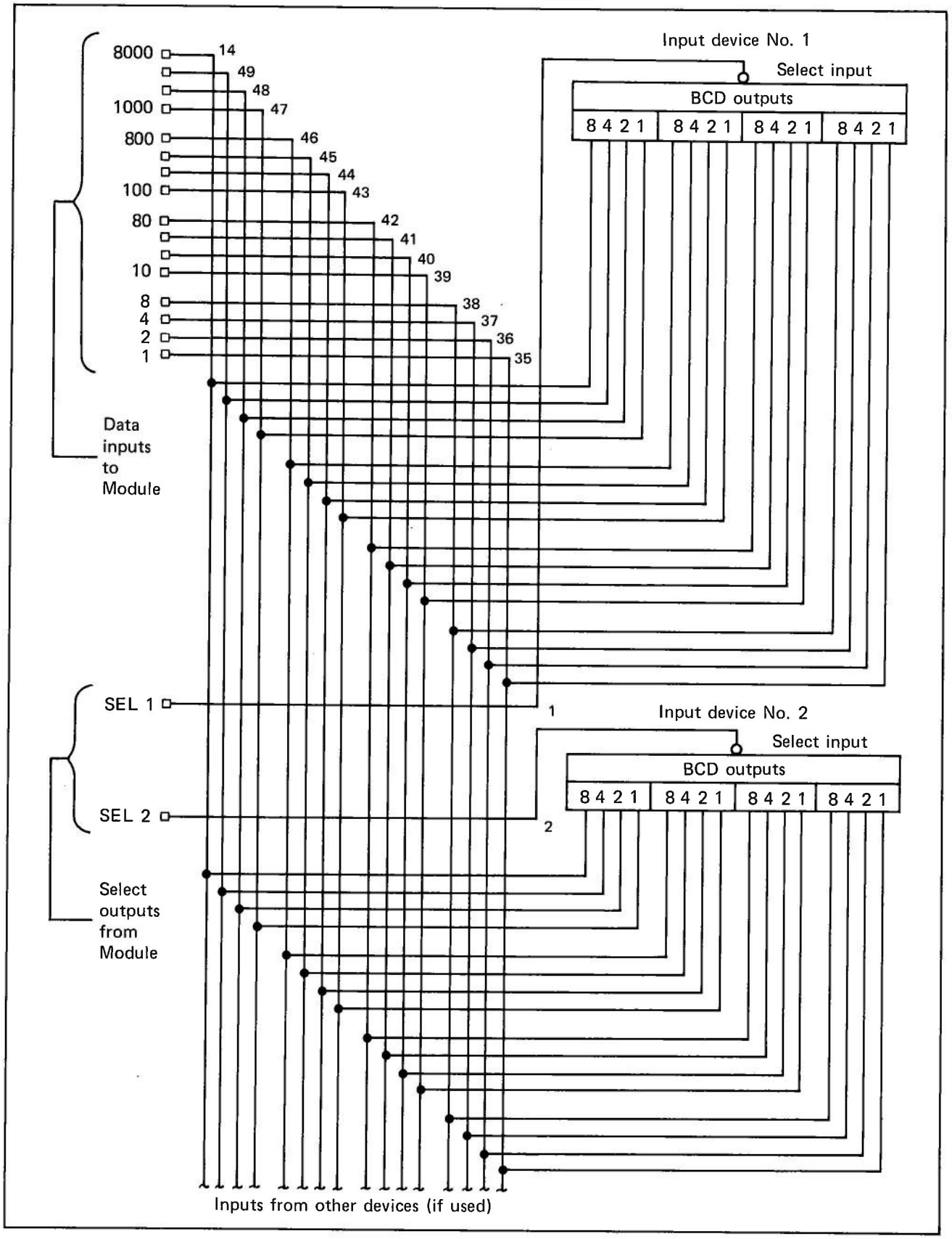


Figure 11 – Typical Non-thumbwheel Connection Diagram

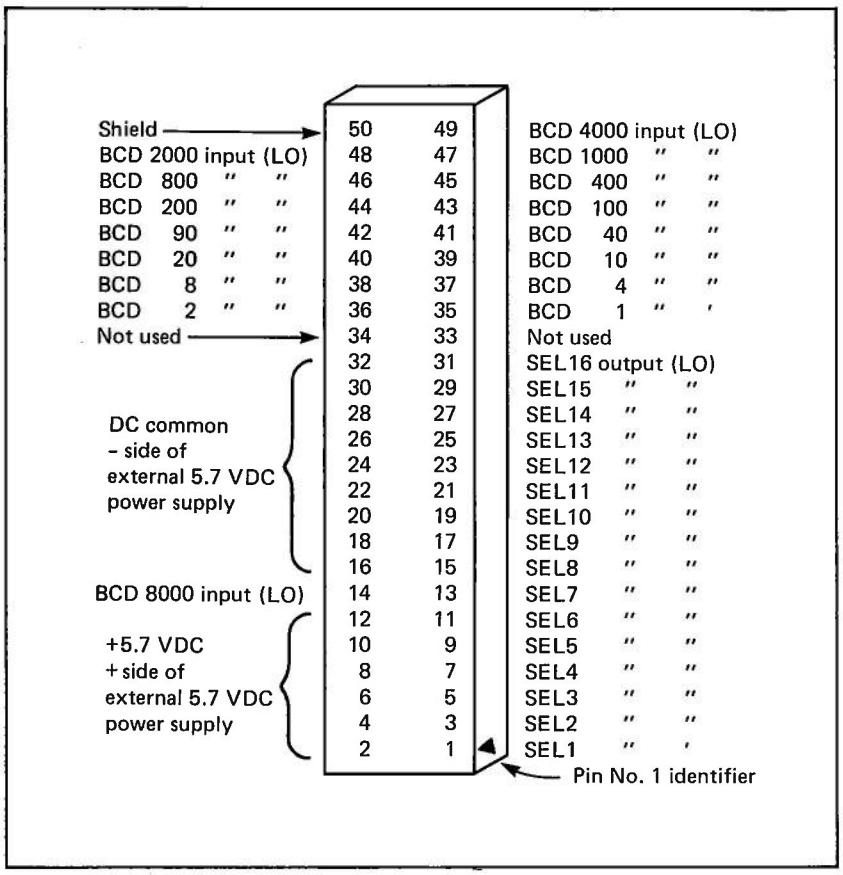


Figure 12 — 50-pin Male Socket on Module

APPLICATION NOTES

1. Switch settings noted in the Installation section of this publication are simplified because they assume only Multiplexing Modules are being used in an I/O Rack. However, it may be that other types of Modules—discrete or register—are also installed in the remaining Positions. If so, set the Rack Switches according to the needs of these Modules. (The Multiplexed Module continues to operate regardless of any—legal—settings.)

2. An external DC power supply is required to operate the Multiplexed Input Module. The Catalog No. NLPS-315, rated at 1.5 amperes, is acceptable and able to power 7 Modules. (For larger loads the -330 and -360 Supplies provide 3 and 6 amperes, respectively.)

The DC supply must be capable of providing +6.0 VDC (±0.25 V) and a current of 200 mA.

3. The external power supply must be connected to the **same** AC power line as the Processor. (This assures coordinated power-up and -down cycles. See Programming Notes 5 and 6.)

4. The Module accepts low/true data inputs only. (That is, 0 to 1.5 VDC is a Logic "1.") If the signals from a field input device are high/true logic, they must be inverted before reaching the Module.

5. The Module's select (SEL) output signals to the field device are low/true at the 50-pin socket. (That is, 0 to +0.8 VDC is a Logic "1.") If the field device requires a high/true input signal, provision must be made to invert the output signal after it leaves the Module.

6. Data signals input to the Module must be in BCD format. (The Module converts BCD into binary before making it available to the Processor's output register.)

7. The field device must be capable of disabling its outputs whenever the select (SEL) line to it goes high. If the Catalog No. NLT-715 Thumbwheel (plug-in type) is used, this function is performed by diodes supplied with the Thumbwheel Interface Board/Cable, Catalog No. NLTB-717A and -B.

Should other types of devices be used, it may be necessary to add diodes, open collectors, or tristate outputs, depending on the design.

8. Data from a field device must be put on the input bus and be stable within 1 ms after its corresponding select line goes low. It must remain stable until the select line goes high, at which time the field device must remove its data from the input bus.

9. There is no time delay from the deselection of one field device and the selection of a second device. For example, SEL1 goes high at the same time SEL2 goes low. (A timing diagram is shown in Figure 13.) The Catalog No. NLT-715 Thumbwheel meets this requirement. However, this may be an application consideration if other types of devices are chosen.

10. The Module's inputs and outputs are not designed to meet the IEEE Surge Withstand Circuitry Standard.

PROGRAMMING NOTES

1. The Multiplexed Input Module is not designed to be used with an I/O Update Immediate (UI) instruction.

2. Due to the required settings on the Module Switch assembly, it is necessary to assign input registers and Reference Numbers according to the groups listed in Table B. In other words, it would be unacceptable to use Reference Numbers IR0016 and IR0017 for individual field devices connected to a single Module. (Remember: 1 input register reflects the 16 lines, or "bits," from 1 field device; the device and its signals are given a unique Reference Number to identify it for the Processor.)

3. The relationships of input register numbers and select lines are shown in Table D.

4. An unconnected or unused input will be reflected in the Processor's corresponding input register as BCD 0000. (Data inputs are pulled high by the Module.)

5. If the external power to the Module is lost, yet the Processor continues to operate, the Module transmits zeros to all related input registers.

6. If AC power to the Processor is lost, yet the external supply continues to power the Module, the input multiplexer stops its operation, sets SEL1 output low and all other SEL outputs high. It continues in this state until the Processor resumes operation.

7. The Module automatically checks all incoming data for valid BCD coding. If an illegal number is detected, this data is ignored and is neither converted nor stored. The last-sent valid data remains unchanged. (No error indication is given. See Table E for a listing of valid and invalid input codes.)

8. The field device selection and reading sequence is fixed. The Module reads each in order regardless of the number of devices connected or the settings of the Module's switches. The maximum scan time for reading all 16 inputs is 200 ms, but it can be as short as 56 ms.

9. For increased noise rejection, the input circuit has a delay network with a response time of about 1 ms. Any noise shorter than this will be ignored.

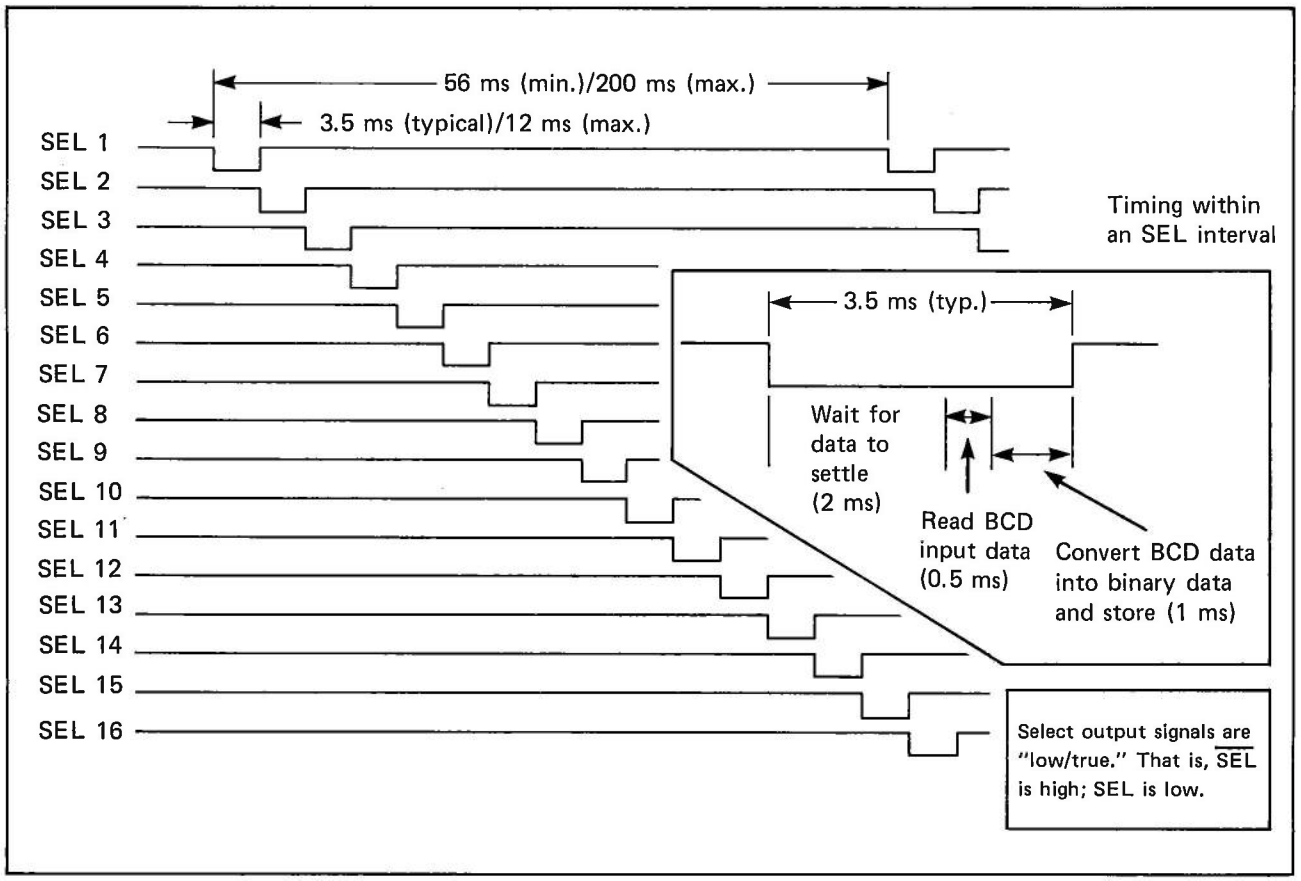


Figure 13 – Module Scan Timing Diagram

10. It is possible that the settings of the thumbwheels or other devices can change when the select line is low and the device has access to the data bus. It is possible that intermediate, and therefore invalid, data could be transmitted, although the probability is small since only 0.5 ms is required to sample all 16 input signals (lines) from a given device.

Consider also that changing all 4 digits of a thumbwheel assembly takes time—usually longer than the 200 ms (max.) scan time of the Module. Because the intermediate positions do not represent the desired settings they are, in effect, invalid inputs.

It is the user's responsibility to determine whether either of the above conditions affects the application and then to act accordingly.

At least one typical method of dealing with either condition is to add an external push button to the system in order to signal when data set on the thumbwheels is valid. This technique also requires a holding register. The input register is used as a temporary storage location; the holding register contains the valid data and is accessed by the user program. Here the push button signal initiates the transfer from the input register to the holding register.

11. The Module's input multiplexer is not synchronized with the scanning of the Processor, but is completely independent of it. This means that the order of input changes may not be carried over into the input registers.

For example, while the Module is reading input device 2, data from devices 1 and 3 simultaneously change. Data from device 3 will be reflected in the Processor 1 scan time plus 12 ms later. The change from device 1, however, will not be reflected until the multiplexer completes its scan, returns to device 1 some 200 ms plus 1 scan time later.

Table E

LEGAL/ILLEGAL CODES

	Digit	BCD Code bit value: 8 4 2 1	Voltage Level ① bit value: 8 4 2 1
valid input codes	0	0 0 0 0	H H H H
	1	0 0 0 1	H H H L
	2	0 0 1 0	H H L H
	3	0 0 1 1	H H L L
	4	0 1 0 0	H L H H
	5	0 1 0 1	H L H L
	6	0 1 1 0	H L L H
	7	0 1 1 1	H L L L
	8	1 0 0 0	L H H H
	9	1 0 0 1	L H H L
invalid input codes	10	1 0 1 0	L H L H
	11	1 0 1 1	L H L L
	12	1 1 0 0	L L H H
	13	1 1 0 1	L L H L
	14	1 1 1 0	L L L H
	15	1 1 1 1	L L L L

① L = low = 0 to 1.5 VDC
H = high = 3.5 to 5.0 VDC

Table D

DEVICE-REGISTER ASSIGNMENT RELATIONS

Groups ①	Select Outputs in Relation to Input Register Assignments															
Input Registers:	SEL1	SEL2	SEL3	SEL4	SEL5	SEL6	SEL7	SEL8	SEL9	SEL10	SEL11	SEL12	SEL13	SEL14	SEL15	SEL16
IR0001 - 0008:	0001	0002	0003	0004	0005	0006	0007	0008								
IR0009 - 0016:	0009	0010	0011	0012	0013	0014	0015	0016								
IR0017 - 0024:	0017	0018	0019	0020	0021	0022	0023	0024								
IR0025 - 0032:	0025	0026	0027	0028	0029	0030	0031	0032								
IR0001 - 0016:	0001	0002	0003	0004	0005	0006	0007	0008	0009	0010	0011	0012	0013	0014	0015	0016
IR0017 - 0032:	0017	0018	0019	0020	0021	0022	0023	0024	0025	0026	0027	0028	0029	0030	0031	0032

① These groups correspond to Table B.

12. System response time is, to a certain extent, a variable. (System response is defined as the amount of time required, after a change in voltage level at a field input device, for a corresponding change of state in the related input register.) To determine this time, add the fixed input circuit delay of 1 ms to the maximum multiplexer scan time of 200 ms and add the specific Processor scan time, which is 10 ms for each 1K words of memory.

Note that this figure is a maximum time, and in many cases may be shorter.

13. If a faster response time is required by the application, it may be necessary to use a Register Input Module, Catalog No. NL-743. (See Instruction Leaflet 15652.)

FUNCTIONAL THEORY

Power Requirements — Regardless of whether the PC-700 or PC-900 Processor is used, the Module's "processor" circuitry uses 165 units (maximum) of power from the Logic Power Supply. (The power used for the field side of the Module originates in the +6.0 VDC external power supply.)

To achieve coordinated operation during power-up and power-down phases, both the external supply and the Processor should be connected to the same AC line.

Power Up, Down — During the power-up cycle, the Processor initiates a series of special I/O scans to allow all input modules to power up, to stabilize and to transmit terminal status to the Processor. Only after this cycle does the Processor begin its normal scan of the user program, at which time data is accepted from the Multiplexed Input Module.

When power is removed from the Processor, it detects the decaying voltage and stops scanning the user program before voltage is so low that improper I/O Module operation or invalid data occurs.

MAJOR CIRCUIT COMPONENTS

General — This discussion, and those that follow, need not be read in order to install the Module. Because of the critical-time element frequently involved in process control, the information may assist the programmer.

Multiplexing, or the sharing of a single data bus in order to input data to the Module, is a process that requires repeated sampling of field device settings (outputs) in a cyclical manner. This process may be thought of as a "scan." Since time is involved, there is a "scan time," or "cycle time" factor, which is 200 ms, maximum, for this Module with 16 devices. There are 3 major components, as shown in Figure 14. These are:

- Input multiplexer
- Data converter
- Output multiplexer

Input Multiplexer — The input multiplexer controls device selection and signal-reading functions. Specifically, it commands, in progressive order, each connected field device to transmit current data to the Module; after a 2 ms wait, it reads the data.

Since up to 16 field input devices are connected to a 16-line data input bus, it is necessary to sample in an orderly fashion individual devices. To effect this arrangement, the Module outputs 16 separate select outputs (SEL1 thru 16) to command the device to transmit the current data. The order is a numerical progression from 1 thru 16, and all 16 devices are read each cycle, unless 8 are switch selected. (A BCD 0000 is transmitted for each unconnected device.)

For this reason the chosen field device must be capable of disabling its outputs to the bus until the SEL signal, which is "low/true," enables it. This function is usually accomplished through the use of tristate or open-collector outputs on each device.

About 2 ms after a SEL signal is transmitted, the Module, assuming that the device has responded, reads data from the bus.

Since the data inputs of the Module have a propagation delay of about 1 ms, field device data must be present and stable on the bus **within** 1 ms after a device SEL line goes low. This data must be maintained on the bus until the line goes high, at which time the field device must immediately disable its output. There is no delay between individual SEL signals. (See Figure 13.)

Data Converter — The data converter validates incoming data. The check occurs immediately after the Module reads individual data. Each group of 4 BCD digits is examined for a valid code. (See Table E where a listing of acceptable combinations is shown.) If a given group is determined to be invalid, it is ignored. (No conversion nor storage occurs.)

If all digits are valid, the 4-digit BCD number is converted to a 16-bit binary number and temporarily stored in one of 16 on-board memory locations.

Output Multiplexer — The output multiplexer makes available the binary data stored in the on-board memory to the Processor's I/O update scan. (It transmits 1 word at a time, or 16 bits of information, which is the equivalent of the contents of a single input register.)

Since as many as 16 input registers may be assigned to the Multiplexed Input Module, the output multiplexer must be commanded by the Processor to transfer data according to the input register update progression.

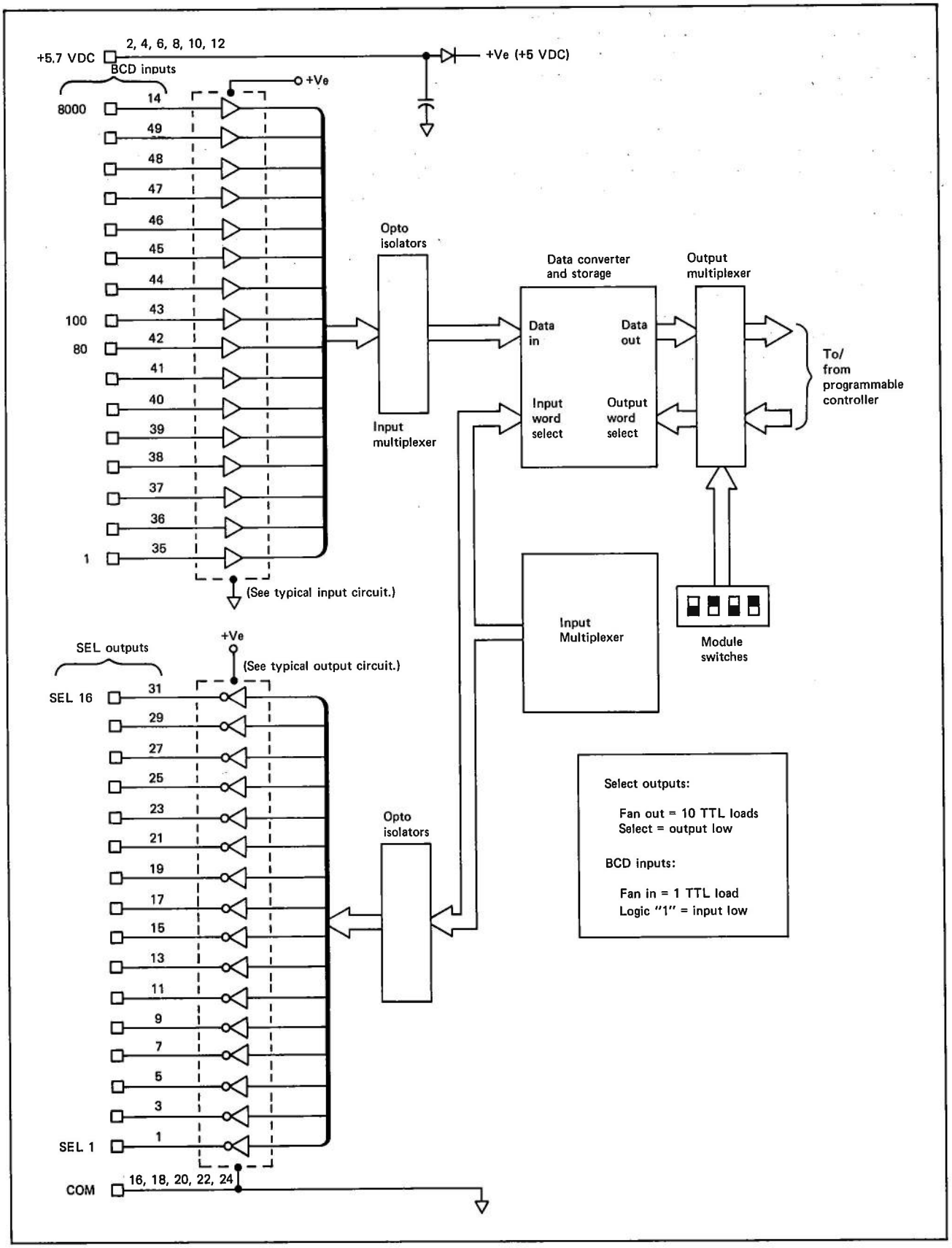


Figure 14 — Input Circuit (simplified)

Switch settings on the Module electrically distinguish it from other Register or Multiplexed Modules. They also relate field inputs to specific input registers and specify the number of field devices connected. (The 2 settings are up to 8 and up to 16.)

Should the Processor lose power, but the external power supply maintains normal operation, the Module stops its own "scan" of the field devices. Also it sets one of the SEL lines to a continuous low state. Only after the Processor resumes normal operation will the Module's "scan" be resumed.

External Supply — If the external supply loses power while the Processor continues to operate, the Module transmits binary zeros to the input registers. When power is restored, there can be about 2 Module "scan" cycles when invalid data is transferred.

CIRCUIT DESCRIPTION

A simplified schematic of a typical input circuit for the Module is shown in Figure 15(a). Note that the logic levels for the CMOS input are: high = +3.5 to +5.0 VDC; low = 0 to 1.5 VDC. The circuit is directly compatible with 74 or 74S Series TTL (fan in of 1) and with the 74LS Series (fan in of 3). The 100K resistor and 0.01 μF capacitor form a noise-rejection delay network.

A highly simplified select output circuit is shown in Figure 15(b). It is a standard TTL type with a fan out of 10 TTL loads. The output voltage levels are:

- High = +2.4 to 5 VDC, 400 μA source
- Low = 0 to 0.8 VDC, 16 mA sink

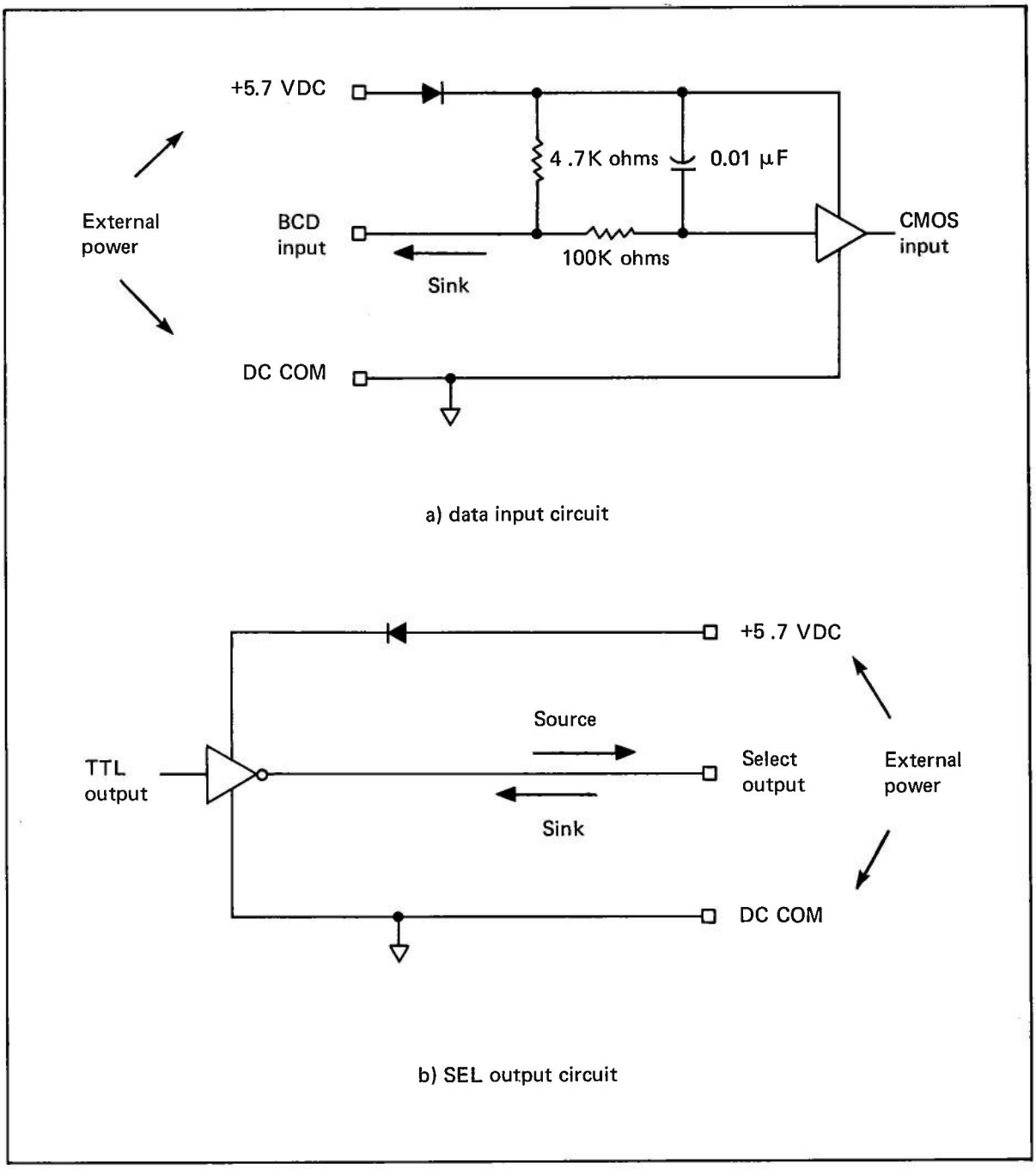


Figure 15 — Schematic Diagram (simplified)

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