7. RWC REAL-WORLD INTERFACE MODULES

7.1 GENERAL SPECIFICATIONS

A "Real-World" module is a connection between the digital world of DCE microcomputers and the real-world analogue voltages, heavy currents, noisy industrial signals, data communication, contact closures and other real-life phenomena. The designer simply inserts these RWC modules in any combination up to 15, along with a DCE microcomputer module and a DCE power supply module into a parallel wired DCE eurocard rack, for realization of his hardware requirements.

Each Real-World module is a specific realization of a DCE-BUS Compatible Module as explained in Section 4. 3.

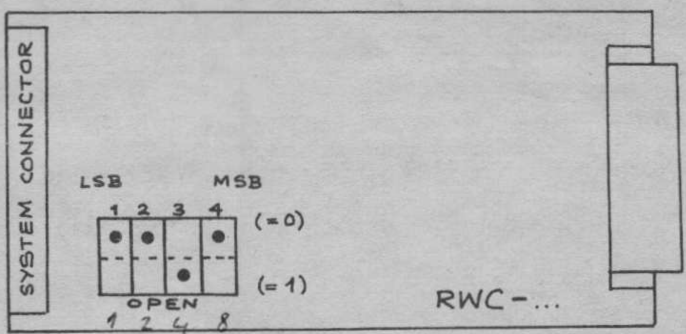
7.1.1 MODULE ADDRESSING

Out of the 8 lines allocated on the DCE-BUS for card and device addressing, 4 are used for the specific card address. In some RWC modules, the other 4 lines are used for addressing data devices (registers) on that module.

Each RWC module has a hexadecimal switch for selecting the identification address. Card Address Decode Logic on each RWC module compares the setting of its switch with the 4 card address lines (from DCE GIC Port 1 Bits 4 to 7), and enables the module if the two are equal. This configuration allows up to 15 RWC modules to be directly connected to the DCE-BUS. Each RWC module must have a unique address setting from 1 to F. Address setting zero should not be used. Address F is normally used by the PROM Programmer Card.

A rotary or a DIP hexadecimal switch is normally used in the RWC modules for address selection. The rotary type switch has a shaft with 16 positions marked from 0 to F. Different switch settings are selected by turning the shaft with a small screw-driver.

The DIP type switch has 4 rockers each corresponding to a binary digit. The 16 possible settings of the 4 rockers define a hexadecimal address in the range 0 to F. One side of each rocker is marked OPEN or OFF and the other side is marked with a number in the range 1 to 4. The end marked 1 corresponds to the least significant binary digit, and the end marked 4 corresponds to the most significant. Each rocker pushed down towards the side marked OPEN or OFF represents a binary 1 in the 4-bit module address. For example, address 4 is selected by pushing down the two rockers at the ends marked 2 and 4, as shown in the diagram below:



(address =

• indicates ends which are pushed down

Note: In case the markings on the DIP switch are different from those mentioned above, the rockers must be set to the corresponding positions as indicated in the diagram above.

A Bus Expand signal (from DCE GIC Port 2 Bit 0) is provided to allow the realization of large systems, by doubling the number of RWC modules that may be driven by a single DCE processor module.

It can be used as an extra addressing line to switch between two banks of RWC modules, each of which responds similarly to the Card/Device addresses. For example, when the two banks are in two separate racks, an inverter can be installed for the Bus Expand signal on the DCE-BUS connection between the two banks.

In normal small system usage, this signal may be used to disable the address decode logic on all the RWC modules on the DCE-BUS while they are inactive. Such an arrangement will prevent the accidental activation of modules, especially during address switching.

7.1.2 DCE-BUS - RWC MODULE INTERFACE

All RWC modules present a standard hardware and software interface to the DCE-BUS. This interface is usually implemented via a Real-World Interface Controller RIC, which is exactly the same type of device as the GIC on DCE processor modules. See Section 2 for complete specifications.

The 3 ports on each RWC module RIC are usually dedicated to specific tasks, and have to be configured in a pre-defined mode. Specific details for each RWC module are given in their specifications.

Software Controlled Read and Write Operations

A Read operation transfers data from a selected register of the addressed RWC module to a CPU register of the DCE processor, via the DCE-BUS. A write operation transfers data in the reverse direction. See Section 4.1 for full details.

Software controlled Read and Write operations are easily performed via the standard DAI subroutines RDRWC and WRRWC. Listings of these subroutines are given in Section 7 of the DCE-DM Development System Users Manual.

In order to read or write to a register on a RWC module, the module address must first be set up in DCE GIC Port 1. For read operations, this should be followed by a Call to subroutine RDRWC, at the end of which the data will be read into CPU register A of the DCE processor module. Similarly, a Call to subroutine WRRWC will transfer the contents of the Accumulator to the selected register of the addressed RWC module.

Note that all the DCE GIC macros can be used only for communication between the CPU and the GIC on the DCE processor module. For mode configuration and data input/output to the RIC on a RWC module, the above Read and Write sequences must be utilized.

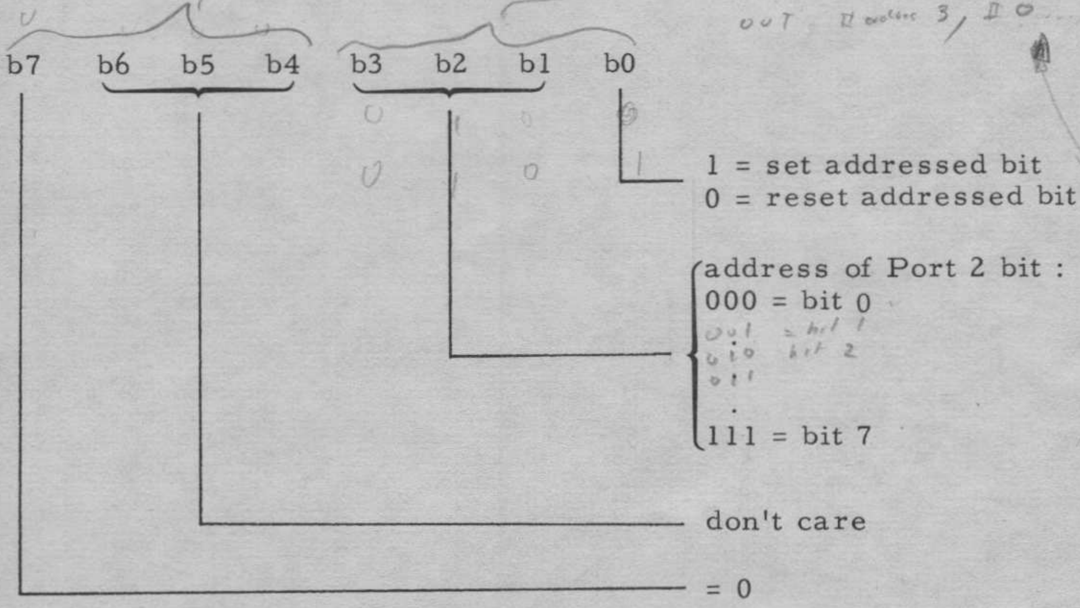
See Section 7.2.4.2, under RWC-F module Programming Specifications, for a summary of control words for RIC configurations. For example the following software will configure RIC Port 0 and Port 2 Bits 4-7 as output, Port 1 and Port 2 Bits 0-3 as input, in a RWC module with address select switch set to 'E' :

```
MVI     A,0E3H
STGI    1           selects RIC Command Register
MVI     A,83H
CALL    WRRWC       configures the RIC ports as specified.
```

After the RIC has been suitably configured, compatible Read and Write operations can be performed on the ports. Ports programmed as output can be read back if desired, for checking the signal status at their pins. The following software example will read Port 2 Bits 0-3, and then output data to Port 2 Bits 4-7:

```
MVI     A,0E2H
STGI    1          selects RIC Port 2
CALL    RDRWC      reads Port 2 into register A (disregard
                   bits 4-7, giving status at pins for bits
                   4-7).
store data
MVI     A,data     Bits 4-7 = data
                   Bits 0-3 are irrelevant
CALL    WRRWC      write data
```

Any of the eight bits of RIC Port 2 can be individually Set or Reset using a single software sequence. Here too the DCE GIC macros BSET and BCLR cannot be utilized. Individual bits of RIC Port 2 can be manipulated by writing the following control word to the RIC Command Register:



The following software example will set RIC Port 2 Bit 3 of a RWC module with address select switch set to 'E':

```
MVI     A,0E3H
STGI    1          selects RIC Command Register
MVI     A,07H
CALL    WRRWC      writes control word to set Port 2 Bit 3
```

When RIC Port 0 is configured in Handshake Input or Handshake Output modes, the free bits (4-7) of Port 2 can only be changed via the above procedure.

7.2 RWC-F : FOUNDATION MODULE

7.2.1 FUNCTIONAL DESCRIPTION

The RWC-F Real-World interface module enables the User to interface custom designed circuitry to the DCE-BUS, via 24 programmable I/O lines provided on each module. It has a 100 x 110 mm free card area with a pre-drilled 2.54 mm (0.1 inch) IC grid. This area is available to the User for installing wire-wrap sockets or any components with standard 2.54 mm lead spacing.

Each module has an identification address defined by a hexadecimal switch, and up to 15 modules may be directly connected to the DCE-BUS.

7.2.2 FEATURES

° 100 x 110 mm free card area with pre-drilled 0.1 inch IC grid for prototyping.

° three 8-bit ports programmable for simple handshaking or bi-directional operation.

° automatic generation of handshake signals.

° standard hardware and software interface to the DCE-BUS.

° selectable card address.

° single 100 x 160 mm eurocard format.

7.2.3 FUNCTIONAL BLOCK DIAGRAM

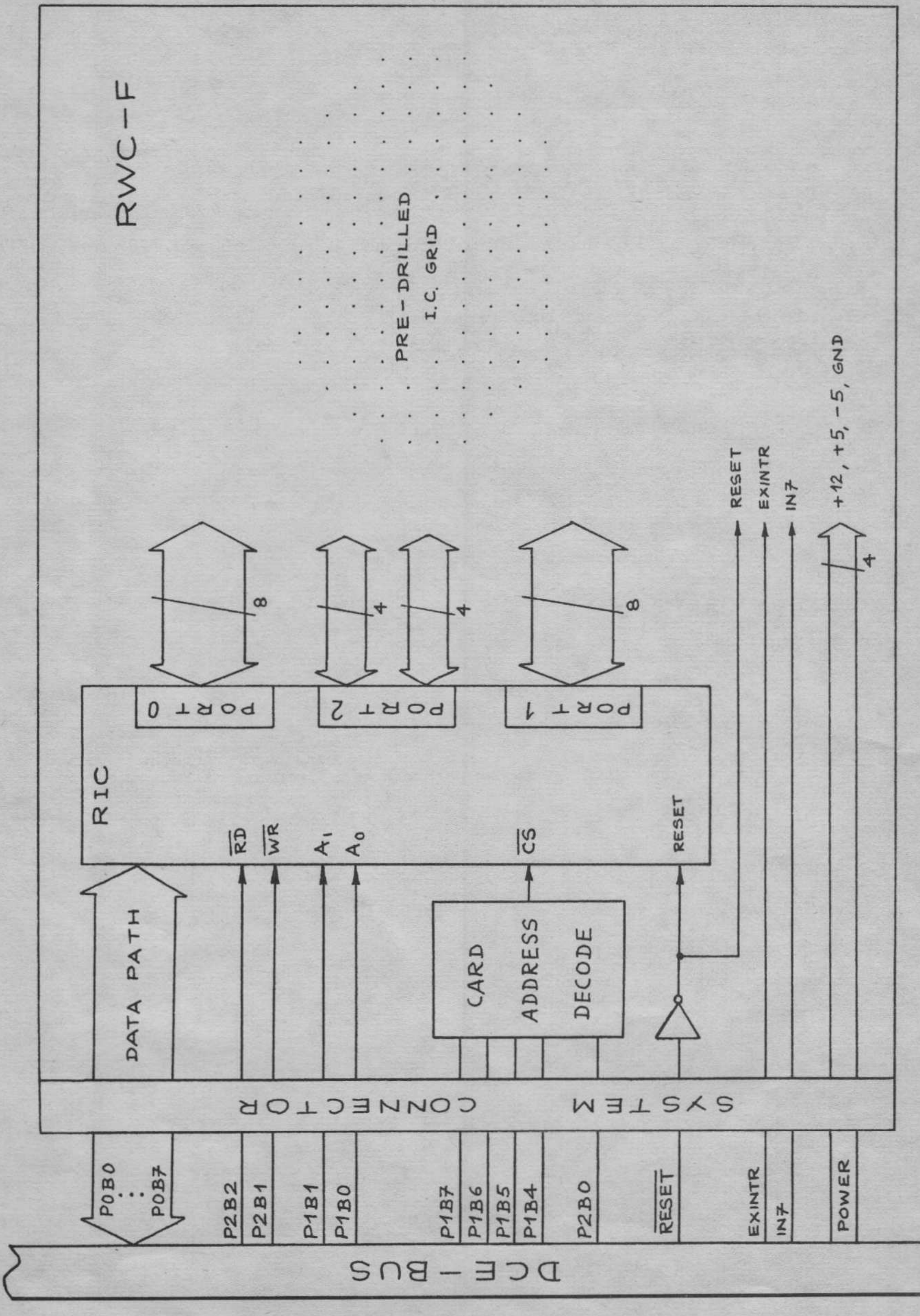


Figure 7.2.1 : RWC-F Block Diagram

7.2.4 SYSTEM DESIGN PARAMETERS

7.2.4.1 Hardware Configuration

The functional block diagram in Figure 7.2.1 illustrates the hardware configuration of the RWC-F module. The 24 programmable I/O lines from the three RIC ports, the two interrupt request lines, the Reset signal and the power supplies are brought to termination at the edge of the pre-drilled grid. Figure 7.2.2 illustrates the relative positions of these signals, available for connection to circuitry implemented by the User.

7.2.4.2 Programming Specifications

The RWC-F module is addressed via the standard DCE-BUS interface. Programming specifications for driving the DCE-BUS are given in Section 4.1.

The RIC on the RWC-F module is the same type of device as the GIC on DCE microcomputer modules. For complete programming specifications, timing diagrams and characteristics of the RIC, refer to Section 2 of this manual. The RIC may be configured in all the possible modes specified for the GIC, and the three ports connected to user designed circuitry on the module.

Note that the DCE GIC macros cannot be used with the RIC.

RIC Device Addresses

The RIC on the RWC-F module has 3 data ports and a command register. Different modes of communication between RIC Ports 0,1,2 and the DCE-BUS Data Path are established depending on the Device Address received by the RWC-F module from the DCE-BUS. Table 7.2.1 shows the Device Addresses for different communication modes.

DEVICE ADDRESS (HEX)	$\overline{RD}$	$\overline{WR}$	OPERATION
Y0	0	1	RIC Port 0 → DCE Data Bus
Y1	0	1	RIC Port 1 → DCE Data Bus
Y2	0	1	RIC Port 2 → DCE Data Bus
Y3	0	1	Illegal Condition
Y0	1	0	DCE Data Bus → RIC Port 0
Y1	1	0	DCE Data Bus → RIC Port 1
Y2	1	0	DCE Data Bus → RIC Port 2
Y3	1	0	DCE Data Bus → RIC Command Register
ZX	X	X	RIC Data Bus in 3-state

Notes:

1. Y is the card address select switch setting in hex (1 to F).
2. Z is any number other than Y.
3. X means don't care.
4. Bits 2 and 3 in Device Addresses are don't care states.
5. RDRWC and WRRWC software routines provide the $\overline{RD}$ and $\overline{WR}$ signals accordingly.

Table 7.2.1 : Device Address Table for RWC-F

RIC Configurations

Below is a summary of the different possible modes that can be used to input and output data through the three RIC ports:

GROUP A MODE	PORT 0	PORT 2	(Bits affected)		
0	Output	Output	(4-7)		
1	Output	Input	(4-7)		
2	Input	Output	(4-7)		
3	Input	Input	(4-7)		
4	H. S. Output	H. S. C.	(3, 6, 7)	Output	(4, 5)
5	H. S. Output	H. S. C.	(3, 6, 7)	Input	(4, 5)
6	H. S. Input	H. S. C.	(3, 4, 5)	Output	(6, 7)
7	H. S. Input	H. S. C.	(3, 4, 5)	Input	(6, 7)
8	Bi-directional	H. S. C	(3, 4, 5, 6, 7)		

GROUP B MODE	PORT 1	PORT 2	(Bits affected)
0	Output	Output	(0-3) +
1	Output	Input	(0-3) +
2	Input	Output	(0-3)+
3	Input	Input	(0-3) +
4	H. S. Output	H. S. C	(0, 1, 2)
6	H. S. Input	H. S. C.	(0, 1, 2)

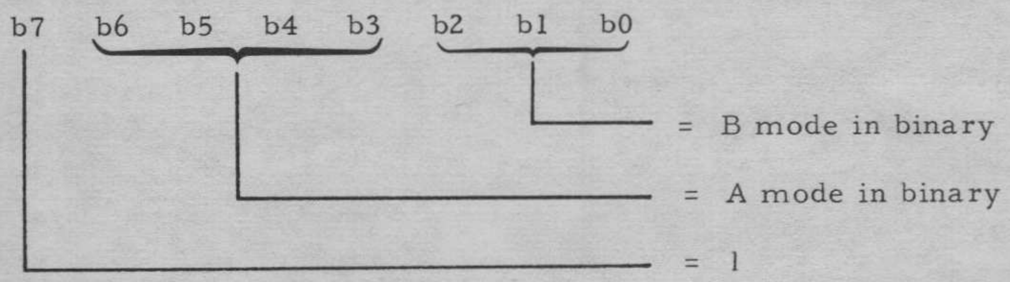
Notes:

+ Bit 3 not affected if Group A in modes 4 through 8

In the above H. S = Handshake

H. S. C = Handshake Control

The RIC on the RWC-F module must first be configured in one of the above mode combinations by writing a control word to its Command Register. The bit definitions for the control word are as follows:



A RIC configuration sequence may be followed by a compatible I/O command to RWC-F via subroutines 'RDRWC', 'WRRWC' or equivalent.

Ensure that the devices connected to the RIC I/O lines correspond to the selected I/O operation.

Special Considerations

When using the RIC in handshake input, output or bi-directional mode, certain timing constraints have to be observed. See Section 2 of this manual for full details.

RWC-F / DCE-BUS Protocol

Each of the three RIC ports may be independently programmed to serve as input or output, with various options. Through selected bits or groups of bits on these ports, the User can input and output data directly to and from a DCE microcomputer via the DCE-BUS. Software controls the selection of data I/O lines and different I/O configuration modes. For handshake input and output modes the handshake control signals are generated automatically by the RIC.

The software sequence for configuring the RIC, reading and writing to it are given in Section 7. 1.

7.2.4.3 Module Connector Definitions

System Connector

See Section 6.1.4 for the pin definitions.

Device Signals

The following signals are available to the user. See Figure 7.2.2 for location of signals on the card.

P0B7-P0B0:	Port 0 Bits 7 through 0 of the RIC on the RWC-F. Port 0 may be programmed as simple input/output, handshaking input/output or bi-directional.
P1B7-P1B0:	Port 1 Bits 7 through 0 of the RIC on the RWC-F. Port 1 may be programmed as simple input/output or handshaking input/output.
P2B7-P2B0:	Port 2 Bits 7 through 0 of the RIC on the RWC-F. Port 2 may be programmed as simple input/output, or it may provide the handshake control signals for Ports 0 and 1. The upper four bits (7 to 4) may be programmed separately from the lower four (3 to 0).
RESET:	Buffered system reset signal. When high, the system is being reset.
EXINTR:	External interrupt request to the DCE. User circuitry may generate a DCE interrupt (vector address 0010H) by a low-to-high transition on this line.
IN7:	Auxiliary interrupt request to the DCE. User circuitry may generate another DCE interrupt (vector address 0038H) by a low-to-high transition on this line.
GROUND:	DCE-BUS digital ground.
+12V:	DCE-BUS +12V D.C.
+5V:	DCE-BUS +5V D.C.
-5V:	DCE-BUS -5V D.C.

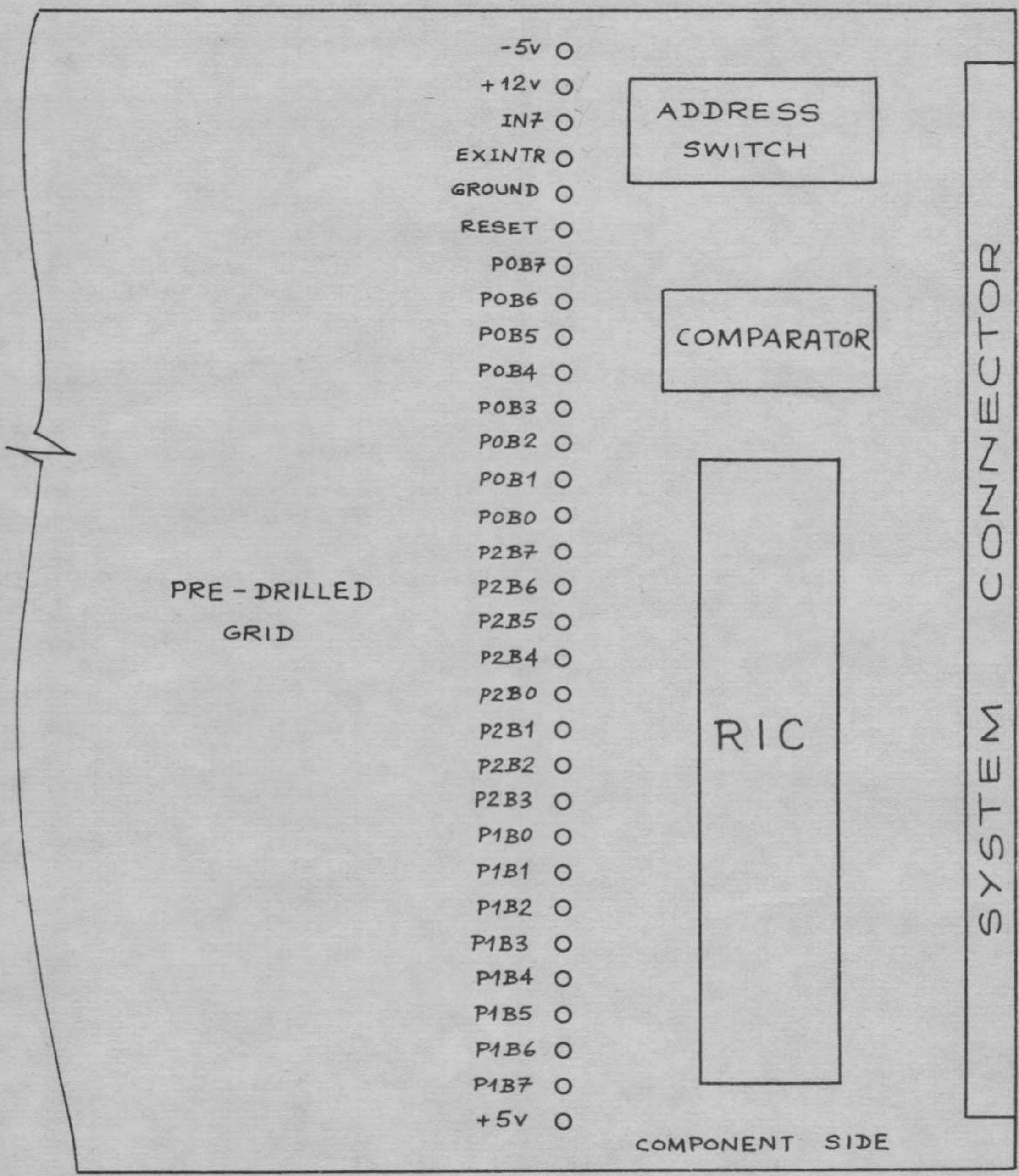


Figure 7.2.2 : Positioning of Available Signals on RWC-F

7.2.4.4 Operational Requirements

Signal Characteristics

All outputs from the RWC-F RIC are capable of driving one standard TTL load. They can drive directly a Darlington configuration (1.5V) and source up to 1mA.

Power Requirements

The RWC-F module uses a single +5V supply. Typical power consumption, excluding circuitry inserted by the User is:

+5V : 60mA

Environmental Requirements

Operating temperature	:	0°C to 55°C
Storage temperature	:	-25°C to +85°C
Relative humidity	:	95% non-condensing

Bus Loading

The RWC-F module presents 1 unit-load to the DCE-BUS (see Section 4.4).

7.2.5 TEST PROCEDURE

The section defines a simple test program for performing a basic functional test on the RWC-F module. Users are advised to carry out such a test procedure when necessary, to establish the correct functioning of a module. The test program also provides a good example of RWC-F module driver software.

```
0000
0000                    ; THIS IS A SIMPLE PROGRAM FOR TESTING THE
0000                    ; STANDARD RWC-F MODULE, WITH CARD ADDRESS
0000                    ; SELECT SWITCH SET TO 'E'. ALTERNATE ZERO
0000                    ; AND ONE BIT PATTERNS ARE OUTPUT TO THE
0000                    ; THREE PORTS. THESE CAN BE VERIFIED USING
0000                    ; A SCOPE.
0000                    ; DCE-DM DEVELOPMENT SYSTEM WITH VERSION 2.0
0000                    ; UTILITY AND RESIDENT ASSEMBLER HAS BEEN USED.
0000                    ;
031E            RDRWC:  EQU     031E
0349            WRRWC:  EQU     0349
0000                                    ;
1000                    ORG     1000
1000                                    ;
1000 0655       BEGIN:  MVI     B,55    ; SET UP TEST PATTERN
1002 3EE3               MVI     A,0E3   ; SELECT CONTROL REGISTER
1004 32011C             STGI    1
1007 3E80               MVI     A,80    ; CONFIGURE ALL 3 PORTS
1009 CD4903             CALL    WRRWC   ;       AS OUTPUT.
100C                                    ;
100C 3EE0       LOOP:   MVI     A,0E0   ; SELECT PORT 0
100E 32011C             STGI    1
1011 78                 MOV     A,B     ; OUTPUT TEST PATTERN
1012 CD4903             CALL    WRRWC
1015                                    ;
1015 3EE1               MVI     A,0E1   ; SELECT PORT 1
1017 32011C             STGI    1
101A 78                 MOV     A,B     ; OUTPUT TEST PATTERN
101B CD4903             CALL    WRRWC
101E                                    ;
101E 3EE2               MVI     A,0E2   ; SELECT PORT 2
1020 32011C             STGI    1
1023 78                 MOV     A,B     ; OUTPUT TEST PATTERN
1024 CD4903             CALL    WRRWC
1027                                    ;
1027 78                 MOV     A,B     ; COMPLEMENT TEST PATTERN
1028 2F                 CMA
1029 47                 MOV     B,A     ;       AND RESTORE.
102A C30C10             JMP     LOOP
                        END
```

7.2.6 ORDERING INFORMATION

RWC-F : Standard Version