DCM-16

Digital Combination and Timer Board

User Manual

DCM-16

User Manual

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OUTLINE DESCRIPTION

The DCM-16 has been designed to offer a wide range of digital input/output and pulse handling facilities.

It features 8 opto-isolated digital inputs sensing contact closures, switches etc. A complementary bank of 8 opto-isolated outputs with Darlington drivers can be used to switch solenoids and relays. Finally, three 16 bit CTC channels allow pulses to be counted and timed.

INTRODUCTION

This card provides eight opto-isolated digital inputs, eight opto-isolated Darlington outputs and three 16 bit interval timers. The timers may be used to generate periodic interrupts and an on board oscillator is provided as a source of pulses for this purpose. Four of the digital inputs are brought out to the connector to allow the isolated inputs to be connected to the timers for pulse counting.

Please note early versions of this board were supplied with the component silk screen overlay showing the board name as DCM-1. The DCM-1 is functionally identical to the DCM-16 in every respect.

IMPORTANT SAFETY NOTE

This version of the DOP/DCM card has a particular type of output chip which will power up a random state with some outputs on and others off.

This power up status is unpredictable and may be a hazard in some applications.

If this feature of the card is a problem in your application, please contact the Sales Office to discuss potential solutions.

1.0 SPECIFICATIONS

1.1 Electrical Specification

Number of Digital Inputs	8
Maximum Input Current	10mA
Number of Digital Outputs	8
Maximum Load Voltage	24V DC
Maximum Load Current	400mA (1.4W total package dissipation)
Number of Counter Inputs	3
Maximum Clock Input	8MHz for 8254
	10MHz for 82C54
Minimum High Pulse Width	30nSec
Minimum Low Pulse Width	50nSec
Maximum Clock Rise Time	25nSec

1.2 Physical Specification

Height	107mm
Width	15mm
Depth	132mm

1.3 Quick Start

Once you have installed the card it is possible to test if it is working correctly by using the programs supplied on the utilities disk.

The opto-isolated inputs may be tested with the BASIC program DCMINPUT.ASC and a 5 volt supply placed in turn on each of the eight pairs of input pins of the 50 way header. The opto-isolated open collector outputs may be tested with the program DCMOUT.ASC and a suitable set of 8 loads.

The counter timer section of the DCM-16 can only be tested by the existing software if you have the card set to port 300 HEX, link LKK set to any position except B and the interrupt link set to IRQ3 or the upper position on link LKF.

Otherwise, if you cannot use port 300 HEX you will have to modify and recompile and link the source files for the program supplied on the disk.

The test program INT3DCM.EXE once executed will produce the word TICK on the screen at regular intervals.

The software disk supplied with the DCM-16 contains a README.TXT file containing details on the files supplied.

Electromagnetic Compatibility (EMC)

This product meets the requirements of the European EMC Directive (89/336/EEC) and is eligible to bear the CE mark.

It has been assessed operating in a Blue Chip Technology Icon industrial PC. However, because the board can be installed in a variety of computers, certain conditions have to be applied to ensure that the compatibility is maintained. It meets the requirements for an industrial environment (Class A product) subject to those conditions.

- The board must be installed in a computer system which provides screening suitable for the industrial environment.

- Any recommendations made by the computer system manufacturer/supplier must be complied with regarding earthing and the installation of boards.

- The board must be installed with the backplate securely screwed to the chassis of the computer to ensure good metal-to-metal (i.e. earth) contact.

- Most EMC problems are caused by the external cabling to the board. Boards fitted with IDC ribbon cable connectors on the metal mounting bracket require particularly careful installation of the external cabling. The cabling must be totally screened; the type of ribbon cable which is rolled to a round form with a braided wire screen is best. Standard ribbon cable will not be adequate unless it is contained wholly within the cabinetry housing the industrial PC. The mounting bracket of the board includes a captive nut as a screen earth point. Connect the screen of the cable to this by the shortest possible wire.

- Ensure that the screen of the external cable is bonded to a good RF earth at the remote end of the cable.

- Cables which connect externally to boards at TTL levels should not exceed two metres in length. This restriction does not apply to opto-isolated boards.

Failure to observe these recommendations may invalidate the EMC compliance.

> Warning
> This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

EMC Specification

A Blue Chip Technology Icon industrial PC fitted with this card meets the following specification:

Emissions:	EN 55022:1995	
	Radiated	Class A
	Conducted	Class A & B
Immunity:	EN 50082-2:1995 incorporating:	
	Electrostatic Discharge	EN 61000-4-2 Performance Criteria B
	Radio Frequency Susceptibility	ENV50140 ENV50204 Performance Criteria A
	Fast Burst Transients	EN 61000-4-4 Performance Criteria B

2.0 USER ADJUSTMENTS

2.1 Selecting the Base Address

The board may be located in any 62 pin slot in the PC motherboard but must be set up to appear at a specified position (or 'address') in the port map. Available positions are shown in the IBM-PC Technical Reference Guide. However, for those who do not possess a copy of this document a good place is the location normally allocated to the prototyping card as supplied by IBM.

This address is 300 Hex or 768 decimal.

All Blue Chip Technology cards are preset to this address at the factory. However, no two devices should be used while set to the same address since contention will occur and neither board will work.

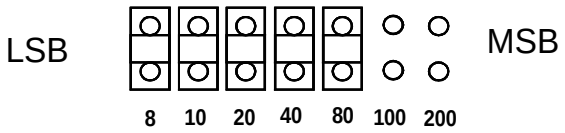
A set of links is provided on the board to set the base address of the board within the IBM-PC port map. The address is in binary with the presence of a link representing a 0 and the absence of a link representing a 1.

To set the base address to (say) 768 (300 Hex) set the following pattern on the links as indicated below:

Figure 1 - Selecting the Base Address

Note: View board with back panel on RHS.

Middle 7 Bits of port address on links.



More example addresses are shown in Appendix A.

2.2 Port Map

The DCM-16 card has three main functions, digital input, digital output and a counter chip. Although the 8 inputs and 8 outputs are physically separate on the card they are mapped as a single 8 bit port. Inputs can be read or outputs generated by reading from or writing to this port. The counter chip has 3 channels and a mode control port. The ports are allocated as follows:

Address	Read	Write
Base + 0	Digital Inputs	Digital Outputs
Base + 4	Counter 0	-
Base + 5	Counter 1	-
Base + 6	Counter 2	-
Base + 7	-	Mode Word

Remember that the DCM-16 takes up eight port addressees even though it only uses five of them

3.0 ELECTRICAL CONNECTIONS

3.1 Input Connections

A 50 way insulation displacement connector (IDC) is provided on the PC rear panel of the board for I/O channel signal connection. If access to individual channels is required, a 50 way IDC ribbon cable may be used to connect the I/O channels to a 50 way screw terminal block available from Blue Chip Technology as part number ST-24. The pins are numbered as shown in the following diagram.

When the connector is viewed from the back of the system odd numbered pins are on the left and even numbered pins are on the right with pin 1at the top of the Connector.

3.2 Connector Pin Details

			Pin	Pin			
Opto	Input	0 +VE	1 o	o 2	Opto	Input	0
Opto	Input	1 +VE	3 o	o 4	Opto	Input	1
Opto	Input	2 +VE	5 o	o 6	Opto	Input	2
Opto	Input	3 +VE	7 o	o 8	Opto	Input	3
Opto	Input	4 +VE	9 o	o 10	Opto	Input	4
Opto	Input	5 +VE	11 o	o 12	Opto	Input	5
Opto	Input	6 +VE	13 o	o 14	Opto	Input	6
Opto	Input	7 +VE	15 o	o 16	Opto	Input	7
TTL	Input	0	17 o	o 18	TTL	Input	1
TTL	Input	2	19 o	o 20	TTL	Input	3
Darlington	Output	0 -VE	21 o	o 22	Common	+VE	Rail
Darlington	Output	1 -VE	23 o	o 24	Common	+VE	Rail
Darlington	Output	2 -VE	25 o	o 26	Common	+VE	Rail
Darlington	Output	3 -VE	27 o	o 28	Common	+VE	Rail
Darlington	Output	4 -VE	29 o	o 30	Common	+VE	Rail
Darlington	Output	5 -VE	31 o	o 32	Common	+VE	Rail
Darlington	Output	6 -VE	33 o	o 34	Common	+VE	Rail
Darlington	Output	7 -VE	35 o	o 36	Common	+VE	Rail
GND			37 o	o 38	GND		
8254	Clock Input	0	39 o	o 40	8254	Output	0
8254	Gate	0	41 o	o 42	GND		
8254	Clock Input	1	43 o	o 44	8254	Output	1
8254	Gate	1	45 o	o 46	GND		
8254	Clock Input	2	47 o	o 48	8254	Output	2
8254	Gate	2	49 o	o 50	GND		

View with gold edge connectors downwards.

4.0 USING THE DCM

4.1 Digital Inputs

Each of the 8 opto-isolated inputs is connected to an individual bit of the base port.

When the input is on and current flows through the input circuit the relevant bit is high. Conversely the bit is low with no input current flows. The individual bits each have a binary value on the port. Bit allocation is as follows:

Opto Input	Base + 0 Bit	Hex Value	Decimal	Value Pins
0	0	01	1	1+2
1	**1**	**02**	**2**	**3+4**
2	2	04	4	5+6
3	**3**	**08**	**8**	**7+8**
4	**4**	**10**	**16**	**9+10**
5	**5**	**20**	**32**	**11+12**
6	**6**	**40**	**64**	**13+14**
7	**7**	**80**	**128**	**15+16**

Note: Even pins -ve
Odd pins +ve

4.1.1 Input Conditioning

Resistor pack RP4 is provided near the top rear panel of the board to condition the input current to s suitable level for the opto-isolators.

N.B. Unless specifically ordered the resistor pack fitted as standard is 330 Ohms and only suitable for 5 volt operation. Using a higher voltage without fitting a suitable resistor pack will result in the possible destruction of the opto-isolators.

The value of these resistors must be calculated to ensure that the current passed through the opto-isolator is limited to 10mA. The opto-isolator will drop
1.5 volts constantly.
The following calculation can be used to find the correct value.

$$\text{REQUIRED RESISTANCE} = \frac{\text{(INPUT VOLTAGE - 1.5V)}}{0.01}$$

The following table gives you some common examples using the preferred resistor values:

Input Voltage	Resistor Value
5V	330R (Fitted as standard)
10V	820R
12V	1K
24V	2K2

Note: Resistor type - 16 pin DIL package, 8 individual resistor elements.

4.1.2 TTL Inputs

Four TTL level inputs may be brought into the DCM to replace the first four opto-isolated inputs. The first .two high speed TTL inputs can be used to generate interrupts. (See Interrupts Section). IC7 and IC8 **MUST BE REMOVE** if the TTL option is being used.

It is important to note that the four TTL inputs (pins 17, 18, 19, 20 - see Input Connections) **REPLACE** the first four opto-inputs (pins 1-8). Only one set of inputs must be connected at any one time; otherwise damage may occur.

The input connects and port map allocations are as follows:

			Pins	Base+0 Bit	
Opto	Input	0	1+2	0	} Can be interrupt
Opto	Input	1	3+4	1	} source
Opto	Input	2	5+6	2	
Opto	Input	3	7+8	3	
TTL	Input	0	17	0	} Can be interrupt
TTL	Input	1	18	1	} source
TTL	Input	2	19	2	
TTL	Input	3	20	3	

Note: Inputs must not be connected to pins 1-8 and 17-20 at the same time.

4.1.3 Example Program

A simple example in GWBASIC shows how an input may be sensed and display an alarm. Note the use of the AND statement to test a specific bit. The program is written to test bit 5.

```
10      A = INP (768)
15      rem A = the base address of the card
20      IF A AND 32 THEN PRINT "ALARM" + CHR$ (7)
30      GOTO 10
```

4.2 Digital Outputs

Each of the 8 isolated outputs is controlled by an individual bit of the base port. When the bit is set high then the output is switched on and vice versa. The bit allocation is as follows:

Darlington Output	Base+0 Bit	Hex Value	Decimal Value	Pins
0	0	01	1	21+22
1	1	02	2	23+24
2	2	04	4	25+26
3	3	08	8	27+28
4	4	10	16	29+30
5	5	20	32	31+32
6	6	40	64	33+34
7	7	80	128	35+36

Note: Even numbers are+ve common, odd numbers are Darlington -ve.

4.2.1 Output Conditioning

The open collector Darlington outputs act as a switch which connects the output pin (P1, 21, 23 etc.) to power ground on P1/ 37 and 38.

Therefore, the electrical load (e.g. relay, solenoid etc.) should be connected between the positive of the external power supply and the appropriate output pin, with the power supply ground connected to pins 37 and 38.

The Darlington drive chip IC17 contains internal catching diodes to prevent it being damaged by the back e.m.f. generated by switching off inductive loads (i.e. relays and solenoids etc.).

These diodes are only effective when connected to the positive power supply (P1/22, 24 to 36 - even numbers only).

The outputs are fully isolated from the computer power supplies by the on-board opto-isolators.

The protection provided by this isolated interface will not work if there is any connection between the computer supplies and the external power supply being used for the load.

Each output can sink 400mA, but not more than two should be switched on together at this current or the open collector Darlington chip IC17 may be damaged by excessive power dissipation 1.4W maximum.

The table below shows the maximum permissible current as a function of the number of outputs switched on at the same time.

No. On	Max. Current per channel (mA)
2	400
3	350
4	280
5	250
6	225
7	200
8	175

4.2.2 Example Program

A single example in GWBASIC shows how an output may be switched on and off, for example, to flash a lamp on. The load is on output bit 4:

```
10      Out (768), 16                ‘Switch ON
20      FOR I=0 to 1000 : NEXT I     ‘Delay a while
30      OUT (768), 0                 ‘Switch OFF
```

5.0 COUNTER/TIMER

The counter timer on the DCM-16 board is the INTEL 8254 device, the programming details of which can be found in the manufacturer's data sheet.

We have included a disk with the package which contains some example machine code based interrupt drive software for testing counter channel 0 on the interrupt 3.

The program is called INT3DCM.EXE and details of how to get the board up to run this software are in Section 1.5.

The 8254 chip is a general purpose counter/timer with many programmable facilities. It is impossible to describe all possible permutations of the chip and the manufacturer's data sheet should be referred to.

The chip has 3 independent counters, 3 get signals and 3 output signals.

These are mapped and connected as follows:

Counter Input	Port Base +	Pins
0	4	39
1	5	43
2	6	47
Gate		
0	-	41
1	-	45
2	-	49
Output		
0	-	40
1	-	44
2	-	48

5.1 TTL External Pulses

Incoming TTL pulses may be connected directly to pins 39, 43 and 47. Correct programming of the 8254 will give the result in addresses Base+3, Base+4 and Base+5. The maximum frequency is 8MHz.

5.2 Isolated External Pulses

When used to count external pulses or time external events it may be desirable to isolate the incoming signal.

Examination of the circuit diagram in the appendix will reveal that the first four opto-isolated inputs are also connected at TTL leel to the rear panel connector.

Isolation of a count input can thus be achieved by hand wiring from the isolation/TTL output pins on the 50 way IDC connector (pins 17, 18, 19 and 20) directly to the counter inputs 0, 1 or 2 (pins 39, 43 and 47).

5.3 On-board/Bus Frequency Source

Counter 0 can be linked to an on-board frequency source or directly to the I/O bus frequency. This is achieved via link LKK.

Note that it should not be arranged such that external and internal pulses can be fed into counter 0 at the same time. Only LKK or input pin 39 should be used at any one time.

To select the on-board/bus source LKK is used as follows:

This shows Counter 0 connected to a 2 MHz on-board clock source.

Position B links Counter 0 to the bus clock which should be 4.77MHz on true PC compatibles. The maximum input frequency is 8MHz.

Note that only one link should be fitted on LKK at any one time.

5.4 Darlington Outputs

Another option is to use the counters as square wave generators to pulse larger external loads than TTL (i.e. stepper motors, relays etc.) via the first three Darlington drivers.

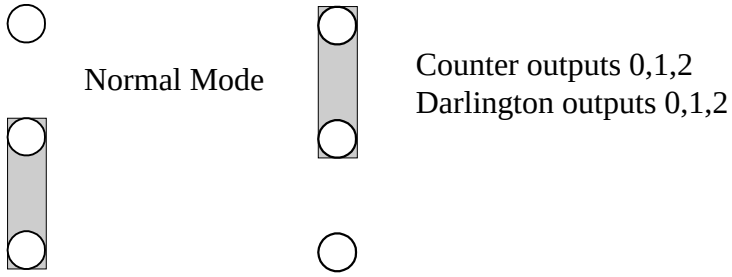
The normal counter outputs can optionally be linked to the Darlington outputs channels 0, 1 and 2.

The counter outputs will then either appear on pins 40, 44 and 48 in normal TTL output mode or on pins 21+22, 23+24 and 25+26 Darlington outputs.

Note, if the Darlington output option is selected the polarity will be reversed.

The output location is set up by links LKB, LKC and LKD as shown:

LKB/C/D



LKB = Output 0, LKC = Output 1, LKD = Output 2.

Note that the links **must** be fitted in the Normal position in order for the first 3 Darlington outputs to operate as normal outputs.

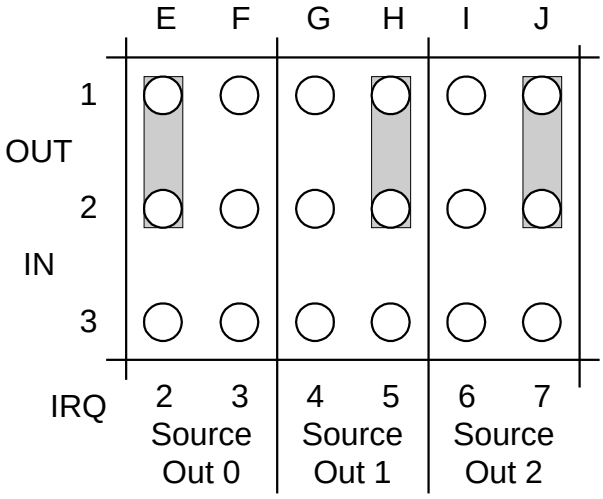
6.0 INTERRUPTS

There are 5 potential interrupt generators:

Counter Output 0
Counter Output 1
Counter Output 2
TTL/Opto Input 0
TTL/Opto Input 1

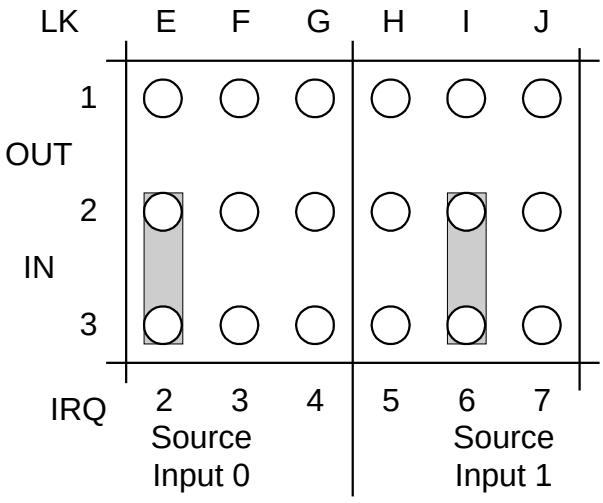
These sources can be linked to IRQ 2-7 as dictated by LKE, LKF, LKG, LKH, LKI and LKJ.

The first two link positions 1-2 select OUT 0, 1 and 2 from the counter. OUT 0 can be linked to IRQ 2 or 3, OUT 1 can be linked to IRQ 4 or 5 and OUT 2 can be linked to IRQ 6 or 7 as shown.



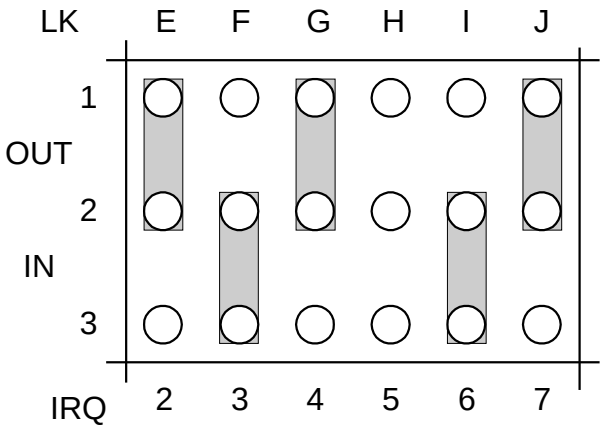
The diagram shows OUT 0 connected to IRQ2, OUT 1 connected to IRQ 5 and OUT 2 connected to IRQ 7.

Similarly, the second link position 2-3 selects INPUT 0 or INPUT 1. INPUT 0 can be linked to IRQ 2, 3 or 4, INPUT 1 can be linked to IRQ 5, 6 or 7 as shown:



The diagram shows INPUT 1 connected to IRQ 2 an INPUT 2 connected to IRQ 6.

The two interrupt sources can be mixed as shown below:

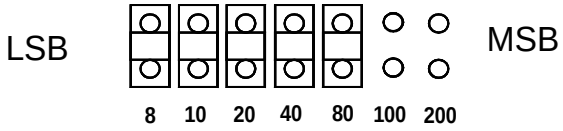


OUT 0 = IRQ 2, INPUT 1 = IRQ 3, OUT 1 = IRQ 4, INPUT 2 = IRQ 6,
OUT 2 = IRQ 7.

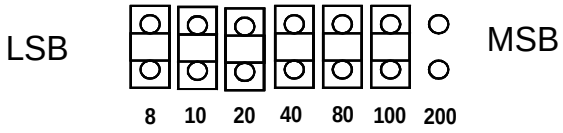
APPENDIX A

Note: View board with back panel on RHS.

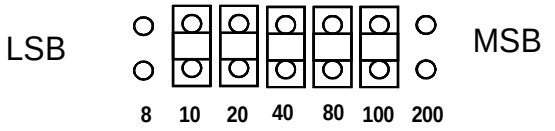
Address Settings for Port 300H



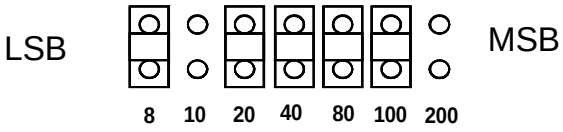
Address Settings for Port 200H



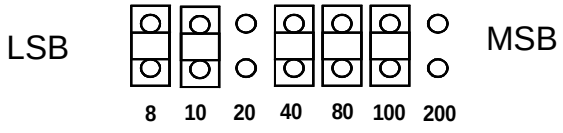
Address Settings for Port 208H



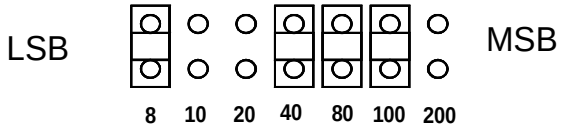
Address Settings for Port 210H



Address Settings for Port 220H



Address Settings for Port 230H



APPENDIX B

PC/XT/AT Port Map
I/O Address Map

Address	Allocated to:
000-01F	DMA Controller 1 (8237A-5)
020-03F	Interrupt Controller 1 (8259A)
040-05F	Timer (8254)
060-06F	Keyboard Controller (8742) Control Port B
070-07F	RTC and CMOS RAM, NMI Mask (Write)
080-09F	DMA Page Register (Memory Mapper)
0A0-0BF	Interrupt Controller 2 (8259)
0F0	Clear NPX (80287) Busy
0F1	Reset NPX (80287)
0F8-0FF	Numeric Processor Extension (80287)
1F0-1F8	Hard Disk Drive Controller
200-207	Reserved
278-27F	Reserved for Parallel Printer Port 2
2F8-2FF	Reserved for Serial Port 2
300-31F	Reserved
360-36F	Reserved
378-37F	Parallel Printer Port 1
380-38F	Reserved for SDLC Communications, Bisynchronous 2
3A0-3AF	Reserved for Bisynchronous 1
3B0-3BF	Reserved
3C0-3CF	Reserved
3D0-3DF	Display Controller
3F0-3F7	Diskette Drive Controller
3F8-3FF	Serial Port 1

APPENDIX C

PC/XT Interrupt Map

Number	Usage
NMI	Parity
0	Timer
1	Keyboard
2	Reserved
3	Asynchronous Communications (Secondary) SDLC Communications
4	Asynchronous Communications (Primary) SDLC Communications
5	Fixed Disk
6	Diskette
7	Parallel Printer

APPENDIX D

AT Interrupt Map

Level		Function
Microprocessor		NMI Parity or I/O Channel Check
Interrupt Controllers		
CTLR 1	CTLR 2	
IRQ 0		Timer Output 0
IRQ 1		Keyboard (Output Buffer Full)
IRQ 2		Interrupt from CTLR 2
	IRQ 8	Real-time Clock Interrupt
	IRQ 9	S/w Redirected to INT 0AH (IRQ 2)
	IRQ 10	Reserved
	IRQ 11	Reserved
	IRQ 12	Reserved
	IRQ 13	Co-processor
	IRQ 14	Fixed Disk Controller
	IRQ 15	Reserved
IRQ 3		Serial Port 2
IRQ 4		Serial Port 1
IRQ 5		Parallel Port 2
IRQ 6		Diskette Controller
IRQ 7		Parallel Port 1