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DATA TRANSLAT

UM-1

# DT2802
# User Manual

**Chromatography Board for the**
**IBM® Personal Computer AT and Compatibles**

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**Fifth Edition**
April, 1992

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# Radio and Television Interferenc

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, i not installed and used in accordance with the instruction manua may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cau harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications to this equipment not expressly approved by Data Translation could void your authority to operate the equipment under Part 15 of the FCC Rules.

***Note*** *This product was FCC-certified under test conditions that included use of shielded cables and connectors between syster components. It is important that you use shielded cables and connectors to reduce the possibility of causing interference to radio, television, and other electronic devices.*

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This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la class A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada.

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# How to Use This Manual

This manual describes the high resolution DT2802 data acquisition board for chromatography applications on the IBM Personal Computer AT and compatibles.

To use the DT2802, it is assumed you have a general understanding of data acquisition and chromatography concepts, and that you possess enough proficiency in softwar write your own application and diagnostic programs.

Listed below is an overview of the information presented in thi manual.

## Installing and Using

Chapter 1, "**Introduction**," presents the major features of the DT2802 board and describes compatible Data Translation products.

Chapter 2, "**Installing the DT2802**," describes how to install th DT2802 in an IBM Personal Computer AT or compatible and h to connect external devices to the board.

Chapter 3, "**Hardware Overview**," discusses the main subsystems of the DT2802 board and the I/O registers for communicating with the board.

Chapter 4, "**Firmware**," describes the firmware commands for performing the board's operations.

Chapter 5, "**Programming Sequences**," lists the sequence of steps necessary for doing commonly-performed board operations.

## Hardware Reference

Reference 1, "**Jumper Configuration**," shows you how to change the base address, interrupt priority level, and operating mode of your board.

Reference 2, "**Board Calibration**," describes the auto-calibration feature of the board.



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Reference 3, "**Board Connectors**," describes the D
connectors and lists their pinouts.

Reference 4, "**Detector Connections**," discusses th
noise in a measurement. It shows you how to conn
detector output to the DT2802 for low noise, high re
measurements.

Reference 5, "**Specifications**," provides the electric
mechanical specifications for the DT2802 board.

### Firmware Reference

Reference 6, "**Remote Control Protocol**," describe
communicate and operate the DT2802 board via its

Reference 7, "**Error Codes**," lists the DT2802 erro

Reference 8, "**Firmware Command Summary**," pr
numerical and alphabetical summary of the firmwa
and references their location in this manual.

Reference 9, "**Product Support**," explains what to
having difficulty using the DT2802 board.

The **Glossary** defines data acquisition and chroma
terms used in this manual.

## Related Documents

*DT2802 Software User Manual*, Document Numbe
Data Translation, Inc.

*DT777 User Manual*, Document Number UM-107
Translation, Inc.

*IBM Technical Reference*, International Business
Corporation

***Note*** *Requests for copies of this manual should be ma
authorized IBM Personal Computer dealer.*

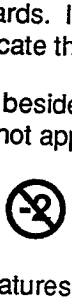


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## Conventions Used in This Manual

Throughout this manual, the term "DT2802" refers to both the DT2802-2 and DT2802-4 boards. Information applying to a particular model only will indicate that board by model numbe

The following symbol is used beside a firmware command to indicate that command does not apply to the DT2802-2 boar



Unless otherwise noted, all features referenced in this manua can be used with both the DT2802-2 and DT2802-4 boards.

The following symbol is used beside a firmware command to indicate that command is not valid in the stand-alone mode of operation:



Unless otherwise noted, all features referenced in this manual apply in both the normal ISA bus mode and the stand-alone mode of operation.

## Where to Get Help

If you have difficulty installing or using your DT2802 board, see Reference 9, "Product Support."



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# Chapter 1

# Introduction

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*Chapter 1, "**Introduction**," introduces you to the m*
*the DT2802 board. It also describes Data Translat*
*packages and hardware accessories. This chapte*
*as follows:*

- *The DT2802 Board*
- *System Requirements*
- *Accessories*



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# The DT2802 Board

The DT2802 is a high resolution (18-bit to 24-bit) microprocessor-controlled data acquisition board for liquid an gas chromatography applications. It is designed for use in th IBM Personal Computer AT and compatible computer system

The DT2802 board provides the following features:

- One (DT2802-2 board) or two (DT2802-4 board) high resolution time-base independent integrators each having two differential input channels
- Background data acquisition
- Four input switch detectors to sense contact closures or T or CMOS levels
- Four optically isolated output switches
- Onboard memory buffers for storing up to 2048 samples p integrator
- Auto-calibration function
- Command driven operation
- RS232 interface for communicating with a chromatograph, auto-sampler, or other RS232-based device; or for operatir remotely from the host system
- Software-selectable board configuration settings

See Chapter 3, "Hardware Overview," for a complete discussion of these features.



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# System Requirements

The minimum system requirements for the DT2802 follows:

- IBM Personal Computer AT (or 100% compatib
- PC-DOS operating system (version 3.30 or higl

Up to four DT2802 boards can be installed in a sing

To acquire sample data, you will need the following

- Chromatography system including a detector h output range between -0.2V and +2.0V

  ***Note*** *Other voltage input ranges may be us attenuated properly.*

- DT777 screw terminal panel and EP777 cable device to connect the detector output to the D

The minimum system requirements listed above a for using the DT2802 to acquire chromatography d of the following components will significantly enha functionality of the DT2802 operating environment

- A hard disk or an additional floppy diskette dri
- 640 Kbytes of free system RAM



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# Accessories

This section describes the Data Translation hardware and software accessories and industry-standard chromatography software compatible with the DT2802 board. Contact Data Translation for the most current information on the accessorie available for the DT2802.

## DT777 Screw Terminal Panel

The DT777 is a screw terminal panel that accommodates all u connections (detector and external device) to the DT2802 boa It provides facilities for installing a resistor network to attenuat the detector inputs, which effectively extend the analog input range of the DT2802 board. It also provides transient overvoltage protection on the switch inputs and output switche

The DT777 requires the EP777 cable assembly (available from Data Translation) to connect to the DT2802 board. The EP777 cable assembly consists of individually shielded twisted pairs housed in a 6-foot flexible cable. This cable assembly has a D-shell connector at each end.

The EP246 shielded enclosure (available from Data Translation helps preserve the integrity of analog signals by shielding the DT777 from electrical noise and from ambient airflow. Data Translation recommends using the EP246 enclosure with the DT777 for best performance.



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## DT2802 Device Driver and Subrou Library

All DT2802 boards ship with the DT2802 Device Dr Subroutine Library (SP0802). This software packa MS-DOS device driver and a set of subroutines wh to the device driver and take full advantage of the b functionality. The *DT2802 Software User Manual* d software tool in detail.



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# Chapter 2

# Installing the DT2802

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*Chapter 2, "**Installing the DT2802**," describes how*
*DT2802 board in your computer and how to connec*
*the input channels, external devices to the input sw*
*and output switch terminals, and peripherals to the*
*port. This chapter is organized as follows:*

- *Unpacking*
- *Installation Procedure*
- *Powering Up the System*



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# Unpacking

If you purchased your DT2802 from Data Translation, make s
that you have received the following items before installing th
board:

- DT2802 board
- *DT2802 User Manual*
- *DT2802 Software User Manual*
- Two 5-1/4-inch diskettes:
  SP0802: DT2802 software and Demonstration progra
  SP0172: C, QuickBASIC examples
- Warranty and Service policy

If you purchased your DT2802 as part of a complete
chromatography data system, the contents of your DT2802
package will vary. Instead of the above items, you will receive
application specific software and documentation provided by y
vendor.

If an item is missing or damaged, call Data Translation's
**Customer Service Department** at **(508) 481-3700**. They will
guide you through the appropriate steps for replacing missing o
damaged items.

If you are located outside the USA, call your local distributor.
The name and telephone number of your nearest distributor are
listed in your Data Translation catalog.

***Note*** *Save the original packing material in the unlikely event your board requires servicing in the future.*

Keep the DT2802 board in its protective anti-static bag until you
are ready to install it. When you remove the board from the bag
hold it by the edges and do not touch the components.



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# Installation Procedure

Install the DT2802 board and connect any external
following the steps below. These steps are describ
the following pages.

Step 1: Check the jumper selections

Step 2: Install the board

Step 3: Connect RS232-based devices

Step 4: Connect the screw terminal panel (if used)

Step 5: Connect the detector(s)

Step 6: Connect the external devices

**Note** *Be sure to read the directions in each step carefull
attempting it. Follow the steps in the order given.*



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## Step 1: Check the Jumper Selections

The DT2802 board ships with a base address of 300H and interrupt priority level of 5. It is configured for installation in t host computer system (ISA bus mode). In most instances yo can use these factory-configured settings. To select an alternative setting for a parameter, see Reference 1, "Jumper Configuration," for instructions.

**Note** *Make sure your jumper settings are suitable BEFORE installi the board. No other peripheral in your system can use these values. Mismatched settings can result in unpredictable beha and inaccurate results!*

Other board configuration settings, such as interrupt source(s) conversion rate, resolution, integration channel, trigger mode, serial data mode, stream data packet size, and serial port bau rate, are software-configurable. See Chapter 4, "Firmware," a Chapter 5, "Programming Sequences," for more information o these configuration parameters.



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## Step 2: Install the Board

Follow the instructions below to install the DT2802 available fully-bussed expansion slot in your compu are remotely operating the DT2802 board (stand-al operation), skip the instructions in this step and inst DT2802 board in your peripheral device.

1. Turn off the computer.

2. Turn off all accessories connected to the comp

3. Unplug the computer and all accessories.

4. Note the location of all cables, and disconnect rear of the computer.

5. Remove the computer's cover.

   *The DT2802 board may be installed in any ful expansion slot. Figure 1 illustrates the expans IBM Personal Computer AT.*

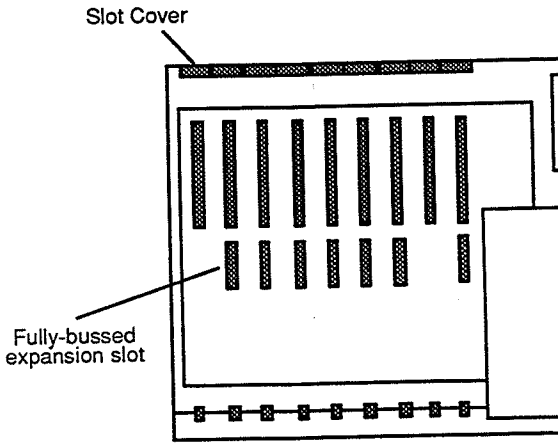



**Figure 1: IBM Personal Computer AT –**



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6. Remove the slot cover from the selected expansion slot.

7. Before handling the board, discharge any static buildup touching the metal case of the computer.

8. Remove the board from its anti-static bag. Holding the b by its edges, position it so that the rear panel connector faces the rear of the computer, as shown in Figure 2.

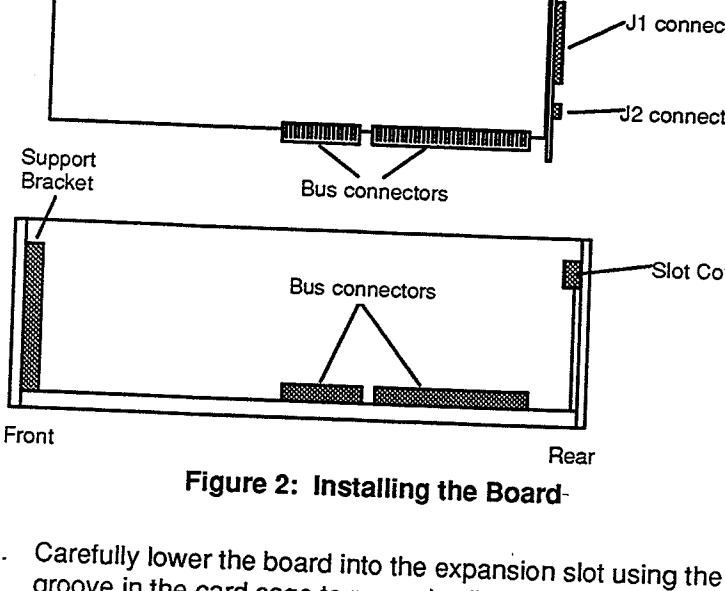



**Figure 2: Installing the Board**

9. Carefully lower the board into the expansion slot using the groove in the card cage to properly align the board in the slot. When the bottom of the board contacts the bus connector, gently press down on the board until it clicks int place.

   ***Caution*** *Do not force the board into place. If you encount resistance when inserting the board, pull it out and try agai Do not wiggle the board from side to side during installatior as this may damage the bus connector.*

10. Gently lift the board to determine if it is properly connected.

    *If the board stays in place, it is installed correctly. If it exhibits no resistance, press down firmly on the board to seat it in its connector.*



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11. Secure the board to the rear panel of the chassi
    screw removed from the slot cover.

12. Replace the computer's cover.

13. Reconnect all cables to the rear of the compute



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## Step 3: Connect RS232-based Devices

The RS232 port may be used to communicate with RS232-b devices to provide, for example, start/stop type of control. TI RS232 port may also be used to pass commands and data t operate the DT2802 board remotely from the host system.

This port has a programmable baud rate. It has 1 start bit, 1 bit, 8 data bits, and no parity.

The RS232 port has an RD (receive data), TD (transmit data) and RS232 control signal. Table 1 lists the location of these signal lines at the J2 connector.

**Table 1: RS232 Signal Lines**

| Description | Pin | | Description |
|---|---|---|---|
| Not connected | 1 | 2 | RS232 signal (control signal) |
| Signal ground | 3 | 4 | RS232-TD (transmit data) |
| RS232-RD (receive data) | 5 | 6 | Not connected |

***Note*** *For information on various RS232 connectors, see Reference "Board Connectors."*

To connect to the RS232 port:

1. Plug one end of the RS232 cable to the J2 connector on th rear of the DT2802 board.

2. Plug the other end of the RS232 cable to the RS232 connector on the communicating device.



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## Step 4: Connect the Screw Termir

If you are using the Data Translation DT777 screw t
panel, follow the instructions below for connecting it
DT2802 board.

1. Position the computer (or peripheral device) so
easily access the board's rear panel connector

2. Plug the 37-pin connector on the screw termina
into the mating connector (J1) on the rear of the
board, as shown in Figure 3.

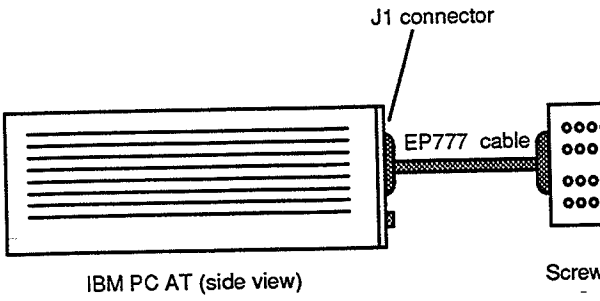



**Figure 3: Connecting a Screw Terminal**

**Note** *For the remainder of this chapter, refer to the user
provided with your screw terminal panel for the sc
assignments. If you are connecting external devic
cable, refer to Table 2 for the DT2802 board's J1
assignments.*



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## Table 2: J1 Pin Assignments

| Description | Pin | | Description |
|---|---|---|---|
| Digital Ground | 1 | | |
| Switch 4 High | 2 | 20 | Switch 4 Low |
| Switch 3 High | 3 | 21 | Switch 3 Low |
| Switch 2 High | 4 | 22 | Switch 2 Low |
| Switch 1 High | 5 | 23 | Switch 1 Low |
| Input 4 High | 6 | 24 | Input 4 Low |
| Input 3 High | 7 | 25 | Input 3 Low |
| Input 2 High | 8 | 26 | Input 2 Low |
| Input 1 High | 9 | 27 | Input 1 Low |
| +12V [1] | 10 | 28 | −12V [1] |
| Digital Ground | 11 | 29 | Digital Ground |
| Analog Ground | 12 | 30 | Analog Ground |
| Channel 4 High | 13 | 31 | Channel 4 Low |
| Analog Ground | 14 | 32 | Analog Ground |
| Channel 3 High | 15 | 33 | Channel 3 Low |
| Voltage Reference High | 16 | 34 | Voltage Reference Low |
| Channel 2 High | 17 | 35 | Channel 2 Low |
| Analog Ground | 18 | 36 | Analog Ground |
| Channel 1 High | 19 | 37 | Channel 1 Low |

[1] *No more than 10 mA should be drawn from the ±12V terminals (pins 10 ar 28). The return for the ±12V is Digital Ground.*



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## Step 5: Connect the Detector(s)

The DT2802-2 board provides two differential input
one or two detectors and the DT2802-4 board provi
differential input channels for up to four detectors.

The DT2802 is capable of converting analog voltag
-0.200V to +2.000V. The detector need not have a
output that ranges to 2V. If your detector's output e
however, you must reduce the voltage using a resis
circuit. The DT777 screw terminal panel can accon
and 10V detector outputs. Refer to the *DT777 Use*
information on these connections.

The DT2802-2 has one integrator (integrator A) an
DT2802-4 has two integrators (integrators A and B
integrator connects to two input channels. Integrat
to input channels 1 and 2 and integrator B connect
channels 3 and 4. Each integrator has its own pro
time base. Therefore, the two channels associate
integrator will have the same sampling rate and re

1. Connect the high level voltage output from the
desired channel Hi terminal on the screw term
the corresponding pin on the J1 connector (se

2. Connect the low side of the detector output to
corresponding Low terminal or pin for that cha

***Note*** *For information on how to make conn
resolution inputs, see Reference 4, "Detector*



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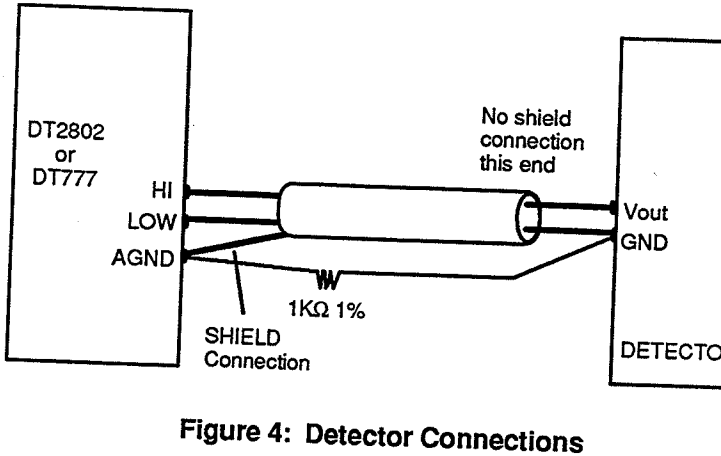



**Figure 4: Detector Connections**

Analog Ground on the DT2802 must be connected to the detector ground to provide a return path for the DT5705 input bias current. The 1kΩ resistor serves to limit the current if the grounds are not at the same potential. Only one connection o this type is necessary per detector.



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## Step 6: Connect the External Devi

The DT2802 has four switch inputs and four output
The inputs can detect switch closures or can be driv
compatible logic. The output switches are optically
switch closures.

### Switch Input Connections

Many injectors and autosamplers output a signal wh
make an injection. You can connect this signal outp
the switch inputs and program the DT2802 to signa
when it senses the change in signal.

To connect an input signal to the DT2802:

1. Connect the high side of the input line to the de
terminal on the DT2802 (see Figure 5).

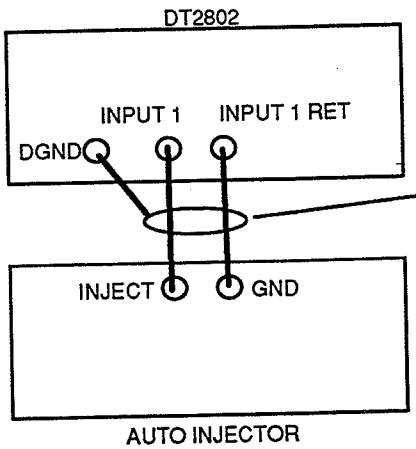



**Figure 5: External Device Input Conne**

***Note*** *Use a shielded cable for minimum no
signal to the detectors.*

2. Connect the low side of the input line to the co
Input Low terminal on the DT2802.



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## Output Switch Connections

To connect an output switch to an external device:

1. Connect one lead from the cable between the device an DT2802 to the desired Switch Low terminal. Connect th corresponding lead on the other end of the cable to a gr terminal on the device (see Figure 6).

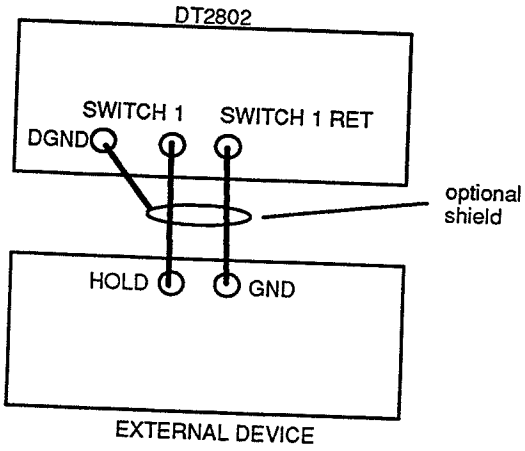



**Figure 6: Output Switch Connection**

***Note*** *Use a shielded cable for minimum noise on the in signal to the detectors.*

2. Connect the other leads on the cable to the corresponding output switch terminal and the input terminal on the device.

***Note*** *The output switches do not supply power to the circuit.*



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# Powering Up the System

Once you are satisfied that all connections are secu
properly, you can power up your system. Plug the c
all accessories into their power outlets.

1. Power up all accessories.

2. Power up the computer.

Upon powerup, the DT2802 automatically executes
self-diagnostics. Once it determines it is operationa
configuration and calibration table, and signals the
ready for operation.



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# Chapter 3

# Hardware Overview

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*Chapter 3, "**Hardware Overview**," describes the ma*
*of the DT2802 board. This chapter is organized as*

- *Overview*
- *Data Acquisition Subsystem*
- *DT2802 Microprocessor*
- *Inputs and Outputs*
- *Serial Port*
- *Bus Interface*



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# Overview

The DT2802 board is a data acquisition system for liquid and chromatography systems in an IBM Personal Computer AT c compatible computer system environment. The DT2802 can perform data acquisition as a background task to the host an capable of RS232 serial I/O, communication with external devices through I/O switches, and data buffering.

Built-in firmware commands manage all DT2802 operations. These firmware commands eliminate the extensive register programming required to perform an operation, thereby simplifying programming. You perform board operations or monitor the board's status by writing commands and paramet to or reading the status or data from four registers. Chapter 4 "Firmware," describes the firmware commands in detail.

Figure 7 provides a block diagram of the DT2802-4 board. Re to this diagram for help in following the discussions throughou this chapter. (The DT2802-2 is identical to the DT2802-4 boa except that the DT5705 portion of integrator B is not present.)



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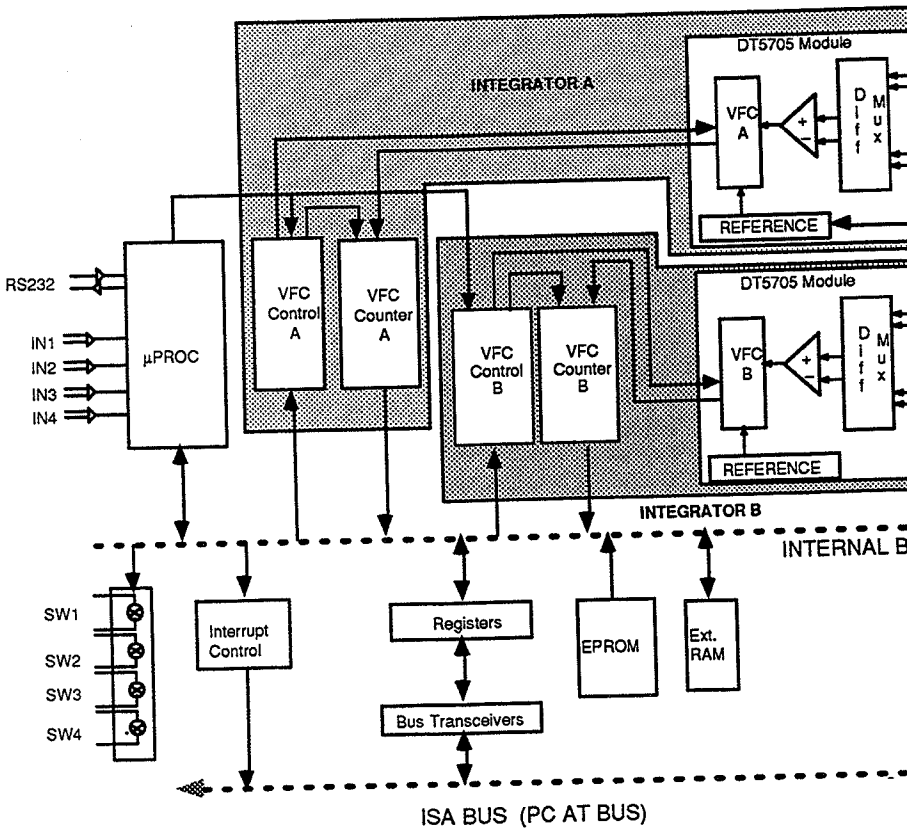



**Figure 7: DT2802-4 Functional Block Diagram**

The DT2802-2 has one integrator and the DT2802 integrators. An integrator consists of a DT5705 m contains a high resolution voltage-to-frequency (V a VFC controller, and a VFC counter. The integra differential input channels. The integrator has pro channel selection, resolution, and sampling rate.

The microprocessor controls the operation of the the board configuration, and controls the integrat tasks. It also calibrates the integrators on comma



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There are three types of memories onboard the DT2802:

- EPROM – programmed at the factory with the code exec by the microprocessor to control DT2802 operations.
- EEROM – resides in the microprocessor. It contains the saved board configuration and calibration tables.
- External RAM – 32 Kbytes – part of which is used as a d buffer. The DT2802 places the digital code from each conversion into the buffer. It is subsequently transferred the host system from this buffer.

The serial I/O port is part of the microprocessor. It provides a RS232 port with a programmable baud rate. It permits the DT2802 to communicate with other RS232-based peripherals operate as a stand-alone peripheral. In the stand-alone mode the host sends commands and arguments to and receives da and board status from the board over the RS232 port.

There are four input switch detectors that accept contact closu or TTL-compatible logic signals from external devices such as injectors and fraction collectors The inputs can be programme to signal the host on a rising edge, falling edge, or both.

There are four optically isolated output switches. Each output written directly, individually or as a group.

The host bus interface provides the communication between th DT2802 and the host in the normal ISA bus mode of operation It has a command/status register at the board's base address and a data I/O register at the base+1 address. The host writes firmware commands and arguments to or reads the board statu or data from these registers.

The DT2802-2 has eight event/interrupt sources and the DT2802-4 has nine event/interrupt sources that are software-enabled or disabled. If the master interrupt is enabled any enabled interrupt source can cause the DT2802 to interrupt the host when that condition occurs. The host can also poll the event/interrupt source list to determine the board state whether interrupts are enabled or disabled.



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The following sections describe these board subsyst
detail:

- Data acquisition
- DT2802 onboard microprocessor
- Digital inputs and outputs
- Serial I/O port
- Bus interface



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# Data Acquisition Subsystem

The data acquisition subsystem (see Figure 8) consists of on (DT2802-2) or two (DT2802-4) integrators. Each integrator h DT5705 module containing a voltage-to-frequency (VFC) converter, a VFC controller, and a VFC counter.

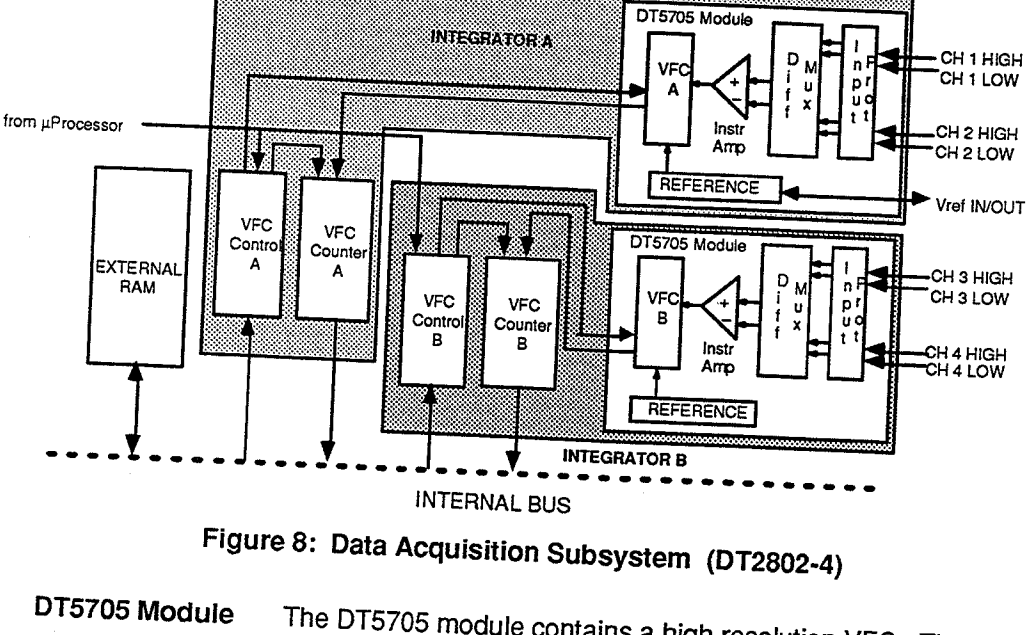



**Figure 8: Data Acquisition Subsystem (DT2802-4)**

**DT5705 Module**

The DT5705 module contains a high resolution VFC. The VFC converts the analog voltage signal from one or two detectors to an output which the DT2802 accumulates and converts to a digital code during each sampling interval.

**VFC Controller**

The VFC controller is a state machine which controls the VFC counter and the DT5705 multiplexer. The state machine has inputs from the onboard microprocessor and crystal clock. It produces integration start and end times at the precision of the crystal clock.



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The state machine sequencer saves the count value
The controller clears and restarts the counter in less
nsec. This allows the DT2802 to make "back-to-bac
measurements.

The microprocessor uses the user-specified resoluti
rate, and trigger to set up the VFC controller. These
user-configurable integrator values. The DT2802 st
settings in EEROM and loads the last saved values
or reset into the microprocessor RAM. You can cha
configuration in RAM without affecting the settings y
EEROM. When integration is triggered, the DT2802
latest values from RAM.

## VFC Counter

The VFC counter accumulates the raw VFC output
integration interval. The DT2802 then converts this
digital code that represents the input voltage. The
codes are listed in Table 3 below. All digital codes
expressed in hex.

**Table 3: Digital Output Codes**

| Voltage | 24 Bits | 23 Bits | 22 Bits | 21 Bits | 20 Bits | 19 Bits |
|---|---|---|---|---|---|---|
| +2.000V (+FS) | FFFFFF | 7FFFFF | 3FFFFF | 1FFFFF | 0FFFFF | 07FFF |
| 0V | 180000 | 0C0000 | 060000 | 030000 | 018000 | 00C00 |
| –0.207V (–FS) | 000000 | 000000 | 000000 | 000000 | 000000 | 00000 |

The following formulas calculate the voltage from t
at each resolution:

**Voltage = (2.0V/E7FFFFH) * (Code – 180000H)** *(24-b*

**Voltage = (2.0V/73FFFFH) * (Code – 0C0000H)** *(23-b*

**Voltage = (2.0V/39FFFFH) * (Code – 060000H)** *(22-b*

**Voltage = (2.0V/1CFFFFH) * (Code – 030000H)** *(21-*

**Voltage = (2.0V/0E7FFFH) * (Code – 018000H)** *(20-*

**Voltage = (2.0V/073FFFH) * (Code – 00C000H)** *(19-*

**Voltage = (2.0V/039FFFH) * (Code – 006000H)** *(18-*



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This digital code is three bytes in length. Since each digital v may be a data point from any of the four input channels, the DT2802 adds a "tag" byte to each digital code to identify it, making it a 4 byte word. It then stores these four bytes as a point in the onboard memory buffer for that integrator until transferred to the host. The Data Buffer Management section (see page 121) of Chapter 4, "Firmware," describes the data format and its transfer to the host system.

## Input Characteristics

The DT5705 module, the VFC controller, and the VFC counter represent a complete integrator. (See Figure 8 on page 29.) The DT5705 has one high-resolution VFC with two detector inp channels. You can configure each integrator separately to suit the needs of the chromatography system.

### Input Type

The DT5705 has two differential input channels and one VFC. The VFC sees the following voltage from its two input channels

$$\text{Input Voltage} = V_{\text{chan high}} - V_{\text{chan low}}$$

Differential inputs are relatively insensitive to electrical noise since the VFC sees only the difference in voltage between the high and low sides of the input channel connections. See page 18 for these connections.

### Input range

The *input range* is the range of voltage levels the VFC can measure. The VFC can measure a detector signal between -0.207V and +2.000V.

### Channel selection

You can configure the DT2802 to integrate the signal at either channel or to automatically switch between the two channels (automux) for each conversion. See Chapter 4, "Firmware," for more information on this feature.



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## Resolution

*Resolution* refers to the number of bits the DT2802 u represent the detector output signal. As the resoluti more digits are used to represent the same input ra each code to represent a smaller signal. Table 4 sh smallest measurable signal as 1 LSB and in nV-sec resolution.

**Table 4: Resolution vs. LSB and nV-s**

| Resolution | 1 LSB | nV-sec @ 60Hz | nV |
|---|---|---|---|
| 18 bits | 8392.3 nV | 69.936 nV-sec | 83. |
| 19 bits | 4196.2 nV | 69.936 nV-sec | 83. |
| 20 bits | 2098.1 nV | 69.936 nV-sec | 83. |
| 21 bits | 1049.0 nV | 69.936 nV-sec | 83. |
| 22 bits | 524.52 nV | 69.936 nV-sec | 73 |
| 23 bits | 262.26 nV | 69.936 nV-sec | 68 |
| 24 bits | 131.13 nV | 69.936 nV-sec | 65 |

*All values in this table are rounded to 5 decimal digits.*

The integrator converts the input voltage from the output pulses which it counts over the sampling int DT2802 then converts these counts to a digital coc maximum sampling rate of 120 or 100 measureme (depending on the line frequency configuration valu DT2802 is able to count 18-bit values. At longer s intervals, the DT2802 can accumulate more counts higher resolution.

You can configure each integrator for a resolution bits. The resolution you choose determines the m sampling rate. The DT2802 takes 8.333 msec (1/ perform a conversion at 18 bits. The DT2802 take (60/120 second) to perform a conversion at 24 bits the maximum sampling rate at each resolution. T sampling rate is approximately 1 sample every 9 r



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**Table 5: Resolution vs. Sampling Rate (Single Chann**

| | Number of Line Cycles | | Maximum Sampling R | |
|---|---|---|---|---|
| Resolution | 60Hz | 50Hz | 60Hz | 50Hz |
| 18 bits | 0.5 | 0.5 | 120 | 100 |
| 19 bits | 1.0 | 1.0 | 60 | 50 |
| 20 bits | 2.0 | 2.0 | 30 | 25 |
| 21 bits | 4.0 | 4.0 | 15 | 12.5 |
| 22 bits | 8.0 | 7.0 | 7.5 | 7.143** |
| 23 bits | 16.0 | 13.0 | 3.75 | 3.846** |
| 24 bits | 30.0 | 25.0 | 2.0 | 2.0 |

** Maximum sampling rate is in measurements per second*

*** These throughput rates are rounded to three decimal places*

**Sampling rate**

The *sampling rate* is the maximum speed at which the DT2802 can acquire data and maintain the specified accuracy. The DT2802 bases its integration timing on the local line frequency selected for the board (60Hz or 50Hz). The smallest measural unit is 1/2 line cycle or 1/120 second (for 60Hz line frequency) 1/100 second (for 50Hz line frequency). This results in the fastest sampling rate of 120 (or 100) samples per second. Wit the exception of 18-bit resolution, all integration times are an integral number of power line cycles. This allows the DT2802 t reject the crosstalk from the power lines to the detector inputs. See "Resolution" above for the effect of resolution on the sampling rate.

To take measurements less frequently than the maximum sampling rates shown in Table 5 above, specify an interval (delay) time between conversions. This interval time is specifie in 0.5 line cycle increments. Refer to the discussion on the Tim Interval command on pages 56 to 61 for further information abou this delay time.



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## VFC Operation

The VFC is always running when the DT2802 is pow
That is, it constantly produces output pulses represe
voltage of the selected input. During data acquisitio
DT2802 counts these pulses over the integration int
calculates a digital code representing the input volta

When you switch inputs to the VFC (either manually
automux mode), the VFC requires a settling time to
output. The length of this settling time depends on
you select for the integrator. Table 6 shows the set
number of power line cycles) at each resolution at t
line frequencies.

**Table 6: VFC Settling Time**

| Resolution | Settling Time (number of l | |
|---|---|---|
| | 60Hz | 5 |
| 18 bits | 0.5 | |
| 19 bits | 0.5 | |
| 20 bits | 0.5 | |
| 21 bits | 1.0 | |
| 22 bits | 2.0 | |
| 23 bits | 3.0 | |
| 24 bits | 3.0 | |

Table 7 shows the effect of resolution on throughp
automux mode.



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**Table 7: Resolution vs. Throughput (Automux Mode)**

| Resolution | Throughput per Channel | |
|---|---|---|
| | 60Hz | 50Hz |
| 18 bits | 30.0 | 25.0 |
| 19 bits | 20.0 | 16.6667* |
| 20 bits | 12.0 | 10.0 |
| 21 bits | 6.0 | 5.0 |
| 22 bits | 3.0 | 2.7778* |
| 23 bits | 1.5789* | 1.5625 |
| 24 bits | 0.9091* | 0.8929* |

** These throughput rates are rounded to 4 decimal places.*

The firmware always waits the settling time before taking a measurement when you switch the input channel or operate in the automux mode.



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# DT2802 Microprocessor

The DT2802 microprocessor, a Motorola 68HC11, c
inputs and outputs with the host and the data acquis
subsystem. This microprocessor (Figure 9) provide
of RAM, 512 bytes of EEROM, one serial I/O port, a
generator, and a timer. An EPROM and external R
the microprocessor subsystem.

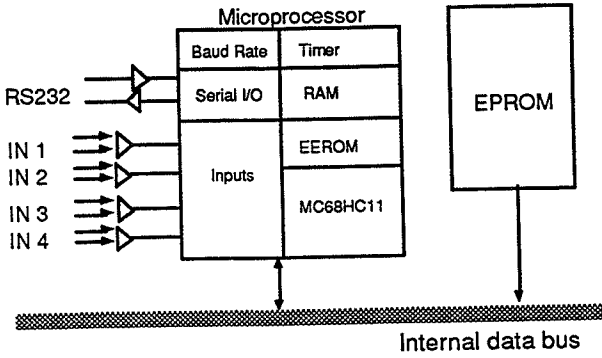



**Figure 9: DT2802 Microprocessor**

**Baud Rate Generator** Generates the baud rate specified for the serial po
rate is one of the board configuration settings.

**Serial Port** This is an RS232 port that permits serial communi
RS232-based peripheral. It also allows the DT280
remotely from the host system. See Reference 6,
Control Protocol," for information on passing firmw
and data over the RS232 port.

**Timer** The timer's frequency is set to two times the local
selected for the board. The timer interrupts the pr
integrator actions take place on ticks of this timer.

The timer hardware also produces an output pulse
VFC counters.



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**RAM** The RAM contains the "working" board configuration settings power up or reset, the microprocessor loads the settings fror EEROM to RAM. These settings can be modified (with the exception of line frequency) and will remain in effect until a re occurs.

**EEROM** The EEROM stores the board configuration settings. These settings represent the last saved configuration. At power up reset, the DT2802 loads these values into RAM to become th working values. The calibration constants are also stored in EEROM. See Chapter 4, "Firmware," for more information or the configuration parameters.

**EPROM** The EPROM is 32 Kbytes in size and contains the code execu by the 68HC11 microprocessor to control DT2802 operations.

**External RAM** The DT2802 places the digital code from each conversion into this 32 Kbyte RAM for its subsequent transfer to a user buffer the host system.



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# Inputs and Outputs

The DT2802 supplies four switch inputs and four ou
A "1" indicates a switch input is high or an output sw
A "0" indicates a switch input is low or an output swi

## Inputs

The four inputs have pullup resistors and can accep
CMOS, or contact closure signal from devices in th
chromatography system. This signal can be the inj
from a manual or auto-injector, or the abort signal f
controller. You can configure each input to sense a
transition, high-to-low transition, or either type of tra
input can interrupt the host or trigger integration wh
the selected change in signal. You can set the inpu
normal or debounce. (Use the debounce mode wh
a contact closure.) See Chapter 4, "Firmware," for
on selecting the active edge and configuring an inp
interrupt or trigger source.

## Output Switches

The output switches are optically isolated switch cl
host writes each output value individually or as a g
provide external device control. You can connect
to devices to provide a chart mark output at the sta
integration, a hold signal in the event of an abort in
signal, etc.



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# Serial Port

The serial I/O port provides an RS232 port that permits seria communication with other RS232-based peripherals. This po intended to pass CTS (clear to send) signals to RS232-base chromatographic equipment or to provide other RS232-compatible on/off controls.

The DT2802 can be remotely controlled by firmware commar received over its RS232 port. This stand-alone mode of operation is jumper-selectable. Reference 6, "Remote Contro Protocol," describes the communications protocol for this mod of operation.

The serial I/O port has an RD (receive data), TD (transmit dat and RS232 control signal. This serial I/O port is part of the DT2802 microprocessor.

Since the microprocessor controls the data acquisition tasks, y should limit serial communication during data acquisition.

The serial port parameters have the following values:

- Baud rate 9600 *(factory-configuration)*
- Data 8 bits/character
- Stop bits 1
- Start bits 1
- Parity None

The baud rate is software-configurable for rates of 300, 1200, 2400, 4800, 9600, 19200, and 38400. The port may also interrupt the host when data is available. See Chapter 4, "Firmware," for information on configuring this port.



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# Bus Interface

The DT2802 board provides four 8-bit registers that
I/O addresses. In the ISA bus mode, all communica
between the host and the DT2802 occur via these r
the stand-alone mode, all communications between
the DT2802 occur via the RS232 port.

The Command and Status registers are located at t
address. The host writes commands to the Comma
and reads the board status from the Status register.
and Data Out registers are located at the base+1 a
host writes the command arguments to the Data In
reads integration and other board information from
register.

The host can read the Status register at any time.
the Command or Data In registers, or read from the
register, only when the Port Ready bit in the Status
(high). Any host action with these registers when t
bit is clear causes an error condition.

Table 8 summarizes the DT2802 registers, their fu
addresses.

**Table 8: DT2802 Registers**

| Register | Function | Address |
|---|---|---|
| Status | Provides board status information | Base + 0 |
| Command | Specifies the firmware command to execute | Base + 0 |
| Data Out | Provides integration results and other board information | Base + 1 |
| Data In | Supplies the arguments for the firmware command | Base + 1 |



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## Conventions

Each register has a two character abbreviation listed beside
name on the following pages. The Status register bits also h
a two or three character abbreviation. (This is not done with
other register bits since they do not have individual functions

It may be necessary from time to time in this manual to refer
the state of a particular bit or bits. Rather than spell out the
register and bit name, this manual will use its abbreviations a
follows: **REGISTER:BIT**. For example, SR:PR represents th
Status register, Port Ready bit.



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## Status Register

***Address: Base Address*** ***Ac***

The Status register returns the status of the DT2802
Figure 10 shows the bit functions of the Status regis

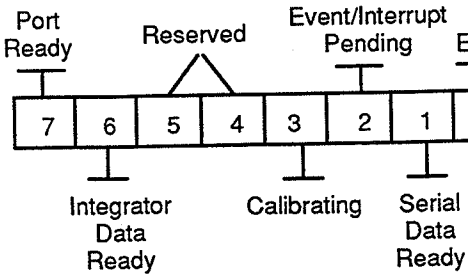



**Figure 10: Status Register Bit Functi**

### Bit 7: Port Ready

This bit is set when the host can access the Comm
and Data In/Out registers. This bit is clear when th
not ready for commands or data. A write to the Co
Data In register, or a read of the Data Out register
is clear causes an error.

**READ:** 0 = DT2802 not ready
1 = DT2802 ready

### Bit 6: Integrator Data Ready

This bit sets when the number of data points speci
integrator is in the data buffer. This bit is clear wh
fewer data points in the data buffer than the Thres
either integrator. Reading enough data values fro
buffer to bring the number of data points in the buf
integrator below its threshold value clears this bit.

**READ:** 0 = Integration data not available
1 = Integration data available for rea



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## Bits 5 and 4: Reserved

These bits are reserved and always return "00."

## Bit 3: Calibrating (C

This bit sets while the board is calibrating the integrators. It clears when the calibration sequence completes. (SR:PR will clear during calibration indicating to the host the board is in a "not ready" state.)

**READ:** 0 = board is not in calibration sequence
1 = calibration in progress

## Bit 2: Event/Interrupt Pending (

This bit sets when any event/interrupt source that has been enabled becomes active. If the Master Interrupt is enabled, th DT2802 also interrupts the host when this bit sets.

The DT2802 has the following event/interrupt sources:

- Data ready integrator A
- Data ready integrator B *(not used by the DT2802-2)*
- Digital input 1 active
- Digital input 2 active
- Digital input 3 active
- Digital input 4 active
- Serial port data ready
- Serial output port ready
- Error

To determine the source of an interrupt or which event has occurred, use the Interrupt Pending command. This command returns a 2-byte event/interrupt mask in which each bit represents a particular event/interrupt source. Figure 11 shows the event/interrupt mask.



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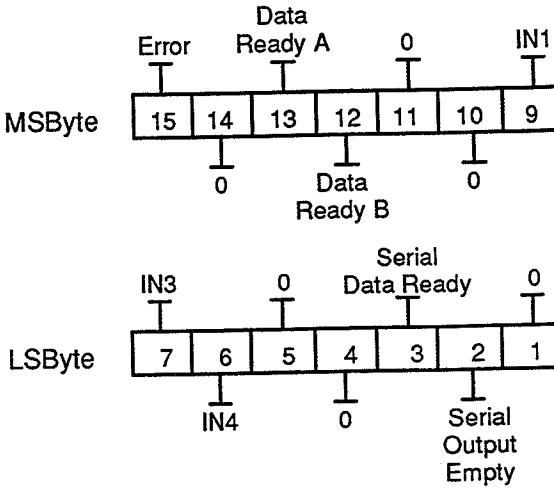



**Figure 11: Event/Interrupt Source Ma**

**READ:** 0 = no interrupt conditions have occu
1 = interrupt condition has occurred

## Bit 1: Serial Data Ready

This bit sets when there is a data byte in the serial
SR:IP also sets when this bit sets if the Serial Port
event/interrupt source is enabled.

**READ:** 0 = serial data buffer empty
1 = serial data available

## Bit 0: Error

This bit sets when an error occurs. This error may
command, an improper number of arguments, etc.
which error occurred, and to clear the error bit, use
SYSTEM ERROR command. If more than one er
this bit remains set after the first error is read. Co
executing the READ SYSTEM ERROR command
clears. See Reference 7, "Error Codes," for a list
errors.

**READ:** 0 = no error
1 = error exists



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## Command Register

***Address: Base Address*** ***Access: W***

The host writes the firmware command to execute to the Command register. Figure 12 shows the bit functions of the Command register.

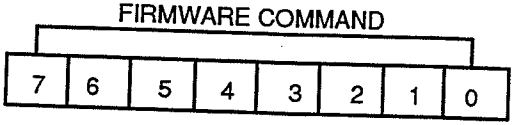



**Figure 12: Command Register Bit Functions**

### Bits 7–0: Firmware Command

A write to this register provides the firmware command for the DT2802 to execute. This register can only be written to when SR:PR is set. Writing to this register when SR:PR is clear causes an error. Most commands have a fixed number of arguments or data bytes that must be written to or read from th Data In/Out registers. Some commands have no arguments, while other commands have one, two, or more arguments. Failure to write the appropriate number of arguments or read th appropriate number of data bytes following a command causes an error.



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## Data Out Register

***Address: Base Address + 1*** ***Ac***

The host reads the data associated with a read com
the Data Out register. Figure 13 shows the bit funct
Data Out register.

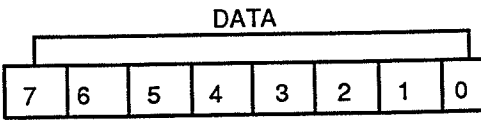



**Figure 13: Data Out Register Bit Functi**

### Bits 7–0: Data

A read of this register returns one byte of data asso
the read command written earlier to the Command
multiple bytes are associated with the read comma
read returns the most significant byte. The next rea
second most significant byte, and so on. The last r
the least significant byte. This register can only be
SR:PR is set. Reading this register when SR:PR is
an error. A read of this register following a write co
causes an error.



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## Data In Register

***Address: Base Address + 1*** ***Access: W***

The host writes the arguments associated with a command to Data In register. Figure 14 shows the bit functions of the Dat register.

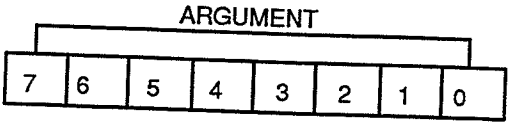



**Figure 14: Data In Register Bit Functions**

### Bits 7–0: Argument

A write to this register provides an argument associated with t firmware command written earlier to the Command register. I multiple arguments are associated with the command, the arguments are written in order of most significant byte to least significant byte. This register can only be written to when SR:P is set. Writing to this register when SR:PR is clear causes an error. A write to this register following a read command also causes an error.



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