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5. Select the resolution of integrator A.

   - Write **84** (Set Integrator A Resolution) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **xx** (desired resolution – 01H to 07H) to the Data In [DI] register.
   - Poll the SR until PR sets.

6. Specify the time between measurements.

   - Write **08** (Set Time Interval Integrator A) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **xx** (MSB of number of line cycles between conversions) to the Data In [DI] register.
   - Poll the SR until PR sets.
   - Write **xx** (LSB of number of line cycles between conversions) to the Data In [DI] register.
   - Poll the SR until PR sets.

7. Set the data buffer threshold for integrator A.

   - Write **60** (Set Threshold Buffer A) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **xx** (MSB of threshold value) to the Data In [DI] register.
   - Poll the SR until PR sets.
   - Write **xx** (LSB of threshold value) to the Data In [DI] register.
   - Poll the SR until PR sets.

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8. Enable the Integrator A Data Ready source in the Event/Interrupt Mask.

   - Write **42** (Set Event/Interrupt Mask) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **20** (MSB of mask) to the Data In [DI] register.
   - Poll the SR until PR sets.
   - Write **00** (LSB of mask) to the Data In [DI] register.
   - Poll the SR until PR sets.

   If you wish to interrupt the host on any other event, enable it at this time.

9. Enable the Master Interrupt.

   - Write **40** (Enable Master Interrupt) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **02** (enable) to the Data In [DI] register.
   - Poll the SR until PR sets.

10. Trigger the conversion.

    - Write **88** (Start Conversions Integrator A) to the Command register [CR].
    - Poll the SR until PR sets.

    Conversions begin on integrator A.

11. Wait for an interrupt to occur.

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12. Read the Event/Interrupt Pending mask and determine if Data Ready A caused the interrupt.

    - Write **54** (Event/Interrupt Pending) to the Command register.
    - Poll the SR until PR sets.
    - Read the MSB from the Data Out [DO] register.
    - Poll the SR until PR sets.
    - Read the LSB from the DO register.
    - Poll the SR until PR sets.

    If the MSB is "20," the Data Ready A bit is set and data is available for reading.

13. If the Data Ready A bit is set, transfer the data to the host.

    - Write **9E** (Read Next Conversion Integrator A) to the Command register [CR].
    - Poll the SR until PR sets.
    - Read the MSB from the Data Out [DO] register.
    - Poll the SR until PR sets.
    - Read the next byte from the DO register.
    - Poll the SR until PR sets.
    - Read the next byte from the DO register.
    - Poll the SR until PR sets.
    - Read the LSB from the DO register.
    - Poll the SR until PR sets.
    - Repeat this step for the threshold number of conversions.

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14. Re-enable the Master Interrupt.

    - Write **40** (Enable Master Interrupt) to the Command register [CR].
    - Poll the SR until PR sets.
    - Write **02** (enable) to the Data In [DI] register.
    - Poll the SR until PR sets.

15. Repeat steps 11 through 14 until you are ready to stop operation.

16. To stop operation, write **8C** (Stop Conversions on Integrator A) to the Command register.

17. Read any data points still in the buffer.

    - Poll the SR until PR sets.
    - Write **72** (Read Number of Samples in Buffer A) to the Command register.
    - Poll the SR until PR sets.
    - Transfer each remaining data point to the host as described in step 13 above.

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I/O Switch Operation

Input detection setup

In order to recognize a change of signal at any of the four input switch detectors, set up the input (or inputs) following the steps below. Insert these steps in your program where desired.

1. Set the debounce/no debounce state of the inputs.
   - Write **27** (Input Mode) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **01** (no debounce) or **02** (debounce) to the Data In [DI] register.
   - Poll the SR until PR sets.

2. Set the active edge for the input.
   - Write the SET ACTIVE EDGE command for that input to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **xx** (desired edge) to the Data In [DI] register.
   - Poll the SR until PR sets.

3. Enable that input source in the Event/Interrupt Mask.
   - Write **42** (Set Event/Interrupt Mask) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **xx** (MSB of mask) to the Data In [DI] register.
   - Poll the SR until PR sets.
   - Write **xx** (LSB of mask) to the Data In [DI] register.
   - Poll the SR until PR sets.

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4. Enable the inputs.

   - Write **0E** (Set Input Enable) to the Command register.
   - Poll the SR until PR sets.
   - Write **02** (enable) to the Data In [DI] register.
   - Poll the SR until PR sets.

5. *OPTIONAL:* Enable the Master Interrupt.

   - Write **40** (Enable Master Interrupt) to the Command register [CR].
   - Poll the SR until PR sets.
   - Write **02** (enable) to the Data In [DI] register.
   - Poll the SR until PR sets.

If you are operating in the polled mode, monitor SR:IP once conversions begin. (In the interrupt mode, wait for an interrupt to occur.) The appropriate bit sets in the Event/Interrupt Pending mask when the DT2802 detects an active edge at that input. Read this mask to determine what caused the bit to set.

To clear the input event and determine which edge caused the event, execute the READ INPUT x command. To recognize another active edge at that input, re-enable the input detection logic as described in step 4 above. If you are operating in the interrupt mode, re-enable the Master Interrupt as described in step 5.

Output switches

To operate a switch, perform these actions:

- Write **26** (Set Output Switches) to the Command register.
- Poll the SR until PR sets.
- Write **xx** (switch and state) to the Data In [DI] register.
- Poll the SR until PR sets.

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Reference 1

Jumper Configuration

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*Reference 1, "**Jumper Configuration**," describes the jumper-selectable features of the DT2802 board and their alternative settings. This section is organized as follows:*

- *Jumper Summary*
- *Base Address Selection*
- *Interrupt Priority Level Selection*
- *Board Mode Selection*

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Jumper Summary

The DT2802 board has jumper settings that you can change if necessary. In most instances you will be able to use the factory-configured jumper settings. If your operating conditions call for alternative settings, however, you must change the appropriate jumpers on the board before installing it.

The jumper-selectable parameters on the DT2802 board are the base address, the interrupt priority level, and the board mode of operation.

Table 19 summarizes the user-configurable jumpers on the DT2802 board.

Table 19: Jumper Summary

Function	Factory Configuration (installed jumpers)
Base Address	Jumpers: A9 to A1 high to low
300 H	A9H, A8H, A7L, A6L, A5L, A4L, A3L, A2L, A1L
Interrupt Level	Jumpers: IRQ15, IRQ12, IRQ11, IRQ10, IRQ7, IRQ6, IRQ5, IRQ4, IRQ3
5	IRQ5
Board Mode	Jumpers: W4
ISA bus	—

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Jumper Locations

The jumper labels are silkscreened onto the component side of the DT2802 board. Figure 24 illustrates the location of the base address and interrupt priority level jumpers on the DT2802 board. The board mode of operation jumper, W4, is located below the microprocessor (68HC11) on the board.

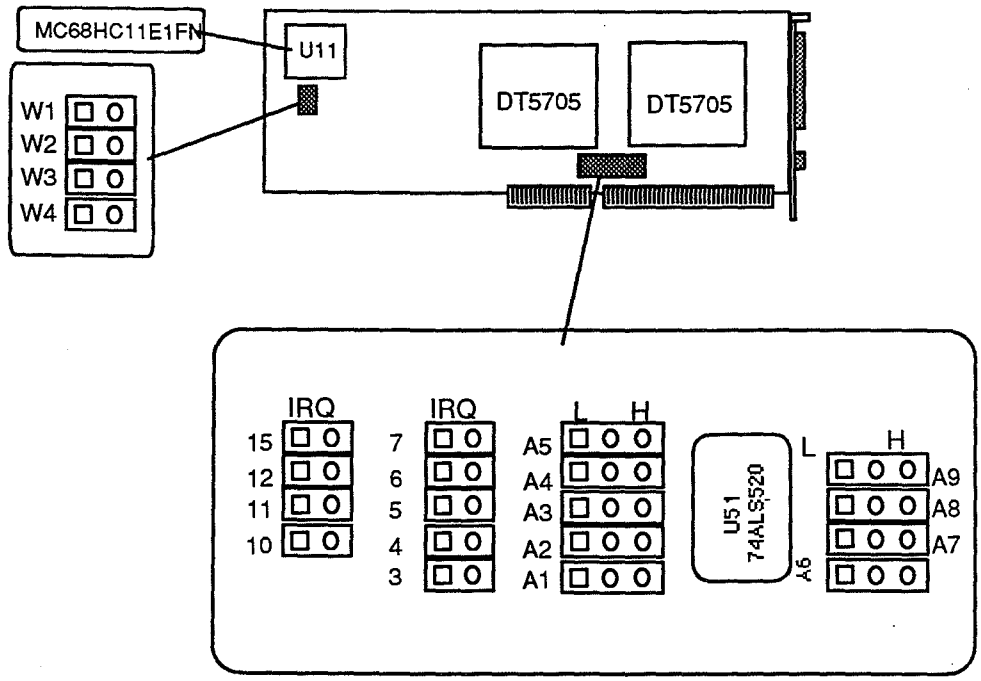


Figure 24: DT2802 Board Jumper Locations

How to Install Jumpers

Note *Make any changes to the jumper configuration before you install the board in your computer. If you need to change the jumper settings after you install the board, first turn off the computer, open the main unit, and remove the board. After changing the settings, replace the board as described in Chapter 2, "Installing the DT2802," and start up your system again.*

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The DT2802 uses nine jumpers for the base address, one jumper for the interrupt priority (IRQ) level, and one jumper for the board mode of operation. Move a jumper from "H" to "L" or "L" to "H" to change the base address. To set the IRQ level, move the jumper to the posts for the desired IRQ level. If you are not using an IRQ level, move the jumper to the posts illustrated in Figure 25.

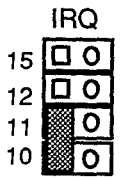


Figure 25: Jumper Location – No IRQ Level

To select the stand-alone mode, move the jumper to W4. If you are operating in the ISA bus mode, the jumper is installed as illustrated in Figure 26.

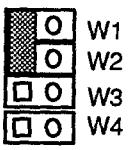


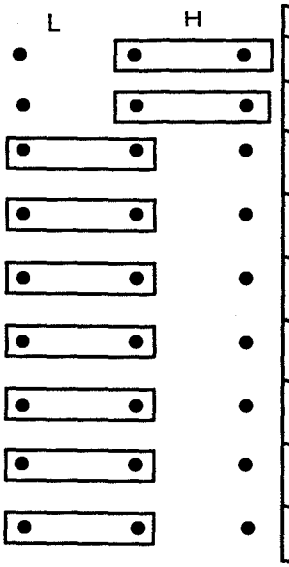
Figure 26: Jumper Location – ISA bus mode

Note *The DT2802 only checks this jumper setting at powerup and reset.*

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Base Address Selection

You can assign the DT2802 board to any base address between 000H and 3FFH. Many of these addresses are already used by your system. We recommend using an address in the range 280H to 370H. Consult your System I/O Address Map to select an unused address. The board occupies that address and the next one only. Figure 27 illustrates the factory configuration setting of 300H.



	Binary	Hex
A9	1	3
A8	1	
A7	0	0
A6	0	
A5	0	
A4	0	
A3	0	0
A2	0	
A1	0	

Figure 27: Base Address

The base address jumpers are labeled A9 to A1. Each address bit has two jumper positions associated with it as shown in Figure 28. A jumper in the "H" position makes that address bit high (1). A jumper in the "L" position makes that address bit low (0).

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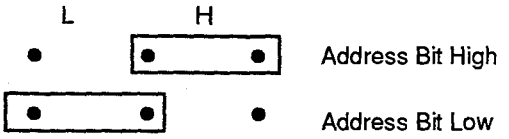


Figure 28: Address Bit Jumper Positions

To change the base address

- Install the jumper plugs at the appropriate "H" or "L" position for each address bit.

Note *The base address (and subsequent address range) you choose must be unused by any other device in the system. Consult the IBM Technical Reference and the technical information included with any other devices in your system to determine the addresses in use.*

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Interrupt Priority Level Selection

Note *The interrupt priority level you choose must be unused by any other device in the system. Consult the IBM Technical Reference for your computer and the technical information provided with any other devices in your system to determine the interrupt levels in use.*

The DT2802 can interrupt the host processor on any of 9 different interrupt levels. The interrupt levels, in order of decreasing priority, are: 3 (highest), 4, 5, 6, 7, 10, 11, 12, and 15 (lowest).

The DT2802 has a jumper location for each interrupt level. Each jumper location is labeled with the IRQ level it represents. Only one jumper can be installed at any of these locations. The installed jumper selects the interrupt priority level for the board. If you do not want to use an IRQ, install the jumpter as shown in Figure 25 on page 163.

To Change Jumper Settings

- Install the jumper plug at the desired IRQ jumper location. Refer to Table 20 below for a list of the external hardware interrupts and their default use in the IBM Personal Computer AT.

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Table 20: IRQ Levels – Default Uses

Interrupt Vector Number (hex)	Priority Level Interrupt	Default Usage (IBM PC-AT)
08	IRQ 0	System Timer
09	IRQ 1	Keyboard
0A	IRQ 2	Cascade from Slave PIC
0B	IRQ 3	Serial Port (COM2)*
0C	IRQ 4	Serial Port (COM1)*
0D	IRQ 5	Parallel Port (LPT2)*
0E	IRQ 6	Floppy Disk*
0F	IRQ 7	Parallel Port (LPT1)*
70	IRQ 8	Real Time Clock
71	IRQ 9	Rerouted Software
72	IRQ 10	Available
73	IRQ 11	Available
74	IRQ 12	Available
75	IRQ 13	Numeric Coprocessor
76	IRQ 14	Fixed Disk
77	IRQ 15	Available

** If you do not have the corresponding peripheral installed in your system, this interrupt level is available. You can not share an interrupt level between two devices.*

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Board Mode Selection

The DT2802 has two modes of operation: ISA bus mode and stand-alone mode. In the ISA bus mode, the DT2802 communicates with the host through its bus connectors, P1 and P2. The DT2802 recognizes firmware commands and arguments, and transfers data at its four registers.

In the stand-alone mode, the DT2802 communicates with the host through its serial I/O port. The host sends firmware commands and arguments to and receives data and status from the board.

The DT2802 is shipped factory-configured for the ISA bus mode (W4 is installed as shown in Figure 26 on page 163).

To Change Jumper Settings

- Install (for stand-alone mode) or remove (for ISA bus mode) the jumper plug at W4.

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Reference 2

Board Calibration

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*Reference 2, "**Board Calibration**," describes the auto-calibration feature of the DT2802 board. This section is organized as follows:*

- *Integrator Calibration*
- *Calibration Procedure*

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Integrator Calibration

During integration, the DT2802 acquires the signal from the detector or detectors connected to its input channels and produces a digital code representing that signal that the application can interpret.

The DT2802 uses voltage-to-frequency converters (VFCs) to convert the input voltage from the detector to an output frequency. (A VFC is a form of analog-to-digital converter.) In order to compute the digital output code, the DT2802 must measure the output frequency of the VFC.

Measuring the VFC frequency requires counting the output pulses of the VFC for a known and highly stable time interval. The DT2802 uses its onboard crystal clock to produce a timebase at two times the local power line frequency selected for the board. The DT2802 uses this timebase to control the integration (i.e., it is this time period during which the VFC pulses are counted). The microprocessor reads the value of the VFC counter and divides it by the integration interval to determine the VFC's frequency. This frequency is proportional to the input voltage, but has a gain and offset factor. The gain factor is the number of pulses the VFC produces for each LSB. The offset factor is the number of pulses the VFC produces at a zero volt input.

The DT5705 module, which houses the VFC, is designed so these gain and offset factors are highly stable. For highly accurate results, it is important to measure these values at the operating temperature of the unit. Your unit should be turned on for at least 2 hours before you perform a calibration.

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Calibration

The DT2802 microprocessor computes correction values for the DT5705 module based on an external calibration (E-cal) done at the factory, and an automatic calibration (A-cal) performed when the host sends the CALIBRATE INTEGRATORS command to the board. The E-cal adjusts for the actual value of the reference voltage and the gain and offset of each input amplifier. The A-cal compensates for the gain and offset drift in the VFC itself. These calibration sequences take many measurements of the voltage sources and determine an average "good" value to use. All measurements are done at 24-bit resolution.

These calibration sequences depend on the overrange capability of the DT5705 module and on the highly stable components used in the module. The overrange capability allows calibration at positive full scale without saturation. The stability ensures that the values measured will have minimal drift.

E-cal E-cal tests each input channel separately with precision voltage sources of zero volts and full scale applied externally. The microprocessor calculates the gain and offset for each channel and stores these values in onboard EEROM. These E-cal values are used later in addition to the A-cal values. E-cal measures the actual values of the internal voltage sources used by A-cal.

A-cal A-cal uses internal voltage sources in the DT5705 to measure the VFC gain and offset. This calibration is performed internally in the DT5705 using a full-scale reference voltage and a zero reference voltage (analog ground). The microprocessor uses the analog ground signal to measure the VFC at zero volts input. This is the VFC's offset. Knowing the offset, the microprocessor uses the full-scale reference voltage to measure the gain of the VFC. Upon successful completion of the A-cal, the DT2802 stores the new gain and offset values in EEROM. These values are available to the DT2802 on powerup or reset, eliminating the need to perform the lengthy calibration sequence at that time.

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This A-cal calibration adjusts for the gain and offset of the DT5705 module. The calibration depends on the linearity of the DT5705 to obtain good values. The calibration process measures only two points and only corrects gain and offset. The DT5705 VFC is typically linear to 14 bits.

All computations for the E-cal and A-cal values from the 26-bit data produced by the VFC counters are performed by the DT2802 microprocessor using 64-bit floating point math. The E-cal and A-cal tables in EEROM are 64-bit floating point values. The DT2802 can report 24-bit values to the application. 24-bit values represent seven and one-half decimal digits. The DT2802 does not use 32-bit floating point math as it may produce significant errors in the seventh decimal digit.

The input range of the DT5705 VFC is +2.000 volts to -0.207 volts. Since the output frequency must be positive, the VFC must be offset more than 10% of full scale at zero volts input. The offset allows the VFC frequency to be about 1 MHz at negative full scale. At zero volts, the VFC frequency is approximately 4.25 MHz, and at positive full scale it is about 37 MHz. These are nominal values and depend on the exact values of several key components. The VFC gain is in MHz/volt. The DT5705 produces about 16.3 MHz/volt (or 16.3 KHz/mV).

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Calculating Digital Codes

The DT2802 stores the E-cal and A-cal values separately in the DT2802 EEROM. The DT2802 computes a working calibration table of gains and offsets on powerup and after an A-cal. The working calibration table values are 32-bit fixed point data and are located in RAM. The DT2802 produces working calibration table values for each resolution based on the E-cal and A-cal values (determined at 24-bit resolution) and the selected local line frequency (60Hz or 50Hz). The DT2802 optimizes these calibration tables for real-time execution.

The output of the calibration equation is the hex code that is passed back to the application as the digital code. This digital code is adjusted by the calibration equation for the gain and offset of the VFC and the input channel used. The digital code (in hex) reported to the application is computed as follows:

Digital Code = (F_vfc – F_ofs) * G + Zero Code

where:

F_vfc is the output frequency of the VFC

F_ofs is the output frequency with 0 volts input

G is the gain of the VFC in units of codes/Hz

Zero Code is the hex code for 0 volts input

Table 21 shows the zero codes at each resolution.

Table 21: Digital Output Codes

Resolution	Zero Code (hex)
24 bits	180000
23 bits	0C0000
22 bits	060000
21 bits	030000
20 bits	018000
19 bits	00C000
18 bits	006000

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F_ofs and G are from the working calibration table. All realtime computations are carried out using 32-bit integer data. The DT2802 microprocessor performs the computations necessary to produce the output code at the maximum sampling rate for each VFC in real time.

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Calibration Procedure

The DT2802 can be calibrated whenever it is not actively performing data acquisition (that is, whenever it is in an "idle" state). The DT2802 performs the calibration sequence when it receives the calibration command, **2D**, from the host.

To calibrate the DT2802 integrators, perform the following steps:

1. Poll the Status register until the Port Ready bit (SR:PR) sets.

2. Write **2D** to the Command register. (This is the CALIBRATE INTEGRATORS command.)

3. Poll the SR until PR sets.

4. Write **01** to the Data In register.

5. Poll the SR until PR sets.

6. Repeat steps 4 and 5, writing **02**, **03**, and **04** in sequence.

After writing "04" to the Data In register, the DT2802 begins the calibration sequence and the Calibrating bit (bit 3) in the Status register sets for the duration of the calibration process. When calibration completes, the Calibrating bit clears, the Port Ready bit sets, and the board performs a reset.

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Reference 3

Board Connectors

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*Reference 3, "**Board Connectors**," describes the bus connector, the detector and I/O switch connector, and the serial I/O connector provided on the DT2802 board. This section is organized as follows:*

- *Connector Summary*
- *P1 and P2: Bus Connectors*
- *J1: Detector and I/O Switch Connector*
- *J2: Serial I/O Connector*

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Connector Summary

The DT2802 board has four connectors labeled P1, P2, J1, and J2 as shown in Figure 29.

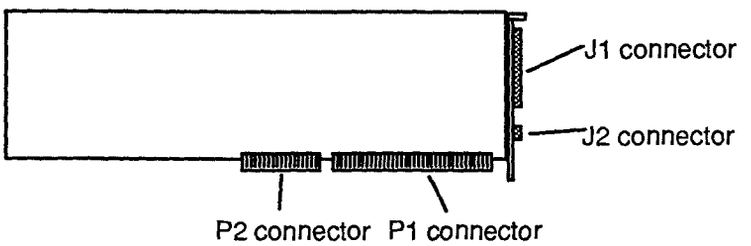


Figure 29: DT2802 Connectors

P1 and **P2**, on the bottom of the board, connect the DT2802 board to the IBM Personal Computer AT bus.

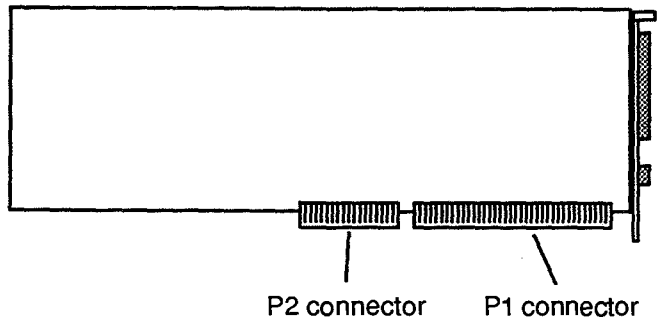
J1, on the rear panel of the board, interfaces detector and I/O switch connections with the board.

J2, also on the rear panel of the board, connects an RS232-based device with the board.

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P1 and P2: Bus Connectors

The IBM Personal Computer AT bus interfaces with the DT2802 board via the P1 and P2 connectors.



P1 is a 62-pin bus connector with two rows of 31 pins each. P2 is a 36-pin AT connector. Table 22 lists the pin assignments for the P1 connector. Table 23 lists the pin assignments for the P2 connector.

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Table 22: P1 Pin Assignments

Pin	Mnemonic	Description
A01	–I/0 CH CK	No connection
A02	SD7	System data bit D7
A03	SD6	System data bit D6
A04	SD5	System data bit D5
A05	SD4	System data bit D4
A06	SD3	System data bit D3
A07	SD2	System data bit D2
A08	SD1	System data bit D1
A09	SD0	System data bit D0
A10	–I/O CH RDY	No connection
A11	AEN	Address enable
A12	SA19	No connection
A13	SA18	No connection
A14	SA17	No connection
A15	SA16	No connection
A16	SA15	No connection
A17	SA14	No connection
A18	SA13	No connection
A19	SA12	No connection
A20	SA11	No connection
A21	SA10	No connection
A22	SA9	System address bit A9
A23	SA8	System address bit A8
A24	SA7	System address bit A7
A25	SA6	System address bit A6
A26	SA5	System address bit A5
A27	SA4	System address bit A4
A28	SA3	System address bit A3
A29	SA2	System address bit A2
A30	SA1	System address bit A1
A31	SA0	System address bit A0

(continued)

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Table 22: P1 Pin Assignments (continued)

Pin	Mnemonic	Description
B01	GND	Ground
B02	RESET DRV	Reset driver
B03	+5VDC	+5V power
B04	IRQ9	No connection
B05	–5VDC	No connection
B06	DRQ2	No connection
B07	–12VDC	–12V power
B08	OWS	No connection
B09	+12VDC	+12V power
B10	GND	Ground
B11	–SMEMW	No connection
B12	–SMEMR	No connection
B13	–IOW	–I/O write
B14	–IOR	–I/O read
B15	–DACK3	No connection
B16	DRQ3	No connection
B17	–DACK1	No connection
B18	DRQ1	No connection
B19	–REFRESH	No connection
B20	CLK	No connection
B21	–IRQ7	Interrupt request 7
B22	–IRQ6	Interrupt request 6
B23	–IRQ5	Interrupt request 5
B24	–IRQ4	Interrupt request 4
B25	–IRQ3	Interrupt request 3
B26	–DACK2	No connection
B27	T/C	No connection
B28	BALE	Address latch enable
B29	+5VDC	+5V power
B30	OSC	No connection
B31	GND	Ground

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Table 23: P2 Pin Assignments

Pin	Mnemonic	Description
C01	SBHE	No connection
C02	LA23	No connection
C03	LA22	No connection
C04	LA21	No connection
C05	LA20	No connection
C06	LA19	No connection
C07	LA18	No connection
C08	LA17	No connection
C09	–MEMR	No connection
C10	–MEMW	No connection
C11	SD08	No connection
C12	SD09	No connection
C13	SD10	No connection
C14	SD11	No connection
C15	SD12	No connection
C16	SD13	No connection
C17	SD14	No connection
C18	SD15	No connection

(continued)

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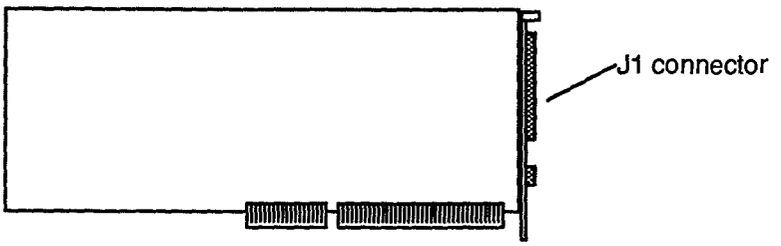
Table 23: P2 Pin Assignments (continued)

Pin	Mnemonic	Description
D01	–MEM CS 16	No connection
D02	–I/O CS 16	No connection
D03	–IRQ 10	Interrupt request 10
D04	–IRQ 11	Interrupt request 11
D05	–IRQ 12	Interrupt request 12
D06	–IRQ 15	Interrupt request 15
D07	–IRQ 14	Interrupt request 14
D08	–DACK0	No connection
D09	DRQ0	No connection
D10	–DACK5	No connection
D11	DRQ5	No connection
D12	–DACK6	No connection
D13	DRQ6	No connection
D14	–DACK7	No connection
D15	DRQ7	No connection
D16	+5VDC	+5V power
D17	–MASTER	No connection
D18	GND	Ground

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J1: Detector and I/O Connector

All detector and I/O switch connections to the DT2802 board interface with the board via connector J1.



J1 is a 37-pin D-shell connector. Table 24 lists the pin assignments for the J1 connector.

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Table 24: J1 Pin Assignments

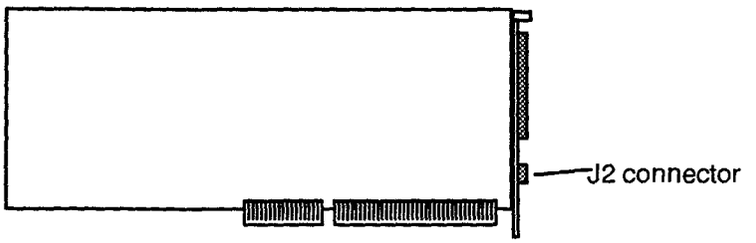
Description	Pin		Description
Digital Ground	1		
Switch 4 High	2	20	Switch 4 Low
Switch 3 High	3	21	Switch 3 Low
Switch 2 High	4	22	Switch 2 Low
Switch 1 High	5	23	Switch 1 Low
Input 4 High	6	24	Input 4 Low
Input 3 High	7	25	Input 3 Low
Input 2 High	8	26	Input 2 Low
Input 1 High	9	27	Input 1 Low
+12V [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 10mA should be drawn from the ± 12V terminals (pins 10 and 28). The return for the ± 12V is Digital Ground.*

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J2: Serial I/O Connector

RS232-based devices interface with the DT2802 via the J2 connector in the ISA bus mode. In the stand-alone mode, the DT2802 interfaces with the host via the J2 connector.



J2 is a 6-pin RJ11 connector. Table 25 lists the J2 pin assignments.

Table 25: J2 Pin Assignments

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

** RS232 Signal will be connected to DTR (Data Terminal Ready) by most DTE Drop Null modems.*

Figure 30 shows the cable required between an IBM PC 25-pin D-shell connector and the DT2802 J2 connector. Figure 31 shows the cable required between an IBM PC 9-pin D-shell connector and the DT2802 J2 connector.

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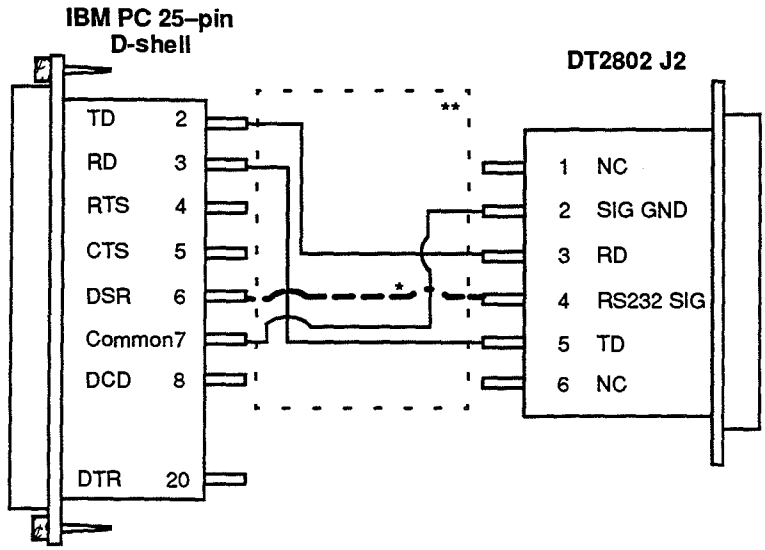


Figure 30: 25-pin D-shell to J2 Connector

** Optional connection if RS232 SIG used as DTR (Data Terminal Ready)*

*** A DTE Drop Null modem Mod Tap #06-988-260-20 (or equivalent) with a standard 4–6 wire telephone cable (standard reversing ends) provides these connections.*

Table 26 lists the RS232 pin assignments for the IBM AT's 25-pin serial connector.

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Table 26: 25-Pin Serial Connector Pin Assignments

Description	Pin		Description
Protective Ground	1	14	Transmitted data (secondary)
Transmitted Data	2	15	Transmission Signal Element Timing
Received Data	3	16	Received data (secondary)
Request to Send	4	17	Receiver Signal Element Timing
Clear to Send	5	18	Unassigned
Data Set Ready	6	19	Request to send (secondary)
Signal Common	7	20	Data Carrier Detect (RLSD)
Data Carrier Detect (RLSD)	8	21	Signal Quality Detector
Reserved for testing	9	22	Ring Indicator
Reserved for testing	10	23	Data Signal Rate Detector
Unassigned	11	24	Transmit Signal Element Timing
Received Line Signal Detect (secondary)	12	25	Unassigned
Clear to Send (secondary)	13		

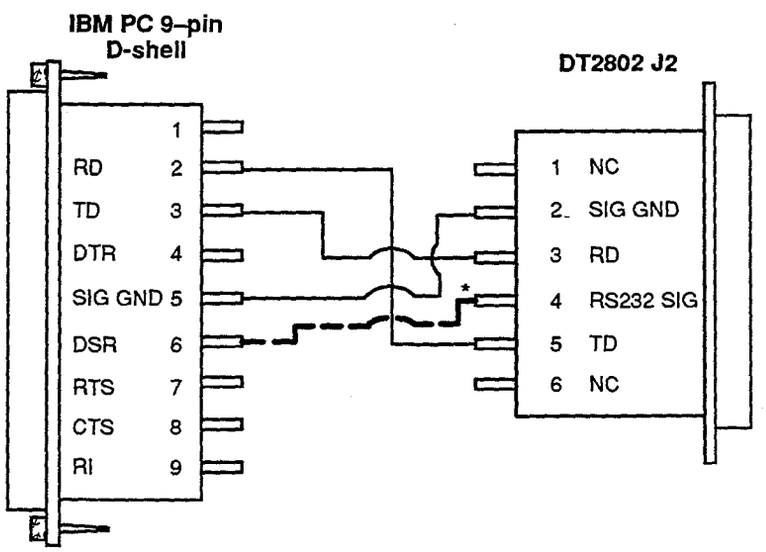


Figure 31: 9-pin D-shell to J2 Connector

** Optional connection if RS232 SIG used as DTR (Data Terminal Ready)*

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Table 27 lists the RS232 pin assignments for the IBM AT's 9-pin serial connector.

Table 27: 9-Pin Serial Connector Pin Assignments

Description	Pin		Description
Received Line Signal Detect	1	6	Data Set Ready
Received Data	2	7	Request to Send
Transmit Data	3	8	Clear to Send
Data Terminal Ready	4	9	Ring Indicator
Signal Ground	5		

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Reference 4

Detector Connections

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*Reference 4, "**Detector Connections**," discusses the sources of noise in a measurement and how to connect your detector to the DT2802 for high resolution measurements. This section is organized as follows:*

- *Noise Sources*
- *Making Connections*
- *DT777 Connections*

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Noise Sources

The DT2802 is a high resolution measurement instrument. It can measure to one part in one million at 20-bit resolution, and to one-sixteenth of a part per million (60 parts per billion) at 24-bit resolution. Because the DT2802 is so sensitive to small changes in signal, it is very easy for it to measure not only the signal you want, but also other (unwanted) signals as well.

There are several types of unwanted signals that can be introduced through the input connections. These error sources include noise picked up through the input cables from the environment, offset errors due to the thermal electro-motive force (emf) of the different metals in the wires and connectors, and other errors.

This chapter discusses how to minimize the contribution from unwanted signals through your connections.

Electrical Noise

There are many sources of electrical noise. These include power lines, radio stations, computers, terminals, and other electronic equipment. These sources interfere with the signals the DT2802 can measure, adding error to the results.

Power Line Noise

The DT2802 is designed to inherently minimize the largest noise contributor, power line noise. It does this through its line frequency configuration which you set to the local line frequency (60Hz or 50Hz). Except for 18-bit resolution, the DT2802 uses one line period as its minimum measurement (integration) time. All other integration times are multiples of this minimum integration time.

Since the power line cycle is nominally a sine wave, the average contribution over one cycle of power line noise is zero. When DT2802 integrates for a number of line cycles, it helps to cancel out the error from the line frequency pickup. By configuring the DT2802 for the correct line frequency, you can minimize the contribution of power line noise.

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Other Electrical Noise

Noise from radio signals, computers, and other electronic sources is frequently picked up in cabling. The DT2802 minimizes the effect of this noise by using differential inputs which are relatively insensitive to noise. Differential inputs "see" only the difference between input HIGH and input LOW. Since noise affects both the high and low signals, this input type cancels out the noise contribution. Using shielded input cables also helps reduce the interference from these sources.

Crosstalk

Crosstalk is the effect one input signal can have on another. The DT2802 allows you to connect up to four detectors to its input channels. For example, if the output of one detector is tracking a peak, and another detector is tracking the baseline, some small amount of the peak may show up in the baseline trace.

You can minimize crosstalk by shielding the input cables from each other. This prevents the two signals from "talking" to each other.

Thermal Effects

When two dissimilar metals are placed in contact, and a temperature difference occurs across the junction, the junction develops a thermal electro-motive force. This connection becomes a battery whose voltage depends on the temperature gradient across the junction. Generally, these effects are small (often less than 1µV/°C), and thermal emf can be ignored. However, the DT2802 has 2µV resolution at 20 bits, and 0.13µV resolution at 24 bits. Therefore, poorly made connections can result in erratic measurements due to thermal emf.

All connections should be enclosed to minimize air movement and temperature gradients.

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Differential Inputs

Each DT2802 input channel consists of input HIGH, input LOW, and Analog Ground. The integrator "sees" input HIGH minus input LOW as its input.

Input HIGH connects to the detector output signal, which is typically an op amp output with low impedance. Input LOW connects to the detector ground, which is also low impedance. Analog Ground is provided for shielding. See the section on "Making Connections" later in this chapter for more information on these connections.

Minimizing Errors

The contribution from noise or an error source when using high resolution instruments cannot be eliminated but can be minimized. This chapter has discussed the major error sources and how the DT2802 deals with them. It has also mentioned additional precautions you can take such as using shielded input cables, ensuring connections are secure, and providing a stable thermal environment. The next section provides more information on making proper connections.

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Making Connections

Proper cabling will result in more consistent measurements and minimize the error influences described above. The following discusses proper cabling and connection techniques.

In order to reduce the noise pickup in the cabling, use a shielded twisted pair cable for each detector input connection. The two wires that make up the pair are used for the signal HI and signal LOW connections. The shield protects the signal wires from outside influences. For best results, connect the shield at only one end, preferably at the DT2802 end. That is, connect the shield wire to ANALOG GROUND and do *not* connect the other end to the detector. (See Figure 32 below.) If you cannot connect the shield at the DT2802, leave that end unconnected and connect the other end to the detector as shown in Figure 33.

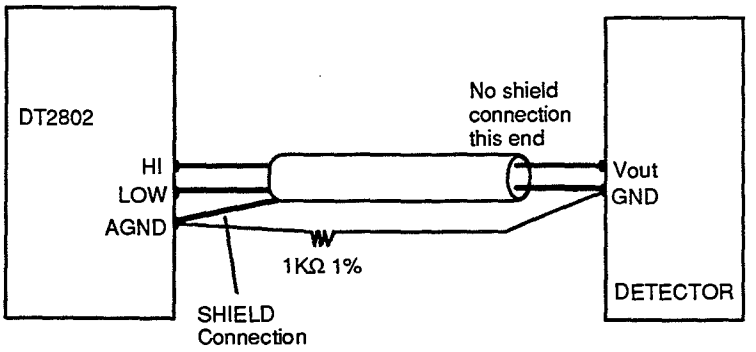


Figure 32: Preferred Detector Connections

Connecting the shield at the detector end of the cable may increase crosstalk to levels that are measurable by the DT2802.

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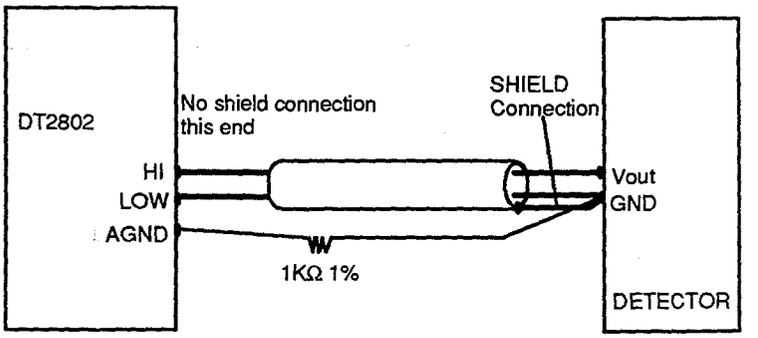


Figure 33: Alternate Detector Connections

By connecting the shield at only one end, the shield carries no electrical current. This means that the shield is all at the same voltage, making it an equipotential or electrostatic shield.

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 such connection is necessary for each detector in the system.

Each detector input to the DT2802 should be connected in this manner. Shielding the input channels from each other minimizes crosstalk, particularly when one input channel is near full-scale and the other is near zero.

Vref In/Out Connections

The DT2802 provides access to the voltage reference of the high resolution DT5705 module. The Vref connection may be an input for a stable, precision voltage reference, or an output with the module's own reference voltage available to the user.

The reference voltage for Integrator A is brought out to the J1 connector. The reference voltage for Integrator B is not available.

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To sense Integrator A's internal reference, you must buffer the Vref I/O and Vref RETURN signals with low drift, low bias current op amps. (We recommend OP-27 op amps.) You must make a differential amplifier with a gain of 1.00 (see Figure 34) where the positive input is the buffered Vref I/O and the negative input is the Vref RETURN. The output of the differential amplifier is then an "image" of the +5.000V internal reference with respect to your ground system.

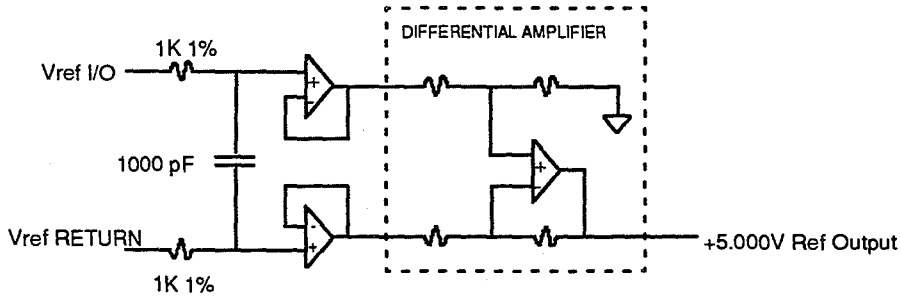


Figure 34: Sensing Vref

To supply a reference to Integrator A, you must provide a voltage source of +5.000V +/- 1%. This voltage source must be an op amp or other low impedance output with respect to the Vref RETURN signal. See Figure 35 below.

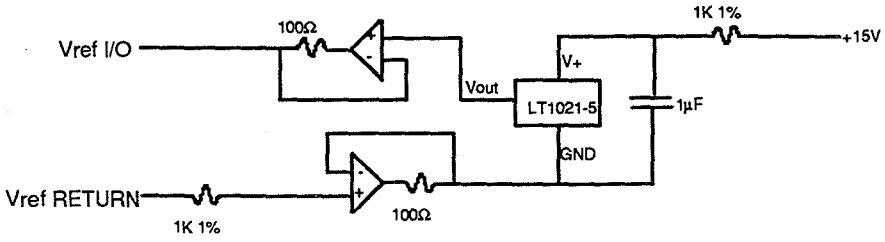


Figure 35: Supplying Vref

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DT777 Connections

The DT777 screw terminal panel allows you to conveniently make detector and I/O switch connections to the DT2802. The panel containing the screw terminals is placed in a box which provides electrical shielding from the noise sources described earlier, and provides protection from air currents that can cause thermal emf problems.

Connections for the detector inputs, reference voltage (Vref), I/O switches, and ± 12V subsystems are the DT2802 board's J1 pins brought out to screw terminal connectors. Each J1 signal name is silkscreened directly onto the DT777 board next to the appropriate screw terminal.

Detector Input Attenuation

The DT777 provides blank circuit pads for installing resistors for attenuating the detector input signal. Each of the four detector input channels can be configured with resistors to increase the -200mV to +2.00V input range of the DT2802 board to -500mV to +5.00V or -1.00V to +10.00V.

Each detector input channel requires a network of three individual precision, low temperature coefficient resistors. Zero ohm resistors are factory installed at the appropriate locations to provide a factory configuration of no attenuation. To install the resistor network, cut out the zero ohm resistors and install the attenuation resistors for each input channel.

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I/O Switch Connections

The DT777 provides screw terminal connections for the DT2802 four differential inputs and four output switches. The differential inputs are protected by circuity on the DT2802 board to ± 50V. The DT777 provides additional protection against transient voltages. Each input has a rated clamping voltage of 47V, and a rated peak single pulse transient current of 500 amps, with a maximum clamping voltage of 70V and a rated transient average power dissipation of 0.4 watts.

The output switches are optically isolated switch closures which have a voltage rating of 24VDC. The DT777 provides additional protection against transient voltages. A metal oxide varistor is connected in parallel with each output switch.

Other Connections

±12V Supplies

The DT2802 provides the user ±12V supplies derived from the PC/AT bus. These supplies are brought out to screw terminal connections on the DT777. Returns for the supplies are provided through DGND. The amount of power available to the user is 10mA from each supply.

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Reference 5

Specifications

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*Reference 5, "**Specifications**," lists the electrical and mechanical specifications for the DT2802 board. This section is organized as follows:*

- *Detector Inputs*
- *Input/Output Switches*
- *Serial Input/Output*
- *Microprocessor*
- *Interface*
- *Physical/Environmental*

Note *All specifications are typical at +25°C and rated voltage unless otherwise specified.*

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Detector Inputs

Number of integrators	
DT2802-2	1
DT2802-4	2
	Each integrator has two differential input channels with an independently controlled time base
Input range	-0.207V to +2.000V
Resolution	18 to 24 bits, programmable

Channel throughput (max) @ 60Hz/50Hz line frequency

18 bits	120/100Hz
19 bits	60/50 Hz
20 bits	30/25 Hz
21 bits	15/12.5 Hz
22 bits	7.5/7.143* Hz
23 bits	3.75/3.846* Hz
24 bits	2.0/2.0 Hz
	* rounded to three decimal places

Minimum conversion time (number of power line cycles) @ 60 Hz/50 Hz line frequency

18 bits	0.5/0.5
19 bits	1.0/1.0
20 bits	2.0/2.0
21 bits	4.0/4.0
22 bits	8.0/7.0
23 bits	16.0/13.0
24 bits	30.0/25.0

Sampling rate	Programmable from maximum throughput to 1 sample every 9 minutes
Common mode rejection ratio	
at 50 and 60Hz	> 72dB
Settling time to 0.1% FSR	1 ms

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Input impedance (differential)	>100MΩ
Bias current	< ±50nA
Maximum input voltage without damage	
Steady state	± 40V
Transient	±100V (10% duty cycle; 5 minute max pulse width)
Common mode Input range	±5V
Normal mode rejection ratio	
Line frequency ± 0.1% of nominal	> 60dB (except at 18 bits, NMRR = 0 dB)
Integrator nonlinearity	0.05% FSR max
Differential linearity error	1 LSB max
Monotonicity	Guaranteed
Dynamic range	> 140dB (@ 24-bit resolution)
Zero drift	5ppm of FSR/°C max (improves with auto-calibration)
Full scale drift	20 ppm of FSR/°C max (improves with auto-calibration)
Gain error	0.03% FSR max
Input noise	125nV rms typ @ 24 bits, $0V_{in}$ 1.0μV rms typ @ 20 bits, $0V_{in}$ (2μV + 1μV/V_{in}) rms max @ 20 bits
Channel-to-channel crosstalk	< -120dB

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Input/Output Switches

Logic sense	programmable

Switch Inputs

Number of inputs	4
Common mode range	± 5V
Compatible inputs	TTL, CMOS, contact closure
Powerup state	high

Output Switches

Number of output switches	4 solid state relay-type
Output voltage	+24VDC, 40mA load
Ron	200Ω max
Roff	10MΩ min

Output common isolated from system ground

One common line for each output

Powerup state	open

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Serial Input/Output

Type	RS232
Baud rates	300, 1200, 2400, 4800, 9600, 19200, 38400
Connector	6-pin, RJ11 RD, TD, Signal, Ground

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Microprocessor

Type	Motorola MC68HC11E1
Function	Supports all host I/O, serial I/O, auto-calibration and control of integrators, I/O switches

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Interface

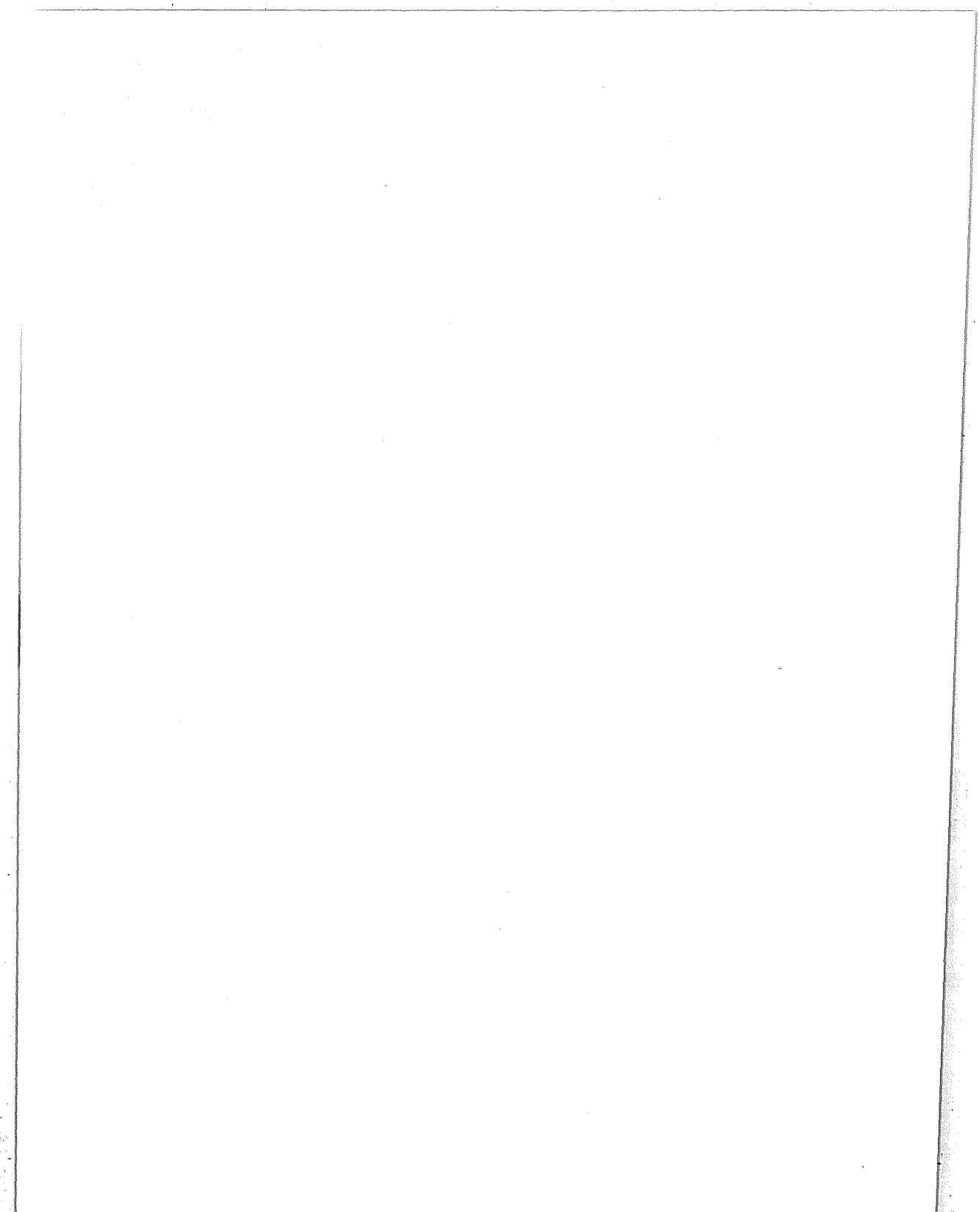
Compatible bus	IBM Personal Computer AT
Interface type	I/O mapped
Data path	8 bits
Base address range	000H to 3FFH in 2H increments; 300H (factory-configuration)
Number of interrupts	1
Interrupt level	3, 4, 5, 6, 7, 10, 11, 12, or 15
Connector	All detector and I/O switch connections are made to a single 37-pin D-shell connector

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Physical/Environmental

Board size	PC AT-compatible EISA-compatible
Operating temperature	0 to +50°C (32 to 122°F)
Storage temperature	-25 to +70°C (-13 to +158°F)
Relative humidity	To 95%, non-condensing
Power requirements	
+5V	+5V ±0.25V @ 1.25A max, 1.0 A typ
+12V	+12V ±0.6V @ 85mA max, 60mA typ
-12V	-12V +/-0.6V @85mA max, 60mA typ
Power consumption	8.3 watts max, 6.5 watts typ

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Reference 6

Remote Control Protocol

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*Reference 6, "**Remote Control Protocol**," describes how to communicate with the DT2802 board via its RS232 port. This section is organized as follows:*

- *Overview*
- *The Serial Interface*
- *The Communications Protocol*
- *Acquiring Data*

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Overview

The DT2802 board is capable of remote communication with a host computer via its serial I/O port. In this "stand-alone" mode, the DT2802 receives firmware commands and transmits data and status information over its serial I/O port. In the normal ISA bus mode, the DT2802 receives firmware commands and transmits data and status information over its ISA bus connector. A single jumper setting determines the communications mode (ISA bus or stand-alone). See Reference 1, "Jumper Configuration," for information on configuring the communications mode.

The stand-alone mode provides serial I/O port access to all DT2802 firmware commands EXCEPT the following:

- SET SERIAL INPUT CONTROL
- WRITE SERIAL DATA BYTE
- ABORT COMMAND
- READ SERIAL DATA BYTE
- SET/CLEAR RS232 CONTROL SIGNAL

These firmware commands control communication over the serial I/O port under the ISA bus mode of operation and will return a "Not Valid Command" error when the DT2802 is configured for stand-alone operation. ABORT COMMAND, which is not a serial I/O port command, is not a valid command in the stand-alone mode because it aborts a command prior to the host sending the last argument. In the stand-alone mode, a command and its arguments are sent in the same transmission block.

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The DT2802 provides two modes of transmitting data in the stand-alone mode: Normal Data and Stream Data. In the Normal Data transmission mode, the host sends a READ NEXT CONVERSION command for each data value as it becomes available. In the Stream Data mode, the DT2802 continuously sends integrator data from one or both VFCs whenever the VFC data buffer contains the number of data points greater than or equal to the Stream Data Packet Size (the maximum packet size is 64 data points, or 256 bytes). In the Stream Data mode, the host can send any commands that are legal while the integrators are running, receive any data from these commands, and receive the integrator data stream.

The RS232 port in the stand-alone mode supports eight data bits, one stop bit, one start bit, and no parity. The baud rate is software-selectable up to 19200 baud.

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The Serial Interface

The DT2802 stand-alone mode of operation uses a Byte Count Oriented protocol, with the data field byte count included as part of the header. The Byte Count Oriented protocol uses a control character to start the packet, followed by a byte count of the data field.

Control Characters

The stand-alone mode uses a limited number of control characters. Table 28 lists the DT2802 control characters.

Table 28: Control Characters

Character	Hex	Description
SOH	01	Start of header
ENQ	05	Enquire
ACK	06	Positive acknowledgment
NAK	15	Negative acknowledgment
CAN	18	Cancel

Error Correction

The DT2802 stand-alone mode of operation uses the Stop and Wait ARQ (Automatic Retransmission reQuest) scheme of alternating messages and acknowledgments. This scheme is simple to implement.

In this scheme, the acknowledgment response to a message can be positive or negative. A positive acknowledgment (ACK) indicates the message was received properly, and invites the sender to transmit the next message, if any. A negative acknowledgment (NAK) indicates faulty transmission of the message, and requires the sender to retransmit the last message.

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The acknowledgment response from the DT2802 consists of an ACK (06H) or NAK (15H) followed by its status byte (contents of the Status register). With the exception of the Port Ready bit (bit 7) and Serial Data Ready bit (bit 1), the host can use the status byte in a polled I/O mode similar to the mode that occurs over the ISA bus.

The acknowledgment response from the host consists of only ACK (06H) or NAK (15H).

The host can also request the status byte by sending an ENQ (05H) to the DT2802. The DT2802 responds to this request with an ACK message followed by the status byte. This is useful when reading integrator data in the Normal Data mode, and when establishing initial communication with the DT2802. For example, the following steps illustrate a simple auto-baud routine for use with the DT2802:

1. Host sets COM port baud rate.
2. Host sends ENQ.
3. Host waits "x" time for response from the DT2802.
4. If the host receives no response, it selects the next valid baud rate.
5. Repeat steps 1 through 4 until the DT2802 responds.

Packet Description

Each information transfer is referred to as a "packet." Figure 36 illustrates the components (fields) of each packet.

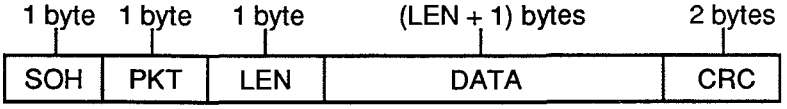


Figure 36: Packet Components

The remainder of this section describes the individual packet components.

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SOH (Start of Header)

The SOH component signifies the start of a message. The two bytes following the SOH are regarded as header information.

PKT (Packet Type)

The PKT component is the packet type identifier. It is part of the header information. The packet type flags the host interface as to the type of data contained in the data field. Table 29 lists the packet types.

Table 29: Packet Types

Packet Type	Data Type
0 = command	Firmware command (always sent by host)
1 = normal	Normal response to a firmware command
2 = stream	Response to send data in user-specified packet size – Stream Data mode
4 = stream interrupt	Same as PKT = 2, but signifies a masked interrupt is set

The host always sends a packet identifier type of 0, since the data field of all host packets is a firmware command.



Firmware Reference

LEN (Length of Data Field)

The LEN component represents the number of data bytes in the data field. It is part of the header information. The LEN byte value is the actual length of the data field minus 1. This is to allow the maximum stream data packet size of 64 four-byte data values (256 total bytes) to be represented by a single LEN byte (255). When the host sends a command, the LEN byte value is the number of arguments included with the command.

DATA

The DATA component is the data field of type specified by PKT and length (in bytes) specified by LEN.

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CRC

The CRC component contains the standard CRC-CCITT (cyclic redundancy check) value calculated on the entire packet, beginning with the PKT byte.

Error Detection

Bit and byte errors commonly occur in serial communication. The frequency of errors increases as the length of the transmission line and the amount of environmental noise increase. The DT2802 uses the CRC method of error detection. This method is very effective in detecting transmission errors.

The CRC algorithm operates on an entire packet (beginning with the PKT byte) as a single unit. Before each message is transmitted (or received), the CRC accumulator is initialized to a value of 0. As each byte of data is transmitted (or received), the high byte of the CRC accumulator is XORed with the data byte. This result is the Combined Value. The low byte of the CRC accumulator is XORed with the CRC remainder calculated on the Combined Value, and the result is stored in the CRC accumulator.

This process is repeated for each byte (after SOH) in the packet. When transmitting, after the final byte of data is sent, the value of the CRC accumulator is tagged to the end of the packet (CRC). When receiving, the CRC of the Combined Value of the CRC accumulator and the CRC attached to the packet by the sender should equal 0 for error-free transmissions.

Because the CRC method requires math-intensive calculations, and there are only 256 possible Combined Values, the DT2802 uses a CRC lookup table to determine the CRC remainder. The CRC-CCITT polynomial, $X^{16} + X^{12} + X^5 + 1$, is used to calculate the CRC remainder for the lookup table. This lookup table allows the DT2802 to perform CRC calculations up to 10 times faster than the conventional method of calculating the remainder. See the example program, SAMP9.C, on the distribution diskette SP0802 supplied with your board, for an example of the lookup table method of CRC calculation.

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The Communications Protocol

This section describes the DT2802 serial communications protocol as required from the host. It describes how to initiate communication with the DT2802, how to send firmware commands, and how to receive integrator data from the DT2802 in the Normal Data mode and Stream Data mode.

Initiating Communication

After powerup or reset, the host initiates communication with the DT2802 by sending an ENQ message and waiting for a response. The response from the DT2802 will consist of the ACK|STATUS message. Figure 37 illustrates a host status enquire message.

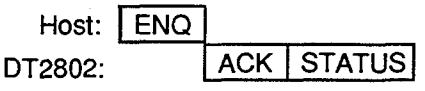


Figure 37: Host Status Enquire

If the host does not receive a response from the DT2802, the host COM port may be at the wrong baud rate. If necessary, change the host baud rate and try the ENQ message again.

If the baud rate is correct, and the DT2802 still fails to respond, the DT2802 may be in a state where it is still waiting for an acknowledgment from the host for a previously sent message. In this case, the host should send a NAK message to the DT2802. If the DT2802 was waiting for an acknowledgment from the host, the NAK will cause the DT2802 to send a packet whose data field consists of the data last requested by the host. Figure 38 illustrates the NAK communication sequence.

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Figure 38: Host Negative Acknowledge

If the host terminates transmission in the middle of receiving a message, the DT2802 waits for the rest of the message. This hang condition may occur if the host is reset in the middle of sending a command or acknowledgment. Whenever communication hangs, you must reset the DT2802. To reset the DT2802, send 16 CAN control characters (18H) to the DT2802. This returns the DT2802 to the last saved configuration. The host must send the CAN control character 16 times to avoid bytes in the data field being confused with the CAN control character. You may also reset the DT2802 by cycling its power or by applying a high to the RESET DRV pin on the DT2802 ISA bus connector.

Sending Firmware Commands

After establishing initial communication with the DT2802, the host can send firmware commands to the DT2802. To send a command, the host first assembles the packet with the DATA field consisting of the command followed by any arguments associated with that command (MSB byte first, LSB byte last), the PKT field set to 0, and the LEN field consisting of the length of the DATA field minus 1. For example, if the host is sending one byte, LEN is set to 0. If the host is sending two bytes, LEN is set to 1. The host calculates the error check value for the packet and adds this value as the last two bytes of the packet. The host then sends the packet over the serial I/O port to the DT2802.

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If the DT2802 detects an error in transmission, it immediately returns a NAK|STATUS message to the host and does not execute the command. (The Error bit, bit 0 in the status byte, will be set.) The host now has two options: (1) send the GET SYSTEM ERROR command and determine the nature of the error (CRC error, framing error, argument count error, etc.); or, (2) ignore the Error bit and resend the original command. If the host simply resends the command and it continues to unsuccessfully transmit on an application-specified number of retries, the host should determine and correct the source of the error. Figure 39 illustrates a host command resend operation.



Figure 39: Host Command Resend

The DT2802 has a 2-second packet timeout on host commands. The DT2802 starts the timeout after it receives the SOH control character from the host. If the DT2802 does not receive the last byte of the packet within two seconds, the receive state of the DT2802 returns to idle (waiting for a control character) and the DT2802 sends a NAK|STATUS message to the host. This prevents a corruption of the LEN byte from forcing the DT2802 to wait forever for more bytes than the host will send. A corresponding timeout in the host application will prevent the host from waiting forever for the wrong number of bytes in a packet it receives. This host timeout should also turn off if the host detects an error, since the host sends a NAK message to the DT2802.



Firmware Reference

If the DT2802 does not detect an error in the transmission, it executes the command. At the completion of the command, the DT2802 sends an ACK|STATUS message to the host, signalling the host that the command has executed and it is ready to accept another command. The DT2802 ignores any command it receives before it has sent the ACK|STATUS message to the host. As in ISA bus operation, the Error bit in the status byte may be set, signalling the host that an error occurred during command execution. The host may send the GET SYSTEM ERROR command to the DT2802 to determine the source of the error(s).

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If the host sends a write command, the DT2802 responds with an ACK|STATUS message after it completes the command. Figure 40 illustrates write command communication.

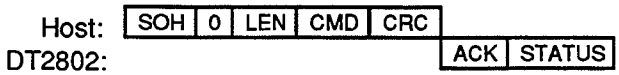


Figure 40: Successful Host Write Command

If the host sends a read command, the DT2802 returns a packet with the DATA field containing the requested data (MSB byte first, LSB byte last). The SOH control character from the DT2802 signals the host that a message is about to be sent and that it should initiate its packet timeout routine. The next byte from the DT2802 is the packet type. For the Normal Data mode, this packet type will be 1. For the Stream Data mode, the packet type will be 2 (stream) or 4 (stream with interrupt). The next byte will be the length of the DATA field minus 1. The next "n" bytes will be the DATA field. The last two bytes of the packet will be the CRC calculated by the DT2802. The host now compares its calculated CRC with the CRC value in the packet. If the remainder is 0, the host sends an ACK message, and the DT2802 responds with an ACK|STATUS message. Figure 41 illustrates a successful host read command transmission.

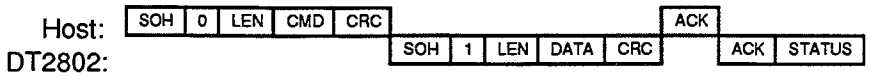


Figure 41: Successful Host Read Command

If the host detects an error (or the packet timeout is exceeded), it sends a NAK message to the DT2802. The DT2802 then retransmits the last message. The DT2802 will retransmit a packet up to five times before it sets the Error bit in the status byte with a "Maximum Retry" error. Figure 42 illustrates a Command–Data Resend transmission.

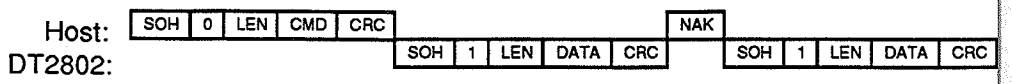


Figure 42: Command Data Resend

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If the DT2802 does not receive an acknowledgment from the host after a 2-second timeout, the DT2802 resends the packet as if it had received a NAK message. This action ensures the DT2802 will resend the message if the host did not properly receive the SOH control character, if the LEN byte was corrupted, or if the ACK byte itself was corrupted. It is strongly recommended that the host application handle the possibility of a corrupted SOH, LEN, or ACK byte from the DT2802 with a similar timeout scheme.

Reading Integrator Data – Normal Data Mode

In the Normal Data mode, the host reads integrator data in a manner very similar to that used in the ISA bus mode. Once conversions are triggered, the host polls the Status register (by sending the ENQ control character) until the Integrator Data Ready bit (bit 6) sets in the status byte. Alternatively, the host can send the GET EVENT PENDING command and loop until the appropriate data pending bit sets. When the appropriate bit sets, the host sends the READ NEXT CONVERSION command and collects the data.

At faster conversion rates, the host can poll the Status register for Integrator Data Ready on the status byte sent with the data. If the bit is set, the host can send the READ NEXT CONVERSION command. If the bit is clear, the host can poll the status byte (by sending ENQ) until the bit sets.

Reading Integrator Data – Stream Data Mode

The Stream Data mode can significantly increase throughput since it sends multiple data point packets in a steady stream to the host. In this mode, the DT2802 can achieve its full rated throughput of two VFCs running at 18-bit resolution at 19200 baud.

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To specify the Stream Data mode, the host sends the SET SIO MODE command with an argument value of 2. The host sends the SET STREAM PKT SIZE command to specify the desired number of data points in the packet. A value of 1 specifies one 4-byte data point per packet, a value of 2 specifies two 4-byte data points per packet, and so on. The default stream packet size is 1, and the default SIO mode is Normal Data mode. These user-configurable settings may be saved in EEROM by sending the SAVE CONFIGURATION IN EEROM command.

Once the conversions are triggered, the DT2802 will send a packet (with packet type = 2 or 4) containing the specified number of data points when the number of data values in the VFC buffers is equal to or greater than the packet size. When both VFCs are running, the packet will contain data points from either or both VFCs. The DT2802 differentiates these data points by the tag byte.

When both VFCs are running, the DT2802 alternates the data points in the packet between the two buffers. That is, the first data point is from buffer A, the second data point from buffer B, the third data point from buffer A, and so on. If the two VFCs are converting at different rates, the DT2802 fills the packet with data points from alternating buffers until the buffer being filled more slowly is empty and then fills the remainder of the packet with data points from the other buffer. When the number of data points in the VFC buffers is again greater than or equal to the packet size, the DT2802 again alternates the data points from the buffers.

If the host detects an error in transmission, it sends a NAK message to the DT2802. The DT2802 resends the packet. If the DT2802 does not receive an acknowledgment from the host within two seconds of sending the packet, it resends the packet. When the host receives the packet without errors, it sends an ACK message to the DT2802. The host should send the ACK message as soon as possible to prevent the VFC buffers from overflowing. The DT2802 sends the next packet when the packet size is reached. The DT2802 does not respond to the host's ACK message with an ACK|STATUS.

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To keep track of maskable events, use the SET/EVENT INTERRUPT MASK command to specify the events. When the DT2802 detects an event/interrupt pending while in the Stream Data mode, it sets the packet type for the stream data packet to 4. This alerts the host to a pending event. The stream data packet type will remain 4 until the host issues the proper command to service/acknowledge the event.

For example, to keep track of errors while streaming, the host should set the error bit mask, and, upon receiving a stream interrupt packet (packet type = 4), issue the GET SYSTEM ERROR command. To be alerted to a change in the state of the digital inputs, the host should set the bit mask for the appropriate digital input(s), and, upon receiving a stream interrupt packet, issue a READ/ACK INPUT command.

To stop streaming data, the host sends the appropriate STOP CONVERSIONS command. The conversions on the specified VFC stop. When both VFCs are stopped, stream data also stops.

To send a command while streaming data, simply follow the same protocol used in the Normal Data mode: assemble the packet, send the command, and wait for a response from the DT2802. The DT2802 will accept commands (or ENQ messages) from the host at any time while streaming data. The host may send a command before it receives a stream packet, after it receives a stream packet, or while it is receiving a stream packet.

When the DT2802 receives a command before or after it sends a stream packet, the DT2802 executes the command, sends any requested data, and resumes the data stream. If the host sends a command while the DT2802 is sending a stream packet or waiting for the host to acknowledge the stream packet, the DT2802 executes the command as soon as the host positively acknowledges (ACK) the stream packet, and then resumes the data stream.

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When the DT2802 receives a write command, it executes the command, responds with the ACK|STATUS message, and resumes the data stream. If the DT2802 responds to the command with a NAK message, the host should resend the command. The DT2802 will resume the data stream as soon as it properly receives the command, executes the command, and sends the ACK|STATUS message to the host.

For a read command, the DT2802 sends the requested data (with packet type = 1) and waits for host acknowledgment of that data. When the host sends the ACK message, the DT2802 responds with the ACK|STATUS message, and resumes the data stream. If the DT2802 sends a NAK message, the host should resend the command. If the host does not receive the data packet from the DT2802 properly, it should send a NAK message. The DT2802 will resend the packet and resume the data stream only when the host responds with the ACK message.

If the DT2802 receives a command (read or write), and the host sends a NAK message as a response to a data packet, the DT2802 will resend the last stream data packet and will not execute the command until the stream packet is positively acknowledged. The host can send the ENQ control character to request the DT2802 status except when it is in the middle of sending a command packet. The DT2802 will respond to the ENQ with the ACK|STATUS message as soon as the previous command completes or the stream packet has been successfully sent.

The size chosen for the stream data packet (1 to 64 four-byte data points) depends on the baud rate, the VFC resolution, and the error tendency of the operating environment. For example, using a large packet size in a noisy environment may require packets to be retransmitted. The time involved in doing this may cause the VFC buffer(s) to overflow. At faster resolutions (18 or 19 bits), the extra time required to process the packet header and CRC may not support full throughput at slower baud rates, even when smaller packet sizes are used. A packet size of 5 to 10 is the optimum size that achieves the maximum throughput.

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The speed of the host also affects throughput, but the main limiting factors are the baud rate and the packet overhead. Table 30 lists the maximum throughput (conversions per second) achieved at various baud rates on a 25MHz Wyse 386 with both VFCs running at the resolution shown.

Table 30: Maximum Throughput vs. Baud Rate

Baud Rate	Throughput* (Pkt size = 1)	Throughput* (Pkt size = 5)
19200	120	240
9600	60	120
4800	30	60
2400	15	30
1200	8	15
300	4	8

*Conversions per second

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Acquiring Data

The programming sequences in this section summarize the steps for programming the DT2802 to acquire data in both the Normal Data and Stream Data modes while operating the board remotely.

Note *These sequences assume no errors occur during the operation. You should, however, monitor the Error bit in the status byte routinely to make sure no errors occurred.*

Normal Data Mode

Perform the steps diagrammed in Figure 43 for continuous conversions in the Normal Data mode on integrator A. If you are using integrator B, substitute the appropriate commands. If you are using a switch input as the trigger source, incorporate the steps for input detection setup (see page 157) into your application.

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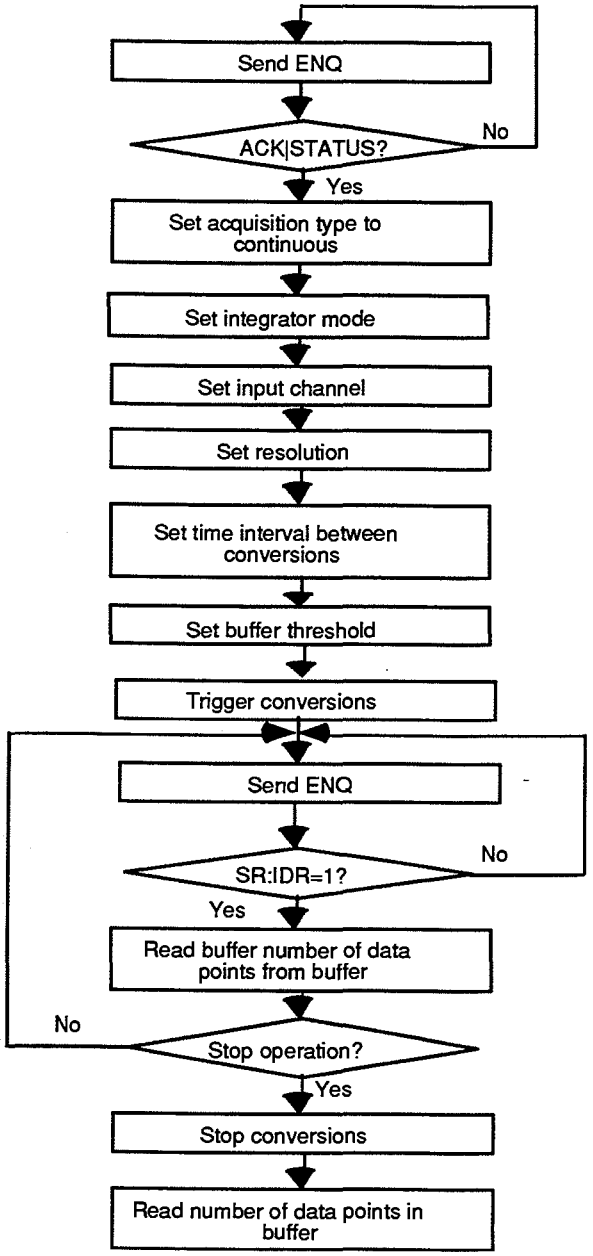
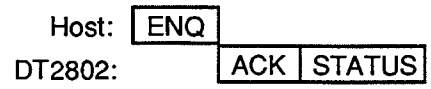


Figure 43: Continuous Conversions – Normal Data Mode

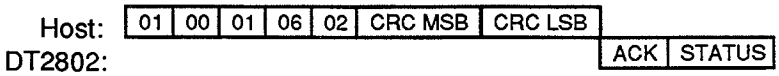
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1. Send ENQ. Wait for the ACK|STATUS response from the DT2802.



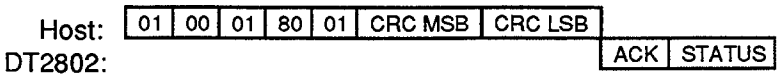
2. Set the acquisition type for integrator A to continuous conversion mode.

   - Send a packet type of 00, length of 1, with command **06** (SET ACQUISITION TYPE INTEGRATOR A) and an argument value of **02** (continuous conversion mode).
   - Wait for the ACK|STATUS response from the DT2802.



3. Set the integrator mode to single channel for integrator A.

   - Send a packet type of 00, length of 1, with command **80** (SET INTEGRATOR MODE A) and an argument value of **01** (single channel mode).
   - Wait for the ACK|STATUS response from the DT2802.



If you wish to automux between the two channels, set the integrator mode to automux (02).

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4. Select the input channel to integrator A.

   - Send a packet type of 00, length of 1, with command **82** (SET INTEGRATOR A INPUT CHANNEL) and an argument value of **01** (single channel mode).
   - Wait for the ACK|STATUS response from the DT2802.

Host:	01	00	01	82	01	CRC MSB	CRC LSB
DT2802:						ACK	STATUS

If you have set the integrator mode to automux, the input channel you specify is the starting channel.

5. Select the resolution of integrator A.

   - Send a packet type of 00, length of 1, with command **84** (SET INTEGRATOR A RESOLUTION) and an argument value of **xx** (desired resolution – 01H to 07H).
   - Wait for the ACK|STATUS response from the DT2802.

Host:	01	00	01	84	xx	CRC MSB	CRC LSB
DT2802:						ACK	STATUS



6. Specify the time between measurements.

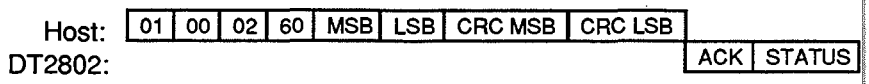
   - Send a packet type of 00, length of 2, with command **08** (SET TIME INTERVAL INTEGRATOR A) and a 2-byte argument value (number of line cycles between conversions).
   - Wait for the ACK|STATUS response from the DT2802.

Host:	01	00	02	08	MSB	LSB	CRC MSB	CRC LSB
DT2802:							ACK	STATUS

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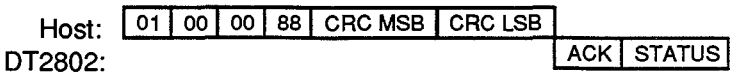
7. Set the data buffer threshold for integrator A.

   - Send a packet type of 00, length of 2, with command **60** (SET THRESHOLD BUFFER A) and a 2-byte argument value (threshold value).
   - Wait for the ACK|STATUS response from the DT2802.



8. Trigger the conversion.

   - Send a packet type of 00, length of 0, with command **88** (START CONVERSIONS INTEGRATOR A).
   - Wait for the ACK|STATUS response from the DT2802.



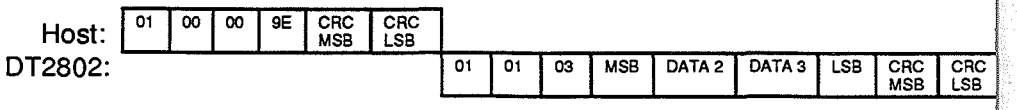
Conversions begin on integrator A.

9. Poll the status byte to determine when the threshold number of data points is available for reading.

   - Send an ENQ to the DT2802. Wait for the ACK|STATUS response from the DT2802.
   - Determine if the Integrator Data Ready bit (IDR) is set.
   - If the IDR bit is not set, repeat these actions.

10. Transfer the data to the host.

    - Send a packet type of 00, length of 0, with command **9E** (READ NEXT CONVERSION INTEGRATOR A).
    - Receive the data point from the DT2802.



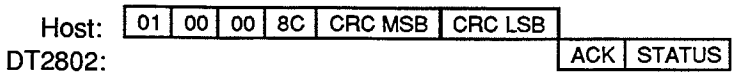
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- Verify the CRC bytes sent in the data packet from the DT2802 are the same as the calculated CRC value.
- Send ACK to DT2802.
- Wait for the ACK|STATUS response from the DT2802.

11. Repeat steps 9 and 10 until you are ready to stop operation.

12. Stop operation.

    - Send a packet type of 00, length of 0, with command **8C** (STOP CONVERSIONS INTEGRATOR A).
    - Wait for the ACK|STATUS response from the DT2802.



Stream Data Mode

Perform the steps diagrammed in Figure 44 for continuous conversions in the Stream Data mode on integrator A. If you are using integrator B, substitute the appropriate commands. If you are using a switch input as the trigger source, incorporate the steps for input detection setup (see page 157) into your application.

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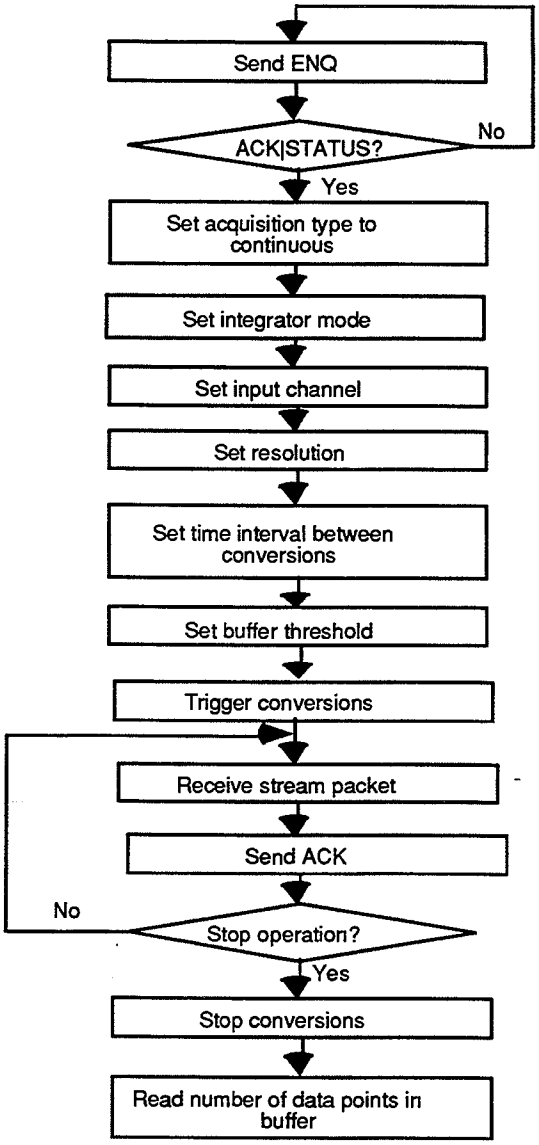
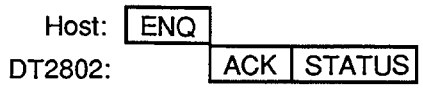


Figure 44: Continuous Conversions – Stream Data Mode

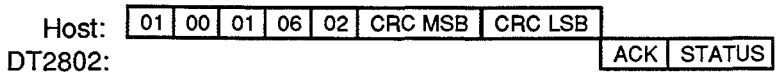
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1. Send ENQ. Wait for the ACK|STATUS response from the DT2802.



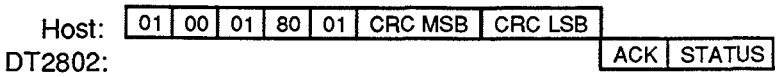
2. Set the acquisition type for integrator A to continuous conversion mode.

   - Send a packet type of 00, length of 1, with command **06** (SET ACQUISITION TYPE INTEGRATOR A) and an argument value of **02** (continuous conversion mode).
   - Wait for the ACK|STATUS response from the DT2802.



3. Set the integrator mode to single channel for integrator A.

   - Send a packet type of 00, length of 1, with command **80** (SET INTEGRATOR MODE A) and an argument value of **01** (single channel mode).
   - Wait for the ACK|STATUS response from the DT2802.

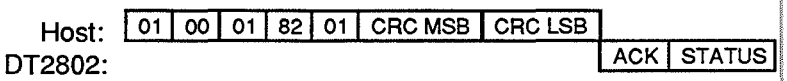


If you wish to automux between the two channels, set the integrator mode to automux (02).

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4. Select the input channel to integrator A.

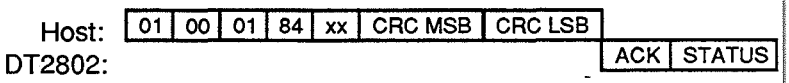
   - Send a packet type of 00, length of 1, with command **82** (SET INTEGRATOR A INPUT CHANNEL) and an argument value of **01** (single channel mode).
   - Wait for the ACK|STATUS response from the DT2802.



If you have set the integrator mode to automux, the input channel you specify is the starting channel.

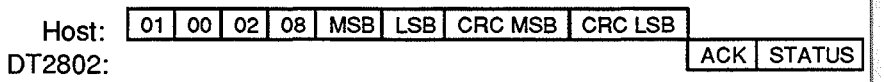
5. Select the resolution of integrator A.

   - Send a packet type of 00, length of 1, with command **84** (SET INTEGRATOR A RESOLUTION) and an argument value of **xx** (desired resolution – 01H to 07H).
   - Wait for the ACK|STATUS response from the DT2802.



6. Specify the time between measurements.

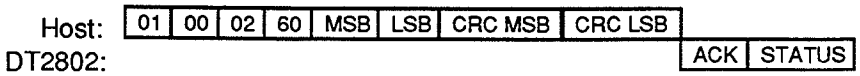
   - Send a packet type of 00, length of 2, with command **08** (SET TIME INTERVAL INTEGRATOR A) and a 2-byte argument value (number of line cycles between conversions).
   - Wait for the ACK|STATUS response from the DT2802.



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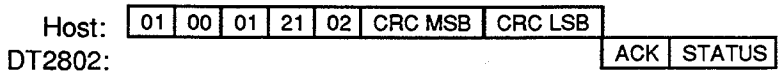
7. Set the data buffer threshold for integrator A.

   - Send a packet type of 00, length of 2, with command **60** (SET THRESHOLD BUFFER A) and a 2-byte argument value (threshold value).
   - Wait for the ACK|STATUS response from the DT2802.



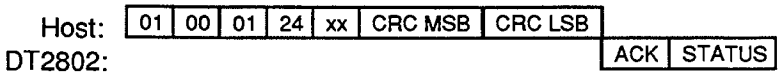
8. Set the serial data mode.

   - Send a packet type of 00, length of 1, with command **21** (SET SERIAL DATA MODE) and a data value of **02** (stream mode).
   - Wait for the ACK|STATUS response from the DT2802.



9. Set the stream data size.

   - Send a packet type of 00, length of 1, with command **24** (SET STREAM DATA SIZE) and a data value of **xx** (number of data points).
   - Wait for the ACK|STATUS response from the DT2802.



10. Trigger the conversion.

    - Send a packet type of 00, length of 0, with command **88** (START CONVERSIONS INTEGRATOR A).
    - Wait for the ACK|STATUS response from the DT2802.

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Host:	01	00	00	88	CRC MSB	CRC LSB	
DT2802:							ACK | STATUS

Conversions begin on integrator A. The stream packet will begin arriving when the number of data points in the buffer is equal to or greater than the stream data size.

11. Receive the stream data packet.

    - Receive the data points from the DT2802.

DT2802:	01	02	xx	MSB	DATA 2	DATA 3	LSB	(4 bytes x stream data size) – 1	CRC	CRC

    - Verify the CRC bytes sent in the data packet from the DT2802 are the same as the calculated CRC value.
    - Send ACK to DT2802.

12. Repeat step 11 until you are ready to stop operation.

13. Stop operation.

    - Send a packet type of 00, length of 0, with command **8C** (STOP CONVERSIONS INTEGRATOR A).
    - Wait for the ACK|STATUS response from the DT2802.

Host:	01	00	00	8C	CRC MSB	CRC LSB	
DT2802:							ACK | STATUS

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Reference 7

Error Codes

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*Reference 7, "**Error Codes**," lists the DT2802 error codes. This section is organized as follows:*

- *Overview*
- *General System Errors*
- *Parameter Errors*
- *Run-Time Errors*
- *Fatal Errors*
- *DT2802 Error Summary*

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Overview

When the DT2802 detects an error, it sets the Error bit in the Status register (SR:ERR). You can determine when an error condition exists by polling SR:ERR. Alternatively, you can enable the error source in the Event/Interrupt mask. If you enable interrupts, the DT2802 will interrupt the host when an error occurs. See Chapter 4, "Firmware," for information on interrupt servicing.

When SR:ERR sets, the DT2802 will not allow further command processing until you clear this error. The conditions that can cause an error include:

- Command was written to Command register when DT2802 was expecting argument. (Exception: ABORT command)
- The Command, Data In, or Data Out register was accessed when the Port Ready bit in the Status register (SP:PR) was clear.
- The Data In or Data Out register was accessed out of sequence.
- A buffer overflow occurred.

Use the READ SYSTEM ERROR command to determine the type of error. Reading the error clears SR:ERR. However, if more than one (1) error occurred, SR:ERR stays set until you read all the errors. (The DT2802 can store up to four separate errors in its error queue. If there are four errors in the error queue and a fifth error occurs, the DT2802 reports an ERR_BUFF_FULL error.)

A complete listing of the DT2802 error messages is provided on the following pages. The error messages are divided into three categories: general system errors, parameter errors, and run-time errors. The error messages are in numerical order within their categories by the hex value of the error codes (listed in brackets).

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General System Errors

Errors in this class occur when you read the Command, Data In, or Data Out registers out of sequence, or an error occurs at the serial port.

NOTVALID_CMD_ERR

[3000] Invalid firmware command

The firmware command written to the Command register was not a valid command.

CMD_OVERLP_ERR

[3001] Unexpected write to Command register

The DT2802 was not expecting a data byte at the Command register.

CMD_ABORT_ERR

[3002] Unexpected write to Command register

The DT2802 was not expecting a firmware command to be written to the Command register.

CMD_DATA_OVRRN_ERR

[3003] Too many data bytes written to Data In register

More than the expected number of data bytes were written to the Data In register for that command.

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DOUT_ERR

[3004] **Too many data bytes read from the Data Out register**

An attempt was made to read more than the expected number of bytes for that command from the Data Out register.

VFCB_NOT_INSTALLED_ERR

[3005] **Integrator B not installed on board**

An attempt was made to program integrator B on a DT2802-2 board.

VFCB_NOT_ENABLED

[3006] **Integrator B not enabled**

An attempt was made to trigger integrator B while it was in a disabled state.

VFCA_NOT_ENABLED

[3007] **Integrator A not enabled**

An attempt was made to trigger integrator A while it was in a disabled state.

VFCA_FAILED_TEST

[3008] **Integrator A failed self-test**

Integrator A did not pass its self-test on powerup or reset.

VFCB_FAILED_TEST

[3009] **Integrator B failed self-test**

Integrator B did not pass its self-test on powerup or reset.

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VFCA_FAILED_CALIB

[300A] Integrator A failed auto-calibration

Integrator A was not within tolerance at 0V and 2V.

VFCB_FAILED_CALIB

[300B] Integrator B failed auto-calibration

Integrator B was not within tolerance at 0V and 2V.

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Parameter Errors

The following errors result when you write an illegal argument value for the specified command.

SET_TRIG_PARAM_ERR

[4001] Trigger value out of range

A trigger value other than 05 (hex) was specified.

SET_ACQ_PARAM_ERR

[4002] Acquisition type value out of range

A value other than 01H (single) or 02H (continuous) was specified as the acquisition type for the integrator.

SET_DIGIN_PARAM_ERR

[4003] Active edge selection out of range

A value other than 01H (high-to-low transition), 02H (low-to-high transition), or 03H (either transition) was specified for the active edge for the input.



SET_BAUD_PARAM_ERR

[4004] Baud rate selection out of range

A value other than 01H (300), 02H (1200), 03H (2400), 04H (4800), 05H (9600), 06H (19200), or 07H (38400) was specified for the baud rate.

SET_SIO_MODE_PARAM_ERR

[4005] Serial input mode selection out of range

A value other than 01H (disable) or 02H (enable) was specified for the serial input enable mode.

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SET_DIGIN_MODE_PARAM_ERR

[4006] Input mode selection out of range

A value other than 01H (no debounce) or 02H (debounce) was specified for the input mode.

SET_LINE_FREQ_PARAM_ERR

[4007] Line frequency selection out of range

A value other than 01H (60Hz) or 02 (50Hz) was specified for the line frequency.

RESET_PARAM_ERR

[4008] Reset selection out of range

A value other than 01H (reset board and restore user configuration) or 02H (restore factory configuration and reset board) was specified for the reset command.

SET_VFC_PARAM_ERR

[4009] VFC selection out of range

A value other than 01H (enable Integrator A, disable Integrator B), 02H (disable Integrator A, enable Integrator B), or 03H (enable both integrators) was specified for the integrator enable command.

SET_HOST_ENABLE_PARAM_ERR

[400A] Host interrupt enable selection out of range

A value other than 01H (disable) or 02H (enable) was specified for the master interrupt.

SET_BUFF_FULL_FLAG_ERR

[400C] Data buffer threshold value out of range

A value greater than 2000 (decimal) was specified for the data buffer threshold.

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SET_CHAN_PARAM_ERR

[400D] **Input channel selection out of range**

A value other than 01H (channel 1 for integrator A or channel 3 for integrator B) or 02H (channel 2 for integrator A or channel 4 for integrator B) was specified for the input channel selection.

SET_RES_PARAM_ERR

[400E] **Resolution selection out of range**

A value other than 01H to 07H was specified for the resolution.

CLR_BUFF_PARAM_ERR

[400F] **Invalid buffer selected**

A value other than 01H (integrator A) or 02H (integrator B) was specified for the buffer to clear.

SET_VFC_MODE_PARAM_ERR

[4010] **Integrator input mode selection out of range**

A value other than 01H (single channel) or 02H (automux) was specified as the integrator input mode.



Firmware Reference

WR_CFG_PARAM_ERR

[4011] **Save configuration sequence parameters not as expected**

The sequence specified was not 01, 02, 03, and 04.

SET_DIGIN_ENABLE_ERR

[4012] **Input enable selection out of range**

A value other than 01H (disable) or 02H (enabled) was specified for the input enable mode.

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SET_DIGOUT_PARAM_ERR

[4013] Output switch state specified out of range

The output switch state specified was not as expected. See the description of the SET OUT SWITCHES command in Chapter 4, "Firmware," for the special values for this command.

SET_SERIN_ENABLE_PARAM_ERR

[4014] Serial input enable selection out of range

A value other than 01H (disable) or 02H (enabled) was specified for the serial input enable mode.

SET_RS232_SIGNAL_PARAM_ERR

[4015] RS232 control signal selection out of range

A value other than 01H (set) or 02H (clear) was specified for the RS232 control signal.

SET_INTEGR_TIME_PARAM_ERR

[4016] Integration time specified out of range

A value greater than 120 (decimal for 60Hz) or 100 (decimal for 50Hz) was specified for the integration time.

ACAL_PARAM_ERR

[4018] Automatic calibration parameter sequence not as expected.

The sequence specified was not 01, 02, 03, and 04.

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Run-Time Errors

Errors in this class result either from explicit command sequences or from various run-time conditions that can occur asynchronously.

TRIG_VFCA_ERR

[5001] Integrator A received trigger while running

Integrator A received a trigger to start conversions while it was actively acquiring data.

TRIG_VFCB_ERR

[5002] Integrator B received trigger while running

Integrator B received a trigger to start conversions while it was actively acquiring data.

BUFF_EMPTY_VFCA_ERR

[5003] No data in buffer A

An attempt was made to read data from buffer A while no data was present.

BUFF_EMPTY_VFCB_ERR

[5004] No data in buffer B

An attempt was made to read data from buffer B while no data was present.

VFCA_RUNNING

[5005] Configuration could not be saved

An attempt was made to save the current board configuration to EEROM while integrator A was acquiring data; or the command could not be executed because integrator A was running.

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VFCB_RUNNING

[5006] Configuration could not be saved

An attempt was made to save the current board configuration to EEROM while integrator B was acquiring data; or the command could not be executed because integrator B was running.

SERIAL_BUFFER_EMPTY

[5007] No serial data

An attempt was made to read data from the serial input buffer while no data was present.

UNEXPECTED_SW_TRIG_VFCA

[5008] Unexpected software trigger for integrator A

Integrator A received a software trigger when expecting a trigger from a switch input.

UNEXPECTED_SW_TRIG_VFCB

[5009] Unexpected software trigger for integrator B

Integrator B received a software trigger when expecting a trigger from a switch input.

BUFF_OVRFLW_VFCA

[500A] Data buffer A overflow

The number of data points in data buffer A exceeds 2048. Check the threshold value and lower the value if necessary.

BUFF_OVRFLW_VFCB

[500B] Data buffer B overflow

The number of data points in data buffer B exceeds 2048. Check the threshold value and lower the value if necessary.

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ERR_BUFF_FULL_ERR

[500C] **Too many errors**

The DT2802 has detected more than four errors at once.

SER_BUFF_FULL

[500D] **Serial input buffer overflow**

The serial input buffer contained 255 bytes and an attempt was made to write another byte to the buffer.

SIO_OVERUN_ERR

[500E] **Serial port overrun**

An RS232 overrun error occurred on the serial input port.

SIO_FRAMING_ERR

[500F] **Serial port framing**

An RS232 framing error occurred on the serial input port.

SIO_NOISE_ERR

[5010] **Noise on serial line**

Noise was detected on the serial input line.

SERIAL_INPUT_INPROCESS

[5011] **Serial input port busy**

An attempt was made to set the baud rate while the serial input port was enabled.

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SERIAL_OUTPUT_INPROCESS

[5012] Data being output serial port

An attempt was made to set the baud rate while the serial port was transferring a data byte.

STREAM_MODE_CMD_ERR

[5014] Stream mode command error

An attempt was made to execute a command that is not allowed in the stream data mode.

SERIAL_COMMAND_ERR

[5015] Serial I/O command error

An attempt was made to execute a serial I/O command that is not allowed in the stand-alone mode of operation.

SET_STREAM_SIZE_ERROR

[5016] Packet size selection out of range

A value of 0 or greater than 64 (decimal) was specified for the stream packet size.

CMD_LEN_ERR

[5020] Command length error

The data packet received from the host has the wrong number of arguments for the command.

SIO_CRC_ERROR

[5021] Serial I/O CRC error

The CRC value of the packet did not match the CRC value calculated by the receiver of the information.

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SIO_MAX_RESEND_ERR

[5022] Data packet resent too many times

The DT2802 tried to resend a packet to the host more than five times.

PACKET_TYPE_ERROR

[5023] Packet type specified was incorrect

The host sent a packet type other than 0 or the DT2802 sent a packet type of 0.

ACK_TIMEOUT_ERROR

[5024] ACK timeout

The DT2802 did not receive an ACK from the host within 2 seconds of sending the packet.

PKT_TIMEOUT_ERROR

[5025] Packet timeout

The DT2802 did not receive the last byte of the packet within 2 seconds of receiving the SOH.

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Fatal Errors

If your DT2802 board reports an error code greater than 6000, record the number of the error, the circumstances that caused it, and call Data Translation's Technical Support staff to report the error.

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DT2802 Error Summary

The following table is a summary of the DT2802 error codes. The error codes are listed in numerical order.

Error	Name	Description
3000	NOTVALID_CMD_ERR	Invalid firmware command
3001	CMD_OVERLP_ERR	Unexpected write to Command register
3002	CMD_ABORT_ERR	Unexpected write to Command register
3003	CMD_DATA_OVRRN_ERR	Too many data bytes written to Data In register
3004	DOUT_ERR	Too many data bytes read from Data Out register
3005	VFCB_NOT_INSTALLED_ERR	Integrator B not installed on board
3006	VFCB_NOT_ENABLED	Integrator B not enabled
3007	VFCA_NOT_ENABLED	Integrator A not enabled
3008	VFCA_FAILED_TEST	Integrator A failed its self-test on powerup or reset
3009	VFCB_FAILED_TEST	Integrator B failed its self-test on powerup or reset
300A	VFCA_FAILED_CALIB	Integrator A failed auto-calibration
300B	VFCB_FAILED_CALIB	Integrator B failed auto-calibration
4001	SET_TRIG_PARAM_ERR	Trigger value out of range
4002	SET_ACQ_PARAM_ERR	Acquisition type value out of range
4003	SET_DIGIN_PARAM_ERR	Active edge selection out of range
4004	SET_BAUD_PARAM_ERR	Baud rate selection out of range
4005	SET_SIO_MODE_PARAM_ERR	Serial input mode selection out of range
4006	SET_DIGIN_MODE_PARAM_ERR	Input mode selection out of range
4007	SET_LINE_FREQ_PARAM_ERR	Line frequency selection out of range
4008	RESET_PARAM_ERR	Reset selection out of range
4009	SET_VFC_PARAM_ERR	Integrator selection out of range
400A	SET_HOST_ENABLE_PARAM_ERR	Host interrupt enable selection out of range
400C	SET_BUFF_FULL_FLAG_ERR	Data buffer threshold out of range
400D	SET_CHAN_PARAM_ERR	Input channel selection out of range
400E	SET_RES_PARAM_ERR	Resolution selection out of range
400F	CLR_BUFF_PARAM_ERR	Buffer selection out of range
4010	SET_VFC_MODE_PARAM_ERR	Integrator input mode selection out of range

continued

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Error	Name	Description
4011	WR_CFG_PARAM_ERR	Save sequence parameters not as expected
4012	SET_DIGIIN_ENABLE_ERR	Input enable selection out of range
4013	SET_DIGOUT_PARAM_ERR	Output switch state specified out of range
4014	SET_SERIN_ENABLE_PARAM_ERR	Serial input enable selection out of range
4015	SET_RS232_SIGNAL_PARAM_ERR	RS232 signal parameter selection out of range
4016	SET_INTEGR_TIME_PARAM_ERR	Integration time selection out of range
4018	ACAL_PARAM_ERR	Calibration sequence parameters not as expected
5001	TRIG_VFCA_ERR	Integrator A received trigger while running
5002	TRIG_VFCB_ERR	Integrator B received trigger while running
5003	BUFF_EMPTY_VFCA_ERR	No data in buffer A
5004	BUFF_EMPTY_VFCB_ERR	No data in buffer B
5005	VFCA_RUNNING	Configuration not saved (integrator A running)
5006	VFCB_RUNNING	Configuration not saved (integrator B running)
5007	SERIAL_BUFFER_EMPTY	No serial data
5008	UNEXPECTED_SW_TRIG_VFCA	Unexpected software trigger (integrator A)
5009	UNEXPECTED_SW_TRIG_VFCB	Unexpected software trigger (integrator B)
500A	BUFF_OVRFLW_VFCA	Data buffer A overflow
500B	BUFF_OVRFLW_VFCB	Data buffer B overflow
500C	ERR_BUFF_FULL_ERR	Too many errors
500D	SER_BUFF_FULL	Serial input buffer overflow
500E	SIO_OVERUN_ERR	Serial port overrun
500F	SIO_FRAMING_ERR	Serial port framing
5010	SIO_NOISE_ERR	Noise on serial line
5011	SERIAL_INPUT_INPROCESS	Serial input port enabled
5012	SERIAL_OUTPUT_INPROCESS	Serial port busy
5014	STREAM_MODE_CMD_ERR	Command not allowed in stream data mode
5015	SERIAL_COMMAND_ERR	Command not allowed in stand-alone mode
5016	SET_STREAM_SIZE_ERR	Stream packet size out of range
5020	CMD_LEN_ERR	Wrong number of arguments with command
5021	SIO_CRC_ERR	Serial I/O CRC error
5022	SIO_MAX_RESEND_ERR	Data packet sent too many times
5023	PACKET_TYPE_ERROR	Packet received with wrong packet type
5024	ACK_TIMEOUT_ERR	ACK timeout
5025	PKT_TIMEOUT_ERR	Packet timeout

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Reference 8

Firmware Command Summary

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*Reference 8, "**Firmware Command Summary**," lists the firmware commands in numerical order and alphabetical order.*

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Numerical Listing – DT2802-4

CMD	DESCRIPTION	PAGE
04	Select Trigger Source Integrator A	82
05	Select Trigger Source Integrator B	82
06	Set Acquisition Type Integrator A	84
07	Set Acquisition Type Integrator B	84
08	Set Time Interval Integrator A	95
09	Set Time Interval Integrator B	95
0A	Set Active Edge Input 1	98
0B	Set Active Edge Input 2	98
0C	Set Active Edge Input 3	98
0D	Set Active Edge Input 4	98
0E	Set Input Enable	102
13	Read Stream Data Size	114
14	Read Trigger Source Integrator A	83
15	Read Trigger Source Integrator B	83
16	Read Acquisition Type Integrator A	84
17	Read Acquisition Type Integrator B	84
18	Read Time Interval Integrator A	95
19	Read Time Interval Integrator B	95
1A	Read Active Edge Input 1	100
1B	Read Active Edge Input 2	100
1C	Read Active Edge Input 3	100
1D	Read Active Edge Input 4	100
1E	Read Input Enable	102
20	Select Baud Rate	109
21	Set Serial I/O Data Mode	113
22	Write Serial Data Byte	111

continued

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Numerical Listing – DT2802-4 (continued)

CMD	DESCRIPTION	PAGE
23	Set Serial Input Control	108
24	Set Stream Data Size	114
25	Set/Clear RS232 Control Signal	112
26	Set Output Switches	103
27	Set Input Mode	101
28	Set Line Frequency	76
29	Reset	77
2C	Save Configuration in EEROM	77
2D	Calibrate Integrators	78
2E	Abort Command	79
2F	Set Integrator Enable	81
30	Read Baud Rate	110
31	Read Serial I/O Data Mode	113
32	Read Serial Data Byte	111
33	Read Serial Input Control	108
34	Read Number of Bytes	111
35	Read RS232 Control Signal	112
36	Read I/O Switch States	104
37	Read Input Mode	101
38	Read Line Frequency	76
39	Read System Error	79
3C	Read Board ID	123
3D	Read Firmware Level	123
3E	Read Board Revision	123
3F	Read Integrator Enable	81
40	Set Master Interrupt	118
42	Set Event/Interrupt Mask	116
50	Read Master Interrupt	118

continued

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Numerical Listing – DT2802-4 (continued)

CMD	DESCRIPTION	PAGE
52	Read Event/Interrupt Mask	116
54	Event/Interrupt Pending Mask	117
56	Read Input 1	105
57	Read Input 2	105
58	Read Input 3	105
59	Read Input 4	105
5A	Read All Inputs	106
60	Set Threshold for Buffer A	120
61	Set Threshold for Buffer B	120
62	Reset/Clear Buffer	119
70	Read Threshold for Buffer A	120
71	Read Threshold for Buffer B	120
72	Read Number of Samples in Buffer A	120
73	Read Number of Samples in Buffer B	120
74	Read Integrator A Status	96
75	Read Integrator B Status	96
80	Set Integrator A Mode	85
81	Set Integrator B Mode	85
82	Select Integrator A Input Channel	87
83	Select Integrator B Input Channel	87
84	Select Integrator A Resolution	89
85	Select Integrator B Resolution	89
88	Start Conversions on Integrator A	97
89	Start Conversions on Integrator B	97
8A	Start Conversions on Both Integrators	97
8C	Stop Conversions on Integrator A	97
8D	Stop Conversions on Integrator B	97
8E	Stop Conversions on Both Integrators	97

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Numerical Listing – DT2802-4 (continued)

CMD	DESCRIPTION	PAGE
90	Read Integrator A Mode	86
91	Read Integrator B Mode	86
92	Read Integrator A Input Channel	88
93	Read Integrator B Input Channel	88
94	Read Integrator A Resolution	92
95	Read Integrator B Resolution	92
96	Read Integration Time Integrator A	94
97	Read Integration Time Integrator B	94
98	Read Settling Time Integrator A	93
99	Read Settling Time Integrator B	93
9E	Read Next Conversion Integrator A	121
9F	Read Next Conversion Integrator B	121

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Numerical Listing – DT2802-2

CMD	DESCRIPTION	PAGE
04	Select Trigger Source Integrator A	82
06	Set Acquisition Type Integrator A	84
08	Set Time Interval Integrator A	95
0A	Set Active Edge Input 1	98
0B	Set Active Edge Input 2	98
0C	Set Active Edge Input 3	98
0D	Set Active Edge Input 4	98
0E	Set Input Enable	102
13	Read Stream Data Size	114
14	Read Trigger Source Integrator A	83
16	Read Acquisition Type Integrator A	84
18	Read Time Interval Integrator A	95
1A	Read Active Edge Input 1	100
1B	Read Active Edge Input 2	100
1C	Read Active Edge Input 3	100
1D	Read Active Edge Input 4	100
1E	Read Input Enable	102
20	Select Baud Rate	109
21	Set Serial I/O Data Mode	113
22	Write Serial Data Byte	111
23	Set Serial Input Control	108
24	Set Stream Data Size	114
25	Set/Clear RS232 Control Signal	112
26	Set Output Switches	103
27	Set Input Mode	101
28	Set Line Frequency	76

continued

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Numerical Listing – DT2802-2 (continued)

CMD	DESCRIPTION	PAGE
29	Reset	77
2C	Save Configuration in EEROM	77
2D	Calibrate Integrators	78
2E	Abort Command	79
30	Read Baud Rate	110
31	Read Serial I/O Data Mode	113
32	Read Serial Data Byte	111
33	Read Serial Input Control	108
34	Read Number of Bytes	111
35	Read RS232 Control Signal	112
36	Read I/O Switch States	104
37	Read Input Mode	101
38	Read Line Frequency	76
39	Read System Error	79
3C	Read Board ID	123
3D	Read Firmware Level	123
3E	Read Board Revision	123
40	Set Master Interrupt	118
42	Set Event/Interrupt Mask	116
50	Read Master Interrupt	118
52	Read Event/Interrupt Mask	116
54	Event/Interrupt Pending Mask	117
56	Read Input 1	105
57	Read Input 2	105
58	Read Input 3	105
59	Read Input 4	105
5A	Read All Inputs	106

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Numerical Listing – DT2802-2 (continued)

CMD	DESCRIPTION	PAGE
60	Set Threshold for Buffer A	120
62	Reset/Clear Buffer	119
70	Read Threshold for Buffer A	120
72	Read Number of Samples in Buffer A	120
74	Read Integrator A Status	96
80	Set Integrator A Mode	85
82	Select Integrator A Input Channel	87
84	Select Integrator A Resolution	89
88	Start Conversions on Integrator A	97
8A	Start Conversions on Both Integrators	97
8C	Stop Conversions on Integrator A	97
8E	Stop Conversions on Both Integrators	97
90	Read Integrator A Mode	86
92	Read Integrator A Input Channel	88
94	Read Integrator A Resolution	92
96	Read Integration Time Integrator A	94
98	Read Settling Time Integrator A	93
9E	Read Next Conversion Integrator A	121

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Alphabetical Listing – DT2802-4

CMD	DESCRIPTION	PAGE
2E	Abort Command	79
2D	Calibrate Integrators	78
54	Event/Interrupt Pending Mask	117
16	Read Acquisition Type Integrator A	84
17	Read Acquisition Type Integrator B	84
1A	Read Active Edge Input 1	100
1B	Read Active Edge Input 2	100
1C	Read Active Edge Input 3	100
1D	Read Active Edge Input 4	100
5A	Read All Inputs	106
30	Read Baud Rate	110
3C	Read Board ID	123
3E	Read Board Revision	123
52	Read Even/Interrupt Mask	116
3D	Read Firmware Level	123
36	Read I/O Switch States	104
56	Read Input 1	105
57	Read Input 2	105
58	Read Input 3	105
59	Read Input 4	105
1E	Read Input Enable	102
37	Read Input Switch Mode	101
96	Read Integration Time Integrator A	94
97	Read Integration Time Integrator B	94
92	Read Integrator A Input Channel	88
93	Read Integrator B Input Channel	88

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Alphabetical Listing – DT2802-4 (continued)

CMD	DESCRIPTION	PAGE
90	Read Integrator A Mode	86
91	Read Integrator B Mode	86
94	Read Integrator A Resolution	92
95	Read Integrator B Resolution	92
74	Read Integrator A Status	96
75	Read Integrator B Status	96
3F	Read Integrator Enable	81
38	Read Line Frequency	76
50	Read Master Interrupt	118
9E	Read Next Conversion Integrator A	121
9F	Read Next Conversion Integrator B	121
34	Read Number of Bytes	111
72	Read Number of Samples in Buffer A	120
73	Read Number of Samples in Buffer B	120
35	Read RS232 Control Signal	112
32	Read Serial Data Byte	111
33	Read Serial Input Control	108
31	Read Serial I/O Data Mode	113
98	Read Settling Time Integrator A	93
99	Read Settling Time Integrator B	93
13	Read Stream Data Size	114
39	Read System Error	79
70	Read Threshold for Buffer A	120
71	Read Threshold for Buffer B	120
18	Read Time Interval Integrator A	95
19	Read Time Interval Integrator B	95
14	Read Trigger Source Integrator A	83
15	Read Trigger Source Integrator B	83

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Alphabetical Listing – DT2802-4 (continued)

CMD	DESCRIPTION	PAGE
29	Reset	77
62	Reset/Clear Buffer	119
2C	Save Configuration in EEROM	77
20	Select Baud Rate	109
82	Select Integrator A Input Channel	87
83	Select Integrator B Input Channel	87
84	Select Integrator A Resolution	89
85	Select Integrator B Resolution	89
04	Select Trigger Source Integrator A	82
05	Select Trigger Source Integrator B	82
06	Set Acquisition Type Integrator A	84
07	Set Acquisition Type Integrator B	84
0A	Set Active Edge Input 1	98
0B	Set Active Edge Input 2	98
0C	Set Active Edge Input 3	98
0D	Set Active Edge Input 4	98
42	Set Event/Interrupt Mask	116
0E	Set Input Enable	102
27	Set Input Switch Mode	99
80	Set Integrator A Mode	85
81	Set Integrator B Mode	85
2F	Set Integrator Enable	81
2B	Set Line Frequency	76
40	Set Master Interrupt	118
26	Set Output Switches	103
25	Set RS232 Control Signal	112
23	Set Serial Input Control	108
21	Set Serial I/O Data Mode	113

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Alphabetical Listing – DT2802-4 (continued)

CMD	DESCRIPTION	PAGE
24	Set Stream Data Size	114
60	Set Threshold for Buffer A	120
61	Set Threshold for Buffer B	120
08	Set Time Interval Integrator A	95
09	Set Time Interval Integrator B	95
8A	Start Conversions on Both Integrators	97
88	Start Conversions on Integrator A	97
89	Start Conversions on Integrator B	97
8E	Stop Conversions on Both Integrators	97
8C	Stop Conversions on Integrator A	97
8D	Stop Conversions on Both Integrators	97
22	Write Serial Data Byte	111



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Alphabetical Listing – DT2802-2

CMD	DESCRIPTION	PAGE
2E	Abort Command	79
2D	Calibrate Integrators	78
54	Event/Interrupt Pending Mask	117
16	Read Acquisition Type Integrator A	84
1A	Read Active Edge Input 1	100
1B	Read Active Edge Input 2	100
1C	Read Active Edge Input 3	100
1D	Read Active Edge Input 4	100
5A	Read All Inputs	106
30	Read Baud Rate	110
3C	Read Board ID	123
3E	Read Board Revision	123
52	Read Even/Interrupt Mask	116
3D	Read Firmware Level	123
36	Read I/O Switch States	104
56	Read Input 1	105
57	Read Input 2	105
58	Read Input 3	105
59	Read Input 4	105
1E	Read Input Enable	102
37	Read Input Switch Mode	101
96	Read Integration Time Integrator A	94
97	Read Integration Time Integrator B	94
92	Read Integrator A Input Channel	88
90	Read Integrator A Mode	86
94	Read Integrator A Resolution	92

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Alphabetical Listing – DT2802-2 (continued)

CMD	DESCRIPTION	PAGE
74	Read Integrator A Status	96
38	Read Line Frequency	76
50	Read Master Interrupt	118
9E	Read Next Conversion Integrator A	121
34	Read Number of Bytes	111
72	Read Number of Samples in Buffer A	120
35	Read RS232 Control Signal	112
32	Read Serial Data Byte	111
33	Read Serial Input Control	108
31	Read Serial I/O Data Mode	113
98	Read Settling Time Integrator A	93
13	Read Stream Data Size	114
39	Read System Error	79
70	Read Threshold for Buffer A	120
18	Read Time Interval Integrator A	95
14	Read Trigger Source Integrator A	83
29	Reset	77
62	Reset/Clear Buffer	119
2C	Save Configuration in EEROM	77
20	Select Baud Rate	109
82	Select Integrator A Input Channel	87
84	Select Integrator A Resolution	89
04	Select Trigger Source Integrator A	82
06	Set Acquisition Type Integrator A	84
0A	Set Active Edge Input 1	98
0B	Set Active Edge Input 2	98
0C	Set Active Edge Input 3	98
0D	Set Active Edge Input 4	98

continued

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Alphabetical Listing – DT2802-2 (continued)

CMD	DESCRIPTION	PAGE
42	Set Event/Interrupt Mask	116
0E	Set Input Enable	102
27	Set Input Switch Mode	99
80	Set Integrator A Mode	85
2B	Set Line Frequency	76
40	Set Master Interrupt	118
26	Set Output Switches	103
25	Set RS232 Control Signal	112
23	Set Serial Input Control	108
21	Set Serial I/O Data Mode	113
24	Set Stream Data Size	114
60	Set Threshold for Buffer A	120
08	Set Time Interval Integrator A	95
8A	Start Conversions on Both Integrators	97
88	Start Conversions on Integrator A	97
8E	Stop Conversions on Both Integrators	97
8C	Stop Conversions on Integrator A	97
8D	Stop Conversions on Both Integrators	97
22	Write Serial Data Byte	111

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Reference 9

Product Support

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*Reference 9, "**Product Support**," describes what to do if you have difficulty using the DT2802 board. This section is organized as follows:*

- *General Checklist*
- *Specific Problems*
- *Service and Support*

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General Checklist

Should you experience difficulty using the DT2802 board, the following sections describe some possible problems and suggest steps you can take to correct them.

If you are experiencing a problem not described here, or have followed the steps suggested and are still having problems, please follow the instructions provided in "Service and Support."

Go through the following checklist when troubleshooting the DT2802 board to help you isolate your problem.

1. Check that the DT2802 board is firmly seated in its bus connector.

2. Check that the +5V power supply on the board is between +4.75 and +5.25V.

3. Make sure that all detector input connections are made properly.

   Refer to Chapter 2, "Installing the DT2802," for the appropriate connection scheme.

4. Verify that all cables associated with the board are firmly connected.

5. Make sure no components on the board are contacting an adjacent board.

6. Verify that the board's jumper settings are configured correctly.

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7. If you are using DT2802 subroutine library and device driver, verify the DT2802 software package is installed correctly.

   Refer to the DT2802 Software User Manual *for software installation instructions.*

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Specific Problems

This section describes specific problems that may occur and suggests some possible causes and solutions. Check all the items listed below before calling Data Translation.

1. The board is not responding.
   - Verify the board is fully seated in the bus connector.

     Test if the board is properly connected by gently lifting it. If the board exhibits no resistance, it is not seated tightly in the connector. Try pressing more firmly on the board to ensure proper connection.
   - *Check that the board's base address does not conflict with other boards in your system.*
   - Clean the board connector fingers with a soft pencil eraser.

2. The digital output code is all 1s or 0s.
   - Verify that the output from the detector connected to the problem channel is between -0.2V and +2.0V.

     If the detector output is outside the selected range, reduce the detector output with a resistor divider circuit.
   - Make sure that no inputs are above the power supply voltage (± 12V).

3. All readings are noisy.
   - Verify all cables are routed away from switching power supplies and digital signals.
   - Use twisted-pair shielded cables for the detector input signals. Connect only one end of the shield, preferably to the DT2802 end. See Reference 4, "Detector Connections," for more information.

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Service and Support

Please be prepared to answer the following questions when you call for technical support. This information helps identify specific system and configuration-related problems.

- What is the serial number of the product?
- What operating system and version are you using?
- What other boards or applications are installed in your system?
- How much RAM do you have?
- What size hard disk are you using?
- How fast is your CPU?
- What type of network, if any, are you using? Approximately how many users are on your network?
- Have you run the example programs or diagnostics shipped with your product? If so, what were the results?
- Have you verified that all connections are made properly and are secure?
- Have you been able to isolate the source of your problem: input or output device, board, software?
- Are all unused input channels grounded?

In addition, if your problem appears to be software-related, specify whether or not it has occurred more than once and, if possible, document the sequence of steps that led up to the problem. This information helps us reproduce the problem in-house.

If your problem is not solved by the steps outlined in the previous sections, the Technical Support staff is available to provide prompt, reliable assistance. They can be reached by calling:

(508) 481–3700

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

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If Your Board Needs Factory Service

If your DT2802 board must be returned to Data Translation:

1. Call the Customer Service Department and obtain a Return Material Authorization (RMA) number.

   All return shipments to Data Translation must be marked with the RMA number in order to ensure proper processing.

2. Package the board as follows:

   - Wrap the board in an electrically conductive plastic material, handling it with ground protection. *A static discharge can destroy components on the board.*
   - Pack the board in its original shipping container, if available and in good condition. If it is not available, use any secure shipping container.

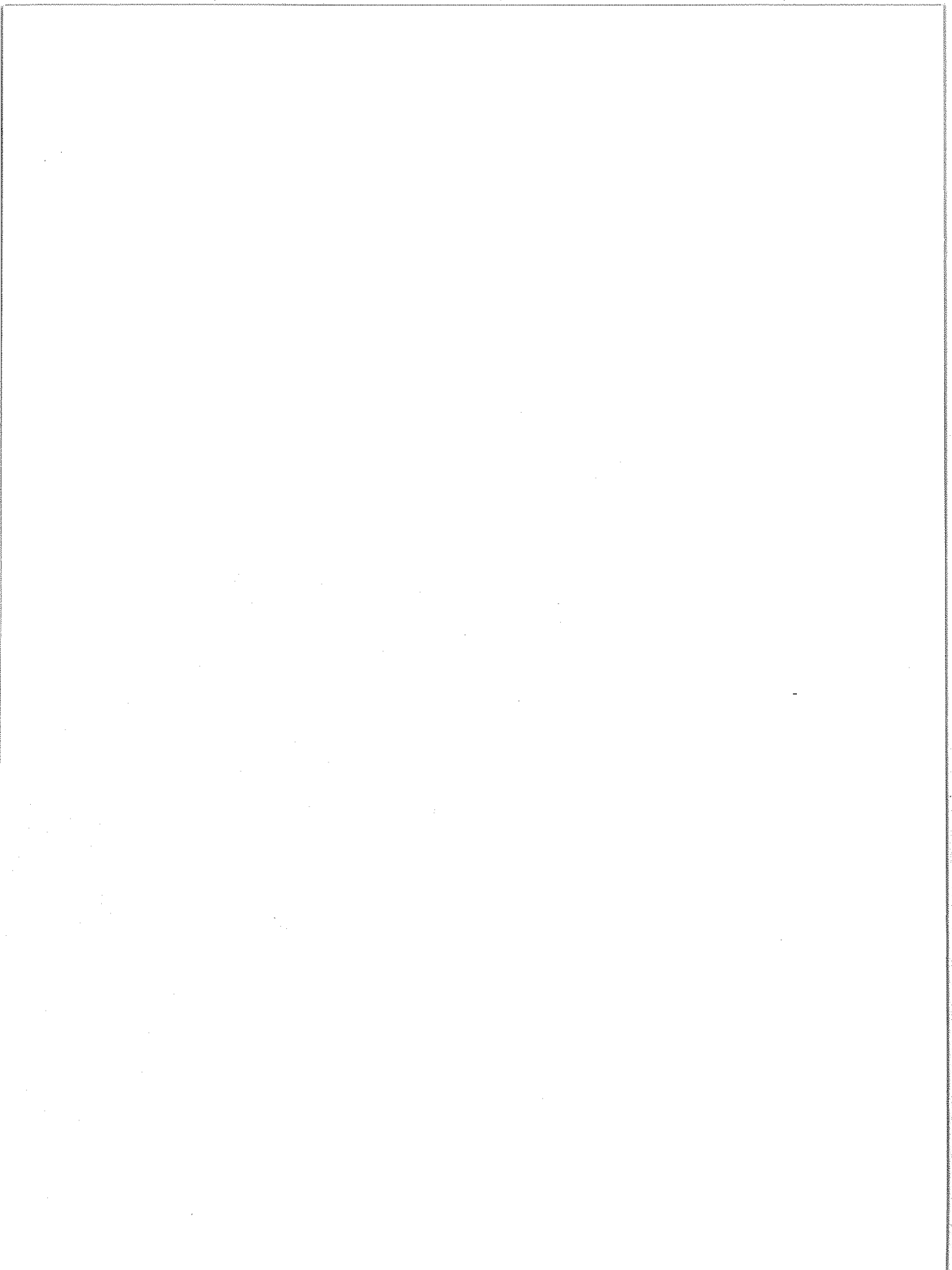
3. Return to board to the following address, making sure the RMA number is visible on the outside of the box.

   Customer Service Dept.
   Data Translation, Inc.
   100 Locke Drive
   Marlboro, MA 01752–1192

Outside the USA

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

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Glossary

Address: The label identifying the memory location where information is stored.

Affirmative Acknowledgment (ACK): Indicates that the previous transmission block was accepted by the receiver and that it is ready to accept the next block of the transmission.

Analog data: Data that is represented by any value between two limits.

Analog-to-digital conversion (A/D): The process of changing an analog signal into a digital value that represents the magnitude of the signal at the moment of conversion.

Analog-to-Digital converter (A/D or ADC): An electronic device, often an integrated circuit, that produces a digital output directly proportional to an analog signal input.

ASCII: American Standard Code for Information Interchange. A popular standard method of encoding alphanumeric characters into 7 or 8 binary bits.

Asynchronous: A timing method in which one event occurs independent of other events; without synchronization to a reference timing clock.

Asynchronous transmission: Data transmission in which the time intervals between transmitted characters may be unequal in length.

Base address: A memory address that serves as a point of reference. All other points are located by offsetting (adding to or subtracting from) in relation to the base address.

Baud: A unit of signaling speed equal to the number of discrete conditions or signal events per second. In asynchronous transmission, it is the unit of signaling speed corresponding to one unit interval per second. That is, if the duration of the unit interval is 20 milliseconds, the signaling speed is 50 baud. Baud is the same as "bits per second" only if each signal event represents exactly one bit.

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Bit: Acronym for binary digit. The smallest entity of data in digital form; it is either a binary 0 or 1.

Buffer: A storage area for data.

Bus: A system of connections that allows each part of a computer to communicate with the other parts.

Byte: A group of 8 bits.

CCITT: Comite Consultatif Internationale de Telegraphie et Telephonie. An international consultative committee that sets international communications usage standards.

Chromatogram: A printed or displayed plot of a chromatographic separation in which the time and relative amounts of sample components are indicated by peaks.

Chromatography: A method of separating and analyzing a mixture of chemical substances.

Clock: The device that generates periodic signals for synchronization.

Command: A communication from the host system to the board directing it to perform some immediate action.

Common-mode rejection ratio (CMRR): A measure of an instrument's ability to ignore or reject interference from a voltage common to its input terminals relative to ground. CMRR is usually expressed in dB (decibels).

Comparator: An analog electronic circuit used to compare two values and set a digital indicator that identifies which value is greater.

Connector: A physical device such as a plug, socket, or jack that connects one hardware component of a system to another.

Contact closure: Terminals not normally in electrical contact (open circuit) which are placed in contact (closed or short circuited) at certain times.

Control character: In serial I/O, a character whose occurrence in a particular context initiates, modifies, or stops a control function.

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Conversion time: The time required to convert data.

Counter: In hardware, a circuit that can count pulses. In software, a memory location used by a program to count certain occurrences.

CPU (Central Processing Unit): The part of a computer that executes the instructions in a program.

Cyclic Redundancy Check (CRC): An error detection scheme in which the check character is generated by taking the remainder after dividing all the serialized bits in a block of data by a predetermined binary number.

Default: A value assigned or an action taken automatically unless another is specified.

Detector: A device used to detect the presence of a molecular or ionic entity.

Differential input: A differential input has two input terminals. Neither input terminal is necessarily ground. The input is sensitive only to the difference between the voltages on its two input terminals. That is, it is sensitive to the voltage on one input terminal with respect to the other input terminal. It is not sensitive to the individual input voltages with respect to ground. See also *Single-ended input*.

Digital data: Data represented by a series of discrete values between two limits.

Drivers: Part of the software that is used to control a specific hardware device such as a data acquisition board or a printer.

EEROM: Electrically-erasable non-volatile read-only memory. Contents of memory are retained when power is lost.

ENQ (Enquiry): Used a a request for response to obtain identification and/or an indication of station status. In binary synchronous (BSC) transmission, ENQ is transmitted as part of an initialization sequence (line bid) in point-to-point operation, and as the final character of a selection or polling sequence in multipoint operation.

EPROM: Electrically-programmable non-volatile memory. Contents of memory are pre-programmed. The contents of memory are not erasable.

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Error: Any discrepancy between a computed, observed, or measured quantity and the true, specified, or theoretically correct value or condition.

Error control: An arrangement that detects the presence of errors. In some systems, refinements are added that will correct the detected errors, either by operations on the received data or by retransmission from the source.

Event: See EXTERNAL EVENT.

Execute: To perform or carry out a specified action or sequence of actions.

External event: An action performed by an external device under the control of the system.

Falling edge: Synonym for negative-going edge.

Firmware: Component of a computer system consisting of programs stored permanently in read-only memory. Such programs are coded at the factory. They can be executed at any time but cannot be modified or erased from main memory. (See also HARDWARE, SOFTWARE.)

Floating-point numbers: Numbers that contain decimal parts or are represented in scientific notation (digits multiplied by a power of 10). Also known as "real" numbers. Integers are a subset of reals containing whole numbers only.

Ground: An electrically neutral wire having the same potential as the surrounding earth. Normally, a non-current carrying circuit intended for safety purposes. A reference point for an electrical system.

Hardware: The visible parts of a computer system, such as the circuit boards, chassis, enclosures, peripherals, cables, etc. It does not include data or computer systems.

Header: The control information prefixed in a message text, e.g., source or destination code, priority, or message type.

Hertz (Hz): A unit of frequency equal to one cycle per second.

I/O (Input/Output): The processing of transferring data to or from a computer system including communications channels, operator interface devices, or data acquisition and control channels.

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Input impedance: The loading effect (in ohms) presented to a signal source.

Initialize: To set counters, switches, addresses, or the contents of storage to known values at the beginning of the operation of a computer routine.

Integer: A whole number, not requiring a fraction, a decimal point, or scientific notation for representation.

Interrupt: A computer signal indicating that the CPU should suspend its current task to service a designated activity.

Kilobyte (kByte): 1024 bytes.

Kilohertz (kHz): 1,000 cycles per second.

Linearity: A measure of the system deviation from a perfect converter (usually 1/2 LSB).

Load: In programming, to enter data into storage or registers.

LSB (Least Significant Bit): The smallest measurable increment of signal.

Megabyte (Mbyte): 1,048,576 bytes.

Megahertz (MHz): 1,000,000 cycles per second.

Memory: Electronic devices that enable a computer to store and recall information. In its broadest sense, memory refers to any hardware capable of servicing that end, e.g., disk, tape, semiconductor storage, etc.

Module: A packaged functional hardware unit designed for use with other components.

Negative Acknowledgment (NAK): Indicates that the previous transmission block was in error and that the receiver is ready to accept a retransmission of the erroneous block. NAK is also the "not ready" reply to a station selection (multipoint) or to an initialization sequence (line bid) in point-to-point operation.

Noise: An undesirable electrical interference to a signal. Sources of noise include the AC power line, motors, generators, transformers, fluorescent lights, soldering irons, CRT displays, computers, electrical storms, welders, radio transmitters, and others.

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Operating system: A software system that organizes the computer's resources and capabilities and makes them available to the user or to the application programs running on the computer.

Overhead bit: A bit other than an information bit, e.g., check bit, framing bit.

Packet: A group of bits including data and control elements which is switched and transmitted as a composite whole. The data and control elements and possibly error control information are arranged in a specified format.

Parameter: A quantity that is constant under a given set of conditions.

Parity check: Addition of non-information bits to data, making the number of ones in each grouping of bits either always odd for odd parity or always even for even parity. This permits single bit error detection in each group.

Peripheral: A device that is external to the CPU and main memory, e.g., printer, modem, data acquisition board, etc.

Polling: The periodic sampling of a control line (for example, to determine if a peripheral needs servicing). Polling is used in programmed I/O operations.

Port: A communications connection on a computer or a remote controller.

Polled I/O: The input or output of data under software control.

Protocol: A formal set of conventions governing the format and relative timing of message exchange between two communicating processes.

Pulse: A signal or event present for a short time in comparison to the time for which the signal or event is not present. That is, the ratio of the time present to the time not present is a small number.

Random Access Memory (RAM): Volatile memory that holds instructions and data for the CPU to operate on. The memory can be both read and changed during computer operation.

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Range: Refers to the maximum allowable full-scale signal (input or output) that yields a specific performance level.

Read-Only Memory (ROM): Memory whose contents can be read but not written; used for storing firmware. Information is written into read-only memory once, during manufacture. It remains there permanently even when the computer's power is turned off, and cannot be erased or changed.

Real numbers: Numbers that can express a fractional value. Also called floating-point numbers.

Real time: Data acted upon immediately instead of being accumulated and processed at a later time.

Register: A storage device, having a specified storage capacity such as a bit, byte, or word; usually intended for a specific purpose.

Resolution: The smallest significant number to which a measurement can be determined. For example, a converter with 12-bit resolution can resolve 1 part in 4096 ($2^{12} = 4096$).

Routine: A part of a program that accomplishes some task subordinate to the overall task of the program.

Sensitivity: A measure of the minimum change in an input signal that an instrument can detect.

Serial interface: An interface in which information is transmitted sequentially, one bit at a time, over a single wire or channel.

Settling time: The time required for the VFC output to read ±1/2 LSB of its final value.

Shielded cable: A cable with foil or other sheathing around it to stop radio frequency interference and magnetic fields from generating extraneous signals on the cable conductors.

Single-ended input: A single-ended input has one input terminal. The other input terminal is ground. A single-ended input is sensitive to the voltage on its input terminal with respect to ground. See also *Differential input*.

Synchronous: A timing method in which one event occurs in a fixed time relationship to another event.

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Throughput: A method of representing how fast data can be moved through all or part of a computer system.

Throughput rate: The maximum repetitive rate at which a data conversion system can operate with a specified accuracy. It is determined by summing the various times required for each part of the system and then taking the inverse of this time.

Timing: The method by which the execution of instructions or events is controlled.

TTL (transistor-transistor-logic): A popular logic circuit family that uses multiple-emitter transistors. A low signal state is defined as a signal 0.8V and below. A high signal state is defined as a signal +2.0V and above.

Volatile: Memory that loses data when power is removed.

Voltage-to-Frequency converter (VFC): An electronic device, often an integrated circuit, that produces a frequency output directly proportional to an analog signal input.

Word: The standard number of bits that a processor manipulates at one time. Microprocessors typically use 8- or 16-bit words.

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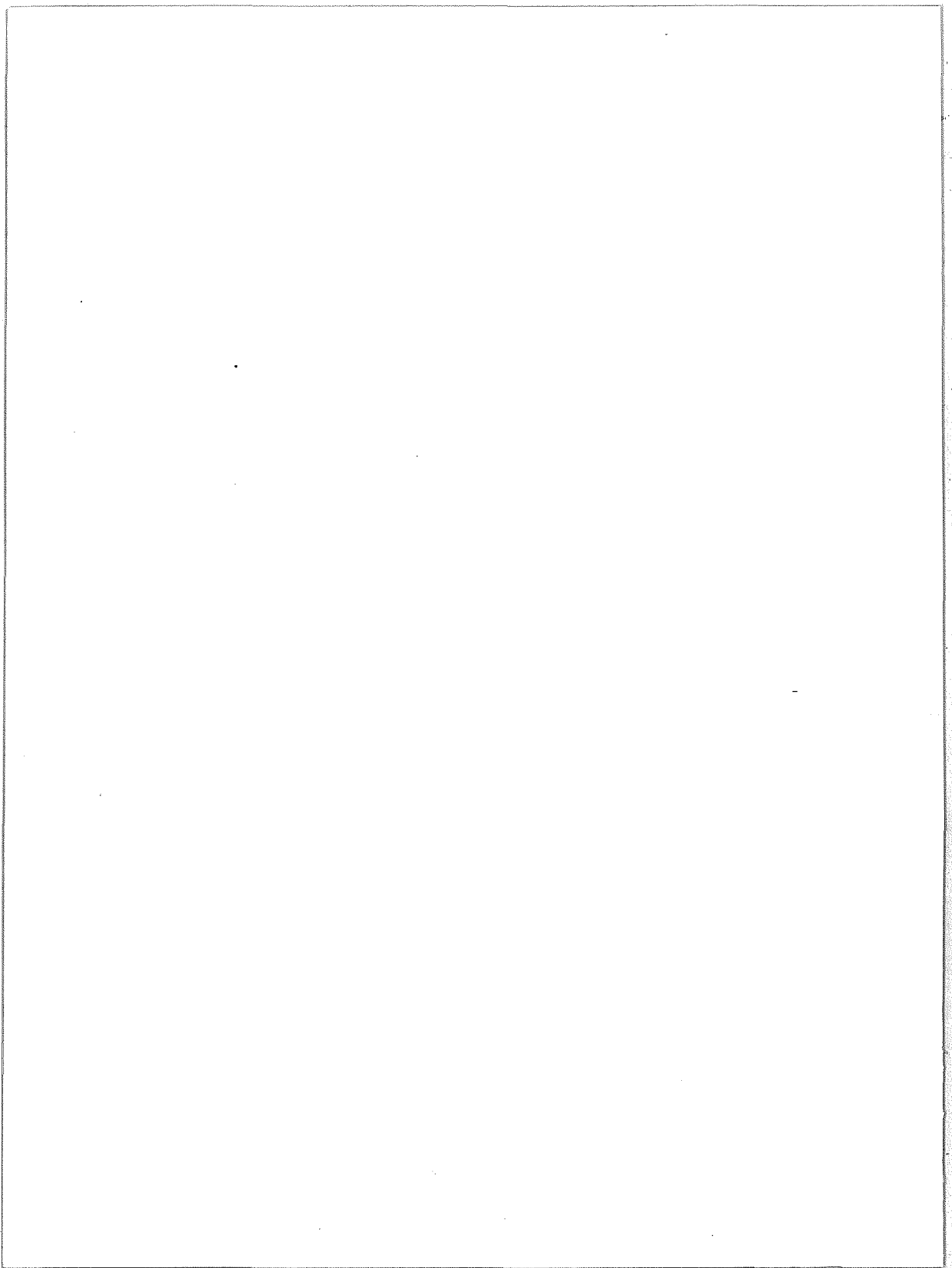
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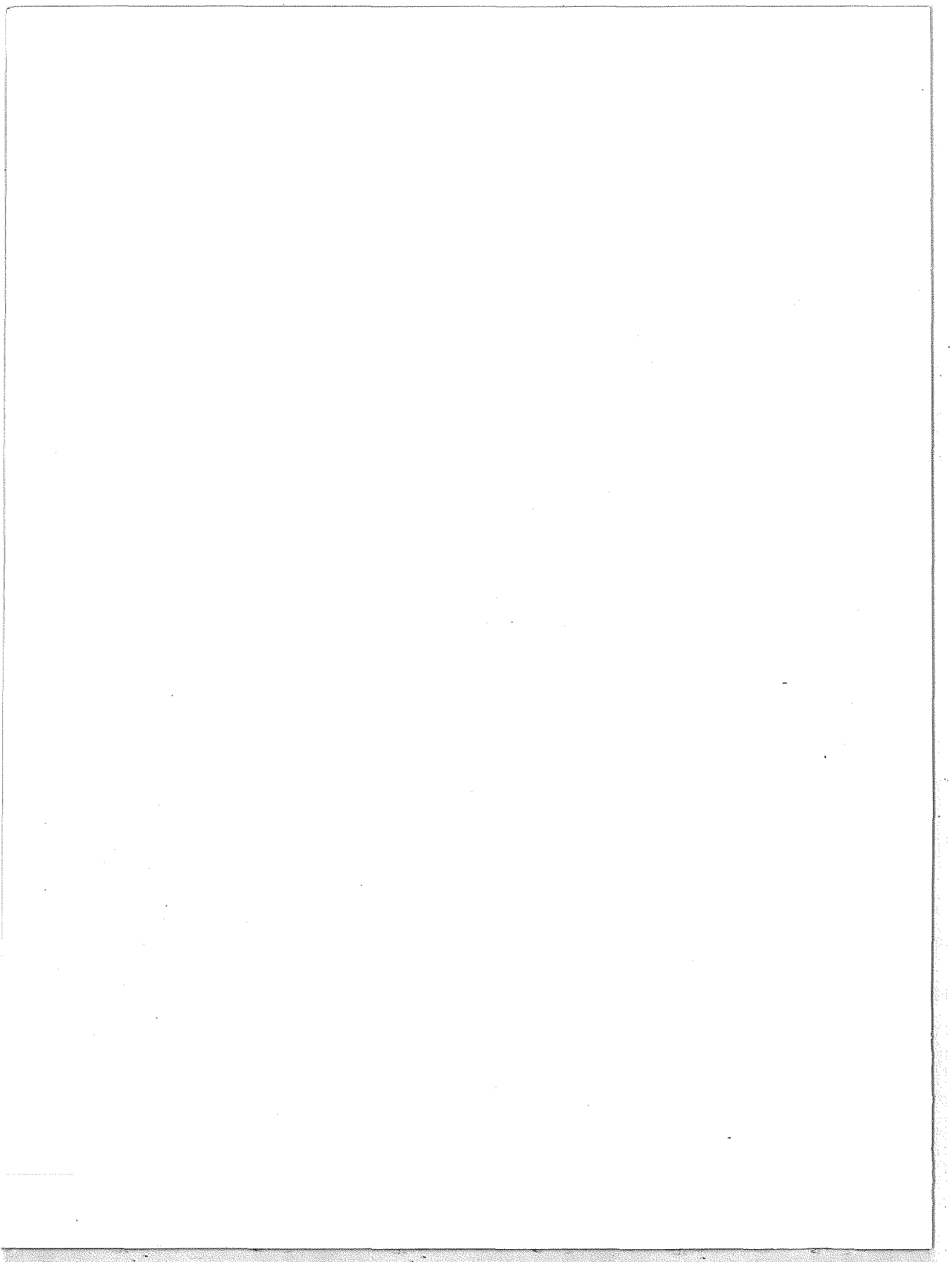
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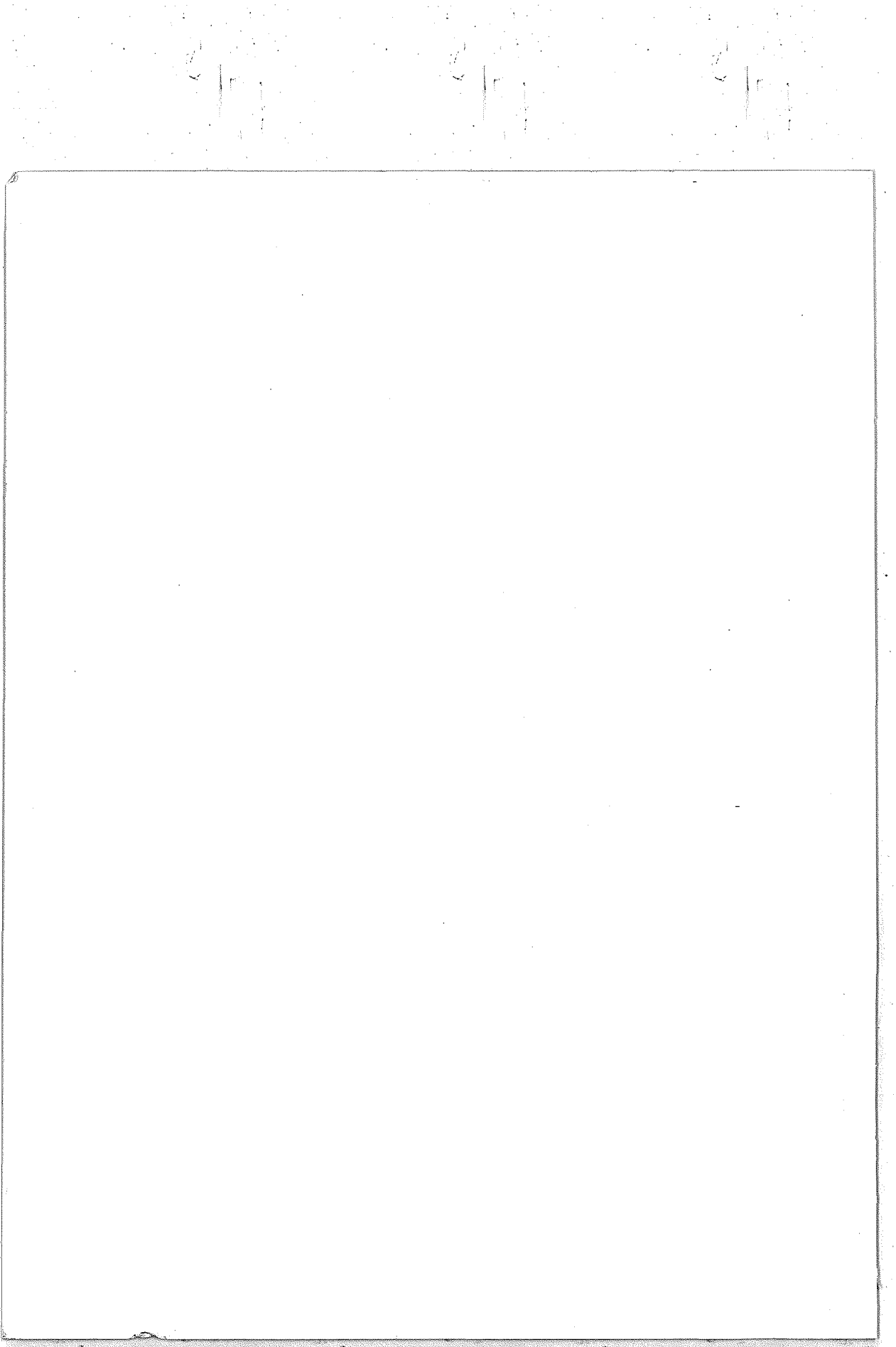
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