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Document UM-05143-0

User Manual
for

DT2814

IBM PC/XT/AT COMPATIBLE

A/D CONVERTER BOARD

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Marlborough, MA 01752-1192

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First Edition
October, 1985

October, 1985 Printing

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PREFACE

This manual is written for the users of Data Translation DT2814 analog to digital converter board. The folowing list provides summeries of all sections in the manual.

CHAPTER 1 - INTRODUCTION

Provides an overview on the DT2814 board and indicates related accessories.

CHAPTER 2 - SPECIFICATIONS

Gives the complete electrical and mechanical specifications for the DT2814 board and accessories used with it.

CHAPTER 3 - UNPACKING AND CONFIGURATION

Gives instructions on how to unpack the board and how to configure it for a specific user application.

CHAPTER 4 - Describes the interconnections of the DT2814 with the host computer system and data acquisition accessories. Provides a diagram of the single-ended connection scheme.

CHAPTER 5 - ARCHITECTURE AND OPERATION

Discusses the main elements of the DT2814 architecture and operation. Describes the registers, functions of the register bits, the initializatiion and A/D conversion processes, and provides a programming sequence.

CHAPTER 6 - CALIBRATION

Describes the calibration of the DT2814 board in unipolar or bipolar input ranges.

CHAPTER 7 - EXAMPLE PROGRAMS

Provides two example programs.

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APPENDIX A - BOARD ASSEMBLY DIAGRAM

Gives the board assembly diagram of the DT2814.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The Data Translation DT2814 is a low cost, half-size analog to digital converter board which offers a complete, IBM PC compatible data acquisition system for laboratory research and industrial control applications.

The DT2814 plugs into a single I/O expansion slot of the IBM PC/XT/AT computer or compatible backplane. It acquires analog signals from user inputs and converts them into a digital code which can be processed by the host microcomputer. The A/D conversion is accomplished by a 12-bit monolithic converter capable of up to 25kHz throughput (25,000 conversions per second). An on-board clock with programmable frequencies can be used to issue conversion triggers.

The DT2814 provides 16 single-ended input channels. It can be configured for unipolar or bipolar input ranges of +/-5V, 0 to +5V, and +/-2.5V. Output coding is straight binary for unipolar input ranges and offset binary for bipolar input ranges. Interrupts to the processor can be generated at the completion of an A/D conversion. The interrupt level is jumper-selectable.

The DT2814 operates from the +5V, +12V, and -12V on the IBM PC bus.

1.2 ACCESSORIES

A wide range of signal conditioning/screw terminal panels can be used with the DT2814 as data acquisition accessories. A brief description of compatible accessories from Data Translation follows:

DT701-20
This is a universal screw terminal panel which

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provides convenient connection points to the input channels. It also provides blank pads for user-supplied passive signal conditioning components.

DT709-S

This is a 16-channel single-ended screw terminal panel. It provides +/-20V input protection.

DT709-Y

This signal conditioning panel provides a differential interface to the 16 single-ended input channels of the DT2814. It contains a differential amplifier at each input for common mode rejection of +/-20V. The DT709-Y obtains +12V and -12V power from the J1 connector of the DT2814 board.

DT709-M

This is a current input version of the DT709-Y. It converts 0 to 20mA inputs to 0 to 5V using a 250 ohm current shunt resistor.

DT756-Y

This board is designed for thermocouple, bridge, and low level inputs. It provides 16 differential inputs and 16 single-ended outputs, and effectively makes the DT2814 analog inputs differential. The board provides common mode rejection of +/-5V. The DT756-Y obtains the +12V and -12V power from the J1 connector of the DT2814 board.

DT750 Backplane/DT6700 Series Modules

The DT750 signal conditioning backplane accommodates up to 16 DT6700 series isolated signal conditioning modules. One module is required for each input channel. Each module provides isolation and one of the following input types: differential voltage input; current loop input; RTD or bridge completion input; tachometer input; or thermocouple input.

The 20-conductor EP047 cable assembly is used to connect the screw terminal panels and signal conditioning accessories to the DT2814 board.

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CHAPTER 2

SPECIFICATIONS

2.1 INTRODUCTION

This chapter lists the specifications of the DT2814 board. Unless noted otherwise, the specifications are typical at +25 degrees C and rated voltage.

2.2 ANALOG INPUTS

Number of Analog Inputs	16 single-ended
Input Ranges (Jumper-selectable)	0 to +5.00V (unipolar) +/-5.00V, +/-2.5V, (bipolar)
Output Data Codes	Straight binary (unipolar) or offset binary (bipolar)
Gain	1 (fixed)
Input Impedance	
Off Channel	>10 megohms, 10pF in parallel;
On Channel	>10 megohms, 100pF in parallel

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SPECIFICATIONS
ANALOG INPUTS

Bias Current	+/-100nA
Maximum Input Voltage Without Damage, Power On	+/-30V
Maximum Input Voltage Without Damage, Power Off	+/-20V

ACCURACY

Resolution	12 bits
Nonlinearity	Less than +/-1/2 LSB
Differential Nonlinearity	Less than +/-1/2 LSB
Inherent Quantizing Error	+/-1/2 LSB
System Accuracy	Within +/-.03% FSR
Channel Crosstalk	-80dB at 1kHz
Gain Error	Adjustable to 0
Zero Error	Adjustable to 0

DYNAMIC PERFORMANCE

Channel Acquisition Time	8 microseconds
A/D Conversion Time	30 microseconds
A/D Converter Throughput	25kHz
Dynamic Error	+/-.75 LSB for a 10V change (max)

THERMAL CHARACTERISTICS

A/D Zero Drift	
Unipolar	20 microvolts/deg. C
Bipolar	17ppm of FSR/deg. C
Gain Drift	30ppm of FSR/deg. C
Differential Linearity Drift C	+/-3ppm of FSR/deg.
Monotonicity	0 to +50 deg. C

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2.3 ON-BOARD CLOCK

Base Frequencies	50 to 600kHz
Selectable Clock Frequencies	0.005Hz to 600kHz
Divisor	1 to 10,000,000 in decade increments
Usable Frequencies	0.005Hz to 20kHz

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2.4 INTERFACE CHARACTERISTICS

Compatible Bus	IBM PC/XT/AT
Interface Type	I/O mapped address
Bus Loading	Presents 1 busload
Number of Locations Occupied	2 bytes
Factory-Assigned Base Address	220H
Interrupt Options	Jumper-selectable to level 3, 4, 5, 6, or 7
Interrupt Source	Finish bit (A/D conversion done)
Analog Data Format	12-bit A/D data left hand justified
Data Path	8 bits

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2.5 POWER REQUIREMENTS

Power Requirements	
+5V	+/-10% @138mA
+12V	+/-10% @22mA
-12V	+/-10% @29mA

2.6 PHYSICAL/ENVIRONMENTAL

Dimensions	4.23" X 4.23" 10.75 X 1075cm
Weight	3.5 ounces (98g)
Maximum Altitude	7,500 feet (2286m)
Operating Temperature Range	0 to +50 deg. C
Storage Temperature Range	-25 to +70 deg. C
Humidity	To 95%, non-condensing

2.7 CONNECTORS AND CABLES

20-pin J1 Connector	3M No. 3493-2003 compatible connector: 3M-3421
Cable Assembly	EP047: 20-conductor, flat ribbon, 8ft. EP047-1: 18" version

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2.8 COMPATIBLE SCREW TERMINAL PANELS

Screw Terminal Panels	DT701-20,DT709-S, DT709-M, DT756-Y, DT750/6700

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CHAPTER 3

UNPACKING AND CONFIGURATION

3.1 INTRODUCTION

This chapter consists of two parts. The first part explains how to unpack the shipped board. The second part discusses the configuration of user-selectable parameters which should be done prior to installing the board.

3.2 UNPACKING

Inspect the shipping carton immediately upon receipt for evidence of mishandling during transit. Depending on the condition of the shipping carton, proceed as outlined in the next two sections.

3.2.1 NO APPARENT DAMAGE

If no visible damage is found, proceed as follows:

1. Place the container on a stable surface and cut the shipping tape.

2. Grasp the front of the flat carton underneath and lift forward and up to open the top.

3. While placing one hand firmly on a metal portion of the system chassis, remove the item from the styrofoam chips. This will prevent any damage to the board components from possible static electricity build-up during transit.

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4. After allowing a moment for the discharge of any static electricity into the host microcomputer chassis, carefully unwrap the board or component from the anti-static bag.

5. Examine the item again for any possible damage. If any sign of damage is encountered, proceed as detailed in the next section.

3.2.2 VISIBLE DAMAGE

If the item container shows any visible damage, open it in the presence of the delivering carrier's agent. Then proceed to unpack it from the shipping container as detailed in the previous section. Then:

1. Examine the item for shipping damage. If damage is detected, do NOT perform any repair or installation of the damaged item. If the delivery carrier's agent was not present during unpacking, call for an insurance claim inspection.

2. Have the insurance agent inspect the damage and arrive at an agreement to repair or replace the damaged item.

3. If the item is to be repaired, call or write:

   Customer Service Department
   Data Translation, Inc.
   100 Locke Drive
   Marlboro, MA 01752-1192
   Tel: (617) 481-3700
   Telex: 951-646

4. Request a Return Material Authorization (RMA) number. This must be obtained before any item will be accepted for return.

5. Repackage the damaged item in the anti-static wrapping and place it in its original shipping material or a secure container for shipment back to the factory.

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NOTE

Ensure that the item is wrapped in anti-static (electrically conductive) packaging, and that it is handled with ground protection. Static electricity is potentially damaging to electrical components on Data Translation products.

6. Return the damaged item, with the RMA number, to the address above.

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3.3 CONFIGURATION

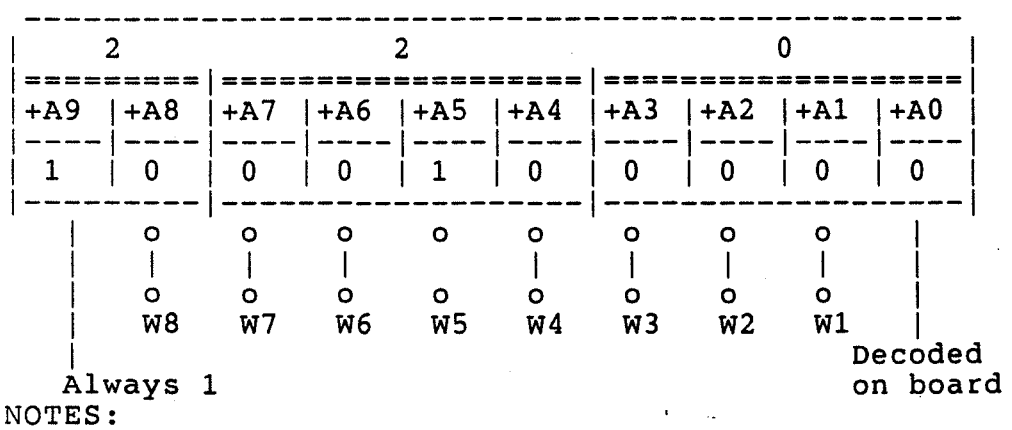
Four operating parameters on the DT2814 are selected by the user: base address of the board, input range, clock base frequency, and the interrupt level. The selection is performed by appropriately jumpering the board.

Jumpers are designated by "W" numbers. A single "W" number (as W19) represents two jumper posts. These posts are connected together when the jumper is installed, or disconnected when it is removed. Jumper configuration is performed by simply installing or removing a wire-wrap or a jumper plug on the pair of jumper posts. Jumper designations are indicated on the component side of the DT2814 board and on the board assembly drawing found in Appendix A.

3.3.1 BASE ADDRESS SELECTION

The DT2814 occupies two locations in the IBM PC I/O address space. The base address ranges from 200H through 3FEH. Figure 3-1 shows the jumpers which select the base address. Address bit A9 is always 1 to define the lower end of the I/O address segment selected for the board. Bit A0 is decoded on the board to select the Control Register, the Status Register, or the Data Register and is not jumper set. The figure also illustrates the jumper configuration for the selection of the factory default base address of 220H. Note that an installed jumper selects the value of "0" for the bit it represents.

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NOTES:

1. The first row from the top represents the factory selected base address. The second row indicates the bit numbers of the base address. The third row shows the binary value of each address bit. A value of "0" indicates that the jumper is installed, and a value of "1" indicates that the jumper is removed.
2. A0 is not configured. It is decoded on the board. When set (1), it selects between the Control Register (write command) and the Status Register (read command). When clear (0), it selects the Data Register.

FIGURE 3-1: BASE ADDRESS SELECTION OF 220H

3.3.2 INPUT RANGES

The DT2814 permits selection of three voltage input ranges: one unipolar (0 to +5V) and two bipolar (+/-2.5V and +/-5V). If the board is configured for unipolar input range, it accepts positive voltages only. If the input range selected is bipolar, then the board accepts both positive and negative input voltages. The jumper configurations for the selection of the input ranges are given in Table 3-1.

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TABLE 3-1: SELECTION OF THE INPUT RANGE

INPUT RANGE	JUMPERS W17	W18	W19	W20
0 to +5V	In	Out	Out	In
+/-2.5V	Out	In	Out	In
+/-5V (FC)	Out	In	In	Out

NOTE:
1. FC is factory configuration.

3.3.3 CLOCK BASE FREQUENCY SELECTION

The on-board programmable pulse generator is used to trigger A/D conversions at selected intervals. Eight different base frequencies--50 to 600kHz--can be derived from the oscillator by configuration of jumpers W9, W10, and W11. Program selected decade divisors further divide each base frequency for the particular application. The software division of the base frequency is discussed in Chapter 5. The selection of the base frequency is shown in Table 3-2.

TABLE 3-2: BASE FREQUENCIES OF THE ON-BOARD CLOCK

BASE FREQUENCY (KHZ)	JUMPERS W9	W10	W11
50	In	In	In
100 (FC)	In	In	Out
120	In	Out	In
150	In	Out	Out
200	Out	In	In
300	Out	In	Out
60	Out	Out	In
600	Out	Out	Out

NOTE:
1. FC is factory configuration.

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3.3.4 INTERRUPT LEVEL

The DT2814 can be jumpered to issue an interrupt request to the processor at any one of five possible levels--3 (highest), 4, 5, 6, or 7 (lowest)--when bit 7 of the Status Register sets (see Chapter 5). The selection of the interrupt request level is given in Table 3-3. The factory configuration does not select any interrupt level.

TABLE 3-3: SELECTION OF THE INTERRUPT REQUEST LEVEL

INTERRUPT REQ. LEVEL	JUMPERS W12	W13	W14	W15	W16
+IRQ3	In	Out	Out	Out	Out
+IRQ4	Out	In	Out	Out	Out
+IRQ5	Out	Out	In	Out	Out
+IRQ6	Out	Out	Out	In	Out
+IRQ7	Out	Out	Out	Out	In

NOTES:
1. All jumpers out in factory configuration.

3.4 JUMPER SUMMARY

Table 3-4 gives a summary of the configurations of jumpers on the DT2814 board. All the jumpers are user-configurable for the selection of various parameters. The factory default configuration of each jumper is noted in parentheses.

TABLE 3-4: DT2814 JUMPER SUMMARY

JUMPER	JUMPER	JUMPER	JUMPER
W1 (In)	W2 (In)	W3 (In)	W4 (In)
W5 (Out)	W6 (In)	W7 (In)	W8 (In)
W9 (In)	W10 (In)	W11 (Out)	W12 (Out)
W13 (Out)	W14 (Out)	W15 (Out)	W16 (Out)
W17 (Out)	W18 (In)	W19 (In)	W20 (Out)

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CHAPTER 4

INTERCONNECTIONS

4.1 INTRODUCTION

The DT2814 plugs into the IBM PC/XT/AT expansion slot or compatible backplane on connector P1, and connects to the user interface on connector J1. This chapter details these two connections. It also illustrates the connection of some Data Translation screw terminal panels to the DT2814 and provides a discussion and a diagram of single-ended inputs.

4.2 CONNECTION TO IBM PC BACKPLANE

The DT2814 plugs into the IBM PC compatible backplane via its 62-pin P1 edge connector. All communication between the host processor and the DT2814 is carried through this connector. The pin assignments of the P1 connector are given Table 4-1.

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TABLE 4-1: P1 PIN ASSIGNMENTS

PIN	MNEMONIC	SIGNAL DESCRIPTION
A1	-I/O CH CK	I/O Channel Check
A2	+D7	Data Bit 7 (MSB)
A3	+D6	Data Bit 6
A4	+D5	Data Bit 5
A5	+D4	Data Bit 4
A6	+D3	Data Bit 3
A7	+D2	Data Bit 2
A8	+D1	Data Bit 1
A9	+D0	Data Bit 0 (LSB)
A10	+I/O CH RDY	I/O Channel Ready
A11	+AEN	Address Enable
A12	+A19	Address Bit 19 (MSB)
A13	+A18	Address Bit 18
A14	+A17	Address Bit 17
A15	+A16	Address Bit 16
A16	+A15	Address Bit 15
A17	+A14	Address Bit 14
A18	+A13	Address Bit 13
A19	+A12	Address Bit 12
A20	+A11	Address Bit 11
A21	+A10	Address Bit 10
A22	+A9	Address Bit 9
A23	+A8	Address Bit 8
A24	+A7	Address Bit 7
A25	+A6	Address Bit 6
A26	+A5	Address Bit 5
A27	+A4	Address Bit 4
A28	+A3	Address Bit 3
A29	+A2	Address Bit 2
A30	+A1	Address Bit 1
A31	+A0	Address Bit 0 (LSB)

Continued on next page

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TABLE 4-1: P1 PIN ASSIGNMENTS(CONT'D)

PIN	MNEMONIC	SIGNAL DESCRIPTION
B1	GND	GROUND
B2	+RESET DRV	RESET DRIVER
B3	+5V	+5 VOLT POWER
B4	+IRQ2	INTERRUPT REQUST 2
B5	-5VDC	-5 VOLT POWER
B6	+DRQ2	DMA REQUEST 2
B7	-12V	-12 VOLT POWER
B8	RESERVED	RESERVED
B9	+12V	+12 VOLTS POWER
B10	GND	GROUND
B11	-MEMW	MEMORY WRITE COMMAND
B12	-MEMR	MEMORY READ COMMAND
B13	-IOW	I/O WRITE COMMAND
B14	-IOR	I/O READ COMMAND
B15	-DACK3	DMA ACKNOWLEDGE 3
B16	+DRQ3	DMA REQUEST 3
B17	-DACK1	DMA ACKNOWLEDGE 1
B18	+DRQ1	DMA REQUEST 1
B19	-DACK0	DMA ACKNOWLEDGE 0
B20	CLOCK	CLOCK
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	DMA ACKNOWLEDGE 2
B27	+T/C	TERMINAL COUNT
B28	+ALE	ADDRESS LATCH ENABLE
B29	+5V	+5 VOLT POWER
B30	+OSC	OSCILLATOR
B31	+GND	GROUND

4.3 USER CONNECTION

The DT2814 is connected to the user interface via the 20-pin, 3M type J1 connector (P/N 3493) . Table 4-2 gives the pin assignments of the J1 connector.

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TABLE 4-2: J1 PIN ASSIGNMENTS

PIN NO.	SIGNAL NAME
1	Channel 0
2	Channel 8
3	Channel 1
4	Channel 9
5	Channel 2
6	Channel 10
7	Channel 3
8	Channel 11
9	Channel 4
10	Channel 12
11	Channel 5
12	Channel 13
13	Channel 6
14	Channel 14
15	Channel 7
16	Channel 15
17	Power Ground
18	Analog Ground
19	+12V out
20	-12V out

NOTE:
1. The +/- 12V on pins 19 and 20 is intended only to power active circuitry on Data Translation screw terminal panels. Very little current is available on those pins. The +/-12V should NOT be used to power external, user-supplied circuits.

4.4 CONNECTIONS TO SCREW TERMINAL PANELS

This section illustrates connections of the DT2814 board to some compatible screw terminal panels available from Data Translation.

Figure 4-1 shows the connection of the DT2814 to screw terminal panel/signal conditioning panels DT709-S, DT709-M, and DT756-Y, and isolated signal conditioning modules of the DT750/DT6700 series.

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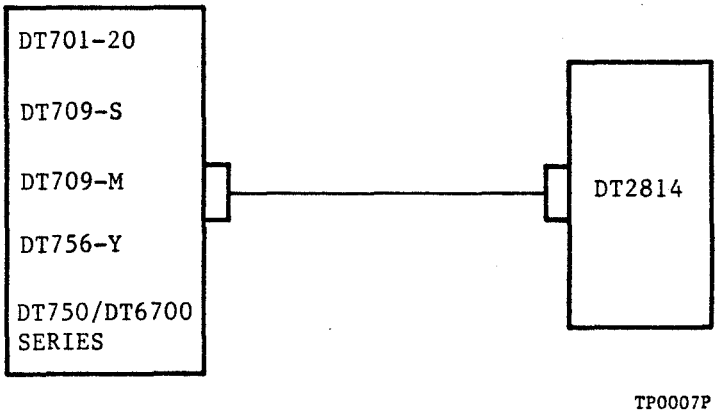


FIGURE 4-1: CONNECTION OF THE DT2814
TO SOME DATA TRANSLATION SCREW
TERMINAL/SIGNAL CONDITIONING PANELS

Figure 4-2 illustrates the connection of the DT701-20 screw terminal panel to two DT2814 boards.

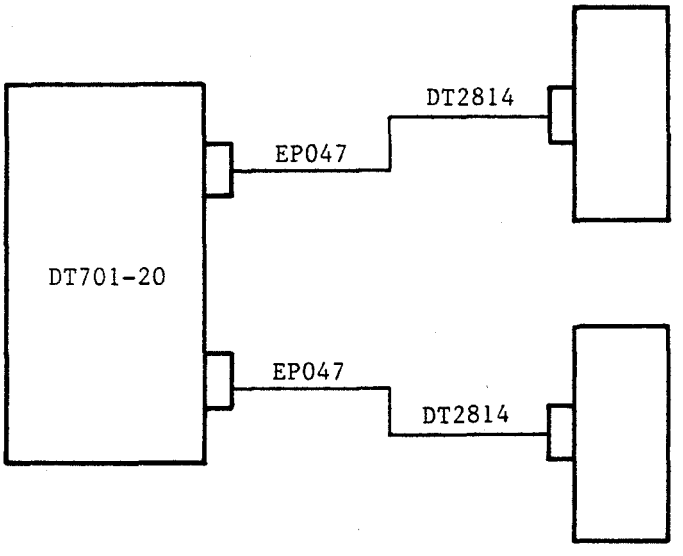


FIGURE 4-2: CONNECTION OF THE DT2814
TO THE DT701-20 SCREW TERMINAL PANEL

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4.5 SINGLE-ENDED CONNECTION SCHEME

The DT2814 A/D board is designed for single-ended inputs only. In single-ended connections, input signals share a common low side which is connected to the Analog Ground (AGND, pin 18). The advantage of this scheme is that the user gets the maximum channel density. The major disadvantage is that the user gives up common mode rejection he could get from a differential input. Single-ended inputs should be restricted to short lead lengths (less than 15 feet). A diagram of the single-ended connection scheme is given in Figure 4-3.

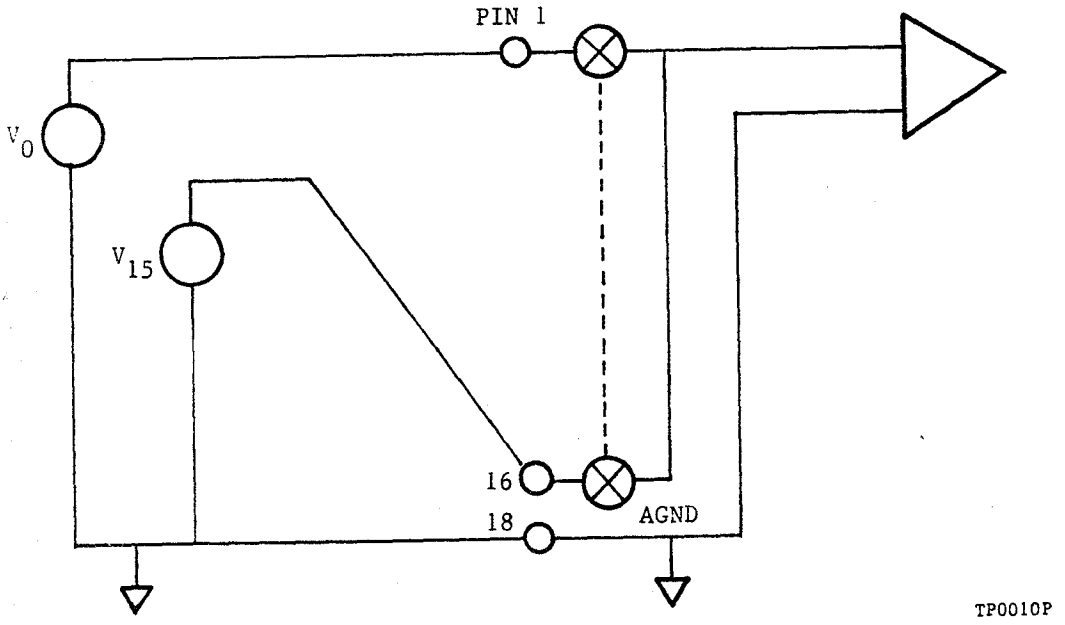


FIGURE 4-3: SINGLE-ENDED CONNECTION SCHEME

NOTES:

1. All signal inputs must be referenced to Analog Ground.
2. All unused analog input channels should be connected to Analog Ground. Failure to do so can result in inaccurate A/D conversions on all other channels, those closest to the floating channel(s) being affected most.

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CHAPTER 5

ARCHITECTURE AND OPERATION

5.1 INTRODUCTION

This chapter describes the architecture and operation of the DT2814 A/D converter board.

5.2 ARCHITECTURE

The DT2814 features a simple architecture which consists of three registers: Control Register, Status Register, and A/D Data Register. All operations on the DT2814 are carried out using these registers. Table 5-1 shows the relative address and accessibility of each register.

TABLE 5-1: DT2814 REGISTERS

REGISTER NAME	ADDRESS	ACCESS
Control Register	Base	Write: byte
Status Register	Base	Read: byte
Data Register	Base + 1	Read: 2 bytes

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5.2.1 CONTROL REGISTER (BASE + 0, WRITE ONLY)

The Control Register is a write only register which contains the parameters for the current A/D conversion. The register is illustrated in Figure 5-1 followed by the description of of the function of each bit in the register.

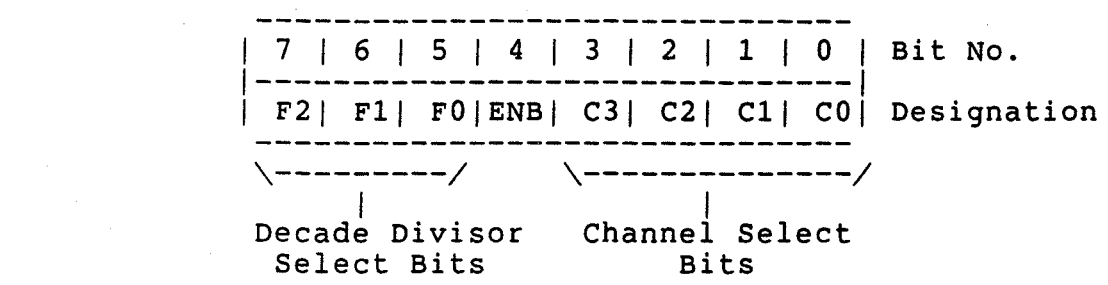


FIGURE 5-1: CONTROL REGISTER

BIT FUNCTIONS

BITS 7-5 - Decade Divisor Select (F2, F1, F0)
These bits select the decade divisor for the on-board clock base frequency. The frequencies obtained by the various settings of these bits are given in Table 5-2. The jumper configurations for the selection of the base frequency are given in Chapter 3.

TABLE 5-2: SOFTWARE SELECTED CLOCK FREQUENCIES

F2	F1	F0	SELECTED FREQUENCY
0	0	0	Base Frequency
0	0	1	Base Frequency/10
0	1	0	Base Frequency/100
0	1	1	Base Frequency/1k
1	0	0	Base Frequency/10k
1	0	1	Base Frequency/100k
1	1	0	Base Frequency/1M
1	1	1	Base Frequency/10M

BIT 4 - Enable (ENB)
This is the clock enable bit. A "1" written to this bit during a write command enables the on-board clock at the rate specified by the user. Each clock tick after the write command triggers another A/D conversion. A "0" issued

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during a write command disables the clock and causes a single step triggering.

BITS 3-0 - Channel Select Bits (C3, C2, C1, C0)
These four bits select one of sixteen (0 to 15) available channels for the current A/D conversion. Table 5-3 shows the bit configurations for channel selection.

TABLE 5-3: A/D CHANNEL SELECTION

CHANNEL SELECT BITS				SELECTED
C3	C2	C1	C0	CHANNEL NO.
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

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5.2.2 STATUS REGISTER (BASE + 0; READ ONLY)

The Status Register is a read only register which provides information about the condition of the A/D conversions. The register is illustrated in Figure 5-2 which is followed by the description of the function of each bit in the register.

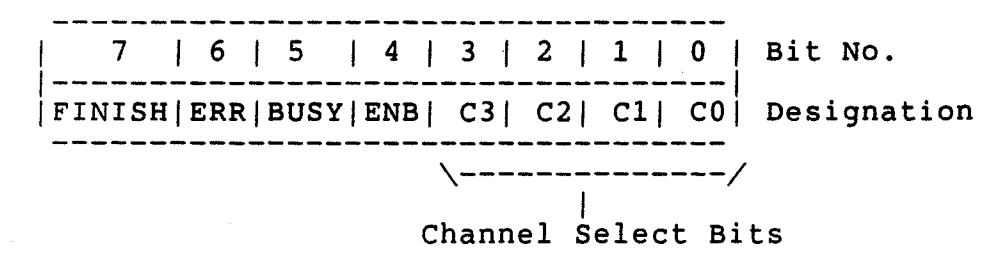


FIGURE 5-2: STATUS REGISTER

BIT FUNCTIONS

BIT 7 - Finish

This bit reports the status of the current conversion cycle. A "1" indicates that the current conversion is complete and that the valid converted data is in the A/D Data Register. A "0" indicates that the current conversion is still in process and that the data in the Data Register is not valid. If an interrupt level is selected for the board (see Chapter 3), the setting of this bit will interrupt the processor and allow the interrupt routine to read the converted data. Reading the A/D Data Register will clear the Finish bit.

BIT 6 - Error (ERR)

A "1" indicates that an error condition has occurred on the board. An error condition results when: a) A new A/D conversion is triggered before the current one has finished; b) A conversion is triggered before the data from the previous conversion has been read. The error flag is cleared by a read of the A/D Data Register.

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BIT 5 - Busy
This flag sets to "1" when an A/D conversion is in progress.

BIT 4 - Enable (ENB)
This bit is a readback of the clock enable on the Control Register. A "1" indicates that the on-board clock is enabled for triggers. A "0" indicates conversions are triggered by a write to the Control Register.

BITS 3-0 - Channel Address Select Bits (C3, C2, C1, C0)
These four bits read back the channel selected for the current conversion by the corresponding bits in the Control Register.

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5.2.3 A/D DATA REGISTER (BASE + 1; READ ONLY)

The A/D Data Register is an 8-bit read only register which holds the digital data resulting from the A/D conversion operation. When the Finish bit (bit 7 of the Status Register) sets, indicating the end of the A/D conversion, the 12-bit converted data can be read from the A/D Data Register. The data is left justified such that the high byte contains the most significant eight bits, while the low byte contains the least significant four bits. The converted data is read from the A/D Data Register in two steps. The first read accesses the high byte, the second read accesses the low byte. The lower four bits of the low byte always read zero. The A/D Data Register format is given in Figure 5-3.

A) First data read - high byte

7	6	5	4	3	2	1	0	Bit No.
D11	D10	D9	D8	D7	D6	D5	D4	Designation

B) Second data read - low byte

7	6	5	4	3	2	1	0	Bit No.
D3	D2	D1	D0	0	0	0	0	Designation

FIGURE 5-3: A/D DATA REGISTER

NOTE

In order to avoid A/D trigger errors and overwriting valid data, it is important that the user maintain a read rate at least equal to the trigger rate specified by the clock frequency.

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5.3 OPERATION

This section discusses the initialization of the DT2814 board, the A/D conversion process, and the programming sequence.

5.3.1 INITIALIZATION

Three steps must be performed to initialize the DT2814:

1. Write 0 to the Control Register.
2. Wait for at least 100 microseconds.
3. Read the high byte and the low byte of the A/D Data Register.

These operations will clear all the registers on the DT2814.

5.3.2 A/D CONVERSION

An A/D conversion starts with a trigger. There are two trigger sources on the DT2814 board: software, by loading the Control Register, and hardware, using the on-board programmable clock. The selection is made by the state of the Enable bit (bit 4) in the Control Register.

Single operations are always triggered by the software method. Simply loading the Control Register with the address of the channel to be acquired starts an A/D conversion. The Enable bit (bit 4) of the byte loaded into the Control Register must be clear. After the A/D conversion is completed and data is read from the A/D Data Register, the Control Register must be loaded again to initiate another conversion. Thus successive conversions occur on successive writes to the Control Register.

Clock triggers are typically used when repetitive conversions are desired on the channel loaded into the Control Register. The Enable bit (bit 4) of the byte loaded into the Control Register must be set (1). Conversion triggers are then issued by the programmable clock at the selected rate. The repetitive conversions can be stopped by writing a new byte to the Control Register with bit 4 clear (disable clock triggers).

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NOTE

It is important that a usable frequency be specified for the clock to avoid error conditions. Even though the clock frequency may vary from 0.005Hz to 600kHz, an output frequency above 20kHz is not recommended. Also, to eliminate contention for system processing time, it is recommended that the IBM system clock be disabled during clocked conversion cycles.

5.3.3 PROGRAMING SEQUENCE

The following sequence must be performed when programming the DT2814.

1. Power up the system and allow time for warm-up.

2. Initialize the board as described earlier in this section.

3. Write a byte into the Control Register. This byte will select the channel to be acquired and the trigger source to be used. If bit 4 (Enable) of the byte is set (1), the board will wait for a clock trigger to initiate repetitive conversions on the channel specified by the channel select bits (bits 3 to 0 of Control Register). Conversions will occur at the clock rate selected by the configuration of jumpers W9, W10, and W11, and the state of bits 7 to 5 of the Control Register. If bit 4 is clear, then A/D conversion will automatically start on the selected channel. Each succeeding conversion requires a new write to the Control Register.

4. Stopping software initiated conversions is trivial. Simply stop writing to the Control Register. To stop clock initiated conversions, disable the clock triggers by clearing bit 4 of the Control Register.

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CHAPTER 6

CALIBRATION

6.1 INTRODUCTION

This section contains calibration procedures for the DT2814 A/D board. The calibration is performed by adjusting two trimpots: R5, the Gain Adjust, and R6, the Offset Adjust. Refer to the assembly drawing in Appendix A for the location of R5 and R6. FULL SCALE.

6.2 GUIDELINES

Some general guidelines must be observed when performing a calibration on the DT2814.

6.2.1 ASSUMPTIONS

1. Calibration will be done on Channel 0 with all other channels returned to Analog Ground (pin 18).

2. The input cable is less than 3 meters (10 ft) long.

3. Software is available to provide continuous readings of Channel 0 and display them on a CRT.

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6.2.2 EQUIPMENT REQUIRED

1. Precision voltage source, Electronic Development Corporation model 501J, or equivalent.

2. Miscellaneous cables and connectors.

6.2.3 PRECAUTIONS

1. Switch the host power off when installing or removing the DT2814.

2. Connect a the voltmeter to the DT2814 as indicated in Figure 6-1.

6.2.4 INTERCONNECTIONS

Connect the voltmeter to the DT2814 as shown in Figure 6-1.

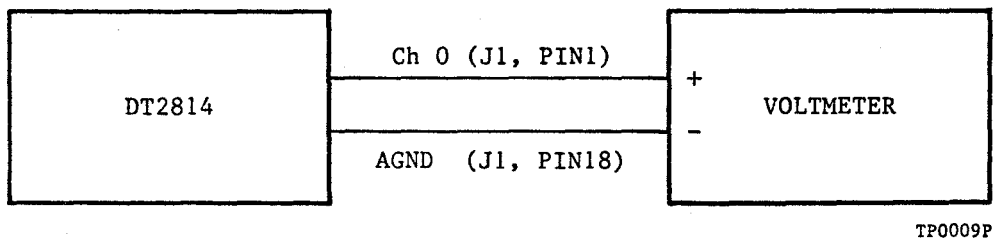


FIGURE 6-1: CONNECTION OF A VOLTMETER TO THE DT2814

6.3 CALIBRATION PROCEDURE

Calibration of the DT2814 should be performed at six month intervals or when the input range has been changed. The offset adjust is always done first, followed by the gain adjust. Note that the input voltages are different for each input range, as shown in Tables 6-1 and 6-2.

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TABLE 6-1: DATA CODING VALUES
FOR UNIPOLAR INPUTS

SCALE	DIGITAL CODE(HEX)	INPUT RANGE 0-5V
+FS - 1 LSB	FFF	+4.9988
+FS - 2 LSB	FFF	+4.9976
1/2 Scale	800	+2.5000
1 LSB	001	1.22mV

TABLE 6-2: DATA CODING VALUES
FOR BIPOLAR INPUTS

SCALE	DIGITAL CODE(HEX)	INPUT RANGE +/-5V	INPUT RANGE +/-2.5V
+FS - 1 LSB	FFF	+4.9976	+2.4988
+FS -2 LSB	FFE	+4.9952	+2.4976
+1/2 FS	C00	+2.5000	+1.2500
1 LSB	801	2.44mV	1.22mV
0	800	0.0000	0.0000
-1 LSB	7FF	-2.44mV	-1.22mV
-1/2 FS	400	-2.5000	-1.2500
-FS + 1 LSB	001	-4.9976	-2.4988
-FS	000	-5.0000	-2.5000

6.3.1 UNIPOLAR OFFSET ADJUST

Apply a dc input voltage of 1/2 LSB (0.610mV) and adjust the offset potentiometer R6 for flicker between output codes 000H and 001H (see Table 6-1).

6.3.2 UNIPOLAR GAIN ADJUST (FULL SCALE)

Apply a dc voltage of 1 and 1/2 LSB below FULL SCALE (4.9982V) and adjust the gain potentiometer R5 for flicker between codes FFE and FFF (see Table 6-1).

6.3.3 BIPOLAR OFFSET ADJUST (+/-5V RANGE)

Apply a dc input voltage of 1/2 LSB above the negative FULL SCALE (-4.9988V) and adjust the offset potentiometer R6 for flicker between output codes 000H and 001H (see Table 6-2).

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6.3.4 BIPOLAR GAIN ADJUST (+/-5V RANGE)

Apply a dc voltage of 1 and 1/2 LSB below FULL SCALE (4.99635V) and adjust the gain potentiometer R5 for flicker between codes FFE and FFF (see Table 6-2).

6.3.5 BIPOLAR OFFSET ADJUST (+/-2.5V RANGE)

Apply a dc input voltage of 1/2 LSB above the negative FULL SCALE (-2.4994V) and adjust the offset potentiometer R6 for flicker between output codes 000H and 001H (see Table 6-2).

6.3.6 BIPOLAR GAIN ADJUST (+/-2.5V RANGE)

Apply a dc voltage of 1 and 1/2 LSB below FULL SCALE (2.4982V) and adjust the gain potentiometer R5 for flicker between codes FFE and FFF (see Table 6-2).

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CHAPTER 7

EXAMPLE PROGRAMS

7.1 INTRODUCTION

This chapter presents two example programs for use with the DT2814 board.

7.1.1 EXAMPLE PROGRAM 1

This BASIC program performs a loop on all sixteen input channels, taking three samples of data at each channel, doing the conversion, and printing out the digital code. The program will loop indefinitely until any key is pressed. Output data does not scroll. It is overwritten by the new data. This program will run faster if it is compiled on the IBM system using their BASCOM function. The program assumes that the DT2814 is set for a base address of 220H and no interrupts are enabled.

```
10  CLS
20  LOCATE 3,1,1,12          'Set cursor to a known
                               position
30  FOR Y=0 TO 15            'Loop on all 16 channels
40  IF Y>9 THEN 70
50  PRINT "ch  ";Y;"      "; 'Print the channel no.
60  GOTO 80
70  PRINT "ch ";Y;"      ";
80    FOR X=1 TO 3           'Sample channel 3 times
90    OUT &H220,Y            'Write, select channel,
                               starts the conversion
100 LET A=0
110 A=INP(&H220)             'Read the Status Reg.
                              until FINISH bit sets
120 IF A>=128 THEN 130 ELSE 100  'If set, end of
                                   conversion,
                                   data valid
130 B=INP(&H221)             'Read high byte at
                               base + 1
```


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```
140 C=INP(&H221)                    'Read low byte at
                                      base + 1
150 PRINT HEX$(B);" ";HEX$(C)        'Print out the data-
                                       high byte, low byte
160 NEXT X                          'Get three readings
170 PRINT
180 NEXT Y                          'Do next channel
190 LOCATE 3,1,0,12                 'Set cursor to overwrite
                                      previous data
200 M$=INKEY$' IF M$="" THEN 30 'If no keyboard input,
                                       then continue
210 LOCATE 24,24,1,12                'Else read 16 channels
                                       and stop
220 END
```


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7.1.2 EXAMPLE PROGRAM 2

This BASIC program prompts the user for a channel number (0-15) and loops on that channel indefinitely, sampling and printing out the data. It performs as the sample program 1, overwriting the previous data block on the screen. Hit any key to exit the program or to select a new channel. This program will run faster if it is compiled on the IBM system using their BASCOM function.

```
10  CLS
20  INPUT "Enter Channel Number (0-15)";N
                              'Wait for user to input
                                desired channel
30  IF N>15 THEN 190 ELSE IF N<0 THEN 190 ELSE 40
40  LOCATE 3,1,1,12           'Set cursor to a known
                                position
50  FOR Y=1 TO 16             '16 lines per data block
60    FOR X=1 TO 8            '8 samples per line
70  OUT &H220,N               'Select channel, trigger
                                sample
80 LET A=0
90 A=INP(&H220)               'Read Status Reg.
                                for FINISH bit
100 IF A>=128 THEN 110 ELSE 90 'If set, conversion done,
                                  data valid
110 B=INP(&H221)               'Read high byte
120 C=INP(_&H221)              'Read low byte
130 PRINT HEX$(B);HEX$(C);"    "; 'Print data high byte,
                                     low byte
140 NEXT X
150 PRINT
160 NEXT Y                    'Do next block of data
170 LOCATE 3,1,0,12           'Set cursor to overwrite
                                previous data
180 M$=INKEY$: IF M$="" THEN 50 ELSE 200
                              'If key stop, otherwise
                                loop
190 PRINT "Channel Number out of range-try again": GOTO 20
200 LOCATE 24,24,1,12
210 END
```


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APPENDIX A

BOARD ASSEMBLY DRAWING

This appendix contains the board assembly drawing of the DT2814.

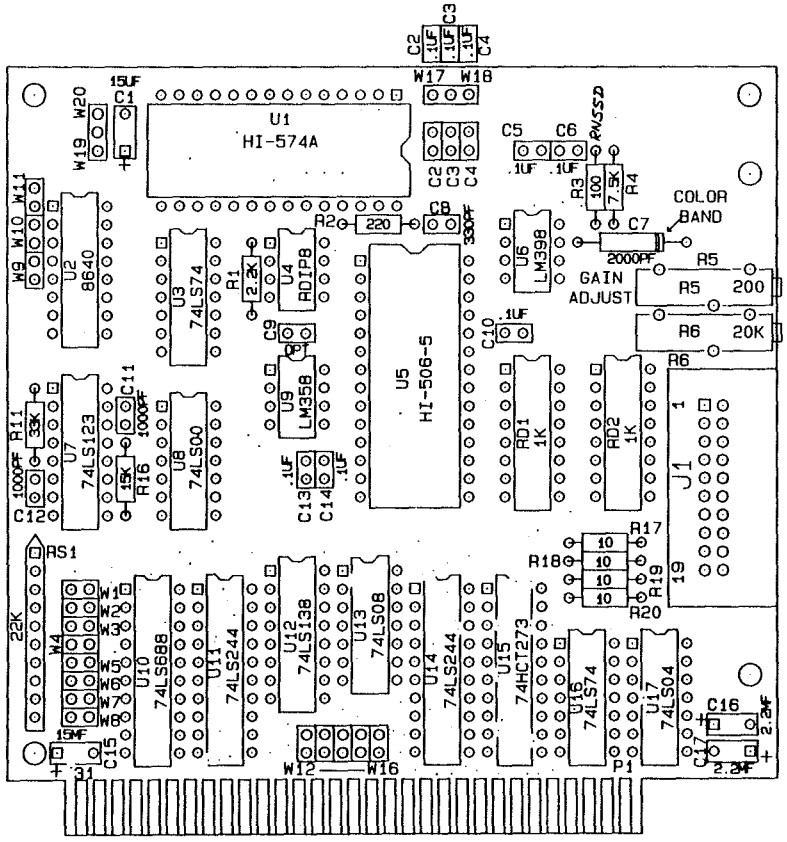
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