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5.2.5 DAC1 DATA REGISTER (LOW BYTE)

Address: Base + 4
Access: Write

The DAC1 Data Register (DADAT1) low byte is a write only register which holds the 8 lower bits of the 12-bit code loaded by the user software into DAC1 for D/A conversion. The bit functions of the DADAT1 (low byte) are shown in Figure 5-6 and are described subsequently. Bit 0 is the least significant bit (LSB).

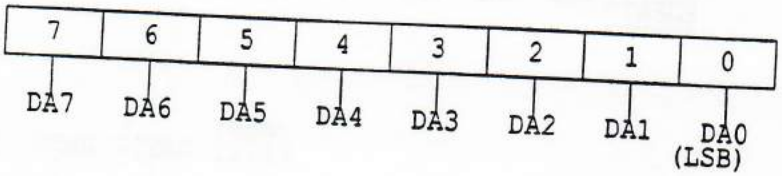


FIGURE 5-6: DAC1 DATA REGISTER (LOW BYTE)

BIT FUNCTIONS

BITS 7-0 - D/A data
These bits form the low byte of the 12-bit code loaded by software into DAC1 for D/A conversion.

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5.2.6 DAC1 DATA REGISTER (HIGH BYTE)

Address: Base + 5
Access: Write

The DAC1 Data Register (DADAT1) high byte holds the four higher bits of the 12-bit code loaded by the user software into DAC1 for D/A conversion. Writing to this register causes a D/A conversion to begin on DAC1. The bit functions of the DADAT1 (high byte) are shown in Figure 5-7 and are described subsequently. Data is right justified and bit 3 is the most significant bit (MSB).

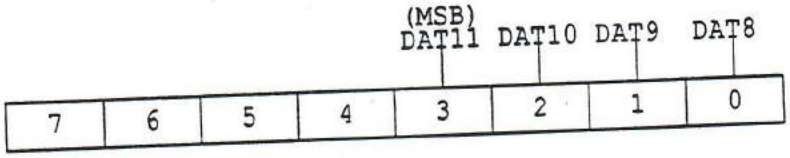


FIGURE 5-7: DAC1 DATA REGISTER (HIGH BYTE)

BIT FUNCTIONS

BITS 7-4 - Not used.

BITS 3-0 - D/A data
These are the four higher bits of the 12-bit code loaded by software into DAC1 for D/A conversion.

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5.2.7 DIGITAL INPUT PORT 0

Address: Base + 6
Access: Read

The DIO Port 0 Register receives digital data to be transferred from the DT2811 to the host processor. The bit functions of this register are given in Figure 5-8 and are described subsequently.

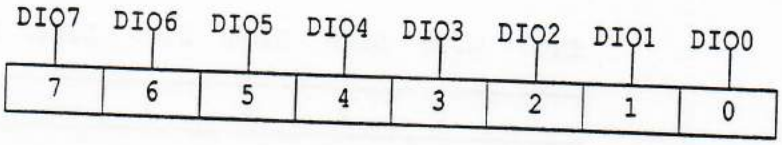


FIGURE 5-8: DIGITAL INPUT PORT 0 REGISTER

BIT FUNCTIONS

BITS 7-0 - Digital Input Data
These bits form the digital data read from an external device into the 2811 to be transferred to the host processor. Digital Input Port 0 bit 0 is associated with pin 28 on the connector J1; bit 1 with pin 29, etc.

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5.2.8 DIGITAL OUTPUT PORT 1

Address: Base + 6
Access: Write

The DIO Port 1 Register is a write only register that receives digital data to be transferred from the host processor to the DT2811. The bit functions of this register are given in Figure 5-9.

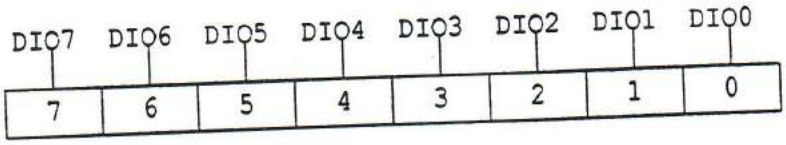


FIGURE 5-9: DIO PORT 1 REGISTER

BIT FUNCTIONS

BITS 7-0 - Digital Output Data
These bits form the digital data loaded onto the 2811 from the host processor to be transferred to an external device. Digital Output Port 1 bit 0 is associated with pin 38 on connector J1; bit 1 with pin 39, etc.

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5.2.9 TIMER/COUNTER

Address: Base + 7
Access: Read/Write

The Timer/Counter Register (TMRCTR) is an 8-bit read/write register which contains the code for the selection of the clock frequency on the DT2811. The digital code specifies a factor by which the pulse rate (base frequency) of the internal clock is divided to derive the selected operating frequency. This frequency scaling can be also applied to the output of the external oscillator if the latter is used as the clock frequency source for DT2811 operations. The bit functions of the TMRCTR are given in Figure 5-10 and are described subsequently.

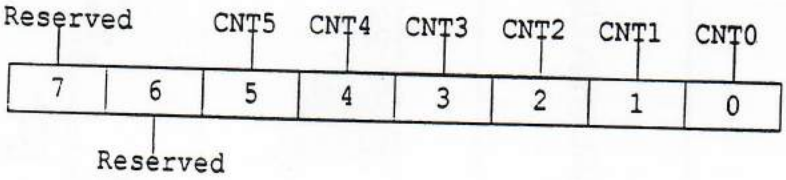


FIGURE 5-10: TIMER/COUNTER REGISTER

BIT FUNCTIONS

BITS 7,6 - Reserved
These bits are not used.

BITS 5-0 - Timer Frequency Control
This 6-bit field defines the divisor value which is applied to the base frequency to derive the desired operating frequency of the clock circuit. Table 5-5 lists the divisor values selected by configuring the TMRCTR bits and the corresponding operating frequencies obtained from the internal clock base frequency of 600kHz--the pulse rate of the DT2811 internal clock. Note that divisor values in the various selectable ranges

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increase in logarithmic progression, that is, they increase by one decade factor for each unitary increment in the binary code of the frequency control bits. Also, the entries listed under TMRCTR represent values of the Timer/Counter Register.

TABLE 5-5: TIMER FREQUENCY SELECTION

TMRCTR CODE (HEX)	BASE FREQUENCY DIVISOR	CLOCK FREQUENCY (HZ)
00	1	600 K
01	10	60 K
02	100	6 K
03	1000	600
04	10000	60
05	100000	6
06	1000000	0.6
07	10000000	0.06
08	10	60 K
09	100	6 K
0A	1000	600
0B	10000	60
0C	100000	6
0D	1000000	0.6
0E	10000000	0.06
0F	100000000	0.006
10	2	300 K
11	20	30 K
12	200	3 K
13	2000	300
14	20000	30
15	200000	3
16	2000000	0.3
17	20000000	0.03
18	3	200 K
19	30	20 K
1A	300	2 K
1B	3000	200
1C	30000	20
1D	300000	2
1E	3000000	0.2
1F	30000000	0.02

(Continued on next page)

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TABLE 5-5 (CONT'D): TIMER FREQUENCY SELECTION

TMRCTR CODE (HEX)	BASE FREQUENCY DIVISOR	CLOCK FREQUENCY (HZ)
20	4	150 K
21	40	15 K
22	400	1.5 K
23	4000	150
24	40000	15
25	400000	1.5
26	4000000	0.15
27	40000000	0.015
28	5	120 K
29	50	12 K
2A	500	1.2 K
2B	5000	120
2C	50000	12
2D	500000	1.2
2E	5000000	0.12
2F	50000000	0.012
30	6	100 K
31	60	10 K
32	600	1 K
33	6000	100
34	60000	10
35	600000	1
36	6000000	0.1
37	60000000	0.01
38	12	50 K
39	120	5 K
3A	1200	500
3B	12000	50
3C	120000	5
3D	1200000	0.5
3E	12000000	0.05
3F	120000000	0.005

NOTE

It is important that a usable frequency be specified for the clock to avoid error conditions. Even though the clock frequency ranges 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 system clock be disabled during clocked conversion cycles. In polled I/O, disabling system interrupts will further improve the performance.

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CHAPTER 6

PRINCIPLES OF OPERATION

This chapter discusses the main operating principles of the three subsystems on the DT2811. It also provides guidelines for successful programming and efficient use of conversion features available on the DT2811. The chapter covers the following topics:

- o A/D Conversion triggers
- o A/D Initialization
- o A/D Operating modes
- o A/D Error conditions
- o D/A Conversion
- o DIO Transfers
- o Example programs

The material presented in this chapter should be carefully read before putting the DT2811 into operation.

6.1 A/D CONVERSION TRIGGERS

All A/D conversions are initiated with a trigger. Two types of triggers are used on the DT2811: software and hardware.

The software trigger is issued by the program running the board. It is accomplished by simply loading the A/D Gain/Channel Register with a valid gain and channel number. Mode 0 and Mode 1 use software triggers to initiate single and continuous conversions, respectively.

A hardware trigger is an electrical pulse generated externally by the user. The pulse triggers conversions on its negative going edge. Mode 2 and Mode 3 use hardware triggers to initiate continuous conversions. The conversion starts with the output pulse of the frequency divider.

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When performing any type of continuous conversions, software or hardware triggered (Modes 1, 2, and 3), it is important to note that the actual conversion will be delayed by one half pulse width of the base frequency of the internal clock.

The internal clock system which provides the outputs for hardware triggers consists of a clock and a frequency divider. The base frequency of the clock is 600kHz. The internal clock system is disabled when Mode 0 is selected. The internal clock and the frequency divider are enabled when the board is operated in Mode 1 or Mode 2. The internal clock base frequency output is disabled when Mode 3 is selected. However, the frequency divider is still active and available for use with an externally supplied frequency. In this mode, the DT2811 receives the basic frequency from the external oscillator.

The use of the various trigger sources for optimum operation of the DT2811 is discussed in Section 6.3.

6.2 A/D INITIALIZATION

Perform the following steps to initialize the A/D subsystem:

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

These operations perform a valid A/D conversion and clear the A/D Control/Status Register. To proceed with new A/D or D/A conversions, you must follow the steps outlined for various operating modes in Section 6.3.

6.3 A/D OPERATING MODES

The A/D subsystem of the DT2811 can operate in four different modes, depending on the requirements of the application. The mode is selected by appropriately setting the mode bits (bits 1 and 0) of the A/D Control/Status Register. The four operating modes are:

- Mode 0 - Single conversion

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- Mode 1 - Continuous conversion with internal clock
- Mode 2 - Continuous conversion with internal clock and external trigger
- Mode 3 - Continuous conversion with external oscillator and external trigger

In all cases, the A/D conversion parameters must be selected by loading the A/D Control/Status Register before issuing a trigger. The next subsections provide brief notes on the operating modes.

6.3.1 MODE 0 - SINGLE CONVERSION

This mode of operation should be selected when single conversions are to be performed on different channels. The conversion is initiated on the selected channel as soon as the A/D Gain/Channel Register is loaded with the number of the channel to be acquired and the gain to be applied to the input signal. The selection of this operating mode automatically disables the internal clock. An A/D conversion in this mode of operation proceeds as follows:

1. Initialize.
2. Load the A/D Control/Status Register with selected parameters for the A/D conversions. The mode field should have the value of 0.
3. Load the A/D Gain/Channel Register with selected gain and channel number. This operation triggers an A/D conversion.
4. Wait for an interrupt signaling the completion of an A/D conversion--if you have enabled interrupts (step 2 in this procedure)--or poll the A/D Done bit (ADCSR bit 7) until set.
5. Read the converted data from the ADDAT/DADAT0; first the low byte then the high byte. Reading the high byte of data clears the A/D Done bit.

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NOTE

You can trigger the next conversion before reading the high byte of the converted data. However, you must finish reading the A/D Data Register before the end of the next conversion; otherwise, data will be overwritten and an error condition will result.

6. To start another conversion on the same channel with the same gain, just reload the A/D Gain/Channel Register as above. For conversion on a different channel, load the A/D Gain/Channel Register with the selected gain and the number of the new channel. Conversion will start as soon as the A/D Gain/Channel Register is loaded.

6.3.2 MODE 1 - CONTINUOUS CONVERSION, INTERNAL CLOCK

This mode of operation is selected when repetitive conversions are to be performed on a given channel at predetermined intervals. Successive conversions are initiated by triggers from the internal clock. The output frequency of the internal clock--intervals between successive conversions--is controlled by the counter bits in the Timer/Counter Register. A new channel for mode 1 conversions can be selected at the end of the last conversion on the current channel by loading the A/D Gain/Channel Register with the number of the new channel and the gain to be applied on the input signal. In this manner, continuous conversions with desired gains can be performed on a list of channels under software control without interruption.

NOTE

While the DT2811 converter can achieve a throughput of 20kHz when operated on a single channel in continuous conversion mode and at gains up to 10, overall throughput may be reduced if conversions are performed on a scan of channels, because of overhead due to software changes of channel and gain.

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A/D conversions in mode 1 proceed as follows:

1. Initialize.
2. Load the A/D Control/Status Register with the selected parameters for the A/D conversions. The mode field should have the value of 1.
3. Load the Timer/Counter Register with code for the selected output frequency of the internal clock.
4. Initiate conversion by loading the A/D Gain/Channel Register with selected gain and channel number. A/D conversion starts with the first pulse from the internal clock.
5. Wait for an interrupt signaling the completion of an A/D conversion--if you have enabled interrupts (step 2 in this procedure)--or poll the A/D Done bit (ADCSR bit 7) until set.
6. Read the converted data from the ADDAT/DADAT0; first the low byte then the high byte. Reading the high byte of data clears the A/D Done bit. Loop on steps 5 and 6 to continue.
7. To change the input channel:
   A. Disable the internal clock outputs by writing to the ADCSR with 0 for the value of the mode field. This disables all hardware triggers.
   B. Go to step 2 of the conversion procedure outlined above.

6.3.3 MODE 2 - CONTINUOUS CONVERSION, EXTERNAL TRIGGER

As with Mode 1, this mode of operation is selected when repetitive conversions are to be performed on a given channel at predetermined intervals. Conversions are initiated by the internal clock just as in Mode 1. However, the outputs of the internal clock are enabled by a user-supplied external trigger. The output frequency of the internal clock--intervals between successive conversions--is controlled by the counter bits in the Timer/Counter

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Register. A new channel for Mode 2 conversions can be selected at the end of the last conversion on the current channel. Continuous conversions with desired parameters can be performed on a list of channels without interruption under software control. A/D conversions in mode 2 proceed as follows:

1. Initialize.
2. Load the A/D Control/Status Register with the selected parameters for the A/D conversions. The mode field should have the value of 2.
3. Load the Timer/Counter Register with code for the selected output frequency of the internal clock.
4. Load the A/D Gain/Channel Register with selected gain and channel number.
5. Initiate conversion by enabling the internal clock outputs with a negative edge external trigger source connected to pin 49 of the J1 connector. A/D conversion starts with the first pulse from the internal clock.
6. Wait for an interrupt signaling the completion of an A/D conversion--if you have enabled interrupts (step 2 in this procedure)--or poll the A/D Done bit (ADCSR bit 7) until set.
7. Read the converted data from the ADDAT/DADAT0; first the low byte then the high byte. Reading the high byte of data clears the A/D Done bit and prepares the board for the next conversion. Loop on steps 6 and 7 to continue.
8. To change the input channel:
   A. Disable the internal clock outputs by writing to the ADCSR with 0 for the value of the mode field. This disables all hardware triggers.
   B. Go to step 2 of the conversion procedure outlined above.

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6.3.4 MODE 3 - CONTINUOUS CONVERSION, EXT OSC, EXT TRIG

This mode of operation is similar to mode 2, except that the base frequency of the internal clock is determined by a user-selected external oscillator attached to pin 50 of the J1 connector. Conversions are initiated at regular intervals by the internal clock and the outputs of the internal clock are enabled by a user-supplied external trigger just as in mode 2. The output frequency of the internal clock--intervals between successive conversions--is controlled by the counter bits in the Timer/Counter Register. The contents of the Timer/Counter Register can be changed via software anytime during the conversion operations. A new channel for Mode 3 conversions can be selected at the end of the last conversion on the current channel by loading the A/D Gain/Channel Register with the number of the new channel and the gain to be applied on the input signal. In this manner, continuous conversions with desired gains can be performed on a list of channels under software control without interruption. The external oscillator is normally used when a base frequency other than 600kHz (the base frequency of the internal clock) is desired. AD conversions in Mode 3 would proceed as follows:

1. Initialize.
2. Load the A/D Control/Status Register with the selected parameters for the A/D conversions. The mode field should have the value of 3.
3. Load the Timer/Counter Register with code for base frequency divider. If the conversion rate is to be the same as the frequency of the external oscillator, TMRCTR should be cleared (code = 0, base frequency divisor of 1).
4. Load the A/D Gain/Channel with selected gain and channel number.
5. Enable the internal clock outputs with an external trigger source connected to pin 49 of the J1 connector. A/D conversion starts with the first pulse from the internal clock .

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6. Wait for an interrupt signaling the completion of an A/D conversion--if you have enabled interrupts (step 2 in this procedure)--or poll the A/D Done bit (ADCSR bit 7) until set.

7. Read the converted data from the ADDAT/DADAT0; first the low byte then the high byte. Reading the high byte of data clears the A/D Done bit and prepares the board for the next conversion. Loop on steps 6 and 7 to continue.

8. To change the input channel:

   A. Disable the internal clock outputs by writing to the ADCSR with 0 for the value of the mode field. This disables all hardware triggers.
   B. Go to step 2 of the conversion procedure outlined above.

6.4 ERROR CONDITIONS

Two types of error conditions can occur on the DT2811: trigger overlap and data overwrite. An error condition in the board operation is indicated when A/D ERR (bit 6 of the ADCSR) sets. This bit should be checked by the user software at the end of each conversion cycle to ensure data integrity. If set, this bit must be cleared immediately before proceeding with the next conversion. This is done by writing a 1 to bit 4 of the ADCSR. Failure to clear this bit effectively disables all further error reports.

A trigger overlap error occurs when a new trigger is issued--software or hardware--while the current conversion is in process. This means that any trigger issued between the time the current conversion is initiated and the time the currently converted data is placed in the A/D and D/A Data Register (low byte and high byte) is illegal. When conversions are initiated with software triggers, A/D Done (bit 7 of the ADCSR) should be set--indicating the completion of the current conversion--before the A/D Gain/Channel Register can be reloading to initiate the next conversion. In hardware initiated conversions, the intervals programmed between successive conversion triggers should allow enough time for conversions to

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complete.

A data overwrite error occurs when the current conversion completes before data from the previous conversion is read. The data overwrite error results in the loss of data as previous data is overwritten with new conversion data. Software should adhere to the legal sequence of events in conversion operations to avoid data overwrite errors. This means that software must read data from the current conversion before a trigger (software or hardware) is issued for the next conversion. When overlap conversions are performed, software must be able to read data from the previous conversion before the current conversion completes.

Figure 6-1 is a timing diagram which illustrates the progress of a conversion operation. When a trigger is issued, TRIG goes low. This causes CONVERT to go high and start the conversion. When conversion completes, CONVERT goes low and pulls A/D DONE high, which sets the DONE in the A/D Control/Status Register indicating the end of the current conversion. A/D DONE stays high until the high byte of the converted data is read from the A/D Data Register. Reading the high byte of the data pulls A/D DONE low, indicating that a new trigger can be issued. Conversions continue to start and complete without error so long as this sequence is adhered to. However, the diagram shows overlap operations which proceed as follows:

1. After the first read, A/D DONE resets. The second trigger is issued, which starts the second conversion.

2. A/D DONE sets at the end of the second conversion.

3. The third trigger is issued prior to reading data from the second conversion.

4. Data from the second conversion is read while the third conversion is in progress.

5. The fourth trigger is issued prior to reading data from the third conversion.

6. The fourth conversion completes while data from the third conversion is not read. This is a data overwrite error condition which sets A/D ERR.

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FIGURE 6-1: A/D CONVERSION TIMING DIAGRAM

6.5 D/A CONVERSION

The D/A conversion on the DT2811 is straightforward. Proceed as follows:

1. Load the low byte of the digital data to the low byte data register of the selected DAC.

2. Load the high byte of the digital data to the high byte data register of the selected DAC.

D/A conversion starts as soon as the high byte of the digital data is clocked in. The output voltage is the analog value corresponding to the digital input code.

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6.6 DIO TRANSFERS

The DIO Port 0 and DIO Port 1 Registers serve to transfer data under program control between the computer system and I/O device attached to the J1 connector of the DT2811. DIO Port 0 is dedicated to inputs, while DIO Port 1 is dedicated to outputs. The direction of data transfer through the DIO ports is determined by the access to the DIO Port 0/DIO Port 1 Registers. In a read operation, the processor accesses DIO Port 0 and reads the data present at the port. In a write operation, the processor sends data to DIO Port 1 where the data is made available to an external I/O device.

To operate the digital I/O subsystem, proceed as follows:

1. For an output (write) operation, load the DIO Port 1 Register with the byte to be transferred to the I/O device.

2. A read of the DIO Port 0 Register always yields the data made available to the port by an external device.

6.7 EXAMPLE PROGRAMS

This section provides simple BASIC example programs which demonstrate the use of the A/D and D/A subsystems. All four modes of A/D conversions are illustrated. Each program is headed by a comment which explains the function performed by the program. The programs may be run using IBM interpreted BASIC, or they may be compiled. Consult manuals BASIC Reference and BASIC Handbook, both published by IBM, for information on BASIC programming.

IMPORTANT

Output codes from A/D conversions are represented in hex coding (see Table 7-1). The leading nibble (four higher bits) of each byte is truncated if it represents a value of zero. This means that the leading nibble of the high byte is always truncated. Thus the high byte appears on the output as the leftmost hex digit. If the leading nibble of the low byte has a value other than zero, the byte appears on the output as two hex digits. The combination of the high

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byte and the low byte shows as a 3-digit hex number. If the leading nibble of the low byte has a value of zero, then it is truncated, and the low byte appears as a single hex digit on the output. In this case, the combination of the two bytes shows as a 2-digit number. In other words, whenever the output appears as two hex digits, read a zero in between. Thus 801 is output as 81, 70F as 7F, etc.

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6.7.1 A/D IN MODE 0

```
10 'PROGRAM: MODE0.BAS
20 '
30 '            MODE 0 OPERATION
40 '
50 'This program demonstrates how to program the
60 'DT2811 for MODE 0 operation. MODE 0 performs
70 'a single conversion on a write to the ADGCR.
80 'Single channel operation (Ch 0) is shown at
90 'a GAIN of one. Any channel may be used or a
100 'channel scan may be performed by incrementing
110 'channels.
120 '
130 'To EXIT during execution, strike any key.
140 '
150 'The following sequence is recommended for
160 'MODE 0 operation:
170 '
180 CLS                              'clear screen
190 BADR=&H218                       'set BASE address
200 OUT BADR,&H10                     'INITIALIZE BOARD
210 FOR I = 0 TO 100                 'wait
220 NEXT I
230 LB=INP(BADR+2)                   'read LOW BYTE
240 HB=INP(BADR+3)                   'read HIGH BYTE
250 '
260 GCR=&H0                          'set GAIN=1,CH=0
270 OUT BADR,&H0                     'write MODE 0 to CSR
280 OUT BADR+1,GCR                   'load GCR which
290 '                                '  starts CONVERSION
300 CSR=INP(BADR)                    'read CSR
310 IF CSR<128 THEN 300              'DONE BIT set?
320 LB=INP(BADR+2)                   'read LOW BYTE
330 HB=INP(BADR+3)                   'read HI BYTE; clear
340 '                                '    DONE bit
350 PRINT HEX$(HB);HEX$(LB)          'print A/D DATA
360 '
370 'This FOR/NEXT loop provides a delay so that data
380 'may be displayed and easily read on a screen.
390 '
400 FOR I=1 TO 100                   'print to screen delay
410 NEXT I
420 '
430 'By using the INKEY$ command, the user can easily
440 'stop program execution.
450 '
460 X$=INKEY$
470 IF X$="" THEN 280                'reload GCR
480 '
490 GOTO 500
500 CLS
510 PRINT "MODE 0 OPERATION COMPLETE"
520 END
```


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6.7.2 A/D IN MODE 1

```
10 'PROGRAM: MODE1.BAS
20 '
30 '              MODE 1 OPERATION
40 '
50 'This program demonstrates how to program the
60 'DT2811 for MODE 1 operation. MODE 1 performs
70 'continuous conversions on a write to the GCR.
80 'Single channel operation (Ch 0) is shown at a
90 'GAIN of one. Any channel may be used or a
100 'channel scan may be performed by incrementing
110 'channels. To STOP program execution strike
120 'any key.
130 'NOTE:There is no need to stop execution while
140 'changing input voltages.
150 '
160 CLS                              'clear screen
170 BADR=&H218                       'set BASE address
180 OUT BADR,&H0                     'INITIALIZE BOARD
190 FOR I = 0 TO 100                 '    wait
200 NEXT I
210 LB=INP(BADR+2)                   '    read LOW BYTE
220 HB=INP(BADR+3)                   '    read HIGH BYTE
230 '
240 TMRCTR=&H34                      'set BASE FREQ=10HZ
250 GCR=&H0                          'set GAIN=1, CH=0
260 CSR=&H11                 'set to MODE 1; clear ADERR
270 '
290 OUT BADR,CSR                     'write MODE 1 to CSR
291 OUT BADR+7,TMRCTR        'write BASE FREQ to TMRCTR
300 OUT BADR+1,GCR              'load GCR which starts
310                              'continuous CONVERSIONS
320 CSR=INP(BADR)                    'read CSR
330 '
340 'Mask the CSR to determine if the
350 'DONE bit or ERR bit is set
360 '
370 MASK=&HC0                        'mask CSR bits 5-0
380 A=CSR AND MASK
390 IF (A=&HC0) OR (A=&H40) THEN 540 ' A/D ERR set?
400 IF A=&H80 THEN 420               'A/D DONE set?
410 GOTO 320                         'poll DONE bit
420 LB=INP(BADR+2)                   'read LOW BYTE,
430 HB=INP(BADR+3)                   'read HIGH BYTE
440 PRINT HEX$(HB);HEX$(LB)          ' print A/D data
450 '
460 'By using the INKEY$ command, the user can
470 'easily stop program execution.
480 '
490 X$=INKEY$
500 IF X$="" THEN 320                ' read CSR again
510 '
520 GOTO 570                         'EXIT program
```


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```
530 '
540 PRINT "******A/D ERROR*******"  'flag A/D ERROR
550 PRINT "  REDUCE BASE FREQUENCY "
560 GOTO 590
570 CLS
580 PRINT "MODE 1 OPERATION COMPLETE"
590 END
```


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6.7.3 A/D IN MODE 2

```
10 'PROGRAM: MODE2.BAS
20 '
30 '                MODE 2 OPERATION
40 '
50 'This program demonstrates how to program the
60 'DT2811 for MODE 2 operation. MODE 2 performs
70 'continuous conversions on an external trigger.
80 'Single channel operation (Ch 0) is shown at a
90 'GAIN of one. Any channel may be used or a
100 'channel scan may be performed by incrementing
110 'channels. To STOP program execution strike
120 'any key.
130 'NOTE:There is no need to stop program
140 'execution while changing input voltages.
150 '
160 CLS
170 BADR=&H218                      'set BASE address
180 OUT BADR,&H0                    'INITIALIZE BOARD
190 FOR I = 0 TO 100                'wait
200 NEXT I
210 LB=INP(BADR+2)                  'read LOW BYTE
220 HB=INP(BADR+3)                  'read HIGH BYTE;
230                                 'clear DONE
240 CSR=&H12            'set to MODE 2; clear ADERR
250 OUT BADR,CSR                    '
260 TMRCTR=&H34                     'set BASE FREQ=10HZ
270 OUT BADR+7,TMRCTR               '
280 GCR=&H0                         'set GAIN=1, CH=0
290 OUT BADR+1,GCR                  'enable Ext. Trigger
300 '
310 'The following prompt indicates that an external
320 'trigger must be applied to start conversions.
330 '
340 PRINT "WAITING FOR EXTERNAL TRIGGER"
350 '
360 CSR=INP(BADR)                   'read CSR
370 '
380 'Mask the CSR to determine if the
390 'DONE bit or ERR bit is set.
400 '
410 MASK=&HC0                       'mask CSR bits 5-0
420 A=CSR AND MASK
430 IF (A=&HC0) OR (A=&H40) THEN 520 'A/D ERR set?
440 IF A=&H80 THEN 460              'A/D DONE bit set?
450 GOTO 360                        'poll DONE bit
460 LB=INP(BADR+2)                  'read LOW BYTE
470 HB=INP(BADR+3)                  'read HIGH BYTE
480 PRINT HEX$(HB);HEX$(LB)         'print A/D data
481 '
482 'The program execution can be easily stopped
483 'with the INKEY$ command.
485 '
```


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```
490 X$=INKEY$
500 IF X$="" THEN 360            'read CSR again
505 '
510 GOTO 550                     'EXIT program
515 '
520 PRINT "********A/D ERROR*********" 'flag A/D ERR
530 PRINT "  REDUCE BASE FREQUENCY "
540 GOTO 570
550 CLS
560 PRINT "                MODE 2 OPERATION COMPLETE"
570 END
```


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6.7.4 A/D IN MODE 3

```
10 'PROGRAM:MODE3.BAS
20 '
30 '                    MODE 3 OPERATION
40 '
50 'This program demonstrates how to program the
60 'DT2811 for MODE 3 operation. MODE 3 performs
70 'continuous conversions with an external trigger
80 'and an external clock.Any channel may be used
90 'or a channel scan may be performed by
100 'incrementing channels. It is not necessary to
110 'stop program execution when changing input
120 'voltages. To STOP program execution strike any
130 'key.
140 '
150 'NOTE: Ext oscillator freq should be set to 10Hz
160 '
170 BADR=&H218                      'set BASE address
180 OUT BADR,0                      'clear CSR
190 FOR I=1 TO 100                  'wait
200 NEXT I
210 LB=INP(BADR+2)                  'read LOW BYTE
220 HB=INP(BADR+3)          'read HIGH BYTE; clear DONE
230 CSR=&H13                'set to MODE 3; clear ADERR
240 TMRCTR=&H0                      'set BASE FREQ=EXT OSC
250 GCR=&H0                         'set GAIN=1, CH=0
260 OUT BADR,CSR                    '
270 OUT BADR+7,TMRCTR               '
280 OUT BADR+1,GCR                  'enable Ext Trigger
290 '
300 'The following prompt indicates that an external
310 'trig must be applied to start A/D conversions.
320 '
330 PRINT "      WAITING FOR EXTERNAL TRIGGER"
340 '
350 CSR=INP(BADR)                   'read CSR
360 '
370 'Mask the CSR to determine if the DONE bit
380 'or ERR bit is set.
390 '
400 MASK=&HC0                       'mask CSR
410 A=CSR AND MASK
420 IF (A=&HC0) OR (A=&H40) THEN 570 'A/D ERR set?
430 IF A=&H80 THEN 450              'A/D DONE bit set?
440 GOTO 350                        'poll DONE bit
450 LB=INP(BADR+2)                  'read LOW BYTE
460 HB=INP(BADR+3)                  'read HIGH BYTE
470 PRINT HEX$(HB);HEX$(LB)         'print A/D data
480 '
490 'The program execution can be easily stopped
500 'with the INKEY$ command.
510 '
```


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```
520 X$=INKEY$
530 IF X$="" THEN 350              'read CSR again
540 '
550 GOTO 600                       'EXIT program
560 '
570 PRINT "  *****A/D ERROR******" 'flag A/D ERR
580 PRINT "  REDUCE EXTERNAL OSCILLATOR FREQUENCY "
590 GOTO 610
600 PRINT " MODE 3 OPERATION COMPLETE"
610 END
```


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6.7.5 A/D IN MODE 1 SCAN

```
10 'PROGRAM: SCAN1.BAS
20 '
30 '            CHANNEL SCAN MODE 1
40 '
50 'This program demonstrates how to use the
60 'DT2811 to SCAN a list of channels. MODE 1
70 'performs continuous conversions on a write
80 'to the GCR.
90 '
100 '
110 '
120 '
130 '
140 CLS
150 LOCATE 12,18
160 PRINT "                    SCANNING CHANNELS"
170 BADR=&H218                      'set BASE address
180 OUT BADR,0                      'clear CSR
190 FOR I=1 TO 100
200 NEXT I
210 HB=INP(BADR+3)                  'clear A/D DONE bit
220 CSR=&H11              'set to MODE 1; clear ADERR
230 OUT BADR,CSR
240 TMRCTR=&H34                     'set BASE FREQ=10HZ
250 OUT BADR+7,TMRCTR
260 FOR GCR= 0 TO 15                'set GAIN=1, CH=0
270 OUT BADR+1,GCR                'start A/D CONVERSION
280 CSR=INP(BADR)                   'read CSR
290 MASK=&HC0                       'mask CSR
300 A=CSR AND MASK
310 IF (A=&HC0) OR (A=&H40) THEN 430 'A/D ERR set?
320 IF A=&H80 THEN 340              'A/D DONE bit set?
330 GOTO 280                        'poll DONE bit
340 LB=INP(BADR+2)                  'read LOW BYTE
350 HB=INP(BADR+3)                  'read HIGH BYTE
360 '
370 '
380 PRINT "CH="GCR;  HEX$(HB);HEX$(LB)
390 'print A/D data
400 '
410 NEXT GCR                        'next channel
420 GOTO 460
430 PRINT "*****A/D ERROR******" 'flag A/D ERR
440 PRINT "  REDUCE BASE FREQUENCY "
450 GOTO 470
460 PRINT "MODE 1 CHANNEL SCAN COMPLETE"
470 END
```


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6.7.6 D/A CONVERSION

```
10 'PROGRAM: DAC.BAS
20 '
30 '          D/A CONVERTER OPERATION
40 '
50 'This program demonstrates how to program the
60 'DT2811to generate square waves using the D/A
70 'converters. The D/A low and high byte
80 'addresses are set for DAC 0. To use DAC 1,
90 'the addresses must be changed to BADR+4 and
100 'BADR+5 respectively.
110 'To EXIT, strike any key.
120 '
130 '
140 BADR=&H218                  'set BASE address
150 LB=BADR+2                   'DAC 0 LOW BYTE addr
160 HB=BADR+3                   'DAC 0 HIGH BYTE addr
170 CLS
180 PRINT "                       SQUARE WAVES"
190 OUT LB,&H0              'output all 0's to LOW BYTE
200 OUT HB,&H0              'then to HIGH BYTE
210                         'for -F.S. reading
220 'The INKEY$ command allows the user to STOP
230 'program execution when any key is pressed. If
240 'no key is pressed, the program continues to run.
250 '
260 X$=INKEY$
270 IF X$="" THEN 300
280 GOTO 360                      'EXIT program
290 '
300 OUT LB,&HFF             'output all 1's to LOW BYTE
310 OUT HB,&HF              'then to HIGH BYTE
320                         'for +F.S. reading
330 X$=INKEY$
340 IF X$="" THEN 190
350 '
360 CLS
370 PRINT "DAC OPERATION COMPLETE"
380 END
```


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CHAPTER 7

CALIBRATION

7.1 INTRODUCTION

This section contains calibration procedures for the A/D and D/A subsystems of the DT2811. The calibrations should be performed at six month intervals or whenever the input range of the A/D subsystem or the output range of the D/A subsystem is changed.

7.2 A/D CALIBRATION

The A/D calibration is performed by adjusting two trimpots: R10, the Offset Adjust, and R9, the Gain Adjust. These potentiometers are easily located on the board and on the board assembly drawing in Appendix C.

CAUTION

Switch the host power off when installing or removing the DT2811.

7.2.1 PREREQUISITES

1. Calibration is done on Channel 0 with all other channels returned to Analog Ground (pin 17).
2. Calibration is performed with the board jumpered for the operating mode in which it will be used.
3. The input cable is less than 3 meters (10 ft) long.

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

7.2.2 EQUIPMENT REQUIRED

1. Precision voltage source, Electronic Development Corporation model 501J, or equivalent.
2. Miscellaneous cables and connectors.

7.2.3 CONNECTIONS

The next sections show the connection schemes for calibration in single-ended and differential input modes.

NOTE

Recall from discussions on connection schemes in Chapter 4 that the pseudo-differential input mode is a variation of the single-ended input mode. If the board is to be used for pseudo-differential inputs, it should be calibrated for single-ended input mode.

7.2.3.1 Single-ended Input Connection

In calibration for single-ended inputs:

1. All the analog inputs are referenced to a single ground potential. Connections are made as indicated in Figure 7-1.

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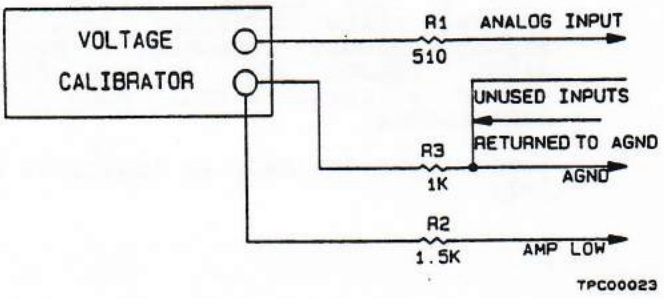


FIGURE 7-1: SINGLE-ENDED INPUT CONNECTIONS

2. R1 is used for additional input protection.

3. R2 isolates the calibrator lo signal from the analog ground.

7.2.3.2 Differential Input Connections

In calibration for differential inputs:

1. Each input has a high (Ch 0) and a low (Ch 0 Ret) connection. The measurement taken is the difference between the two inputs, thereby rejecting any noise common to both inputs.

2. With non-isolated systems, care must be taken to ensure that the inputs are referenced to Analog Ground.

3. If the signal to be measured is isolated, a return path for the bias current must be provided back to Analog Ground. This may be done by connecting a 1kΩ to 100kΩ resistor from the signal return to Analog Ground.

4. If all analog inputs are referenced to a single Analog Ground, only one resistor is required between the external Analog Common and the board Analog Common.

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5. A direct connection could be made between signal return and Analog Ground. However, this could cause large ground currents to flow if the computer ground potential is several volts different from the input signal ground potential. Even if the signal inputs are isolated from earth ground ac currents could flow due to stray capacitance.

6. Connections are made as indicated in Figure 7-2.

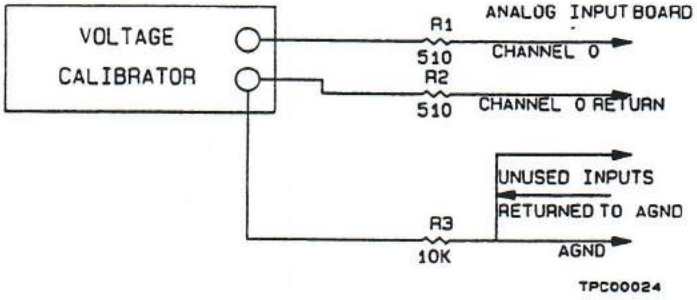


FIGURE 7-2: DIFFERENTIAL INPUT CONNECTIONS

7. R1 and R2 are used for additional input protection.

8. R3 is used to reference the inputs to Analog Ground. Without R3, input bias currents can build an input voltage exceeding the common mode voltage range.

7.2.4 CALIBRATION PROCEDURE

The A/D subsystem must be calibrated for the gain at which it will operate. Regardless of the gain, however, calibration must be first performed at a gain of 1. If the A/D module is to be programmed for a gain different than 1 in the application, then a second calibration must be performed with the A/D module programmed for the required gain. In all

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calibrations, the offset is adjusted first, followed by the gain adjustment.

Tables 7-1 and 7-2 give the input voltages for the three input ranges.

TABLE 7-1: CODING VALUES FOR UNIPOLAR INPUTS

SCALE	DIGITAL CODE (HEX)	INPUT VOLTAGE 0-5V
+FS - 1 LSB	FFF	+4.9988
+FS - 2 LSB	FFE	+4.9976
1/2 FS	800	+2.5000
1 LSB	001	+1.2207mV
0 LSB	000	0.0000V

TABLE 7-2: CODING VALUES FOR BIPOLAR INPUTS

SCALE	DIGITAL CODE (HEX)	INPUT VOLTAGE ±5V	±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	+2.4414mV	+1.2207mV
0	800	0.0000	0.0000
-1 LSB	7FF	-2.4414mV	-1.2207mV
-1/2 FS	400	-2.5000	-1.2500
-FS + 1 LSB	001	-4.9976	-2.4988
-FS	000	-5.0000	-2.5000

Table 7-3 lists the offset and scale voltage values to be used for calibration at different gains.

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TABLE 7-3: INPUT VOLTAGE VALUES FOR CALIBRATION

GAIN	-FS ±5V	-FS ±2.5V	+FS - 1LSB 0-5V	+FS - 1LSB ±5V	+FS - 1LSB ±2.5V
1	-5.0	-2.5	4.9988	4.9976	2.4988
2	-2.5	-1.25	2.49938	2.4988	1.24938
4	-1.25	-0.625	1.24969	1.24969	0.62469
8	-0.625	-0.3125	0.62484	0.62469	0.312347
10	-0.5	-0.25	0.49988	0.49976	0.249877
100	-0.05	-0.025	0.049988	0.049976	0.024988
500	-10mV	-0.005	0.009998	9.9951mV	0.004998

7.2.4.1 Gain Of 1

To calibrate the module at a gain of 1, proceed as follows:

Unipolar Offset Adjust

Apply a dc input of 0 volts and adjust the offset potentiometer R10 for an output code of 000 (hex).

Unipolar Gain Adjust

Apply a dc voltage of +FS -1LSB (see Table 7-1 or Table 7-3) and adjust the gain potentiometer R9 for an output code of FFF (hex).

Bipolar Offset Adjust

Apply a dc input voltage of -FS (see Table 7-2 or Table 7-3) and adjust the offset potentiometer R10 for an output code of 000 (hex) in offset binary (800 in two's complement).

Bipolar Gain Adjust

Apply a dc voltage of +FS - 1LSB (see Table 7-2 or Table 7-3) and adjust the gain potentiometer R9 for an output code of FFF (hex) in offset binary (7FF in two's complement).

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7.2.4.2 Gains Other Than 1

For calibration at gains other than 1, proceed as follows:

1. Calibrate the module at a gain of one as outlined in the previous section.
2. Program the module for the desired gain.
3. Apply a dc input of 0 volts and adjust the offset potentiometer R21 for 0LSB output code ±6LSB (see Table 7-1 or 7-2).
4. Go back to the previous section and perform offset and +FS -1LSB calibrations on potentiometers R9 and R10 exactly as you did for a gain of 1, but with the module operating at the programmed gain. Obtain the pertinent +FS -1LSB values for various gains from Table 7-3.

7.3 D/A SUBSYSTEM

In this calibration, a digital data code is input to the D/A subsystems and the output voltage is adjusted until the correct value is obtained. The offset and gain for the board are adjusted by trimpots attached to the summing junction and gain inputs of the DAC.

CAUTION

Switch the computer power off when installing or removing the DT2811.

7.3.1 PREREQUISITES

1. Software is available which can program the DAC with the appropriate output codes.
2. The output cable is less than 3 meters (10 feet) long.
3. The load impedance on the output of the DAC is not less than 10,000 ohms.

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7.3.2 EQUIPMENT REQUIRED

1. Precision voltage meter, accurate to at least five decimal places.
2. Small, flat-bladed screw driver for potentiometer adjustments.
3. Miscellaneous cables and connectors.

7.3.3 CONNECTIONS

The positive input of the precision voltmeter should be connected to the output of Channel 0 and the ground of the precision voltmeter should be connected to the analog ground of the DAC. Note that if the ground of the voltmeter is connected to any ground other than the proper one, ground loop currents may degrade the accuracy of the calibration.

7.3.4 CALIBRATION PROCEDURE

Data input to the DACs is encoded either in straight binary or offset binary, depending on the output range selected. Table 7-4 relates the analog outputs of the DAC to the digital input codes.

TABLE 7-4: RELATIONS OF BOARD INPUT CODES TO ANALOG OUTPUTS

INPUT CODE	DIGITAL INPUT MSB											LSB	ANALOG OUTPUT
STRT. BINARY	1	1	1	1	1	1	1	1	1	1	1	1	+Full Scale-1LSB
	1	0	0	0	0	0	0	0	0	0	0	0	Mid Scale
	0	1	1	1	1	1	1	1	1	1	1	1	Mid Scale-1LSB
	0	0	0	0	0	0	0	0	0	0	0	0	Zero
OFFSET BINARY	1	1	1	1	1	1	1	1	1	1	1	1	+Full Scale-1LSB
	1	0	0	0	0	0	0	0	0	0	0	0	Zero
	0	1	1	1	1	1	1	1	1	1	1	1	Zero -1LSB
	0	0	0	0	0	0	0	0	0	0	0	0	-Full Scale

Table 7-5 gives the actual voltage values at different ranges corresponding to the various input codes.

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TABLE 7-5: SELECTED OUTPUT VALUES AT VARIOUS OUTPUT RANGES

INPUT CODE (HEX)	OUTPUT RANGE 0-5V	±2.5V	±5V
FFF	+4.9988	+2.4988	+4.9976
800	+2.5000	+0.0000	0.0000
7FF	+2.4988	-0.0012	-0.0024
001	+0.0012	-2.4988	-4.9976
000	0.0000	-2.5000	-5.0000

Table 7-6 gives the 1/2 LSB values for the various output ranges. These values are used in the calibration of the DACs.

TABLE 7-6: 1/2 LSB VALUES AT VARIOUS OUTPUT RANGES

OUTPUT RANGE	1/2 LSB VALUE
0-5V	0.610mV
±2.5V	0.610mV
±5V	1.22mV

Connect the voltmeter to the DT2811 as shown in Figure 7-3.

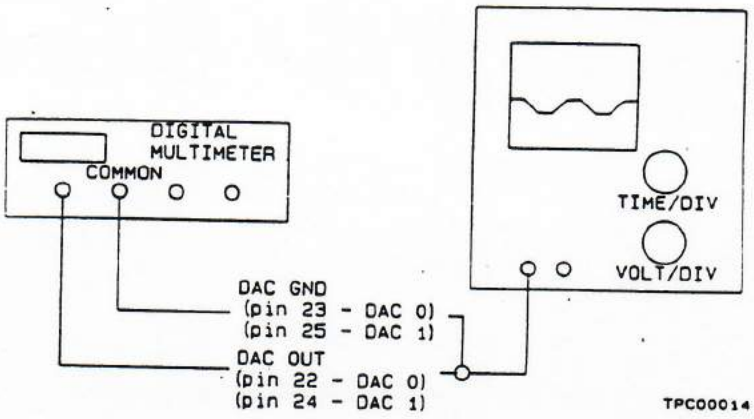


FIGURE 7-3: CONNECTION FOR DAC CALIBRATION

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Allow one hour for the entire system to warm up and stabilize before calibration then proceed as follows:

1. Set the input code to all zeros and adjust potentiometer R8 for DAC0 or R4 for DAC1 until the offset is within 1/2 LSB of the value listed in Table 7-6 for the selected range.

2. Input all ones and adjust potentiometer R6 for DAC0 or R2 for DAC1 until the + full scale is within 1/2 LSB of +FS - 1 LSB (see Table 7-6).

3. Do a second calibration to eliminate interaction between the offset and the gain adjustments.

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APPENDIX A

DT707 AND DT752 SCREW TERMINAL PANELS

A.1 INTRODUCTION

The DT707 and DT752 screw terminal panels are accessory products which provide a convenient means of connecting the user interface to the DT2811. On the DT707 all fifty connection points (A/D, D/A, digital I/O, external trigger, and external oscillator) to the DT2811 are made on screw terminals. The DT752 divides the 50-pin J1 connection into a 30-pin connection (pins 21-50) and 20-pin connection (pins 1-20). The 30-pin connection is brought out to screw terminals on the DT752. This connection is used by the D/A subsystem, digital I/O subsystem, external trigger, and external oscillator. The 3M-type 20-pin connection is directed outside the DT752 board and is used for analog inputs. This connection is intended for A/D inputs via a secondary screw terminal panel, usually a panel which provides conditioning to the input signals. Data Translation DT709-Y, DT756-Y, and the DT6700 series signal conditioning/screw terminal panels are designed for this type of application. These products provide the interface to the user analog inputs and connect to the J1 connector of the DT2811 via the 20-pin connector. Both the DT707 and the DT752 have rubber feet for horizontal table-top mounting.

The DT707-T is a DT707 panel equipped with a thermocouple cold-junction compensation circuit. It is intended to be used in temperature measurement applications with the DT2811-PGL low level input board.

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A.2 SPECIFICATIONS

Specifications are given for both DT707 and DT752. They are typical at +25°C and standard voltages, unless otherwise noted.

GENERAL SPECIFICATIONS

Outline Dimensions:
5.20"H X 8.75"W X 0.875"D
(13.21 X 22.23 X 2.22 cm)

Weight:
12.5 ounces
(355 grams)

Screw Terminal:
The screw terminal panel consists of 80 barrier strip connections in four sections of 20 connections each

Barrier Strip Screw Size:
6-32 Screws

Barrier Strip Screw Material:
Magnum

Barrier Strip Material:
Polyester, UL grade, 94V-0 polypropylene

Acceptable Wire Size:
18 to 22 AWG

THERMOCOUPLE CJC COMPENSATION CIRCUIT

Output Impedance:
Amplifier Output 100mΩ, 800Ω divider

Output Voltage Equation:
Output Voltage = .5mV/degree Celsius x T
where T=temperature of DT707-T board in degrees Celsius

Operating Temperature Range:
0 to +55 °C

Power requirements:
+/- 15 volts from DT707--5.5mA (+15V), 0.5mA (-15V)

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A.3 USING THE DT707

The function of each screw terminal on the DT707 is indicated directly on the board's silkscreen. The silkscreen for the DT707 is reproduced in the board's assembly drawing, located in Appendix C.

The DT707 accommodates:

- Differential inputs
- Single-ended inputs
- Thermocouple inputs (DT707-T)

The next three subsections describe the use of the DT707 with these three types of inputs.

A.4 SINGLE-ENDED INPUTS

Single-ended inputs have a common return path to Analog Ground. The DT707 connects Signal Ground to Analog Ground. Connecting single-ended inputs consists of hooking the channel up, and making the return path connection.

A.4.1 DIFFERENTIAL INPUTS

This type of input requires that an external return path be provided between channel X RET (the low or return side of any differential analog input channel) and Analog Ground. This is accomplished easily on the DT707 by installing 10 kilohm ¼watt resistors at resistor locations R2, R3, R6, R7, R10, R11, R14, and R15. These resistors are user-supplied.

A.4.2 THERMOCOUPLE INPUTS

The DT707-T can be used with any type of thermocouple. Because thermocouple inputs provide very low voltage signals, and are very susceptible to electrically-induced noise, they should be used only with the DT2811-PGL in differential input mode. The DT707-T has factory-installed 10KΩ resistors which provide the return path from Channel X RET to Analog Ground required whenever differential inputs are used.

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A.4.2.1 Open Input Detection

Revision A DT707-T boards have built-in open input detection circuitry (the revision number of the board is in etch on the solder side of the DT707-T board). On these boards, an open input will result in a plus full scale output code for gains of 8 or greater.

A.4.2.2 Cold Junction Compensation Circuit

When the wires from a measurement thermocouple are connected to the screw terminals on the DT707-T's barrier strip, a second, cold-junction thermocouple is formed. This cold-junction thermocouple is of the same type (R, S, or J, for example) as the measurement thermocouple, but with opposite electrical polarity. The signal created by the cold-junction thermocouple therefore tends to reduce that of the measurement thermocouple. Since the cold-junction thermocouple is referenced to the ambient temperature of the DT707-T screw terminal panel, and the ambient temperature varies over time, this can result in large measurement errors.

To compensate for these errors, the DT707-T contains a thermocouple cold-junction compensation (CJC) circuit. The CJC circuit provides a means by which users can determine the temperature of the DT707-T board. A user-written program can then compensate for the cold-junction thermocouple formed at the DT707-T.

The DT707-T CJC circuit consists of a solid state temperature sensor which is used to determine the temperature of the screw terminal panel. When the CJC circuit is calibrated (see the calibration discussion in the next subsection), the sensor's output is .5mV/degree Celsius. The CJC outputs are brought out on jumpers W1 and W2. Installing W1 and W2 enables the CJC by connecting its output to differential channel 0 of the DT2811-PGL.

To use the CJC to compensate for the cold junction thermocouple when some thermocouple type X is connected to the DT707-T terminals for Channel Y, do the following:

1. Read the temperature of the DT707-T by sampling channel 0 on the DT2811-PGL series board. The temperature (T1) of the DT707-T can be determined by the following formula:

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T1 = V/(.5mV/degree Celsius)

where V is the voltage present on channel 0 in millivolts.

2. Using the tables or formula for thermocouple type X determine the error voltage (Ve) for thermocouple type X at T1 degrees Celsius.

3. Read the thermocouple's sample voltage (Vs) on channel Y.

4. Obtain the corrected voltage (Vc) by performing the following addition:

   Vc = Vs + Ve

5. Using the tables or formula for thermocouple type X, determine the temperature T2 of the thermocouple input on channel Y by finding the temperature corresponding to Vc.

Whenever the CJC circuit is used, it occupies differential input channel 0. Channels 1 through 7 can be used for thermocouple inputs. Table A-1 indicates the function of jumpers W1 and W2.

TABLE A-1: THE DT707-T CJC CIRCUIT

CJC CIRCUIT	W1	W2
Enabled	In	In
Disabled	Out	Out

A.4.2.3 Calibration Of The CJC Circuit

Calibration of the cold-junction compensation circuit is accomplished as follows:

1. Refer to the DT707 assembly diagram in Appendix C.

2. Connect a voltmeter to the DT707-T screw terminals marked Channel 0 and Channel 0 Ret. Set the voltmeter for a 100mV full scale dc range.

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3. Adjust potentiometer R23 on the DT707-T for a reading of E mV, where:

$$E = T \times .5mV/\text{degree Celsius}$$

where T= the temperature of the DT707-T board in degrees Celsius.

A.4.3 REFERENCE JUMPERS ON DT707

On the DT707, jumpers W3 and W4 are installed at the factory, and should be left installed for all applications discussed in this manual.

When installed, W3 connects all screw terminals marked SGND (Signal Ground) on the DT707 to AGND (Analog Ground) on the DT2811 through a zero-ohm resistor. When the DT2811 is jumpered for single-ended inputs, W4 connects Amp Low (the low side of the DT2811 series board's A/D instrumentation amplifier) to AGND on the DT2811. W4 has no effect when the DT2811 is jumpered for differential inputs.

If AGND is connected directly to an external ground, ground loops may be formed resulting in electrical noise and inaccurate data conversions. Should this be a problem, replace R17 on the DT707 with a 1 kilohm resistor.

A.5 USING THE DT752

The DT752 screw terminal panel accommodates user connections for the D/A subsystem, digital I/O subsystem, external trigger, and external oscillator. It directs analog input connections to a separate 20-pin connector. Like the DT707, the function of each screw terminal on the DT752 is indicated directly on the board's silkscreen. The silkscreen for the DT752 is the same as that for the DT707, and is reproduced in Appendix C.

Connections for the D/A subsystem, Digital I/O subsystem, external clock, and external trigger are simply the DT2811 J1 pins brought out to screw terminal connectors. Even though the DT752's screw terminal panel has screws marked for analog input, there is no connection between these screw terminals and the DT2811 J1 connector. When a DT752 is used, ALL ANALOG INPUT CONNECTIONS MUST BE MADE USING THE 20-PIN 3M CONNECTOR ATTACHED TO THE DT752.

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Typically, connections can be made using a Data Translation signal conditioning board, like the DT709-Y, DT756-Y, or the DT6700 series. A/D connections are then made to the signal conditioning panel. Table A-2 gives the pin assignments for the DT752's 20-pin analog input connector.

TABLE A-2: DT752 20-PIN CONNECTOR PIN ASSIGNMENTS

PIN	SIGNAL
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	AGND
18	Amp Low
19	+15V Out
20	-15V Out

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APPENDIX B

TROUBLESHOOTING AND FACTORY SERVICE

B.1 INTRODUCTION

If you encounter a difficulty with the operation of the DT2811 or screw terminal panel, consult the following checklist before calling Data Translation.

1. Check that the DT2811 is firmly seated in the IBM PC/XT/AT expansion slot. The DT2811 series board is powered from the computer system and transfers all data and instructions over the IBM PC bus.

2. Check that all ICs are firmly seated in their sockets.

3. Check the +5V power supply. It should be between +4.75V and +5.25V.

4. Check the +12V supply. It should be between +11.52V and +12.6V.

5. Check the -12V supply. It should be between -10.92V and -13.2V.

6. Check that the screw terminal cable assembly, or whatever user-supplied cable assembly is used, is connected securely to J1.

7. Check the DT2811 series board jumpering. The jumper functions are described in Chapter 3.

8. Check to make sure no components are making contact with an adjacent board.

After going through the above checklist, try the hints given in the next section if the problem is not corrected.

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B.2 SYMPTOMS AND SOLUTIONS

The following sections list specific problems and solutions. If the problem persists after trying these solutions, call the Customer Service department and get a Return Material Authorization (RMA) number.

B.2.1 NO BOARD RESPONSE

- Check the board's base address jumpers.
- Clean the board connector fingers with a soft pencil eraser.

B.2.2 DIGITAL OUTPUT CODE ALL ONES (OR ALL ZEROS)

- Check for floating inputs (see the section on Floating Inputs).
- Make sure that the input is not greater than the range that the A/D is set to.
- Make sure that none of the other inputs is above the power supply voltage.
- In unipolar mode, check for a negative voltage input.

B.2.3 FIRST READING ON A CHANNEL IS INCORRECT

Input settling time is budgeted from one linear region to another. If the sample and hold is saturated due to overvoltage on an open channel, the first reading on a valid channel could be in error.

- Check for floating inputs (see the section on Floating Inputs).
- Check to make sure the input cable is not over 3 meters (10 feet) in length.
- Check to make sure the source impedance is not over 1 kilohm.

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B.2.4 ZERO WILL NOT CALIBRATE

The total adjustment range of the ZERO pot in the A/D converter is approximately 40 counts. If there are offsets in the system, such as bridge imbalances, they usually cannot be removed with the ZERO pot on the module.

B.2.5 FULL SCALE WILL NOT CALIBRATE

The total adjustment range of the FULL SCALE pot in the A/D converter is approximately 40 counts. If there are other gain errors in the system, they usually cannot be adjusted out with the FULL SCALE pot.

B.2.6 THE READINGS ARE NOISY

- All cables must be routed away from switching power supplies and digital signals.
- In a high noise environment, the inputs should be differential with shielded twisted pair cable. The shield should only be connected at one end.
- RC filters can be added at the inputs to remove high frequency noise pickup.
- Digital averaging of the data can be done simply by adding 16 12-bit A/D conversions and then shifting right 4 times (divide by 16). This is especially useful to minimize the rms noise in high gain applications.

B.2.7 FLOATING INPUTS

Floating inputs are those signals that do not have a reference to analog ground of the DT2811.

With single-ended inputs, it is recommended that the inputs be isolated from earth ground. All the signal commons then would be connected separately to analog common of the board (for example, SGND on the DT707).

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With differential inputs, it is necessary to reference the signal's return path to analog ground of the system. If the signal is not referenced back to analog common, leakage currents on the input drive the signal out of the common mode voltage range (±11V) thereby saturating the amplifier. This reference should not be a direct connection, but should be some impedance from 1 kilohm to 100 kilohms. Refer to the calibration procedure, and specifically the section on the differential connections for more information.

IMPORTANT

Unused differential inputs must be returned to analog common.

B.3 RMA NUMBER

If you determine that factory service is necessary, call the Customer Service department at Data Translation [(508) 481-3700] for a Return Material Authorization (RMA) number. All return shipments to Data Translation must be marked with RMA numbers.

Wrap the DT2811 series board in the original shipping materials, if available and in good condition. Be careful to wrap the board in an electrically conductive plastic, and to handle it with ground protection. A static electric discharge can destroy components on the DT2811. Ship the board to the following address:

Customer Service
Data Translation, Inc.
100 Locke Drive
Marlborough, MA, USA 01752-1192

The Data Translation Customer Service can be reached by:

Telephone: (508)481-3700
Telex: 951646 (DATATRANS MARO)
Easylink 62825999

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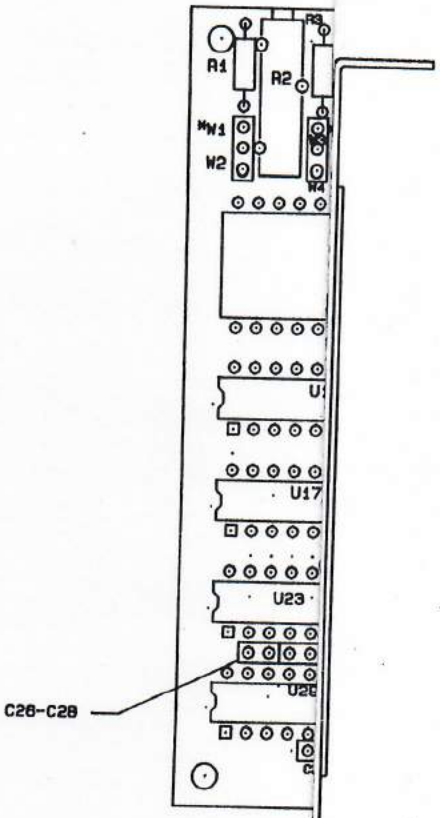
APPENDIX C
ENGINEERING DRAWINGS

This appendix contains:

- DT2811 assembly drawing
- DT2811 jumper map
- DT707 assembly drawing
- DT752 assembly drawing

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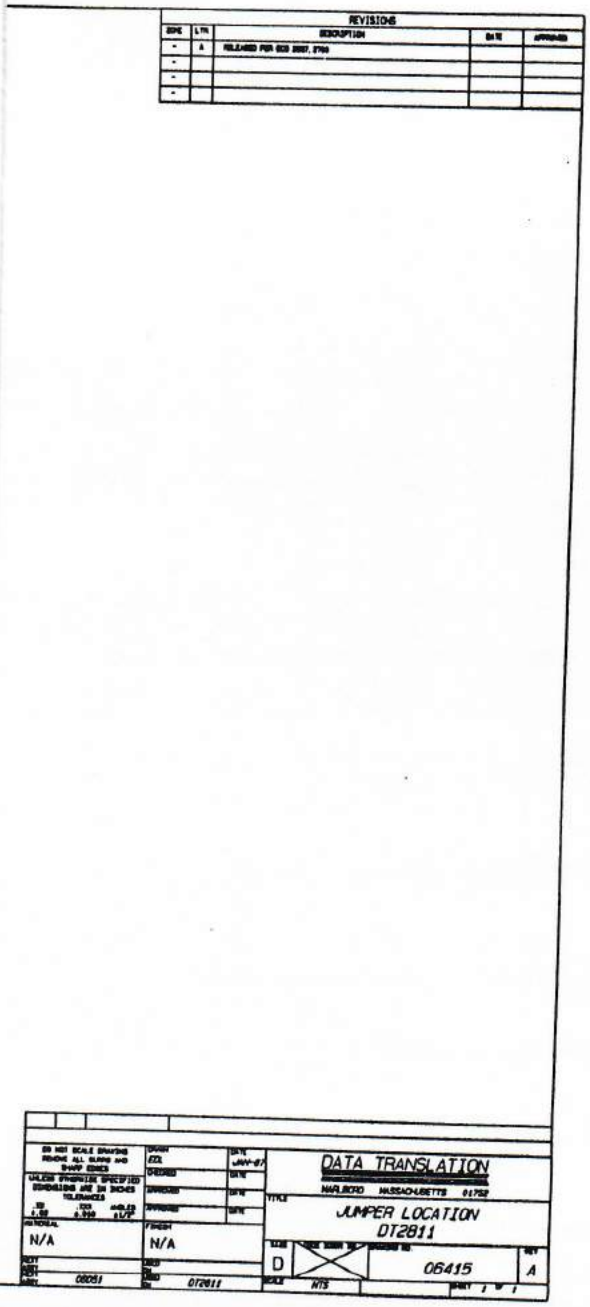
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1. UNLESS
2. * INDIC
   W1, 3, 5,
3. ICS SHO
   ERASED
4. R3, 7, 13
5. R22

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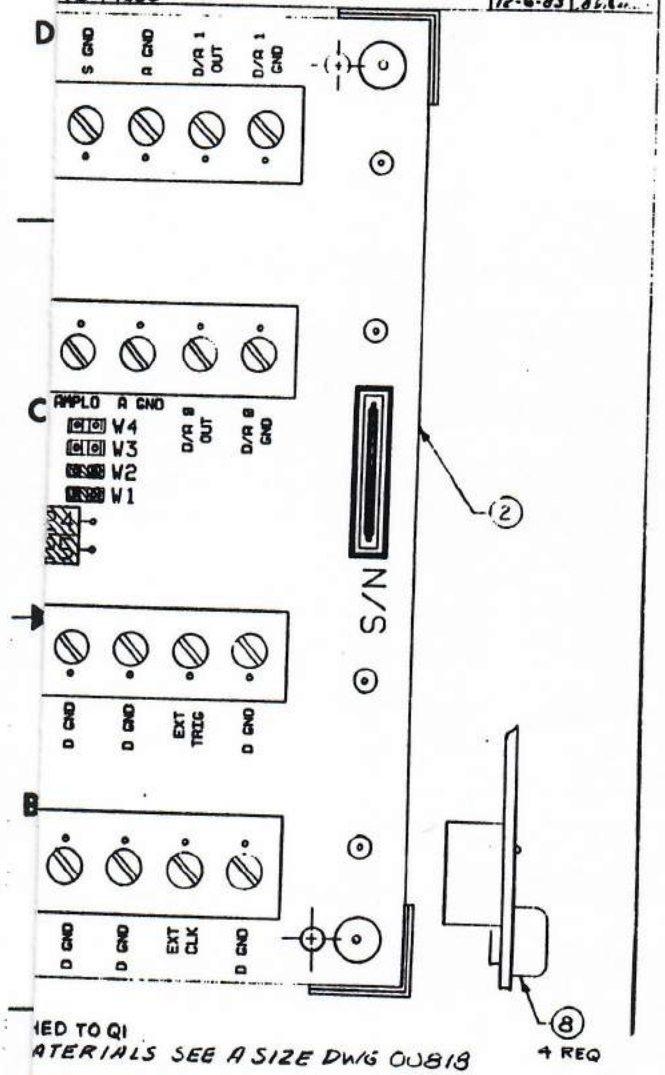
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1	REVISED	2 11 83	JAE
A	RELEASED FOR PRODUCTION	10-03-83	JT
B	1238	12-6-83	[illegible]



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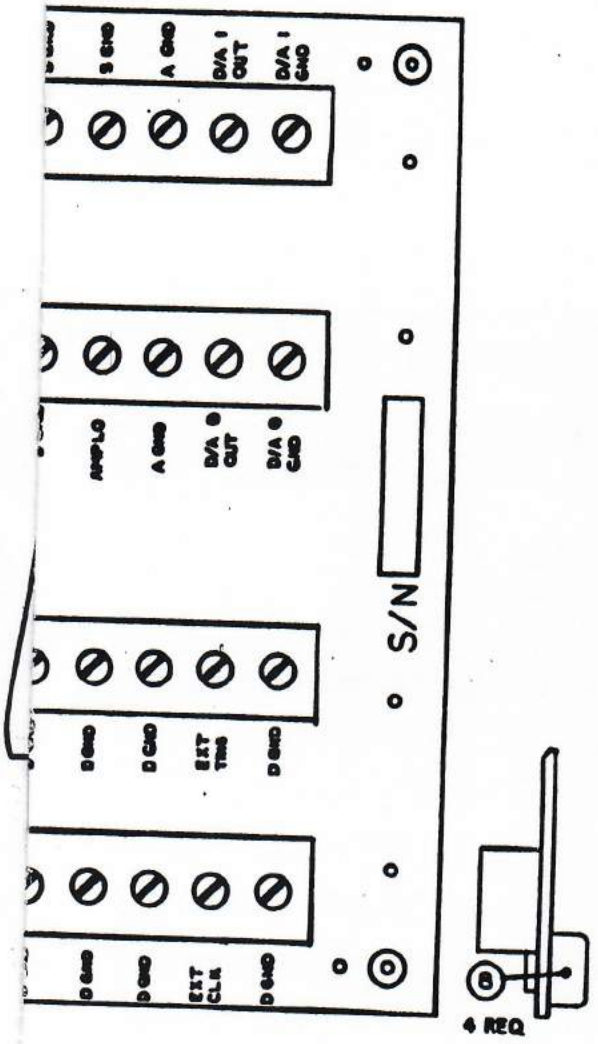
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WARRANTY AND SERVICE POLICY

WARRANTY

Data Translation, for the effective period of the warranty set out below, warrants that its standard hardware products and software media will be free from defects in materials and workmanship under normal use and service. Data Translation's obligation under this warranty shall not arise until the Buyer returns the defective product, freight prepaid, to Data Translation's facility or another specified location. The only responsibility of Data Translation under this warranty is, at its option, to replace or repair, free of charge, any defective component part of such products.

EFFECTIVE PERIOD OF WARRANTY

All boards, modules, systems, and software media are warranted for one year from date of invoice. Products repaired or replaced within this warranty period maintain their original warranty. Products repaired or replaced outside the warranty period are warranted for 30 days from invoiced date of return.

RETURN OUTSIDE USA AND CANADA

Contact the local sales representative or factory for authorization and shipping instructions.

LIMITATIONS ON WARRANTY

The warranty set forth above does not extend to and shall not apply to:

1. Products which have been repaired or altered by other than Data Translation personnel, unless Buyer has properly altered or repaired the products in accordance with procedures previously approved in writing by Data Translation.

2. Products which have been subject to misuse, neglect, accident, or improper installation.

THE WARRANTY AND REMEDIES SET FORTH ABOVE ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, ORAL OR WRITTEN, EITHER IN FACT OR BY OPERATION OF LAW, STATUTORY OR OTHERWISE, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH DATA TRANSLATION SPECIFICALLY DISCLAIMS. DATA TRANSLATION, INC. NEITHER ASSUMES NOR AUTHORIZES ANY OTHER LIABILITY IN CONNECTION WITH THE SALES, INSTALLATION, OR USE OF ITS PRODUCTS. DATA TRANSLATION, INC. SHALL HAVE NO LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND ARISING OUT OF THE SALE, INSTALLATION, OR USE OF ITS PRODUCTS.

CUSTOMER SERVICE POLICY

a. Data Translation, Inc. will repair or replace, at its option, any faulty item within ten days after receipt of said part regardless of its warranty status.

b. A Quick Turnaround Plan is available to expedite servicing. Contact the Data Translation Customer Service Department for details.

c. If a product should fail during the warranty period, it will be repaired free of charge. For out-of-warranty repairs, the customer will be invoiced for repair charges.

RETURN/REPAIR PROCEDURES

Upon determining that repair services are required, or to return a product to Data Translation, contact the Data Translation Customer Service Department at (508) 481-3700, extension 394 to obtain a Return Material Authorization (RMA) number. Have the following information ready when you call: complete product model number, product serial number, name, address, and telephone number of person returning product; and any special repair instructions.

Carefully package the product in anti-static packaging, making sure the RMA number appears on the outside of the package. Ship prepaid to:

Customer Service Department
Data Translation, Inc.
100 Locke Drive
Marlboro, MA 01752-1192 USA

On completion of required service, an invoice is issued stating charges, when applicable, and the work that has been completed. A packing slip is enclosed in the return shipment.

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