BCC30A
BCC ADC-DAC Expansion Board
Technical Manual

Release 1.0
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REV. 5/93

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BCC30A
Analog-to-Digital and Digital-to-Analog
Expansion Board

1. Specifications

- Drop-in replacement for the BCC30 but also offers enhanced features.

- One 12-bit plus sign analog-to-digital converter (ADC)
  - 16 Single-ended or 8 differential channels
  - Gain of each channel is programmable through software for x1, x2, x4, or x8
  - Bipolar (-5 to +5V) input range
  - Conversion time = 15.68μS (min)
  - Conversion start to data valid time = 34.5μS (min)
  - ADC auto-zeros itself before each conversion
  - ADC can self-calibrate at the user's request
  - Maximum continuous input range: -7 to +7 volts
  - Inputs protected from -34 to +34 volts, transient input
  - Input impedance: > 100 MΩ

- Two 2-channel, 12-bit digital-to-analog converters (DAC)
  - Board can be configured with 0, 2, or 4 channels
  - Outputs are jumper selected for 0-5V, 0-10V, or -5 to +5V
  - Output settling time = 10μS (max)
  - Minimum load impedance: min. 2 kΩ load recommended for full output

- 6-bit TTL input port

2. General Description

The BCC30A is a analog-to digital and digital-to-analog expansion board for the BCC bus. The board features a 16-channel (single-ended) or 8-channel (differential) 12-bit plus sign ADC and up to four channels of 12-bit analog output. The BCC30A also offers a 6-bit TTL level input port which can be used for configuration or control.

The ADC section can be hard jumpered for a gain of 1 across all the channels or each channel's gain may be set through software. The ADC can accept voltages in the range of -5 to +5 volts. Analog signals on brought onto the board through a pair of Molex style connectors (J3 & J4).

The DAC section of the board can be populated for 0, 2, or 4 output channels. The outputs can be set through jumpers to be 0-5V, 0-10V, or -5 to +5V. The analog outputs come off the board through a 2x4 pin header (J5).

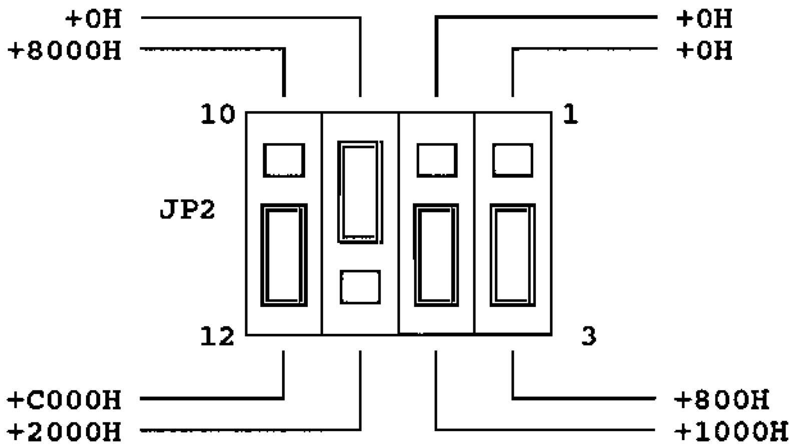
3. Power Requirements

Power is supplied to the board through the BCC bus. The board requires the following power:

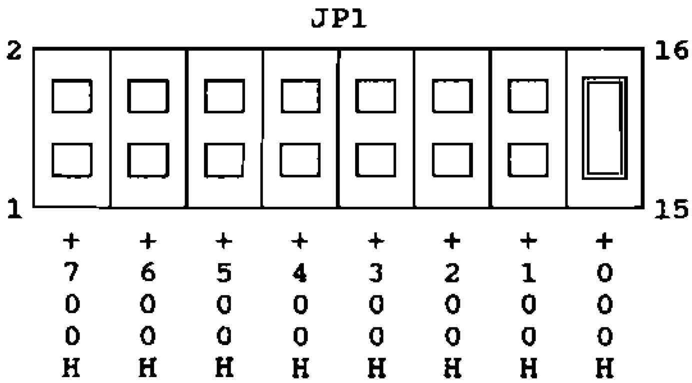
+5V @ 175mA
+12V @ 60mA
-12V @ 25mA

4. Addressing

The BCC30A is addressed through two sets of jumpers. JP2 is used to select the base address and JP1 selects the offset address.



JP2 shown selecting a base address of D800H
(C000H + 0H + 1000H + 800H)



JP1 shown selecting an offset address of 000H

The examples on the previous page show a board address of D800H. This address when combined with a function address allows you to control the various sections of the board. The function address' for the board are selected through your software and are as follows:

ADC	+00H = ADC *CS (U16 Chip select)
	+10H = TTL Input port and ADC EOC status
	+20H = ADC *CAL (U16 Calibrate select)
	+30H = not used
DAC	+40H = Ch. 0 (U19) LS input latch
	+41H = Ch. 0 (U19) MS input latch
	+42H = Ch. 1 (U19) LS input latch
	+43H = Ch. 1 (U19) MS input latch
	+50H = Ch. 0 & 1 (U19) Transfer data
	+60H = Ch. 2 (U20) LS input latch
	+61H = Ch. 2 (U20) MS input latch
	+62H = Ch. 3 (U20) LS input latch
	+63H = Ch. 3 (U20) MS input latch
	+70H = Ch. 2 & 3 (U20) Transfer data

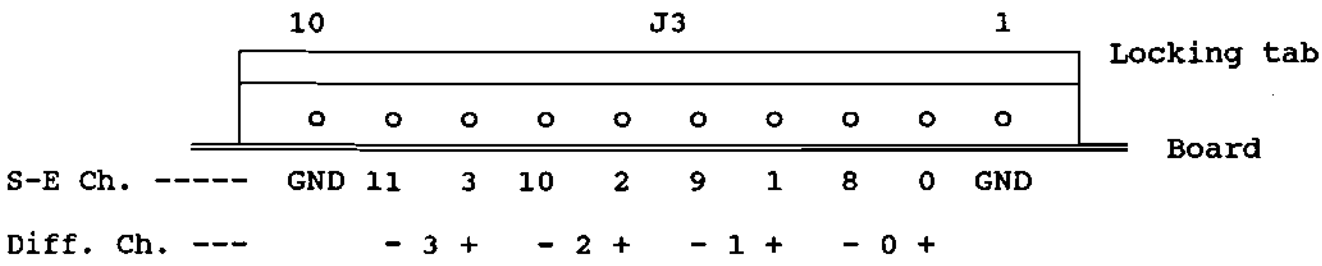
To use a particular function you write to (or read from) the combined address of Base + Offset + Function. For example, to start the ADC's self-calibration function you would write to the base address (D800H) + the offset (0H) + the function (20H) = D820H.

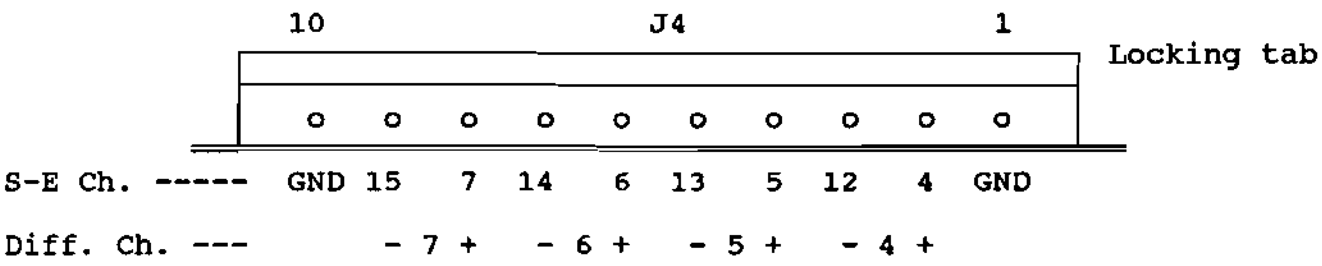
5. Using the Analog-to-Digital Converter

The ADC section of the BCC30A consists of three parts, a multiplexer (U13 & U14), a programmable gain amplifier (U15), and the actual ADC (U16). Accessing the analog-to-digital converter can be as simple as two write and three read statements.

5.1 Analog Input Connectors - J3 & J4

The analog signals are brought onto the board through connectors J3 and J4. The drawings below show how the connectors are laid out.





5.2 The A/D Conversion Process

Each time a conversion starts, the ADC automatically goes through an auto-zero cycle to minimize zero errors. The ADC can also be put into an auto-calibrate cycle by pulling its *CAL pin low. The auto-calibrate cycle will correct zero, full-scale, and linearity errors. To start the auto-calibrate cycle a dummy value is written to the address equal to Base + Offset + 20H. For example:

```
XBY(0D820H) = 0   (in BASIC-52)

OUT $D820,0   (in BASIC-180)
```

To read an analog input the channel number and gain must be sent to the address equal to Base + Offset + 00H. The control word which defines the channel number and gain is configured as follows:

ADC Control Word **Address = Base + Offset + 00H**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bit 7	Bit 6	Gain
0	0	1
0	1	2
1	0	4
1	1	8

Bit 3	Bit 2	Bit 1	Bit 0	Ch
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

From the tables above we can see that if we want to read channel 0 with a gain of 1 the control word would be 00H. If we wish to read channel 11 with a gain of 4, the control word would be 8BH.

The End of Conversion (EOC) status bit is used to detect when a conversion is completed. The EOC status bit is bit 0 of the digital input port which is addressed as Base + Offset +10H (D810H in this example). **The EOC bit will be low (logical 0) during a conversion or when the analog-to-digital converter is in its calibration cycle. The bit will be high (logical 1) when a conversion is completed.**

EOC Status & Digital Input Port **Address = Base + Offset + 10H**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
J2.2	J2.4	J2.6	J2.8	J2.10	J2.12	x	EOC

See section 7

To determine the status of the conversion, a dummy value is first written to the EOC bit. The conversion is then started and the EOC bit is read. Once the EOC bit goes high the conversion is completed.

After it has been determined that the conversion is completed, the data may be read. This is accomplished by doing two reads of the analog-to-digital converter at address Base + Offset + 00H. The first read produces the four most significant bits and the sign bit. The second read produces the eight least significant bits.

First Read - MSBs & sign **Address = Base + Offset + 00H**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sign	Sign	Sign	Sign	Bit 11	Bit 10	Bit 9	Bit 8

Second Read - LSBs **Address = Base + Offset + 00H**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Reading the ADC can be broken down into four steps.

1 - Reset the EOC status by writing a dummy value to it.

2 - Send a control word to start the conversion.

3 - Wait for EOC.

4 - Read the data from the ADC.

5.3 Sample A/D Programs

BASIC-52 ADC sample

```
10 REM BASIC-52 - BCC30A ADC sample program
20 REM ***** Address Initialization *****
30 ADCB = 0D800h
40 ADCC = 0D820h
50 ADCE = 0D810h
60 REM ***** Calibrate the ADC *****
70 XBY(ADCE)=0
80 XBY(ADCC) = 0 : REM start by pulsing *CAL low
90 IF ((XBY(ADCE).AND.1)=0) THEN 90
100 REM ***** Choose a channel, set the gain, and read the channel *****
110 INPUT "Select a channel (0-15)",CHNL
120 INPUT "Select a gain (1,2,4,8)",GN
130 IF GN=1 THEN GN=0H
140 IF GN=2 THEN GN=40H
150 IF GN=4 THEN GN=80H
160 IF GN=8 THEN GN=0C0H
170 XBY(ADCE)=0
180 XBY(ADCB) = (GN + CHNL) : REM start the conversion
190 IF ((XBY(ADCE).AND.1)=0) THEN 190
200 ADCH = XBY(ADCB)
201 ADCH=ADCH.AND.1Fh
210 ADCL = XBY(ADCB)
220 IF (ADCH<16) THEN ADC=((256*(ADCH.AND.15)+ADCL)/4096)*5
230 IF (ADCH>15) THEN ADC=-(((0FFFH.XOR.(256*ADCH+ADCL))+1)/4096)*5
240 PRINT "Channel ",CHNL, " reads ",ADC, " volts"
250 GOTO 110
```

BASIC-180 ADC sample

```
10 'BASIC-180 - BCC30A ADC sample program
20 INTEGER ADCB, ADCE, ADCC, ADCH, ADCL, GN, CHNL, EOC
30 REAL ADC
40 PRINT
50 ' ***** Address Initialization *****
60 ADCB = $D800
70 ADCE = $D810
80 ADCC = $D820
90 ' ***** Calibrate the ADC *****
95 OUT ADCE,0
100 OUT ADCC,0      'start the auto-calibrate cycle
110 IF BAND(INP(ADCE),1)=0 THEN 110
120 ' ***** Choose a channel, set the gain, and read it *****
130 PRINT "Select a channel (0-15)"
140 INPUT CHNL
150 PRINT "Select a gain (1,2,4,8)"
160 INPUT GN
170 IF GN=1 THEN GN=$0
180 IF GN=2 THEN GN=$40
190 IF GN=4 THEN GN=$80
```

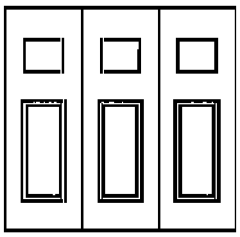
```
200 IF GN=8 THEN GN=$C0
205 OUT ADCE,0
210 OUT ADCB,(GN+CHNL)      'start the conversion
220 IF BAND((INP(ADCE)),1)=0 THEN 220     'wait for EOC to go low
230 ADCH=INP(ADCB)      'read MSBs and sign
240 ADCL=INP(ADCB)      'read LSBs
250 'determine if value is pos. or neg. and convert
260 IF ADCH<16 THEN ADC=((256*(BAND(ADCH,15))+ADCL)/4096)*5
270 IF ADCH>15 THEN ADC=-(((BXOR($FFFF,(256*ADCH+ADCL))+1)/4096)*5)
280 PRINT "Channel ";CHNL;" reads ";ADC;" volts"
290 GOTO 130
```

5.4 Differential versus Single-ended Inputs

The previous discussion and sample code have dealt with using the BCC30A in single-ended mode. Using the board in differential mode is very similar. In single-ended mode the signal being measured is referenced to the ground of the BCC30A. In differential mode the signal is not referenced to ground.

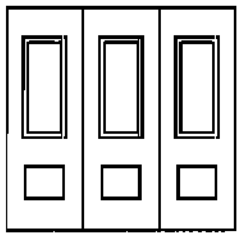
Differential Mode

JP3



Single-Ended Mode

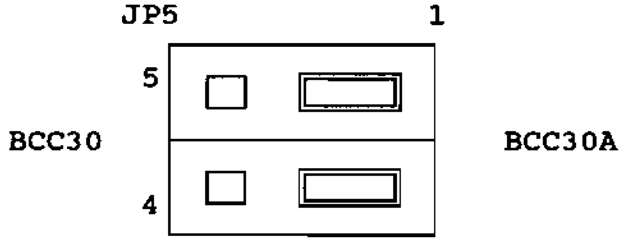
JP3



JP3 is used to select single-ended or differential mode as shown above. No changes in software are needed except to note that in differential mode there are only eight channels instead of sixteen. The eight differential channels are read as channels 0-7.

5.5 Emulating the BCC30

The BCC30A can also be used as a drop-in replacement for the original BCC30 board. To do this JP5 is set so that the gain applied to the inputs will always be x1.

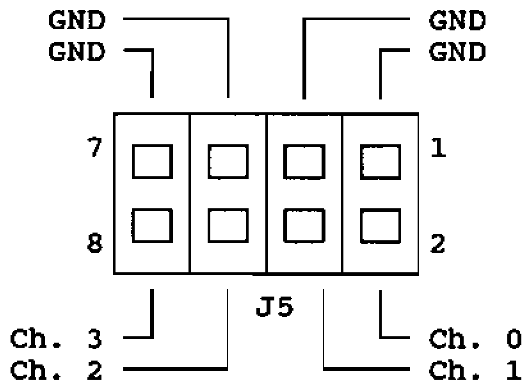


JP5 shown selecting BCC30A mode

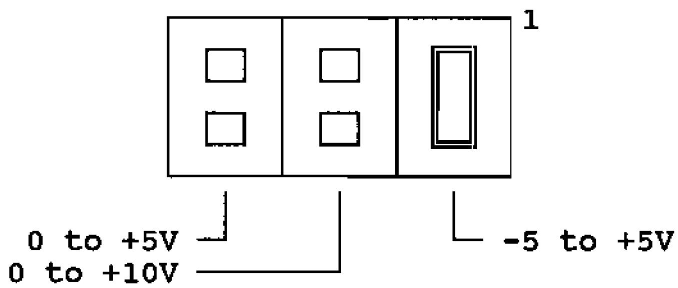
6. Using the Digital-to-Analog Converters

Depending on which version of the BCC30A you have, the board may contain 0, 2, or 4 channels of digital-to-analog conversion. The two DACs, U19 and U20, each provide two output channels. The DAC outputs are connected to J5.

6.1 Analog Output Connector J5



The output of each channel can be set to one of three ranges: 0 to +5V, 0 to +10V, or -5 to +5V. Selection is accomplished through jumpers JP6 (Ch. 0), JP7 (Ch. 1), JP8 (Ch. 2), and JP9 (Ch. 3).



The 0 to +10V output mode is a special case. The maximum output of a channel configured in this mode is approximately 80% of the +12V supply. For example, if your +12V supply is actually putting out 11.8 volts then the maximum output of the DAC will be approximately 9.44 volts. This anomaly does not change the relationship between the data input to the DAC and the output. Sending 0 to the channel will still result in a 0V output and sending 2048 (800h) will still result in a +5V output. The only difference that will be noted is the maximum voltage which can be output.

6.2 The D/A Conversion Process

Control of the DAC is accomplished by writing the value to the input latches and then transferring the data to the output. Each channel has two inputs latches associated with it, the 4-bit most significant and the 8-bit least significant. Either of these latches may be written to first. For example, if channel 1 is configured for the -5 to +5V output range and we wish to have a 4V output then the following must be done.

10V (output range) ÷ 4096 = 0.00244V (resolution)

Since the range is -5 to +5V then 0 = 2048 = 800h. So if the value to be output is greater than or equal to zero then we must add 2048 (or 800h) to it.

4V ÷ 0.00244V = 1639 = 667h

1639 + 2048 = 3687 = value sent to DAC
or
667h + 800h = E67h = value sent to DAC

MS 4 bits	LS 8 bits
E	67

With this information we are now ready to write the data to the DAC. Using our example board address of D800h:

Write 0Eh to D842h	Load MS 4 bits
Write 67h to D843h	Load LS 8 bits
Write a dummy value to D850h	Transfer the data to the output

It is important to note that when a transfer is begun, the data for both channels is transferred from the input latches to the outputs at the same time. Because of this you can load the input latches for both channels and then do a transfer. This will update both outputs simultaneously.

6.3 Sample D/A Programs

BASIC-52 DAC Sample

```
10 REM BASIC-52 DAC sample
20 PRINT
30 REM ***** addresses *****
40 BASE = 0D800h
50 T01 = 50h
60 T23 = 70h
70 REM ***** select a channel *****
80 PRINT
90 INPUT "Select a channel (0,1,2,3) ",CH
100 IF CH=0 THEN CH=40H
110 IF CH=1 THEN CH=42H
120 IF CH=2 THEN CH=60H
130 IF CH=3 THEN CH=62H
140 PRINT
150 REM ***** select an output range *****
160 PRINT "What output range is selected by JP6/7/8/9?"
170 PRINT " 1  -  -5 to +5V"
180 PRINT " 2  -  0 to +5V"
190 PRINT " 3  -  0 to +10V"
200 INPUT "Enter your choice (1,2,3) ",RG
210 PRINT
220 REM ***** select a voltage to output *****
230 INPUT "Enter the voltage you wish to output ",V
240 PRINT
250 REM ***** convert and output *****
260 PRINT "Converting the data and setting the output ..."
270 IF RG=2 THEN  GOTO 400
280 IF RG=3 THEN  GOTO 470
290 IF (V<0) THEN  GOTO 320
300 V = (INT(V/0.0024415)) + 2048
310 GOTO 340
320 V = (5 + V)
330 V = (V/0.00244)
340 MSB = (V.AND.0F00h)/0FFh
350 LSB = V.AND.0FFh
360 XBY(BASE+CH) = LSB
370 XBY(BASE+CH+1) = MSB
380 GOSUB 540
390 GOTO 80
400 V = (INT(V/0.0012207)
410 MSB = (V.AND.0F00h)/0FFh
420 LSB = V.AND.0FFh
430 XBY(BASE+CH) = LSB
440 XBY(BASE+CH+1) = MSB
450 GOSUB 540
460 GOTO 80
470 V = INT(V/0.002442)
480 MSB = (V.AND.0F00h)/0FFh
490 LSB = V.AND.0FFh
```

```
500 XBY(BASE+CH) = LSB
510 XBY(BASE+CH+1) = MSB
520 GOSUB 540
530 GOTO 80
540 IF (CH<60H) THEN XBY(BASE+T01)=0
550 IF (CH>42H) THEN XBY(BASE+T23)=0
560 RETURN
```

BASIC-180 DAC Sample

```
10 'BASIC-180 - BCC30A DAC sample program
20 INTEGER BASE, T01, T23, CH, RG, MSB, LSB, VT
30 REAL V
40 PRINT
50 ' ***** Address Initialization *****
60 BASE = $D800
70 T01 = $50
80 T23 = $70
90 ' ***** Select a Channel *****
95 PRINT
100 PRINT "Select a channel (0,1,2,3) "
110 INPUT CH
120 IF CH=0 THEN CH=$40
130 IF CH=1 THEN CH=$42
140 IF CH=2 THEN CH=$60
150 IF CH=3 THEN CH=$62
160 PRINT
170 ' ***** Select an Output Range *****
180 PRINT "What output range is selected by JP6/7/8/9 ?"
190 PRINT " 1  -  -5 to +5V"
200 PRINT " 2  -  0 to +5V"
210 PRINT " 3  -  0 to +10V"
220 PRINT "Enter your choice (1,2,3) "
230 INPUT RG
240 PRINT
250 PRINT "Enter the voltage you wish to output "
260 INPUT v
270 PRINT
280 ' ***** Convert Data *****
290 PRINT "Converting the data and setting the output ..."
300 IF RG=2 THEN GOTO 420     'range = 0 to +5
310 IF RG=3 THEN GOTO 490     'range = 0 to +10
315 ' ***** Output range = -5 to +5 *****
320 IF (V<0) THEN GOTO 350
330 VT = (V/0.0024415) + 2048
340 GOTO 370
350 V = 5 + V
360 VT = V/0.0024415
370 MSB = BAND(VT,$F00)/$FF
380 LSB = BAND(VT,$FF)
390 OUT (BASE+CH),LSB
400 OUT (BASE+CH+1),MSB
410 GOTO 540
```

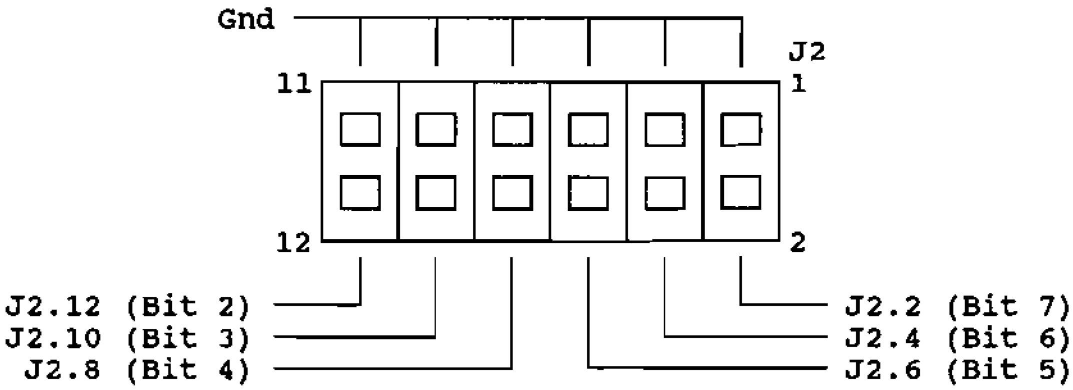
```
415 ' ***** Output range = 0 to +5 *****
420 VT = V/0.0012207
430 MSB = BAND(VT,$F00)/$FF
440 LSB = BAND(VT,$FF)
450 OUT (BASE+CH),LSB
460 OUT (BASE+CH+1),MSB
470 GOTO 540
480 ' ***** Output range = 0 to +10 *****
490 VT = V/0.0024415
500 MSB = BAND(VT,$F00)/$FF
510 LSB = BAND(VT,$FF)
520 OUT (BASE+CH),LSB
530 OUT (BASE+CH+1),MSB
535 ' ***** Transfer data *****
540 IF (CH<$60) THEN OUT (BASE+T01),0
550 IF (CH>$42) THEN OUT (BASE+T23),0
560 GOTO 95
```

7. Digital Input Port

The BCC30A's digital input port is connected to the 2x6 header J2. The input port resides at the same address as the end-of-conversion bit (Base + Offset + 10h) and occupies the six most significant bits.

Digital Input Port & EOC status Address = Base + Offset + 10H

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
J2.2	J2.4	J2.6	J2.8	J2.10	J2.12	x	EOC



Because each input bit is pulled up to +5 volts, they may be triggered by a contact closure to ground or a low-going TTL signal. It is important to remember that this port was not designed to interface with high-voltage signals. Signals applied to this port must have a maximum range of 0 to 5 volts.

8. Adjustment and Calibration

All BCC30A adjustments are calibrated at the factory. If you feel a unit is in need of adjustment, we recommend the unit be sent back for calibration. A calibration charge of $20.00 must accompany all returned units. This charge is only for calibration and does not cover the replacement or repair of any components that have been damaged through misuse.

The accuracy of the BCC30A depends on the accuracy of the equipment used in calibration. Do not attempt calibration without the proper equipment. A 4 1/2 digit multimeter is required for proper calibration of the BCC30A.

8.1 Reference Voltage Calibration

To calibrate the reference voltage, set the multimeter to a range which will measure a +5 volt signal. Connect the positive lead of the meter to test point TP1 on the board. Connect the common (ground, negative) lead to test point TP2. Once the test leads are connected adjust potentiometer P1 for a reading of +5.000 volts.

8.2 Offset Calibration

The BCC30A has two adjustments for offset. Potentiomer P3 adjusts the input offset and potentiometer P2 adjusts the output offset of the ADC section. To calibrate the offset a program must be run to continuously read one of the input channels at the maximum gain and then at the minimum gain.

To begin the alignment, make sure the board is in the single-ended mode and short Input 0 to ground. Make sure that the shorting wire is as short as possible. Set the multimeter to it's lowest voltage range. Connect the common (ground, negative) lead of the meter to pin 1 of J3 (ground). Connect the positive lead to pin 1 of U16 (ADC1251).

Once the test program is running, it should be reading Input 0 at the highest gain (8). Adjust the input offset (P3) for a reading as close to 0.000V as possible. Next instruct the program to begin reading Input 0 at the lowest gain (1). Now adjust the output offset (P2) until a reading as close to 0.000V is again reached. These two steps should be repeated until the reading does not change, or changes very little, when the gain is switched between the maximum and minimum.

9. Demo Programs

9.1 BASIC-52 Demo Program

```
10 B=0D800H : REM BASE ADDRESS OF BCC30A IS 0D800H
20 C=0 : A=1 : D=0
30 G=GET
40 PRINT : PRINT "BCC30A FUNCTION TEST"
50 PRINT
60 PRINT "SELECT A FUNCTION BY HITTING A # KEY"
70 PRINT
80 PH0. "1 - Set a different BASE ADDRESS, presently ",B
90 PRINT "2 - Call the A/D CALIBRATE function"
100 PRINT "3 - Change the channel number, presently ",C
110 PRINT "4 - Change the gain factor, presently ",A
120 PRINT "5 - Read the A/D channel"
130 PRINT "6 - Change the D/A channel, presently ",D
140 PRINT "7 - Write a ramp waveform to D/A channel"
150 PRINT "8 - To continuously write the D/A and read the A/D"
160 PRINT "9 - To adjust the trim pots"
170 PRINT : PRINT "0 - End"
180 G=GET
190 IF (G=30H) THEN  END
200 IF (G=31H) THEN  GOTO 1000
210 IF (G=32H) THEN  GOTO 2000
220 IF (G=33H) THEN  GOTO 3000
230 IF (G=34H) THEN  GOTO 4000
240 IF (G=35H) THEN  GOTO 5000
250 IF (G=36H) THEN  GOTO 6000
260 IF (G=37H) THEN  GOTO 7000
270 IF (G=38H) THEN  GOTO 8000
280 IF (G=39H) THEN  GOTO 9000
290 GOTO 180
1000 INPUT "Please enter your new address",B
1010 GOTO 40
2000 XBY(B+10H)=0
2010 XBY(B+20H)=0
2020 IF (XBY(B+10H).AND.0) THEN  GOTO 2020
2030 GOTO 40
3000 INPUT "Please enter your new channel (0-7)",C
3010 IF (C<0.OR.C>7 THEN  GOTO 3000
3020 GOTO 40
4000 INPUT "Please enter your new gain (1,2,4,8)",A
4010 IF (A<>1.AND.A<>2.AND.A<>4.AND.A<>8) THEN  GOTO 4000
4020 GOTO 40
5000 XBY(B+10H)=0
5010 IF (A=1) THEN T=C
5020 IF (A=2) THEN T=C+64
5030 IF (A=4) THEN T=C+128
5040 IF (A=8) THEN T=C+192
5050 XBY(B)=T
5060 IF (XBY(B+10H).AND.0)=1 THEN  GOTO 5060
5070 M=XBY(B) : L=XBY(B)
5080 IF (M<16) THEN V=((256*(M.AND.15)+L)/4096)*5
```

```
5090 IF (M>15) THEN V=-(((0FFFH.XOR.(256*M+L))+1)/4096)*5
5100 PRINT V," volts"
5110 PRINT USING(0),
5120 GOTO 40
6000 INPUT "Please enter your new channel (0-3)",D
6010 IF (D<>0.AND.D<>1.AND.D<>2.AND.D<>3) THEN  GOTO 6000
6020 GOTO 40
7000 PRINT "Hit any key to stop"
7010 IF (D=0) THEN O=50H : P=40H
7020 IF (D=1) THEN O=50H : P=42H
7030 IF (D=2) THEN O=70H : P=60H
7040 IF (D=3) THEN O=70H : P=62H
7050 FOR X=0 TO 15
7060 FOR Y=0 TO 255 STEP 32
7070 XBY(B+P)=Y : XBY(B+P+1)=X : XBY(B+O)=0
7080 G=GET
7090 IF (G<>0) THEN 40
7100 NEXT Y
7110 NEXT X
7120 GOTO 7050
8000 PRINT "Jumper JP6/7/8/9 is set for:"
8010 PRINT "1 = -5 to +5"
8020 PRINT "2 = 0 to +5"
8030 PRINT "3 = 0 to +10"
8040 INPUT J
8050 IF (J<>1.AND.J<>2) THEN  PRINT "Don't use this selection" :  GOTO 8000
8060 PRINT "(Hit any key to stop)"
8070 IF (D=0) THEN O=50H : P=40H
8080 IF (D=1) THEN O=50H : P=42H
8090 IF (D=2) THEN O=70H : P=60H
8100 IF (D=3) THEN O=70H : P=62H
8110 FOR X=0 TO 15
8120 FOR Y=0 TO 255 STEP 32
8130 PRINT "Writing ",
8140 W=(((X*256)+Y)/4096)*5
8150 IF (J=1) THEN W=(W*2)-5
8160 PRINT USING(#.###),W," volts ",
8170 XBY(B+P)=Y : XBY(B+P+1)=X : XBY(B+O)=0
8180 PRINT "Reading ",
8190 XBY(B+10H)=0
8200 IF (A=1) THEN T=C
8210 IF (A=2) THEN T=C+64
8220 IF (A=4) THEN T=C+128
8230 IF (A=8) THEN T=C+192
8240 XBY(B)=T
8250 IF (XBY(B+10H).AND.1)=0 THEN  GOTO 8250
8260 M=XBY(B) : L=XBY(B)
8270 IF (M<16) THEN V=((256*(M.AND.15)+L)/4096)*5
8280 IF (M>15) THEN V=-(((0FFFFH.XOR.(256*M*L))+1)/4096)*5
8290 PRINT V, "volts"
8300 PRINT USING(0),
8310 FOR Q=1 TO 1000 : NEXT Q
8320 G=GET
8330 IF (G<>0) THEN 40
```

```
8340 NEXT Y
8350 NEXT X
8360 GOTO 8110
9000 PRINT "Using a voltmeter connected to TP1 and TP2,"
9010 PRINT "adjust P1 for 5.000 volts"
9020 GOSUB 10000
9030 XBY(B)=192
9040 PRINT : PRINT "In single ended mode short out CHANNEL 0 to ground"
9050 PRINT "That's J3.1 to J3.2"
9060 PRINT : PRINT "Using a voltmeter (black) connected to J3.1 (gnd)"
9070 PRINT "and (red) to U16.1, adjust P3 for 0.000 volts"
9080 GOSUB 10000
9090 XBY(B)=0
9100 PRINT "Now adjust P2 for 0.000 volts"
9110 GOSUB 10000
9120 PRINT : PRINT "Press  1  to repeat the P3 - P2 procedure"
9130 PRINT "Press  0  to return to the main menu"
9140 INPUT G
9150 IF (G=31) THEN  GOTO 9030
9160 GOTO 40
10000 PRINT : PRINT "(hit a key to continue)"
10010 IF (GET=0) THEN 10010
10020 RETURN
```

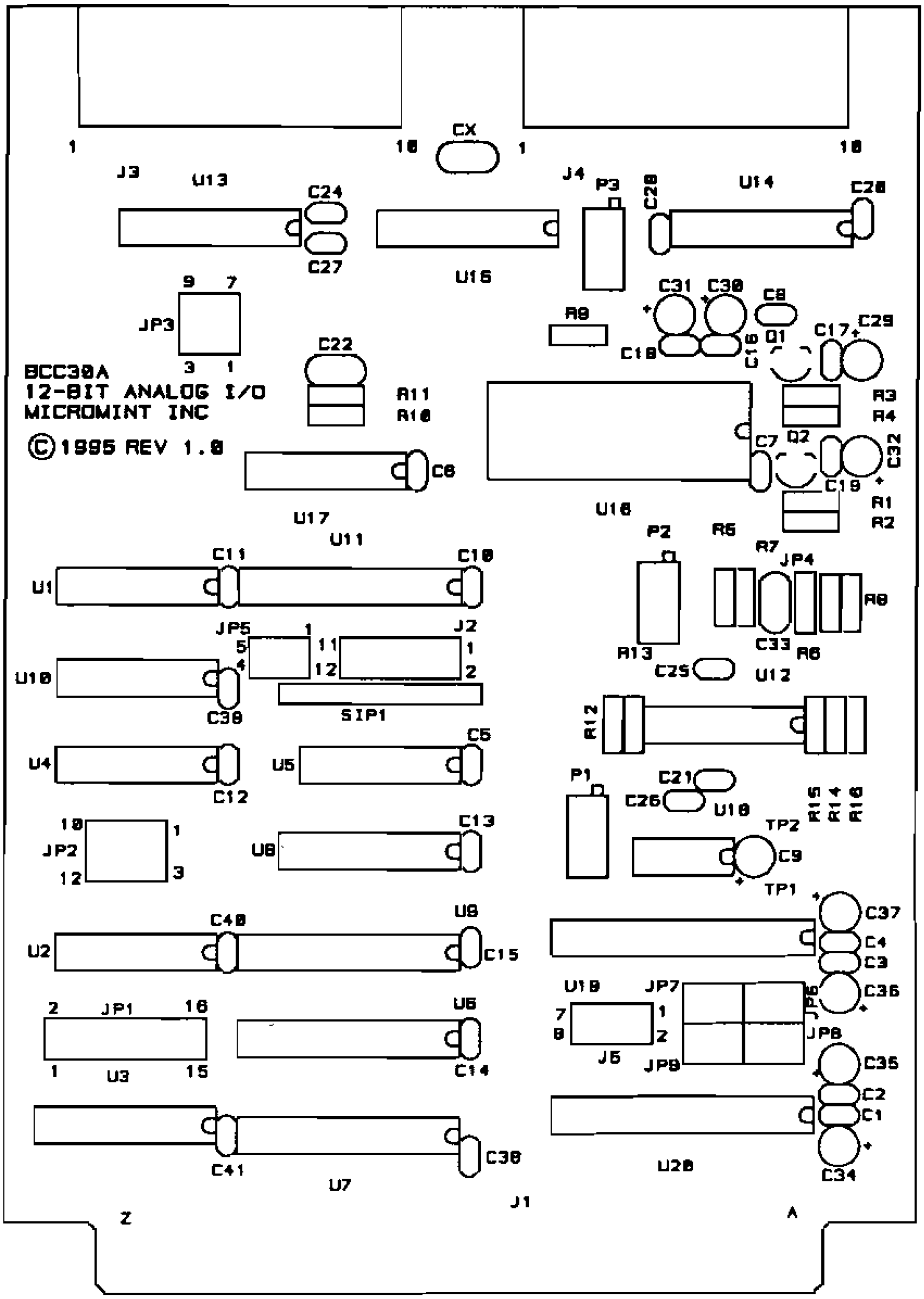
9.2 BASIC-180 Demo Program

```
10 INTEGER B,C,A,D,G,T,M,L,X,Y,P,J,O,Q
20 REAL V,W
30 B=$D800 : 'Base address of BCC30A is D800h
40 C=0 : A=1 : D=0
50 PRINT : PRINT "BCC30A FUNCTION TEST" : PRINT
60 PRINT "SELECT A FUNCTION BY HITTING A # KEY"
70 PRINT
80 PRINT "1 - Set a different BASE ADDRESS, presently ";
85 FPRINT "H4",B
90 PRINT "2 - Call the A/D CALIBRATE function"
100 PRINT "3 - Change the channel number, presently ";C
110 PRINT "4 - Change the gain factor, presently ";A
120 PRINT "5 - Read the A/D channel"
130 PRINT "6 - Change the D/A channel, presently ";D
140 PRINT "7 - Write a ramp waveform to D/A channel"
150 PRINT "8 - To continuously write the D/A and read the A/D"
160 PRINT "9 - To adjust the trim pots"
170 PRINT : PRINT "0 - End"
180 G=KEY
190 IF (G=$30) THEN STOP
200 IF (G=$31) THEN 1000
210 IF (G=$32) THEN 2000
220 IF (G=$33) THEN 3000
230 IF (G=$34) THEN 4000
240 IF (G=$35) THEN 5000
250 IF (G=$36) THEN 6000
260 IF (G=$37) THEN 7000
270 IF (G=$38) THEN 8000
280 IF (G=$39) THEN 9000
290 GOTO 180
1000 PRINT "Please enter your new address", : INPUT B
1010 GOTO 50
2000 OUT (B+$10),0
2010 OUT (B+$20),0
2020 IF BAND(INP(B+$10),0) THEN 2020
2030 GOTO 50
3000 PRINT "Please enter your new channel (0-7) ", : INPUT C
3010 IF (C<0 OR C>7) THEN GOTO 3000
3020 GOTO 50
4000 PRINT "Please enter your new gain (1,2,4,8) ", : INPUT A
4010 IF (A<>1 AND A<>2 AND A<>4 AND A<>8) THEN 4000
4020 GOTO 50
5000 OUT (B+$10),0
5010 IF (A=1) THEN T=C
5020 IF (A=2) THEN T=C+64
5030 IF (A=4) THEN T=C+128
5040 IF (A=8) THEN T=C+192
5050 OUT B,T
5060 IF BAND(INP(B+$10),0) THEN 5060
5070 M = INP(B) : L = INP(B)
5080 IF (M<16) THEN V = ((256*BAND(M,15)+L)/4096)*5
5090 IF (M>15) THEN V = -(((BXOR($FFF,(256*M+L)))+1)/4096)*5
```

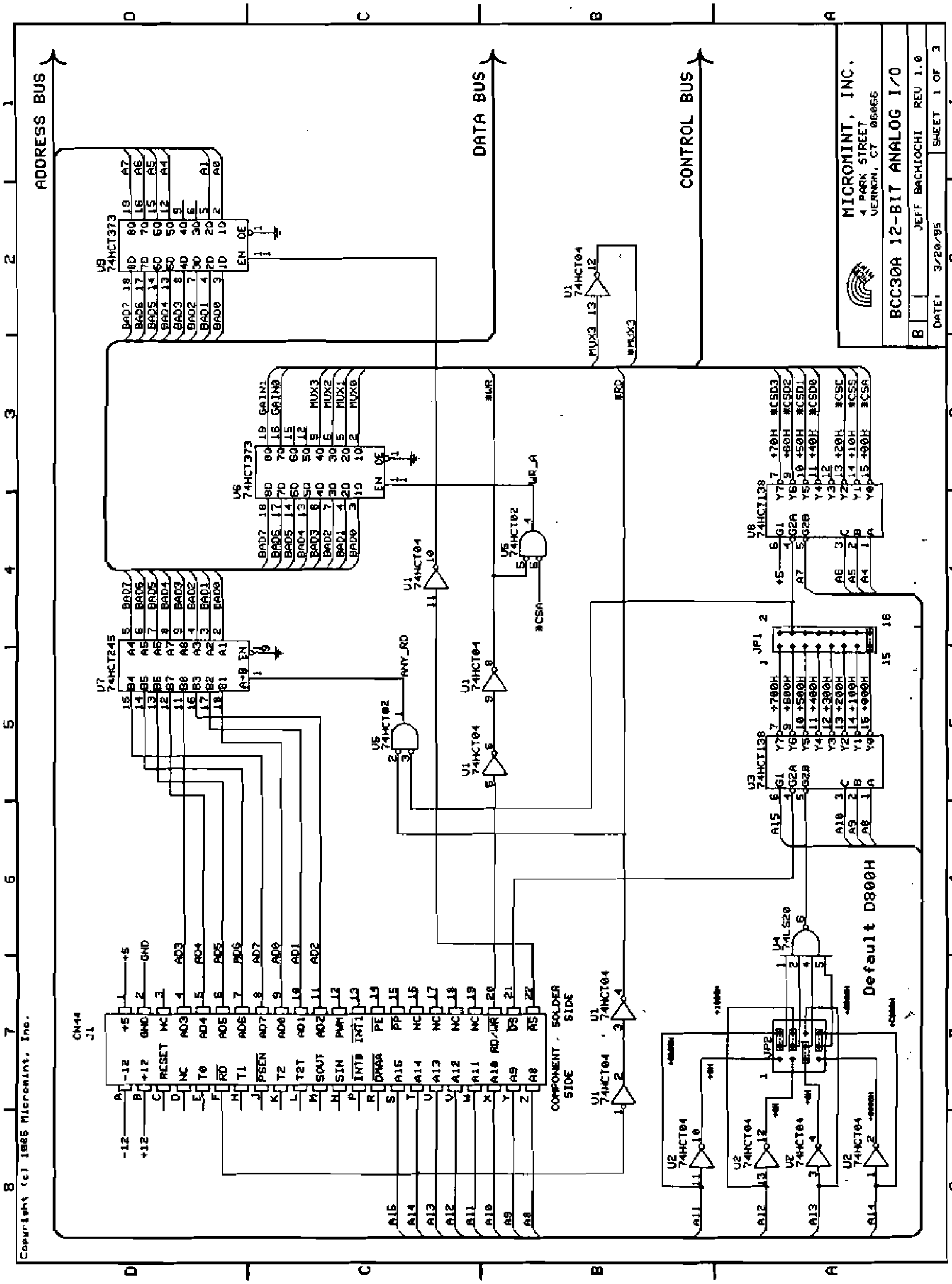
```
5100 FPRINT "F2.3",V," volts"
5110 PRINT
5120 GOTO 50
6000 PRINT "Please enter your new channel (0-3) " : INPUT D
6010 IF ((D<>0) AND (D<>1) AND (D<>2) AND (D<>3)) THEN 6000
6020 GOTO 50
7000 PRINT "Hit any key to stop"
7010 IF (D=0) THEN O=$50 : P=$40
7020 IF (D=1) THEN O=$50 : P=$42
7030 IF (D=2) THEN O=$70 : P=$60
7040 IF (D=3) THEN O=$70 : P=$62
7050 FOR X=0 TO 15
7060 FOR Y=0 TO 255 STEP 32
7070 OUT (B+P),Y : OUT (B+P+1),X : OUT (B+O),0
7080 G=KEY
7090 IF (G<>0) THEN 40
7100 NEXT Y
7110 NEXT X
7120 GOTO 7050
8000 PRINT "Jumper JP6/7/8/9 is set for:"
8010 PRINT "1 = -5 to +5"
8020 PRINT "2 = 0 to +5"
8040 INPUT J
8050 IF ((J<>1) AND (J<>2)) THEN PRINT "Choose again" : GOTO 8000
8060 PRINT "(Hit any key to stop)"
8070 IF (D=0) THEN O=$50 : P=$40
8080 IF (D=1) THEN O=$50 : P=$42
8090 IF (D=2) THEN O=$70 : P=$60
8100 IF (D=3) THEN O=$70 : P=$62
8110 FOR X=0 TO 15
8120 FOR Y=0 TO 255 STEP 32
8130 PRINT "Writing ",
8140 W=(((X*256)+Y)/4096)*5
8150 IF (J=1) THEN W=(W*2)-5
8160 FPRINT "F2.3",w," volts",
8170 OUT (B+P),Y : OUT (B+P+1),X : OUT (B+O),0
8180 PRINT "Reading ",
8190 OUT (B+$10),0
8200 IF (A=1) THEN T=C
8210 IF (A=2) THEN T=C+64
8220 IF (A=4) THEN T=C+128
8230 IF (A=8) THEN T=C+192
8240 OUT B,T
8250 IF BAND(INP(B+$10),1)=0 THEN GOTO 8250
8260 M = INP(B) : L = INP(B)
8270 IF (M<16) THEN V=((256*(BAND(M,15))+L)/4096)*5
8280 IF (M>15) THEN V=-(((BXOR($FFFF,(256*M+L))+1)/4096)*5)
8290 FPRINT "F2.3",V," volts"
8300 PRINT
8310 FOR Q=1 TO 1000 : NEXT Q
8320 G=KEY
8330 IF (G<>0) THEN 50
8340 NEXT Y

8350 NEXT X
```

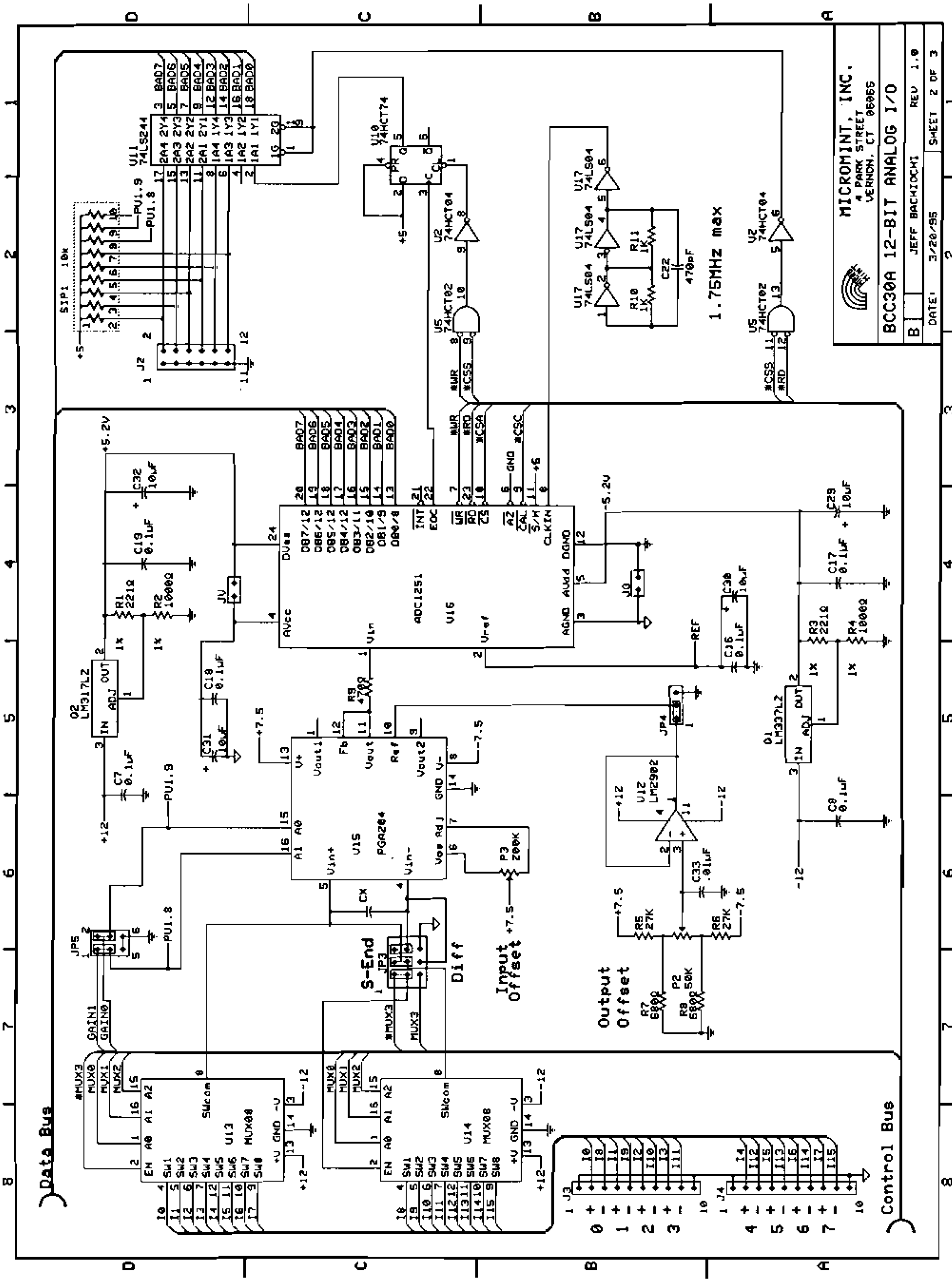
```
8360 GOTO 8110
9000 PRINT "Using a voltmeter connect to TP1 and TP2,"
9010 PRINT "adjust P1 for 5.000 volts."
9020 GOSUB 10000
9030 OUT B,192
9040 PRINT : PRINT "In single-ended mode, short CHANNEL 0 to ground"
9050 PRINT "That's J3.1 to J3.2"
9060 PRINT : PRINT "Using a voltmeter (black) connected to J3.1 (ground)"
9070 PRINT "and (red) to U16.1, adjust P3 for 0.000 volts"
9080 GOSUB 10000
9090 OUT B,0
9100 PRINT "Now adjust P2 for 0.000 volts"
9110 GOSUB 10000
9120 PRINT : PRINT "Press  1  to repeat the P3 - P2 procedure"
9130 PRINT "Press  0  to return to the main menu"
9140 INPUT G
9150 IF (G=31) THEN GOTO 9030
9160 GOTO 50
10000 PRINT : PRINT "(hit any key to continue)"
10010 IF (KEY=0) THEN 10010
10020 RETURN
```

10. BCC30A Silkscreen

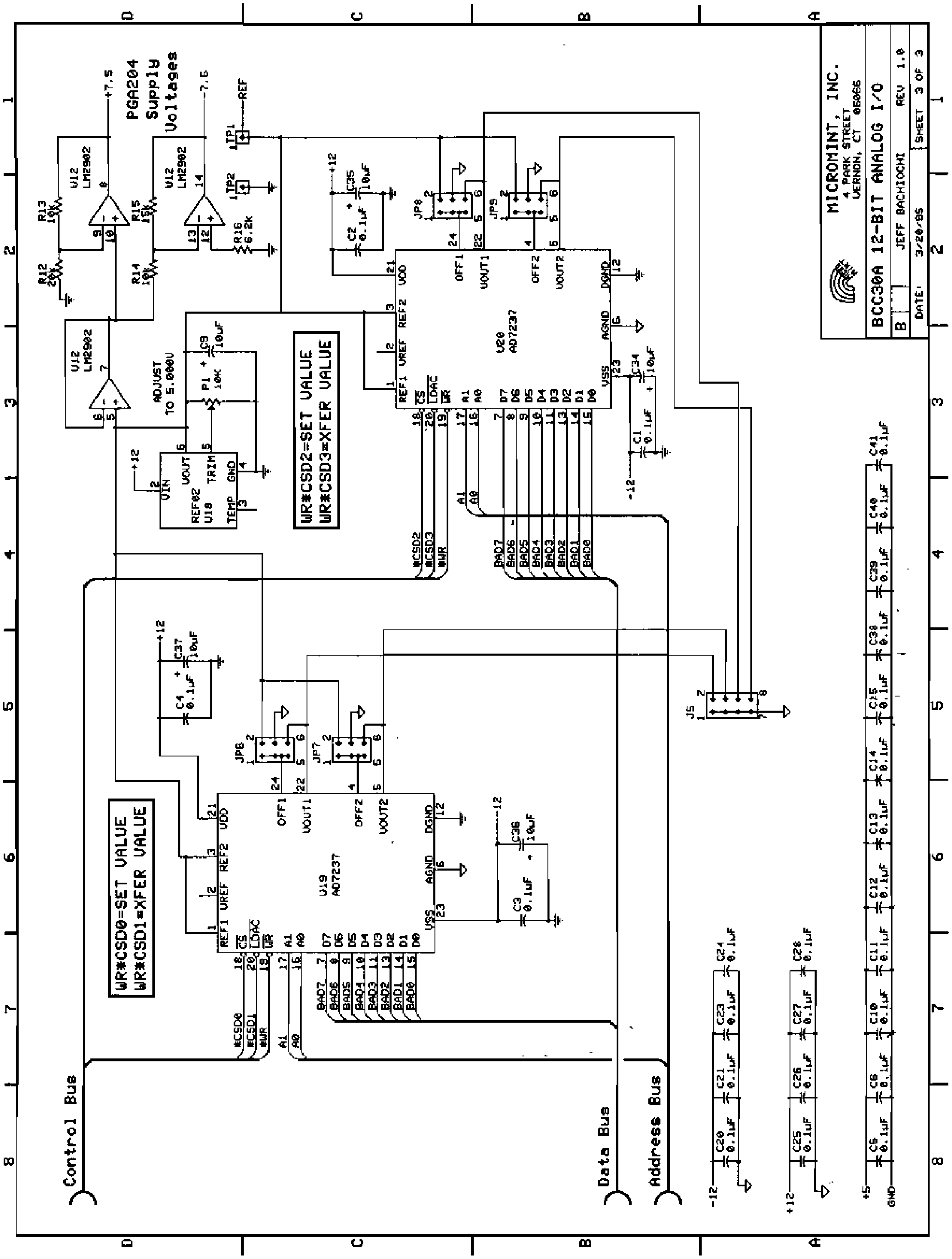


11. BCC30A Schematic




MICROMINT, INC.
4 PARK STREET
VERNON, CT 06066
BCC30A 12-BIT ANALOG I/O
JEFF BACHIOCHI
DATE: 3/20/95
REV 1.0
SHEET 2 OF 3
Data Bus
Control Bus

8/95


MICROMINT, INC.
4 PARK STREET
VERNON, CT 06066
BCC30A 12-BIT ANALOG I/O
JEFF BACHIOCHI
REV 1.0
DATE: 3/20/95
SHEET 3 OF 3
PGA204 Supply Voltages
WR*CSD2=SET VALUE
WR*CSD3=XFER VALUE
WR*CSD0=SET VALUE
WR*CSD1=XFER VALUE
U20 AD7237
U19 AD7237
REF02 U18
ADJUST TO 5.000V
Control Bus
Data Bus
Address Bus

12. BCC30A Parts List

Printed Circuit Board

PCB1	BCC30A PCB

Integrated Circuits

U1, U2, U17	74LS04
U3, U8	74LS138
U4	74LS20
U5	74LS02
U6, U9	74LS373
U7	74LS245
U10	74LS74
U11	74LS244
U12	LM2902
U13, U14	MUX08
U15	PGA205
U16	ADC1251
U18	REF02
U19, U20	AD7237

Resistors

R1, R3	180Ω, 1/4W, 1%
R2, R4	576Ω, 1/4W, 1%
R5, R6	27kΩ, 1/4W, 5%
R7, R8	680Ω, 1/4W, 5%
R9	470Ω, 1/4W, 5%
R10, R11	1kΩ, 1/4W, 5%
R12	20kΩ, 1/4W, 5%
R13, R14	10kΩ, 1/4W, 5%
R15	15kΩ, 1/4W, 5%
R16	6.2kΩ, 1/4W, 5%
SIP1	10kΩ, 9 element, 10 pin
P1	10kΩ multi-turn pot., side adjust
P2	50kΩ multi-turn pot., side adjust
P3	200kΩ multi-turn pot., side adjust

Capacitors

C1-C8, C10-C21, C24-C28, C38-C41	0.1μF, 50V, .10", Monolythic
C9, C29-C32, C34-C37	10μF, 16V, Tantalum

C22	470pF, 1/8", Ceramic
C33	0.01µF

Connectors

J2, (JP6-7), (JP8-9)	2 Position Terminal Block, side loading
J3, J4	Molex 10 Pin Header, right angle
J5, JP2	2x4 Header
JP1	2x8 Header
JP2	1x4 Header
JP3, JP5	2x3 Header
JP3, JP4	1x3 Header

Sockets

SK1, SK 2, SK4, SK5, SK10, SK12, SK17	14 pin DIP socket
SK3, SK8, SK13-SK15	16 pin DIP socket
SK6, SK7, SK9, SK11	20 pin DIP socket
SK16	24 pin DIP socket
SK18	8 pin DIP socket
SK19, SK20	24 pin DIP socket, 0.300"

Semiconductors

Q1	LM337LZ
Q2	LM317LZ

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