INTELLISENSOR
Digital Barometer/Altimeter
User Manual.

Model AIR-DB series

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INTRODUCTION

The INTELLISENSOR™ Digital Barometer/Altimeter measures pressure 10 times per second and makes it available in digital format to a terminal or computing device. The barometer can output pressure, altitude or altimeter setting. Altitude is computed from the pressure based on the U.S. standard atmosphere. Altimeter setting is computed from the pressure and a fixed specified altitude. Groups of readings can be averaged before transmission. Data are available on a serial port in ASCII coded format or on an 8 bit parallel port in either ASCII or binary coded format. Modes of operation are selected by jumpers inside the barometer.

The barometer is housed in a sealed aluminum case, uses a stable capacitance type pressure sensor, and has microcomputer control. Voltage requirements are +8 to +16 volts DC for LSTTL output. Use with RS-232C requires +11 to +16 volts DC and -11 to -16 volts DC. The analog electronics and sensor are computer calibrated together for full range accuracy. Calibration data is stored in ROM memory to assure data integrity and reliability. As shipped from the factory the instrument is configured as a barometer with 1200 baud RS-232C serial output, 10 readings averaged, and pressure units of millibars.

Included with the INTELLISENSOR Digital Barometer/Altimeter are:

* Mounting bracket
* Cable with connector
* Manual
* Calibration data sheet

This manual tells you how to use your digital barometer. Chapter 1 discusses the power requirements and communication interface. Chapter 2 explains the modes of operation and how to select them. Chapter 3 discusses the output data formats and how to read the data. Chapter 4 discusses the mechanical mounting and pressure line connections.

1. POWER AND COMMUNICATION INTERFACE

This section explains how to connect the hardware interface cable to provide power and to transfer data to an external device. Signal names are in capital letters and preceeded by a "+" or "-". A "+" means the signal is asserted or active when the voltage is at the more positive level. A "-" means the signal is asserted or active when the voltage is at the more negative level. For example, +DAV (parallel data valid) is asserted by +5v and negated by 0v. The RS-232C signal -DTR is asserted by -12v and negated by +12v. See Appendix D "Digital Board Schematic" for the barometer's interface electronics. Appendix F "Digital Barometer External Cable Diagram" contains connector pin assignments and wire colors.

1.1 CONNECTING POWER

The barometer must be powered from a dc power supply; either a battery or an ac/dc converter which meets the requirements listed in Table 1.1. These specifications apply at 22 degrees C and are average values which may vary by +-20%. At higher temperatures the current increases slightly and at lower temperatures it decreases slightly. The positive supply should have less than 100 mv of noise and ripple and the negative supply less than 500 mv of noise and ripple.

data interface	shutdown	voltage range	current
RS-232C serial	negated	+11 to +16 v	14.5 ma
		-11 to -16 v	8.5 ma
RS-232C serial	asserted	+11 to +16 v	8.5 ma
		-11 to -16 v	8.5 ma
LSTTL serial	negated	+8 to +16 v	6.3 ma
	asserted	+8 to +16 v	10.0 ua
LSTTL parallel	negated	+8 to +16 v	6.3 ma
	asserted	+8 to +16 v	10.0 ua

TABLE 1.1 POWER REQUIREMENTS

Apply power to the barometer's IO connector as follows.

+ voltage to pin 15
- voltage to pin 16
  ground to pin 13

1.2 USING THE POWER SHUTDOWN

You may use the logic level power shutdown feature to conserve power in battery applications. The barometer is turned off by asserting the +SHUTDOWN (pin 14) with a voltage greater than +1.4 volts but less than the voltage of the external positive supply. This signal can be driven by a LSTTL gate, a port bit on a CMOS or NMOS microcomputer, or by a microprocessor interface chip. It is turned on by negating the +SHUTDOWN with a voltage less than 0.8 volts. The barometer restarts just as though power had been applied.

This feature provides a convenient means of turning off the barometer in remote low power applications. For example, in a remote weather buoy application the external microcomputer turns on the barometer once every 10 minutes for 10 seconds to read the average of 100 readings. This reduces current by a factor of 10/600 to save battery power. If the power shutdown feature is not used then pin 14 may be left floating with no wire connected to it. If a wire is connected such as in the AIR supplied cable, it should be grounded to prevent stray capacitively coupled signals from asserting the +SHUTDOWN pin.

1.3 CONNECTING THE SERIAL INTERFACE

The serial port is used to interface the barometer to a serial device like a printer, a CRT terminal, or a data acquisition computer. Serial signals are available in both RS-232C and LSTTL voltage levels. The RS-232C Transmit Data signal is named -RSTXD and the RS-232C Data Terminal Ready is named -RSDTR. The LSTTL Transmit Data signal is named +LSTXD and the LSTTL Data Terminal Ready is named -LSDTR. The +LSTXD signal is capable of driving one TTL load. Voltage level specifications and pin numbers for the serial lines are given in Table 1.2. The protocol for each transmitted serial character is: one start bit, eight data bits, no parity and two stop bits.

If the external device is not ready to accept data when an average of measurements is completed then the barometer erases that measurement and goes on to make the next. Data will not be available again until another average is complete. For a successful data transfer to occur, the -RSDTR (-LSDTR) signal must be asserted at the time the barometer is ready to start transmitting a reading. The -RSDTR (-LSDTR) signal can be negated between characters to slow down transmission. Once transmission is begun, all characters must be sent before the barometer will begin the next measurement cycle.

If a Data Terminal Ready signal is not available from the external device, then -LSDTR pin 11 should be connected to ground to enable transmission. If both -RSDTR and -LSDTR are left unconnected, no data will be transmitted.

Note that the barometer is considered to be "Data Communication Equipment" (DCE) according to the EIA RS-232C specification because the data is originating at the barometer. Your device which is accepting data from the barometer is "Data Terminal Equipment" (DTE).

Serial Transmitted Data	RS-232C -RSTXD pin 2 voltage range	LSTTL +LSTXD pin 1 voltage range
meaning		
negated (logic 0)	+3v to +15v	0v to +.8v
asserted (logic 1)	-3v to -15v	2.4v to 5v

Serial Data Terminal Ready	RS-232C -RSDTR pin 12 voltage range	LSTTL -LSDTR pin 11 voltage range
meaning		
negated (not rdy)	+3v to +15v	2.4v to 5v
asserted (ready)	-3v to -15v	0v to +.8v

TABLE 1.2 SERIAL INTERFACE SPECIFICATIONS

CHOOSING BETWEEN LSTTL AND RS-232C SERIAL OUTPUT

When interfacing to an existing device with a RS-232C port the decision is simple, use the RS-232C levels. The only disadvantage is the higher power consumption, especially if the +shutdown signal is used. To obtain the RS-232C level output the two jumpers in the upper right of the digital pc board must be in place to enable the RS-232C level driver chip.

The LSTTL levels are more economically interfaced to and require less power, much less when the shutdown feature is used. You can only use LSTTL when the cable to the external device is less than a few feet. The actual distance depends upon the type of cable and baud rate. The LSTTL serial signals interface directly with common UART chips like the Motorola MC6850 ACIA.

1.4 CONNECTING THE PARALLEL INTERFACE

The parallel port is used to interface the barometer to an 8 line input port of a data acquisition computer. The data may be in ASCII or binary coded format and is transferred 8 bits at a time.

A two line handshake is used to synchronize transfers between the barometer and external device. The external device controls the +RFD (ready for data) signal and the barometer controls the +DAV (data valid) signal. The barometer writes the data on the 8 lines +D0, +D1, ... +D7. These 9 parallel output lines are each capable of driving 1 TTL load and should be connected to high impedance inputs. The +RFD signal can be driven by a LSTTL gate, a port on a CMOS or NMOS microcomputer or by a microprocessor interface chip. Table 1.3 shows the voltage levels for these interface lines.

Figure 1.1 shows the parallel transfer handshake sequence. It can be implemented in either hardware or software. The logic sequence used by the barometer for parallel transfers is:

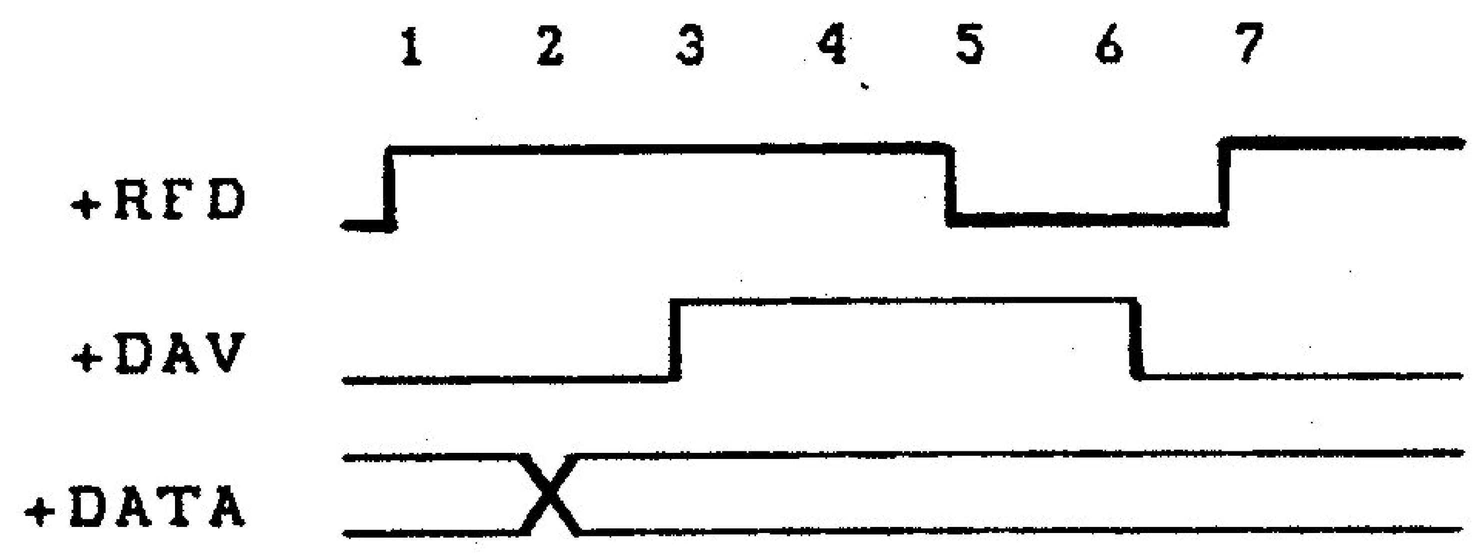
```
Do for each byte
     Wait for +RFD to become asserted.
     Put out data byte.
     Assert +DAV.
     Wait for +RFD to become negated.
     Negate +DAV.
End do
```

The complimentary logic sequence for the external device is:

```
Do for each byte
     Assert +RFD
     Wait for +DAV to become asserted
     Read one 8 bit byte
     Negate +RFD
     Wait for +DAV to become negated
End do
```

When the barometer finishes a measurement averaging cycle it tests the +RFD signal. If +RFD is negated, it begins another measurement cycle and the data is lost. If +RFD is asserted it begins a parallel data transfer sequence. Once a transfer is begun it must be completed before the barometer will begin another measurement. If the external device expects fewer bytes than the barometer sends and quits performing the handshake, the barometer will hang up.

Appendix D "Digital Board Schematic" shows the parallel interface electronics. The parallel signals are connected to the Motorola MC146805E2 microcomputer's parallel port pins. These pins, PA0 thru PA7 and PB0 thru PB7, are software programmable as either inputs or outputs. PA6 is an output and drives +DAV. PA7 is an input and receives +RFD. PB0 thru PB7 are outputs and drive +D0 thru +D7.



1 computer asserts +RFD
2 barom writes data byte
3 barom asserts +DAV
4 computer reads data byte
5 computer negates +RFD
6 barom negates +DAV
7 computer asserts +RFD

FIGURE 1.1 PARALLEL HANDSHAKE SEQUENCE

signal	meaning	voltage range
+DAV	negated (data not valid) asserted (data vaid)	0v to +.8v 2.4v to 5v
+RFD	negated (not ready for data) asserted (ready for data)	0v to +.8v 2.4v to 5v
+DATA	negated (logic 0) asserted (logic 1)	0v to +.8v 2.4v to 5v

TABLE 1.3 PARALLEL SIGNAL VOLTAGE LEVELS

1.5 PROTECTION FROM ABNORMAL VOLTAGES

Protect the barometer from abnormal voltages such as power surges and over/under voltages which might cause CMOS latch up or chip destruction. For example, you can protect the sensitive CMOS circuitry of the barometer from power line transients which might be passed through the external power supply with transient supressors attached to the power lines and to the serial and parallel data lines. The line of General Semiconductor Industries Inc. TransZorbs might be used to accomplish this kind of transient protection. These devices also supress some transients from near by lightning strikes.

You should also take precautions to avoid CMOS latch up of the chips on board the barometer or CMOS chips in external interface devices. Avoid applying voltages to the input lines, -LSDTR (+RFD), which are above +5.5 v or below -0.5 v. The output lines +D0, +D1, ... +D7, +DAV and +LSTXD should be connected only to high impedance inputs to avoid damage or latch up. The proper power up sequence is to make all signal inputs between -0.5v and +0.5v. About 400 milliseconds after power is applied, normal logic level signals may be applied. This also applies when negating the +SHUTDOWN with power already applied.

In some interfacing cases you may want to insert resistors in the signal lines between the barometer and the external device to minimize current which might be sourced to the barometer if the external signals can not be lowered to 0 volts when power is shut off. These resistors will prevent CMOS latch up of the chips in the barometer but their values must be low enough to prevent distortion of the data which is transferred from the barometer.

CMOS LATCH UP SUMMARY

To avoid CMOS latch up on power up, make certain that the voltage on each interface signal pin is between -0.5v and +0.5v with respect to ground.

For more information on interfacing to CMOS devices and a treatment of the latch up problem refer to the COS/MOS Integrated Circuits Manual by RCA, CMS-272.

2. SELECTING A MODE OF OPERATION

The barometer may operate in one of 4 modes. The mode is determined at power up by the jumpers inside the aluminum housing. After you position the jumpers, you must turn the barometer off and then on to enter the new mode. The following list summarizes each mode.

1) Barometer mode

In this mode the instrument operates as a pressure transducer and provides pressure readings. You may select the units of pressure, the number of measurements to average, and either serial or parallel data outputs. Tables 2.1 and 2.2 show the available jumper options.

2) Altimeter mode

In this mode the instrument operates as a pressure altimeter and provides pressure altitude or pressure altitude and pressure. You may select the units of altitude and pressure, the number of measurements to average, and either serial or parallel data outputs. Tables 2.3 and 2.4 show the available jumper options.

3) Altimeter setting mode

In this mode the instrument operates to provide altimeter setting. The indicated altimeter setting is accurate when the barometer is operated at a specific elevation above sea level. This elevation is specified at the time of order and is stored in the instrument during the calibration procedure. If no elevation was specified then 0 is assumed and the altimeter setting is accurate only at sea level. The units of altimeter setting are always in(Hg). You may select the number of measurements to average, and either serial or parallel data outputs. The pressure reading in in(Hg) follows each altimeter setting reading. Tables 2.5 and 2.6 show the available jumper options.

4) Test mode

The test mode is used for calibration and troubleshooting. You may select an ASCII coded serial output of raw data, raw data accompanied by the computed pressure, serial number identification information, or a digital test mode for troubleshooting. Table 2.7 shows the available jumper options.

2.1 GENERAL INFORMATION ABOUT THE MODES

The available pressure units are millibars, inches of Hg, millimeters of Hg, and PSIA. Pressure altitude is in either feet or meters. Altimeter setting is always inches of Hg.

The number of measurements averaged can be 1, 10, 100 or 1000. At approximately 10 measurements per second, data is output about every .1, 1, 10 or 100 seconds. The measurement time varies slightly with pressure and temperature.

Serial Data is transmitted at 110, 300, 1200 or 9600 baud, with either RS-232C or LSTTL voltage levels. All data are transmitted as ASCII strings suitable for use with a printer or computer. Numbers are converted to ASCII decimal and the most significant digit sent first. The string includes an embedded decimal point and terminates with carraige return and line feed <cr><lf>. The external device controls the DTR (Data Terminal Ready) signal to enable or disable the transfer of characters.

Parallel data tansmission requires an interactive handshake from an external device. The external device controls the RFD (ready for data) line and the barometer controls the DAV (data valid) line. Data are transmitted as either ASCII strings or as binary numbers. The ASCII strings have the same format as with serial transmission. Numbers are converted to ASCII decimal and the most significant digit sent first. The string includes an embedded decimal point and terminates with carraige return and line feed <cr><lf>.

The parallel binary format is a 24 bit integer transmitted as three bytes with the most significant byte sent first. The floating point number in the barometer is scaled by powers of ten to preserve decimal place accuracy and converted to a 24 bit integer.

2.2 SETTING THE MODE JUMPERS

The options jumpers are located inside the aluminum cover on the top printed circuit board. First remove power to the barometer. Now remove the 4 socket head screws on the side of the cylindrical aluminum cover. Then carefully pull the housing until it slides over the O-ring gasket. A slight twisting and pulling motion works best. There is a cable from the housing to the printed circuit board so don't twist more than about 20 degrees. Lift the housing off and to one side being careful not to stress the cable or short the electronics. Now hold the instrument with the jumper block nearest you so that you can read the label "AIR Inc." at the bottom of the PC board. Jumper #0 is at the right and jumper #7 is at the left. You select a jumper value of 1 by connecting an upper pair of pins with a jumper and a 0 by connecting a lower pair of pins. All 8 jumpers must be installed for reliable operation.

Two more jumpers are just above the ribbon cable connector. They must be in place for RS-232C serial data formats. When RS-232C is not in use, they may be removed to reduce power requirements. Figure 2.1 shows the location of all jumpers.

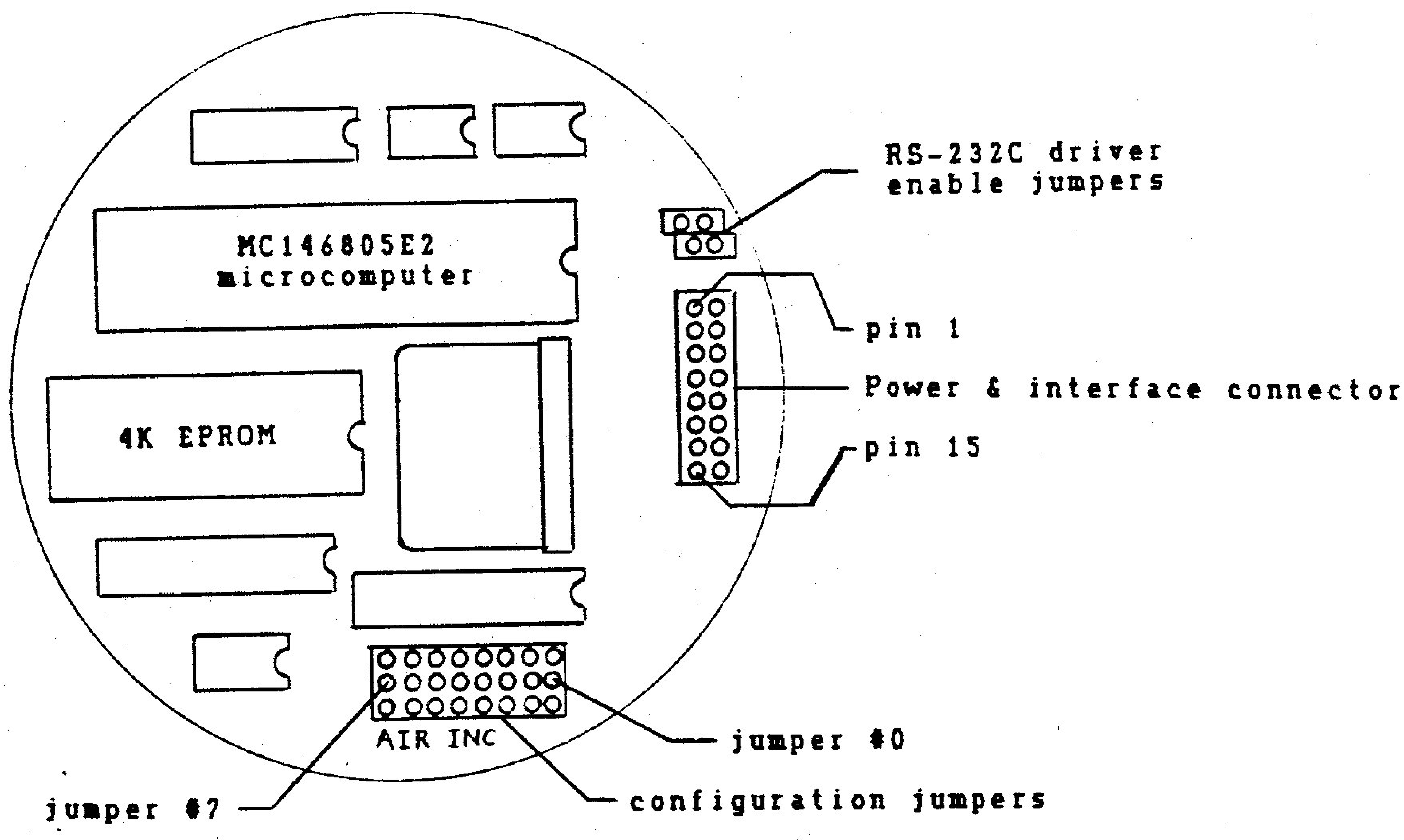


FIGURE 2.1 LOCATION OF JUMPERS ON DIGITAL BOARD

The following tables show you how to specify the modes and options with the jumpers. The abbreviations used are:

b = binary/ASCII coded parallel output
n = number of measurements to average
r = baud rate
t = test to run
u = units of output
* = don't care, jumper must be installed

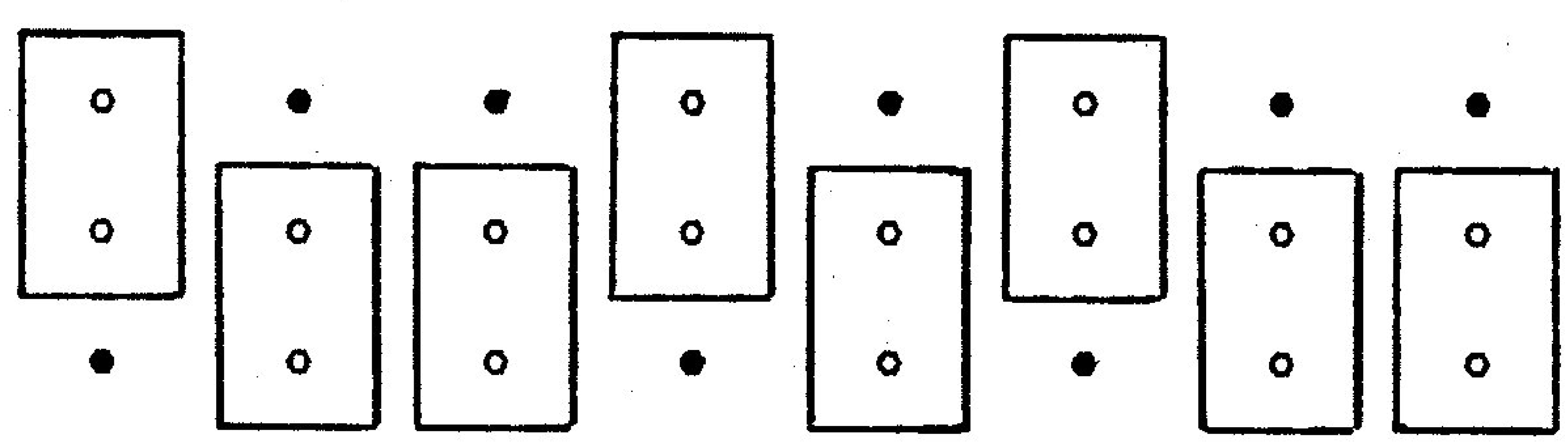
2.3 BAROMETER MODE WITH SERIAL OUTPUT

Jumper #		7	6	5	4	3	2	1	0
Jumper use		units		baud rate		number average		serial barom	
Serial Barometer		u	u	r	r	n	n	0	0
Number of measurements averaged	1	u	u	r	r	0	0	0	0
	10	u	u	r	r	0	1	0	0
	100	u	u	r	r	1	0	0	0
	1000	u	u	r	r	1	1	0	0
Serial output baud rate	9600	u	u	0	0	n	n	0	0
	1200	u	u	0	1	n	n	0	0
	300	u	u	1	0	n	n	0	0
	110	u	u	1	1	n	n	0	0
Units of output	mb	0	0	r	r	n	n	0	0
	in(Hg)	0	1	r	r	n	n	0	0
	mm(Hg)	1	0	r	r	n	n	0	0
	PSIA	1	1	r	r	n	n	0	0

TABLE 2.1 SERIAL BAROMETER JUMPER CONFIGURATIONS

The following example selects barometer mode with serial output (jumpers 0 & 1), 1200 baud (jumpers 4 & 5), average 10 measurements (jumpers 2 & 3), and pressure units of mm(Hg) (jumpers 6 & 7).

Jumper value 1 0 0 1 0 1 0 0



Jumper number 7 6 5 4 3 2 1 0

The two jumpers just above the ribbon cable connector must be in place for RS-232C serial data outputs.

2.4 BAROMETER MODE WITH PARALLEL OUTPUT

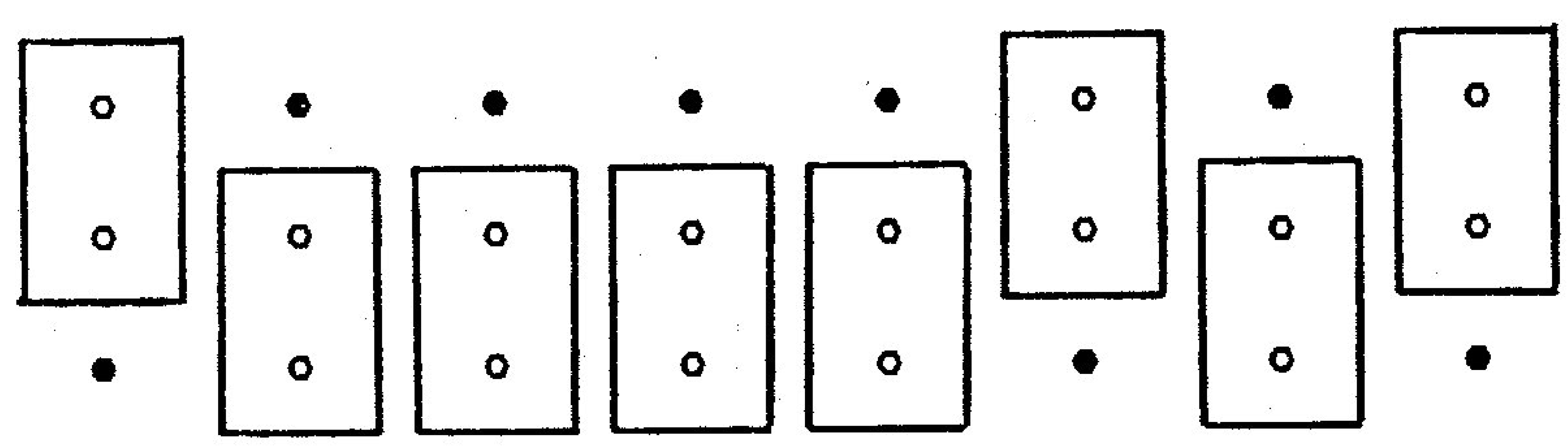
Jumper #	7	6	5	4	3	2	1	0
Jumper use	units		par bar	binry ASCII	number average		parallel barom	
Parallel Barometer	u	u	0	b	n	n	0	1
Number of 1	u	u	0	b	0	0	0	1
measurements 10	u	u	0	b	0	1	0	1
averaged 100	u	u	0	b	1	0	0	1
1000	u	u	0	b	1	1	0	1
ASCII coded output	u	u	0	0	n	n	0	1
Binary coded output	u	u	0	1	n	n	0	1
Units of mb	0	0	0	b	n	n	0	1
output in(Hg)	0	1	0	b	n	n	0	1
mm(Hg)	1	0	0	b	n	n	0	1
PSIA	1	1	0	b	n	n	0	1

Table 2.2 PARALLEL BAROMETER JUMPER CONFIGURATIONS

The following example selects barometer mode with parallel output (jumpers 0, 1 & 5); ASCII coded output (jumper 4); average 10 measurements (jumpers 2 & 3); and pressure units of mm(Hg) (jumpers 6 & 7).

Jumper value 1 0 0 0 0 1 0 1

Pictorial Representation of Jumpers



Jumper number 7 6 5 4 3 2 1 0

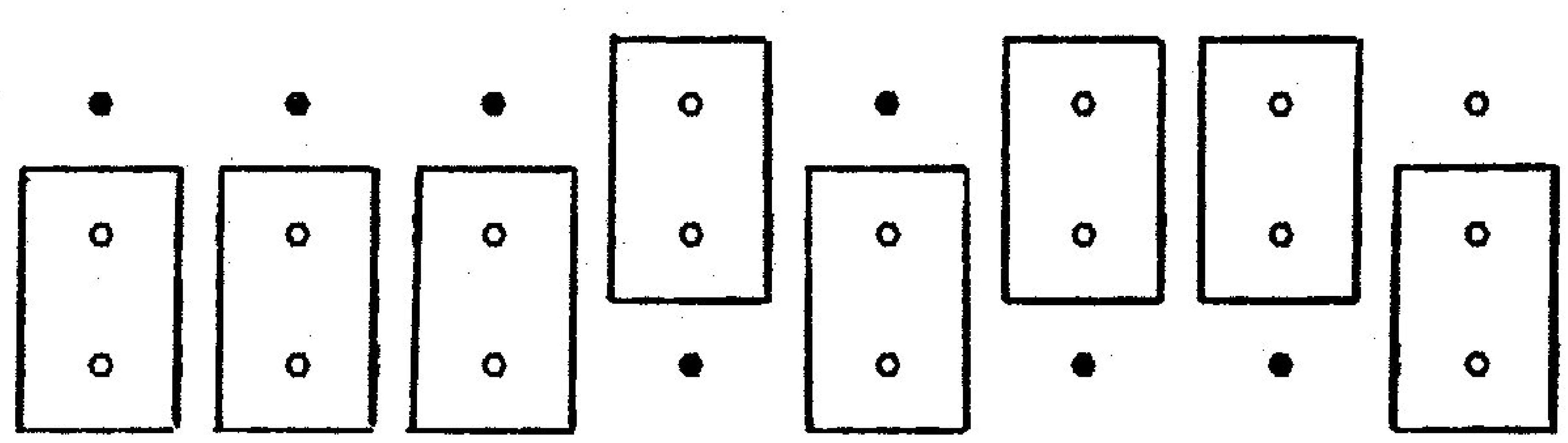
2.5 PRESSURE ALTIMETER MODE WITH SERIAL OUTPUT

Jumper #	7	6	5	4	3	2	1	0
Jumper use	units		baud rate		number average		serial altimetr	
Serial Altimeter	u	u	r	r	n	n	1	0
Number of measurements averaged 1	u	u	r	r	0	0	1	0
10	u	u	r	r	0	1	1	0
100	u	u	r	r	1	0	1	0
1000	u	u	r	r	1	1	1	0
Serial output baud rate 9600	u	u	0	0	n	n	1	0
1200	u	u	0	1	n	n	1	0
300	u	u	1	0	n	n	1	0
110	u	u	1	1	n	n	1	0
Units of output ft	0	0	r	r	n	n	1	0
m	0	1	r	r	n	n	1	0
ft/in(Hg)	1	0	r	r	n	n	1	0
m/mb	1	1	r	r	n	n	1	0

Table 2.3 SERIAL ALTIMETER JUMPER CONFIGURATIONS

The following example selects altimeter mode with serial output (jumpers 0 & 1), average 10 measurements (jumpers 2 & 3), 1200 baud (jumpers 4 & 5), and altitude units of feet (jumpers 6 & 7).

Jumper value 0 0 0 1 0 1 1 0



Jumper number 7' 6 5 4 3 2 1 0

The two jumpers just above the ribbon cable connector must be in place for RS-232C serial data outputs.

2.6 PRESSURE ALTIMETER MODE WITH PARALLEL OUTPUT

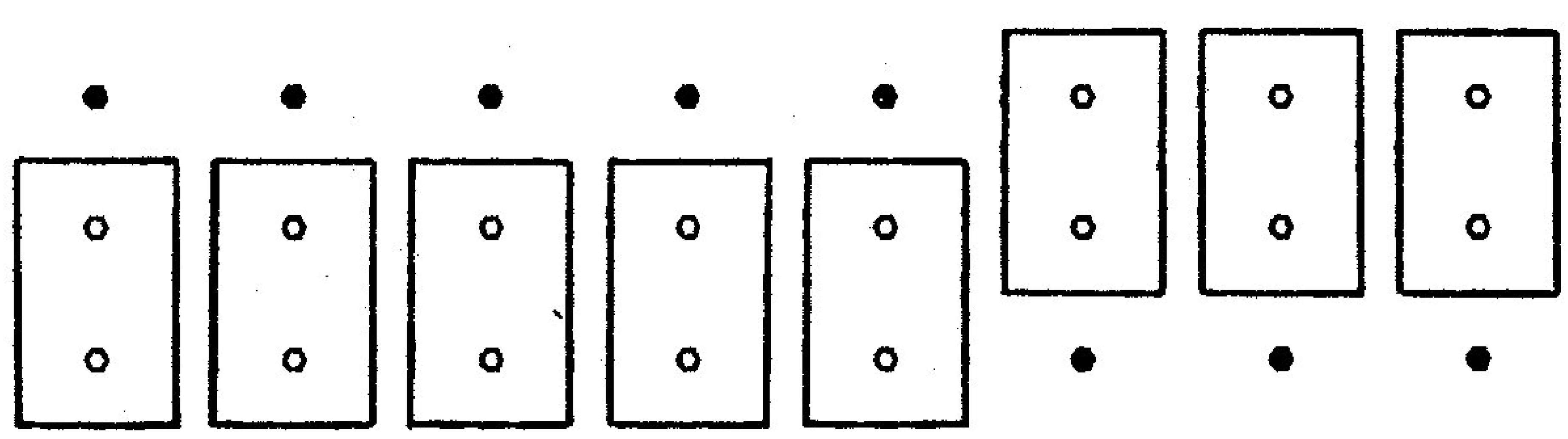
Jumper # / Jumper use	7	6 (units)	5 par alt	4 binry ASCII	3	2 (number average)	1	0 (parallel altim)
Parallel Altimeter	u	u	0	b	n	n	1	1
Number of 1	u	u	0	b	0	0	1	1
measurements 10	u	u	0	b	0	1	1	1
averaged 100	u	u	0	b	1	0	1	1
1000	u	u	0	b	1	1	1	1
ASCII coded output	u	u	0	0	n	n	1	1
Binary coded output	u	u	0	1	n	n	1	1
Units of ft	0	0	0	b	n	n	1	1
output m	0	1	0	b	n	n	1	1
ft/in(Hg)	1	0	0	b	n	n	1	1
m/mb	1	1	0	b	n	n	1	1

TABLE 2.4 PARALLEL ALTIMETER JUMPER CONFIGURATIONS

The following example selects altimeter mode with parallel output (jumpers 0, 1 & 5), average 10 measurements (jumpers 2 & 3), ASCII coding (jumper 4), and altitude units of feet (jumpers 6 & 7).

Jumper value 0 0 0 0 0 1 1 1

Pictorial representation of jumpers.



Jumper number 7 6 5 4 3 2 1 0

2.7 ALTIMETER SETTING MODE WITH SERIAL OUTPUT

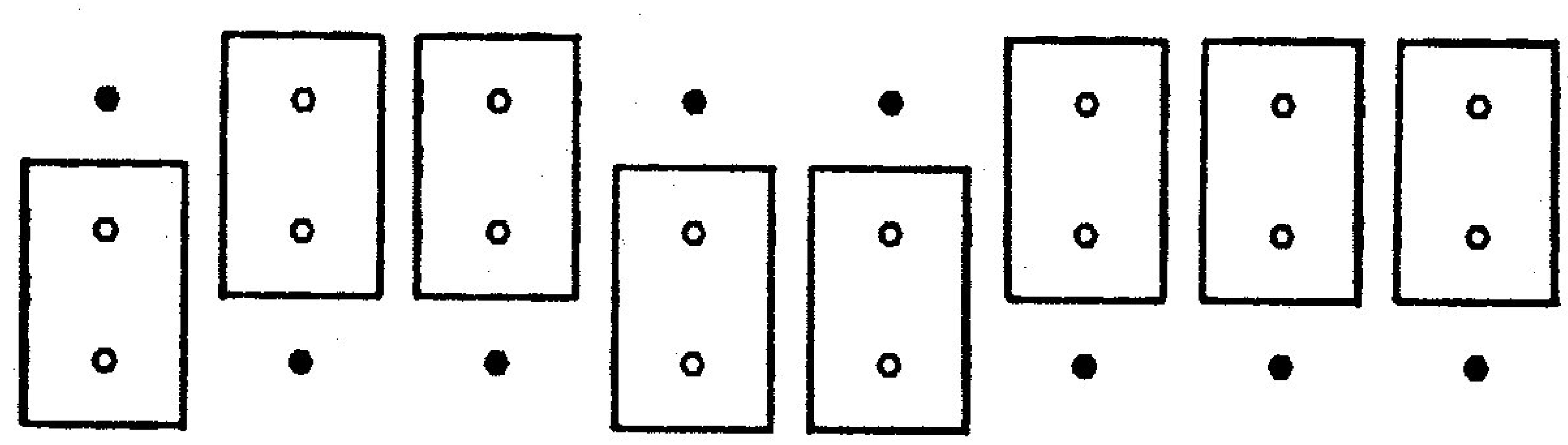
Jumper # / Jumper use		7 6 baud rate	5 4 serial alt set	3 2 number average	1 0 altimetr setting
Serial altimeter setting		r r	1 0	n n	1 1
Number of measurements averaged	1	r r	1 0	0 0	1 1
	10	r r	1 0	0 1	1 1
	100	r r	1 0	1 0	1 1
	1000	r r	1 0	1 1	1 1
Serial output baud rate	9600	0 0	1 0	n n	1 1
	1200	0 1	1 0	n n	1 1
	300	1 0	1 0	n n	1 1
	110	1 1	1 0	n n	1 1

TABLE 2.5 SERIAL ALTIMETER SETTING JUMPER CONFIGURATIONS

The following example selects altimeter setting mode with serial output (jumpers 0, 1, 4 & 5), average 10 measurements (jumpers 2 & 3), 1200 baud (jumpers 6 & 7). The units are always in(Hg).

Jumper value 0 1 1 0 0 1 1 1

Pictorial representation of jumpers.



Jumper number 7 6 5 4 3 2 1 0

The altitude of the site where the instrument is to be used has been entered at the factory during the custom calibration procedure.

The two jumpers just above the ribbon cable connector must be in place for RS-232C serial data outputs.

2.8 ALTIMETER SETTING MODE WITH PARALLEL OUTPUT

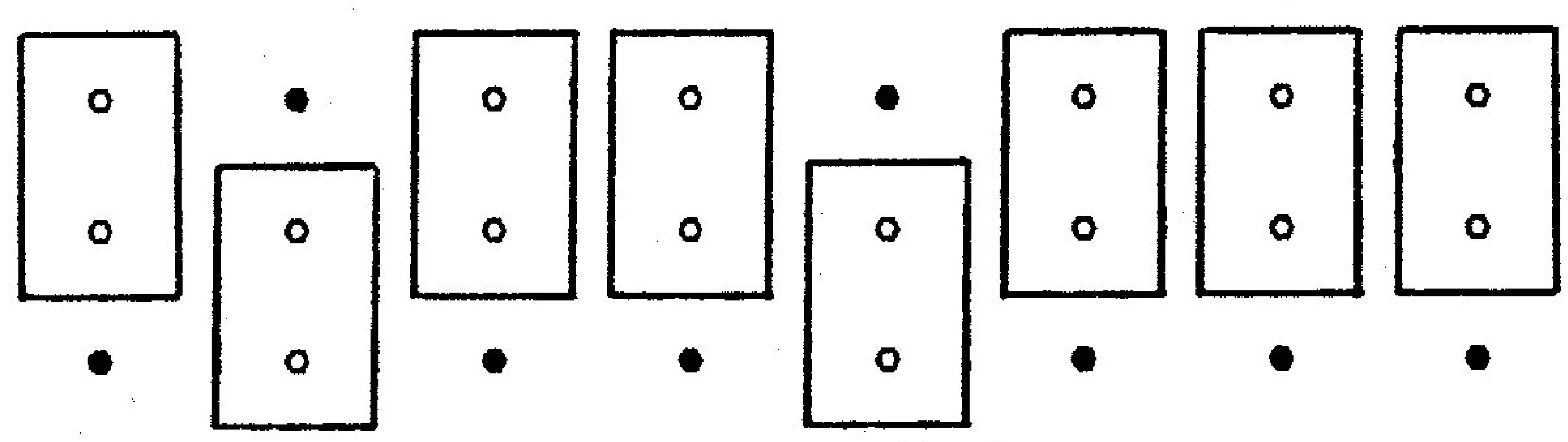
Jumper # / Jumper use	7 6 don't care	5 4 parallel alt set	3 2 number average	1 0 parallel alt set
Parallel altimeter setting	* *	1 1	n n	1 1
Number of measurements averaged 1	* *	1 1	0 0	1 1
10	* *	1 1	0 1	1 1
100	* *	1 1	1 0	1 1
1000	* *	1 1	1 1	1 1

TABLE 2.6 PARALLEL ALTIMETER JUMPER CONFIGURATIONS

The following example selects altimeter setting mode with parallel output (jumpers 0, 1, 4 & 5), and average 10 measurements (jumpers 2 & 3). The units are always in(Hg) and the output format is always ASCII coded decimal. Note that even though jumpers 6 and 7 are "don't cares" they must still be in place.

Jumper value	1	0	1	1	0	1	1	1

Pictorial representation of jumpers.



Jumper number	7	6	5	4	3	2	1	0

The altitude of the site where the instrument is to be used has been entered at the factory during the custom calibration procedure.

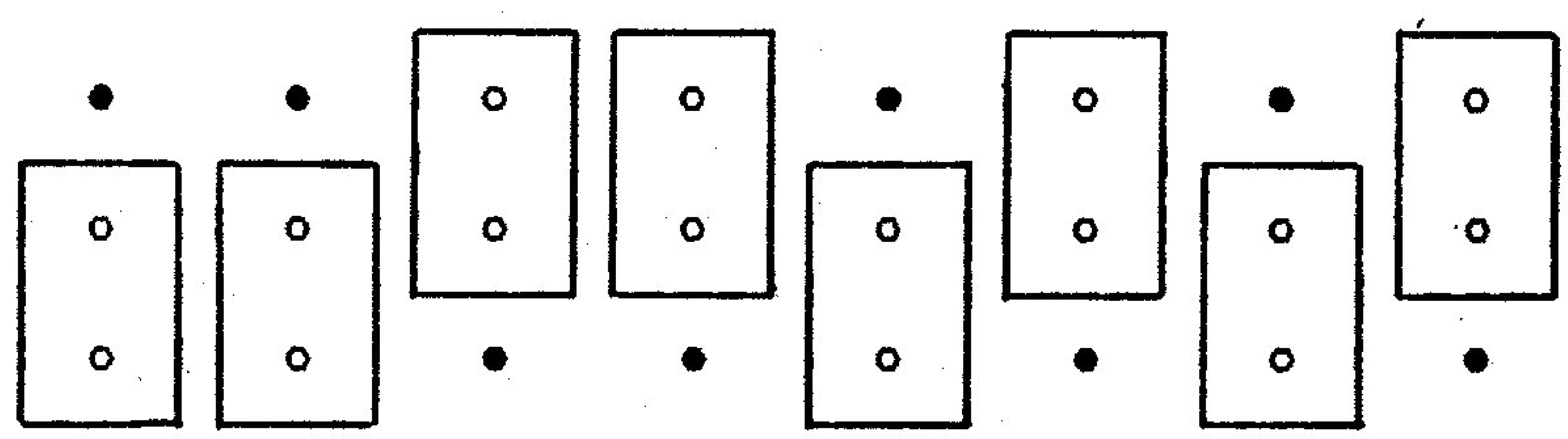
2.9 TEST MODE WITH SERIAL OUTPUT

Jumper # / Jumper use	7 6 baud rate	5 4 test mode	3 2 number average	1 0 test mode
Test mode	r r	1 1	t t	0 1
Raw data/pressure	r r	1 1	0 0	0 1
Serial ID test	r r	1 1	0 1	0 1
Signature analys	r r	1 1	1 0	0 1
Raw data	r r	1 1	1 1	0 1
Serial 9600	0 0	1 1	t t	0 1
output 1200	0 1	1 1	t t	0 1
baud rate 300	1 0	1 1	t t	0 1
110	1 1	1 1	t t	0 1

TABLE 2.7 SERIAL TEST JUMPER CONFIGURATIONS

The following example selects the serial test mode (jumpers 0, 1, 4 & 5), identification test (jumpers 2 & 3), 9600 baud (jumpers 6 & 7).

Jumper value 0 0 1 1 0 1 0 1



Jumper number 7 6 5 4 3 2 1 0

The two jumpers just above the ribbon cable connector must be in place for RS-232C serial data outputs.

The test mode is used to service the barometer at the factory or in the field. There are tests for the serial output, for the analog circuitry, for factory calibration and for signature analysis. A description of the four tests follows.

1) Serial ID test - This test is used to identify the instrument and to test the serial output independently of the other circuitry. The first number is the calibration code consisting of the year, month, day, hour and test position of last calibration. Next is a hardware serial number, the software revision date, and the altitude in feet of the site for which the altimeter setting mode is set. A sample output is:
8401271701 00013 02/27/84 Alt=5280.

2) Raw data and pressure in mb - This test is used to verify that the front end analog circuits are working properly. The serial output consists of four raw counts used to calculate pressure followed by the calculated pressure in millibars. A sample output is:

*63319. 44408. 47570. 28063. 838.09

The first number is the high reference and should be the largest. It is insensitive to temperature and pressure. The second number is sensitive to pressure. Increase pressure to increase the number or decrease pressure to decrease the number. The third number is sensitive to temperature. Increase temperature to decrease the number or decrease temperature to increase the number. The fourth number is the low reference and should be the smallest. It is insensitive to temperature and pressure. The last number is the pressure computed from the previous 4 numbers and the calibration coeficients stored in ROM.

3) Raw data - This test is used for factory calibration. It is the same as test 1 without the pressure output. A sample output is:
*63319. 44408. 47570. 28063.

4) SA test - The signature analysis test is used by an electronics technician to locate faults in a defective barometer. By using this test and a digital signature analyzer, the technician may isolate and replace bad integrated circuits.

3. READING DATA FROM THE BAROMETER

3.1 MEASUREMENT AND DATA TRANSFER CYCLE

Refer to Figure 3.1 "Barometer Sequence of Operation" as you read this section. At power up, the barometer reads the configuration jumpers and initializes the hardware. It then enters the measurement and data transfer cycle. The specified number of measurements are made and summed. This takes from approximately 0.1 to 100 seconds depending on the number. Next it computes the average pressure and, if required, the altitude or altimeter setting. Appendix C "Computational Procedures", contains the relevant formulas. Finally it converts to the proper units and output format to complete the measurement part.

If the external device is not ready then another measurement cycle begins and the data is lost. If the external device is ready then the first byte or character is output. The transfer continues until all bytes or characters are output. Another cycle then begins.

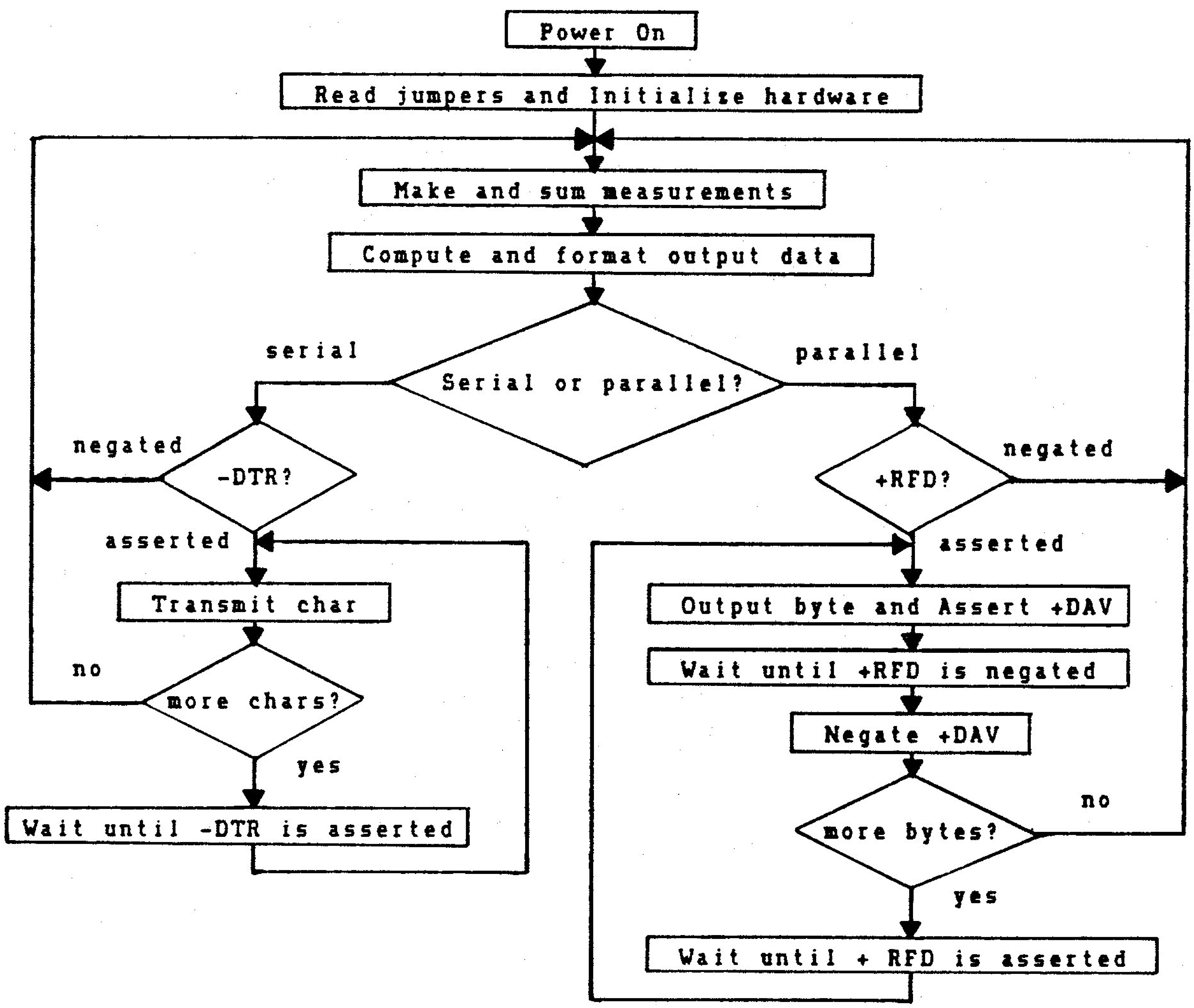


FIGURE 3.1 BAROMETER SEQUENCE OF OPERATIONS

3.2 ASCII CODED FORMATS

All ASCII formated numbers in the barometer, altimeter and altimeter setting modes are right justified in a 7 character field with an embedded decimal point. The numbers in the test mode are left justified in a variable width field with an embedded decimal point. The symbols <cr> and <lf> denote a carraige return and linefeed. The # symbol represents a leading blank or a digit.

The external computer should read characters until it detects a <lf>. The output formats are shown in Table 3.1.

BAROMETER MODE

units	output format	sample output
mb	####.##<cr><lf>	1013.25<cr><lf>
in(Hg)	###.###<cr><lf>	29.921<cr><lf>
mm(Hg)	####.##<cr><lf>	760.04<cr><lf>
PSIA	##.####<cr><lf>	16.6921<cr><lf>

ALTIMETER MODE

units	output format	sample output
ft	######.<cr><lf>	5139.<cr><lf>
m	#####.#<cr><lf>	1566.4<cr><lf>
ft/in(Hg)	######. ###.###<cr><lf>	5139. 25.057<cr><lf>
m/mb	#####.# ####.##<cr><lf>	1566.4 848.52<cr><lf>

ALTIMETER SETTING MODE

units	in(Hg)
output format	P=###.### AS=###.###<cr><lf>
sample output	P= 21.114 AS= 21.114<cr><lf>

TEST MODE

test	output format
Serial ID	YYMMDDhhcc sssss MM/DD/YY ALT=#####.<cr><lf>
Raw data	*#####. #####. #####. #####.<cr><lf>
Raw data w P	*#####. #####. #####. #####. ####.##<cr><lf>
Signature	no serial output

test	sample output
Serial ID	8404211302 00013 04/13/84 ALT=0.<cr><lf>
Raw data	*63287. 44387. 47595. 28044.<cr><lf>
Raw data w	*63287. 44387. 47595. 28044. 864.78<cr><lf>
Signature	no serial output

TABLE 3.1 ASCII CODED OUTPUT DATA FORMATS

3.3 BINARY CODED FORMATS

The parallel binary format is a 24 bit integer transmitted as three bytes with the most significant byte sent first. The floating point number in the barometer is scaled by powers of ten to preserve decimal place accuracy and converted to a 24 bit integer. For example, the reading of 987.35 mb would be transmitted as a binary representation of the decimal number 987350. In binary the 3 bytes are 00001111 00010000 11010110. Those modes such as altimeter setting which transmit two numbers will send two 24 bit integers as 6 bytes.

The external computer must read the number of bytes as specified in Table 3.3. Each byte must be acknowledged by the external device before the barometer transmits the next. Table 3.2 shows the scale factor used for the various units of output. One possible formula for reconstruction of the floating point representation is:

F = ((B1 * 256.0 + B2) * 256.0 + B1) / SF

where F = floating point representation
B1 = most significant binary byte
B2 = next most significant binary byte
B3 = least significant binary byte
SF = scale factor from Table 3.2

UNITS	SCALE FACTOR	UNITS	SCALE FACTOR
mb	1000.0	ft	10.0
in(Hg)	10000.0	m	100.0
mm(Hg)	1000.0		
PSIA	100000.0		

TABLE 3.2 PARALLEL BINARY SCALE FACTORS

BAROMETER MODE				
units	internal value	number of bytes	sample output in decimal	sample output in hexadecimal
mb	1013.250	3	1013250	0F 76 02
in(Hg)	29.9214	3	299214	04 90 CE
mm(Hg)	760.043	3	760043	0B 98 EB
PSIA	16.69128	3	1669218	19 78 62

ALTIMETER MODE				
units	internal values	# of bytes	sample output in decimal	sample output in hexadecimal
ft	5139.3	3	51393	00 C8 C1
m	1566.42	3	156642	02 63 E2
ft/inHg	5139.3 25.0576	6	51393 250576	00 C8 C1 03 D2 D0
m/mb	1566.41 848.529	6	156641 848529	02 63 E2 0C F2 91

TABLE 3.3 PARALLEL DATA FORMATS

4. INSTALLATION

4.1 MECHANICAL CONNECTIONS

The barometer is supplied with mounting hardware which may be attached at either of two locations on the body. The orientation of the barometer is not important. Care should be taken that the barometer is not mounted to a significant heat source or sink which might produce large thermal gradients. A difference in temperature between the pressure sensor and temperature sensor causes an error in pressure of approxiametely 0.1 mb per degree centigrade. The standard pressure port consists of a 3/16" OD x 1/8" ID x 5/8" long NPT brass fitting for use with 3/16" I.D. flexible tubing.

4.2 ENVIRONMENTAL CONSIDERATIONS

Moisture should not be allowed to condense on the pressure sensor or accumulate within the sensor chamber. Condensation can be avoided by keeping the barometer above the dewpoint or by using a dessicant to dry the sample air.

Each barometer is calibrated over a specific range of pressure and temperature, and may not be accurate outside that range. The sensor is designed for use at pressures between 0 and 38.4 in(Hg) or 1300 mb. Higher pressures may permanently change the sensor thus altering the accuracy.

APPENDIX A. QUICK REFERENCE SHEET

	Jumper #	7	6	5	4	3	2	1	0
Barometer mode with serial output		u	u	r	r	n	n	0	0
Barometer mode with parallel output		u	u	0	b	n	n	0	1
Altimeter mode with serial output		u	u	r	r	n	n	1	0
Altimeter mode with parallel output		u	u	0	b	n	n	1	1
Altimeter setting mode with serial output		r	r	1	0	n	n	1	1
Altimeter setting mode with parallel output		*	*	1	1	n	n	1	1
Test mode with serial output		r	r	1	1	t	t	0	1
Units of output - Barometer modes	mb	0	0	-	-	-	-	-	-
	in(Hg)	0	1	-	-	-	-	-	-
	mm(Hg)	1	0	-	-	-	-	-	-
	PSIA	1	1	-	-	-	-	-	-
Units of output - Altimeter modes	ft	0	0	-	-	-	-	-	-
	m	0	1	-	-	-	-	-	-
	ft/in(Hg)	1	0	-	-	-	-	-	-
	m/mb	1	1	-	-	-	-	-	-
Number of measurements averaged - All modes	1	-	-	-	-	0	0	-	-
	10	-	-	-	-	0	1	-	-
	100	-	-	-	-	1	0	-	-
	1000	-	-	-	-	1	1	-	-
Serial output baud rate - Barometer mode and Altimeter mode	9600	-	-	0	0	-	-	-	-
	1200	-	-	0	1	-	-	-	-
	300	-	-	1	0	-	-	-	-
	110	-	-	1	1	-	-	-	-
Serial output baud rate - Altimeter setting mode and Test mode	9600	0	0	-	-	-	-	-	-
	1200	0	1	-	-	-	-	-	-
	300	1	0	-	-	-	-	-	-
	110	1	1	-	-	-	-	-	-
Parallel output data format - All modes	ASCII	-	-	-	0	-	-	-	-
	Binary	-	-	-	1	-	-	-	-
Test mode tests -	Raw data/press (mb)	-	-	-	-	0	0	-	-
	Serial ID test	-	-	-	-	0	1	-	-
	SA test	-	-	-	-	1	0	-	-
	Raw data	-	-	-	-	1	1	-	-

Key to table abbreviations -

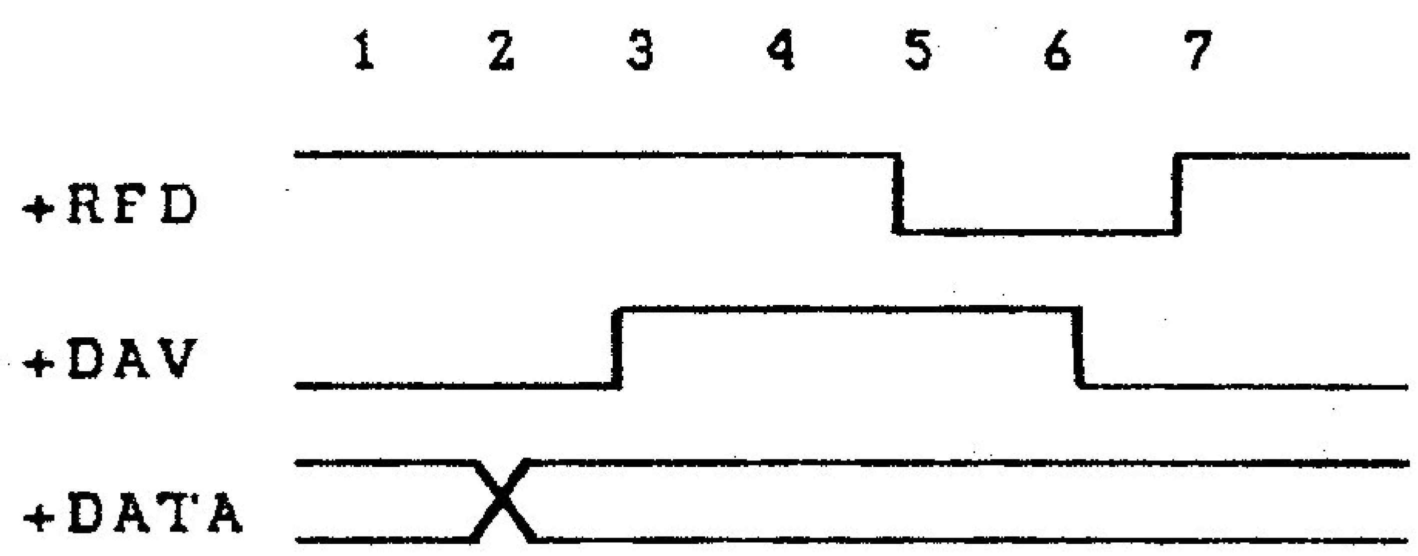
- r = Serial output baud rate.
- n = Number of measurements to be averaged.
- b = Format of parallel output - binary/ASCII coded.
- u = Units of output.
- * = Don't care - jumpers must be in place however.
- t = Test type.

MODE SELECTION JUMPERS

QUICK REFERENCE SHEET

pin	wire color	serial data use	parallel data use	signal dir
1	WHT	+LSTXD	+DAV	out
2	RED	-RSTXD	nc	out
3	BLK	nc	+D0	out
4	BLU	nc	+D1	out
5	GRN	nc	+D2	out
6	ORG	nc	+D3	out
7	WHT/RED	nc	+D4	out
8	RED/BLK	nc	+D5	out
9	BLK/RED	nc	+D6	out
10	BLU/WHT	nc	+D7	out
11	GRN/BLK	-LSDTR	+RFD	in
12	ORG/RED	-RSDTR	nc	in
13	WHT/GRY	GROUND	GROUND	
14	RED/GRN	+SHUTDOWN	+SHUTDOWN	in
15	BLU/BLK	+8 TO +16	+8 to +16	
16	GRN/WHT	-8 TO -16	nc	

CABLE AND CONNECTOR PIN ASSIGNMENTS



1 computer asserts +RFD
2 barom writes data
3 barom asserts +DAV
4 computer reads data
5 computer negates +RFD
6 barom negates +DAV
7 computer asserts +RFD

PARALLEL TIMING DIAGRAM

BAROMETER MODE

units	output format
mb	####.##<cr><lf>
in(Hg)	###.###<cr><lf>
mm(Hg)	####.##<cr><lf>
PSIA	##.####<cr><lf>

ALTIMETER MODE

units	output format
ft	######.<cr><lf>
m	#####.#<cr><lf>
ft/in(Hg)	######. ###.###<cr><lf>
m/mb	#####.# ####.##<cr><lf>

ALTIMETER SETTING MODE

units	output format
in(Hg)	P=###.### AS=###.###<cr><lf>

TEST MODE

test	output format
Serial ID	cccccccccc sssss vv/vv/vv ALT=######.<cr><lf>
Raw data	*######. #####. #####. #####.<cr><lf>
Raw data & P	*######. #####. #####. #####. ####.##<cr><lf>
SA	no serial output

OUTPUT DATA FORMATS

APPENDIX B. SPECIFICATIONS

GENERAL SPECIFICATIONS

Pressure Resolution:	0.01 mb (0.001 in Hg)
Altitude Resolution:	0.1 m (1 ft)
Max. Operating Pressure:	1300 mb (38.4 in Hg)
Operating Modes:	Barometer, Altimeter Altimeter Setting, Test
Selectable Data Units:	Pressure - mb, in Hg, mm Hg, psia Altitude - feet, meters Altimeter Setting - in Hg
Sampling Rate (max):	10/second
Selectable Averaging:	1, 10, 100, 1000 samples/average
Selectable Interfaces:	RS-232C or LSTTL Serial (110, 300, 1200, 9600 baud) Parallel (8-bit with handshaking)
Data Format:	Serial ASCII, Parallel ASCII or binary
Power Requirements:	RS-232C +11 to +16 & -11 to -16 vdc 14.5 ma (oper), 8.5 ma (stdby) LSTTL Serial or parallel +8 to +16 vdc 6.3 ma (oper), 10 ua (stdby)
Connector:	AMP CPC 207292-1
Size:	Length - 3.5 in (8.9 cm) Diameter - 3.5 in (8.9 cm)
Weight:	20.5 oz (0.58 kg)
Finish:	Black Anodized Aluminum

APPENDIX C. COMPUTATIONAL PROCEDURES

The indicated pressure output by the barometer is derived from four seperate internal measurements of capacitance. Two measurements sense pressure and temperature. The other two compensate for drift in the analog electronics. These four measurements are used as independent variables in a pressure transfer function. The coefficients of the transfer function are unique for each barometer and are determined by calibration. They are stored in the ROM of the microcomputer. The microcomputer executes floating point routines to evaluate the transfer function, convert to the selected units and compute altitude or altimeter setting.

The indicated altitude is based on the U.S. Standard Atmosphere, 1976. In this model of the atmosphere, altitude is a function of pressure alone. The equation for altitude is:

H = 44330.77 * (1.0 - (P / 1013.25) ** .19026)

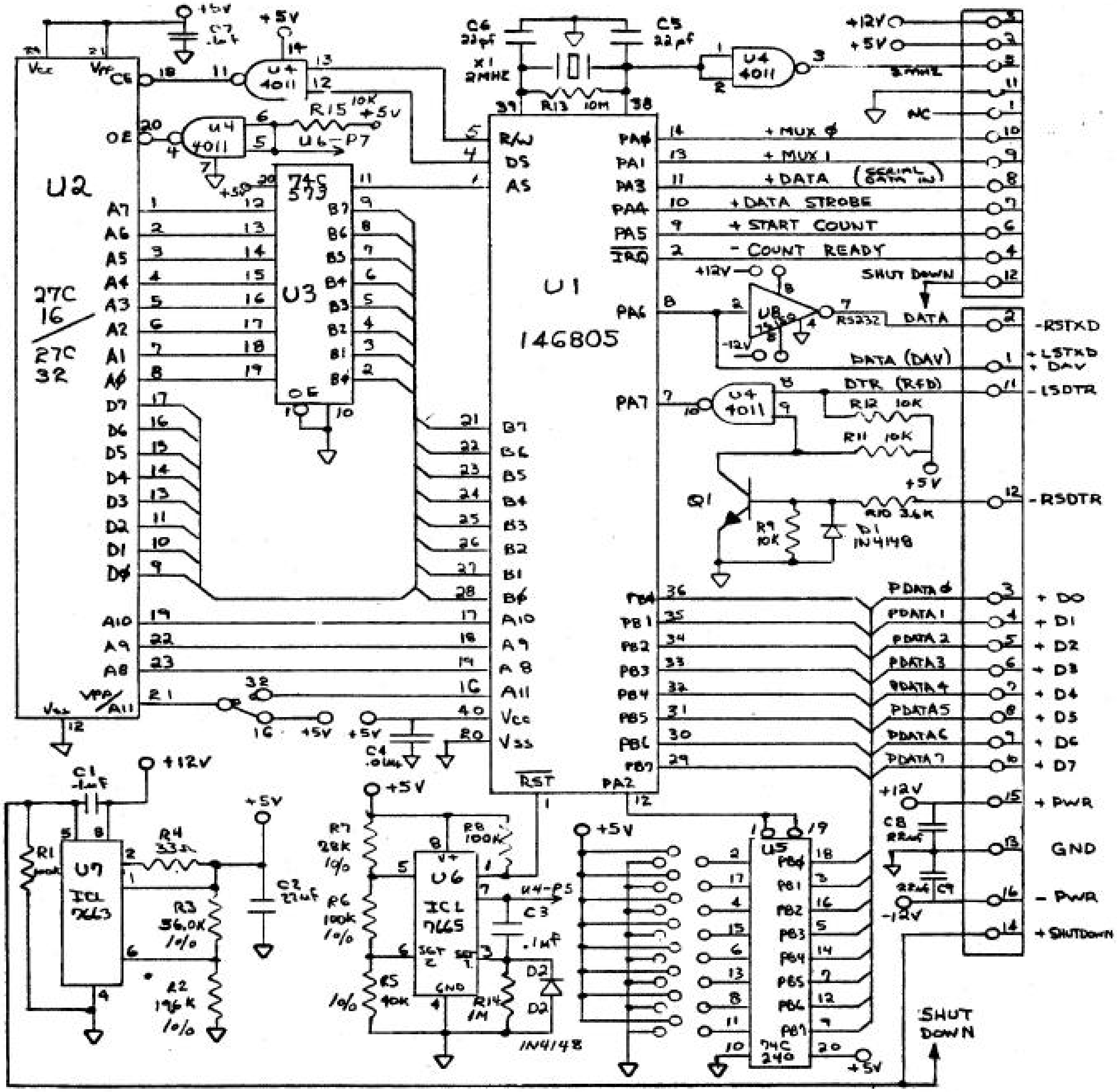
where H = altitude in meters
P = pressure in millibars

The indicated altimeter setting is also based on the U.S. Standard Atmosphere, 1976. The equation for altimeter setting is:

A.S. = 0.02953 * exp(Ln(P) - Ln(1.0 - EL / 44330.77) / 0.19026)

where P = pressure in millibars
EL = elevation in meters stored in ROM during calibration
A.S. = altimeter setting in(Hg)

APPENDIX D. DIGITAL BOARD SCHEMATIC



APPENDIX E. DIGITAL BAROMETER INTERNAL CABLE DIAGRAM

AMP pin	wire color	MOLEX pin	serial output use	parallel output use	signal dir
1	BRN-1	1	+LSTXD	+DAV	out
2	RED-1	2	-RSTXD	nc	out
3	ORG-1	3	nc	+D0	out
4	YEL-1	4	nc	+D1	out
5	GRN-1	5	nc	+D2	out
6	BLU-1	6	nc	+D3	out
7	VIO-1	7	nc	+D4	out
8	GRA-1	8	nc	+D5	out
9	WHT-1	9	nc	+D6	out
10	BLK-1	10	nc	+D7	out
11	BRN-2	11	-LSDTR	+RFD	in
12	RED-2	12	-RSDTR	nc	in
13	ORG-2	13	GROUND	GROUND	
14	YEL-2	14	+SHUTDOWN	+SHUTDOWN	in
15	GRN-2	15	+8 TO +16v	+8 to +16v	
16	BLU-2	16	-8 TO -16v	nc	

AMP CPC
206404-1
Male
Connector

MOLEX
15-25-1561
Female
Connector

5 inch x 16 conductor
ribbon cable

APPENDIX F. DIGITAL BAROMETER EXTERNAL CABLE DIAGRAM

pin	wire color	serial output use	parallel output use	signal dir
1	WHT	+LSTXD	+DAV	out
2	RED	-RSTXD	nc	out
3	BLK	nc	+D0	out
4	BLU	nc	+D1	out
5	GRN	nc	+D2	out
6	ORG	nc	+D3	out
7	WHT/RED	nc	+D4	out
8	RED/BLK	nc	+D5	out
9	BLK/RED	nc	+D6	out
10	BLU/WHT	nc	+D7	out
11	GRN/BLK	-LSDTR	+RFD	in
12	ORG/RED	-RSDTR	nc	in
13	WHT/GRY	GROUND	GROUND	
14	RED/GRN	+SHUTDOWN	+SHUTDOWN	in
15	BLU/BLK	+8 TO +16v	+8 to +16v	
16	GRN/WHT	-8 TO -16v	nc	

AMP CPC 207292-1
Female Connector

7 foot x 16 conductor cable