ASB200 — Motorola Sensor Development Controller Board

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An MC68HC705JP7 based controller board that is part of a systems development tool set for pressure sensors is presented here. When used with a series of companion plug–in modules, it provides a complete systems solution for measuring pressure and developing code.

SENSOR DEVELOPMENT CONTROLLER DESCRIPTION

Function

The development board shown in Figure 1 is designed to receive signal inputs from a series of pressure sensor modules, receive command inputs via a dip switch or a terminal's keyboard, process the input signal, and send results to a terminal or liquid crystal display. Temperature display is an optional output of the system.

The ASB200 Sensor Development Controller will run in two configurations. As delivered, it will operate on its own with the pre–programmed microcontroller supplied with the board. Or, for code development, it will connect to an M68EM05JP7 emulator via an M68CBL05A cable and M68TA05JP7P28 target head adapter, when the microcontroller is removed. The emulator board may be run on either an MMDS05 or MMEVS05 system.

The input connector (P1) connects any one of several plug–in modules. At the time of this publication the following modules are supported by the system's hardware and software:

- **ASB 201: Uncompensated Series Sensor Module**
- **ASB 202: MPX2000 Compensated Series Sensor Module**
- **ASB 205: MPX5000 Integrated Series Sensor Module**
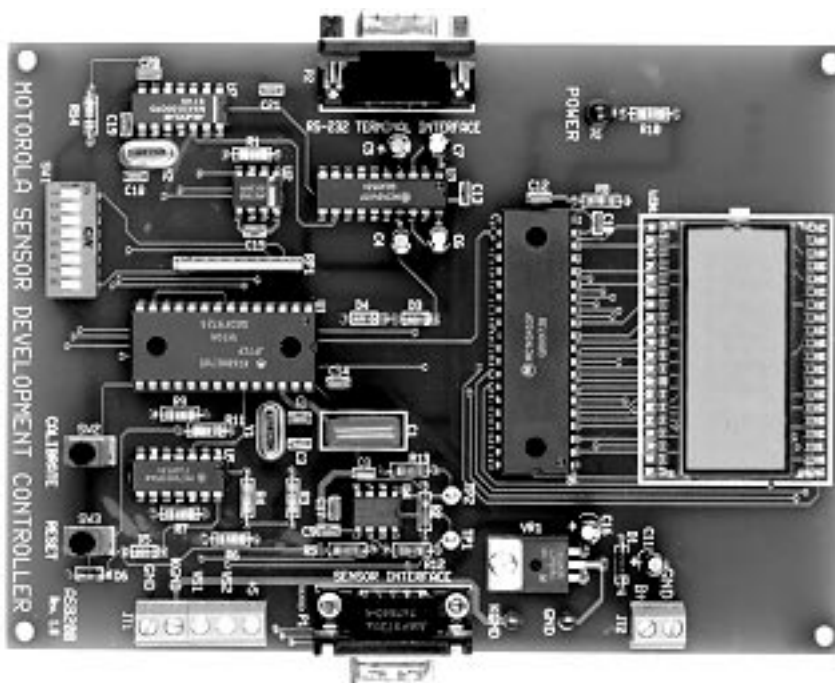- **ASB 210: MPX2010 Low Pressure Module**

Figure 1. ASB200 — Development Controller Board

REV 1

MOTOROLA

Electrical Characteristics

The following electrical characteristics apply to operation at 25 degrees Celsius, and unless otherwise specified B+ = 12 volts.

Table 1. ASB200 Electrical Characteristics

Characteristic	Symbol	Min	Typ	Max	Units
Power Supply Voltage	B+				
— Stand alone		7.5	12	26	Volts
— Connected to ASB201		9.5	12	15.8	Volts
— Connected to ASB202		11.6	12	15.8	Volts
— Connected to ASB205		7.5	12	26	Volts
— Connected to ASB210		22	24	26	Volts
Quiescent Current	I_{CC}	—	25	—	mA
Min Analog Input Voltage	$V_{IN(MIN)}$	50	—	—	mV
Max Analog Input Voltage	$V_{IN(MAX)}$	—	—	5.0	Volts
Buffer Gain					
— VS1 Input	A_{VS1}	—	1.0	—	—
— VS2 Input	A_{VS2}	—	1.0	—	—
Resolution	A/D_{RES}	10	10.5	—	Bits
Output Sink Current	I_{SINK}	—	25	—	mA

Content

The ASB200 controller includes an MC68HC705JP7 microcontroller, liquid crystal display (LCD), RS232 communications interface, EEPROM, a 5 volt regulator, and an analog input interface. Its contents are described in the following parts list, schematics, and pin by pin circuit description. Software is programmed into the microcontroller and is also supplied on an enclosed disk. The disk also includes PSPICE models for Uncompensated, MPX2000, and MPX5000 series sensors.

Table 2. Parts List

Designators	Qty	Description	Manufacturer	Part Number
C1	1	.12 µf Capacitor Polypropylene	Digi–Key	P3214
C2,3,9,18,19	5	22 pf Capacitor Cer	Digi–Key	P4841
C4,5,6,7,11,16	6	1 uF Electrolytic 50V Cap	Digi–Key	P5268
C8	1	.01 uF Cap	Digi–Key	P4904
C10	1	470 pf Capacitor	Digi–Key	P4808
C12,13,14,15,17,20	6	.1UF CAP	Digi–Key	P4910
D1	1	General Purpose Diode	Motorola	1N4002
D2	1	Red LED	Quality Tech	HLMP–4700
D3,D4,D5,D6	4	1N914	—	1N914
LCD1	1	4 DIGIT LCD	AND	FE0202W–DU
P1 SENSOR INTERFACE	1	DB–9 Connector (Male)	AMP	#177597–3
P2 TERMINAL INTERFACE	1	DB–9 Connector (Female)	Mouser	#152–3409
RP1	1	10K 10 PIN SIP Resistor	Digi–Key	770–101–R10K–ND
R1	1	47K Ohm Resistor	Yaego	47K CR–1/4W–B 5%
R2,R5,R12,R13	5	750 Ohm Resistor	Yaego	750 CR–1/4W–B 5%
R3,R4,R6,R7,R9,R11,R14	1	10K Ohm Resistor	Yaego	10K CR–1/4W–B 5%
R8	1	470K Ohm Resistor	Yaego	470K CR–1/4W–B 5%
R10	1	470 Ohm Resistor	Yaego	470 CR–1/4W–B 5%
SW1	1	8 POS DIP SWITCH	Digi–Key	CAN3007
SW2,3	1	SPST Pushbutton Switch	NKK	AB15AP–FA
TP1 V_{out}	1	Test Point Yellow	Components Corp.	TP–104–01–04
TP2 V_{temp}	1	Test Point Yellow	Components Corp.	TP–104–01–04
TP3 KGND, TP4 GND	2	Test Point Black	Components Corp.	TP–104–01–00
JT1	1	5 Screw Terminal Connector	Phoenix Contact	MKDSN 1,5/5–5,08
JT2	1	2 Screw Terminal Connector	Phoenix Contact	MKDSN 1,5/2–5,08
U1	1	Microprocessor MC68HC705JP7	Motorola	MC68HC705JP7
U1X	1	28 pin Socket	Digi–Key	AE7228–ND
U2	1	256 Bit Serial EEPROM	National	NM93C06N 8 PIN DIP
U3	1	RS–232 Driver/Receiver	Motorola	MC145407P
U4	1	Dual Op–Amp	Motorola	MC33502P
U5	1	Quad Bus Driver	Motorola	MC74HC125P
U6	1	32 Segment LCD Driver	Motorola	MC145453P
U7	1	SPI/Microware–Compatible UART	Maxuim	MAX3100CPD 14 PIN DIP
VR1	1	Voltage Regulator	Motorola	MC7805ACT
Y1	1	4.00 MHz Crystal	Digi–Key /CTS	X405–ND
Y2	1	3.6864 MHz Crystal	Digi–Key /CTS	X402–ND
—	2	Insulator for Y1 and Y2	Bivar	C1–192–028
—	1	4–40 x 1/4″ Screw for VR1	—	—
—	1	4–40 Nuts for VR1	—	—
—	6	Self stick rubber feet	Fastex	5033–01–00–5001
ASB200	1	Bare PCB	—	—
ASB200	—	—	—	—

Rev. 1.0
Note 1: All resistors are 1/4 W with a tolerance of 5% unless otherwise noted.
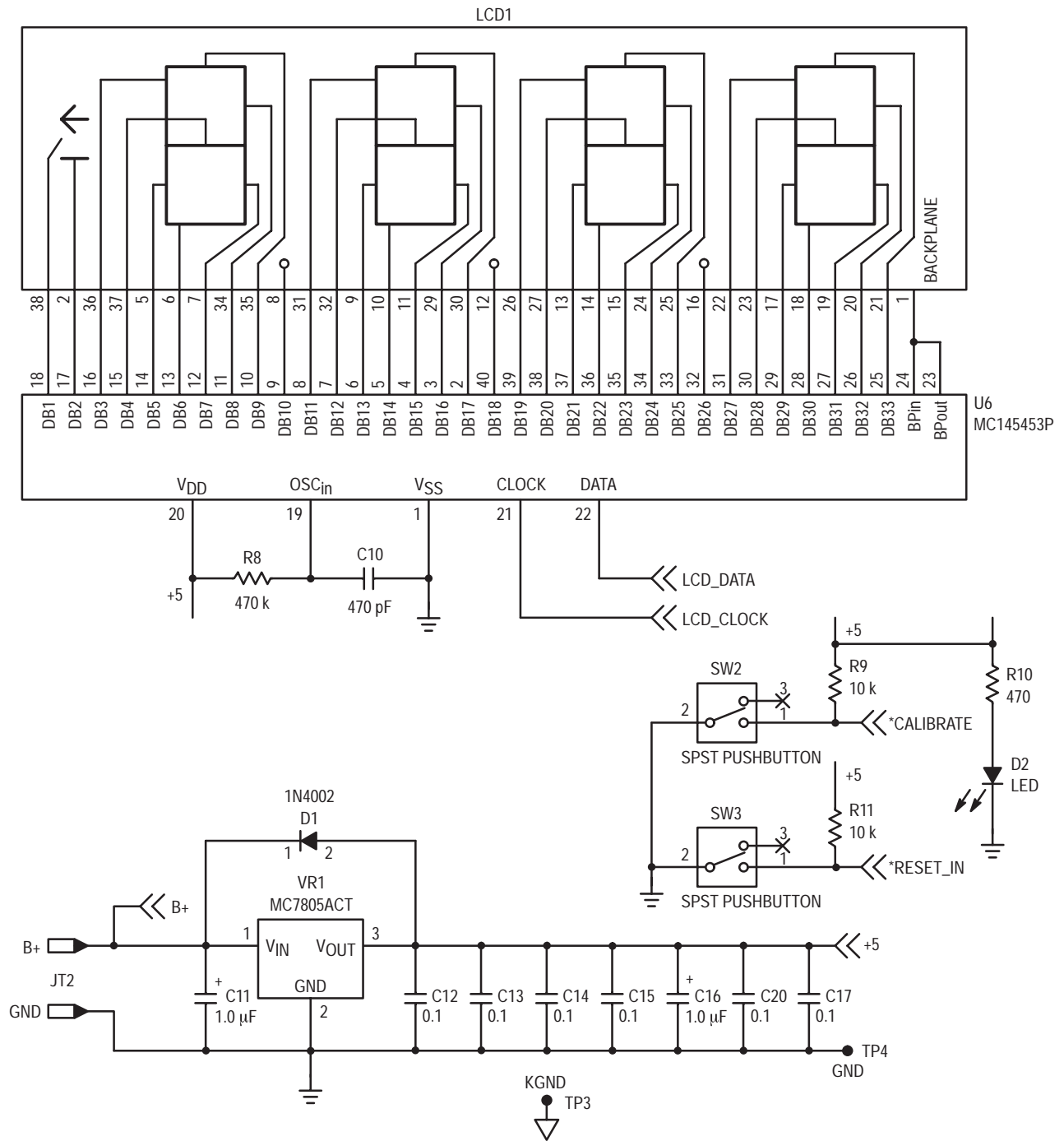
Figure 2a. Schematic

1 UP = AUTO ZERO
2 UP = FULL SCALE CAL
3, 4, 5, 6 = SENSOR TYPE
7, 8 = ENGINEERING UNITS
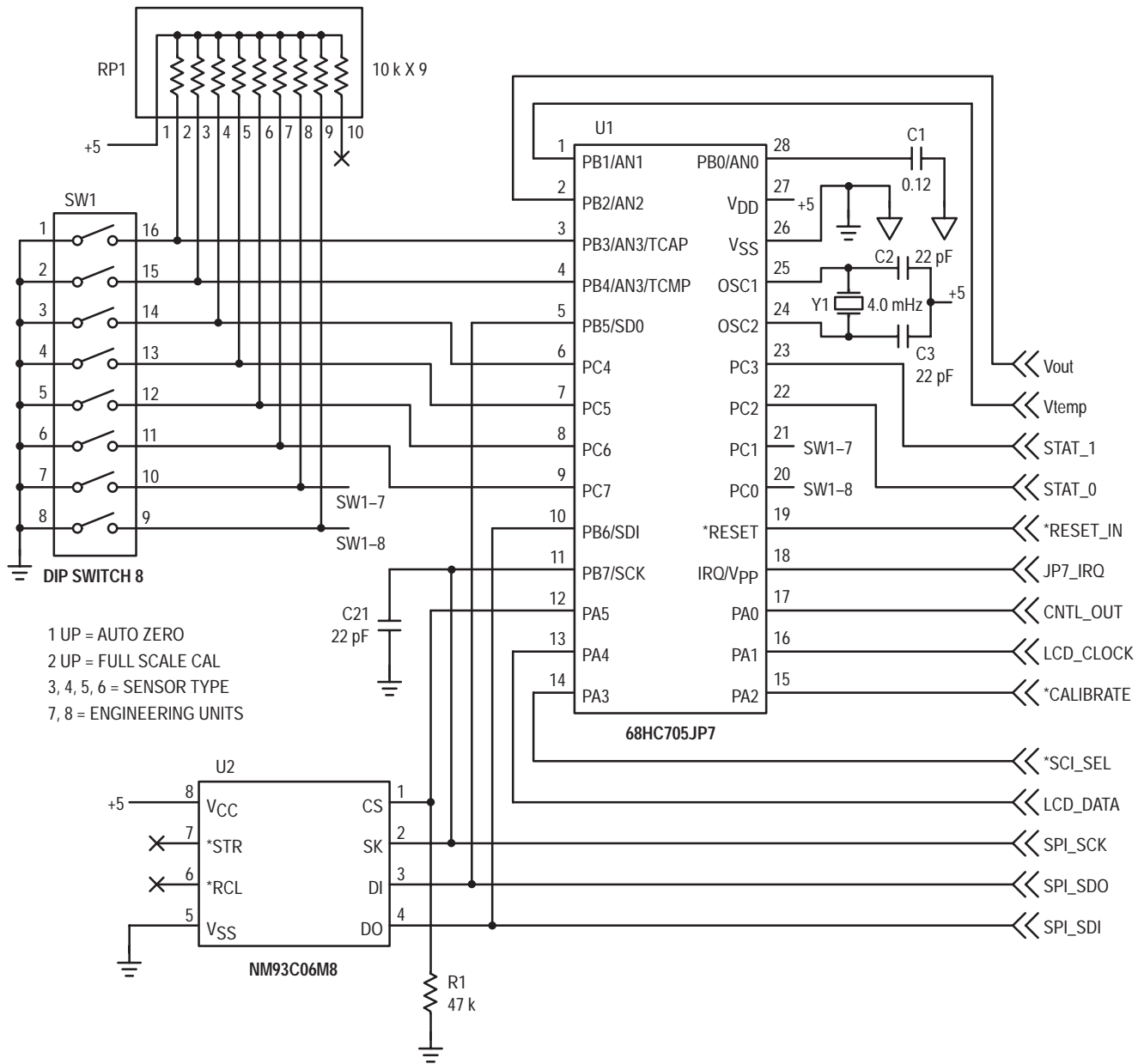
Figure 2b. Schematic

Figure 2c. Schematic

NOTE:
U4 pin 4 connects to GND
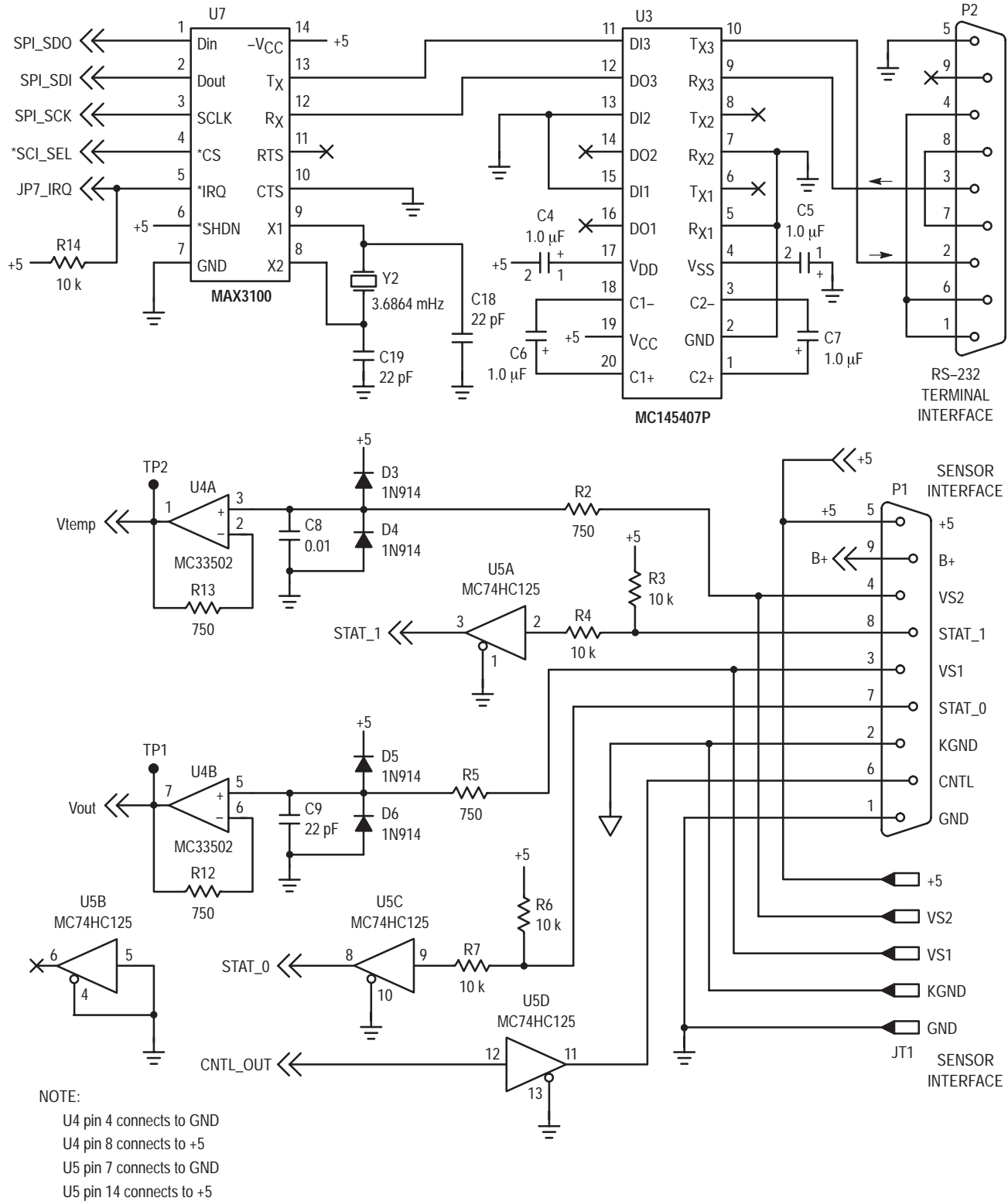U4 pin 8 connects to +5
U5 pin 7 connects to GND
U5 pin 14 connects to +5

Pin by Pin Description

External inputs and outputs are grouped into two DB–9 connectors and two screw terminals. Connector P1 is the interface connection to ASB201, ASB202, ASB205, and ASB210 sensor plug–in modules. Screw terminal JT1, auxiliary sensor interface, is intended for stand alone operation with user supplied code. Screw terminal JT2 is the DC power input connector. Connector P2 is an RS–232 interface connection that allows optional 9600 baud communications with a terminal.

Screw Connector JT2

B+:
B+ is the power supply input. Power supply voltage varies with plug–in module, per Table 1. +12 VDC is the nominal input voltage, except for use with ASB210 plug–in modules, where it increases to +24 VDC.

GND:
The GND terminal on this connector is used as the return for power supply B+.

DB–9 Male Sensor Module Interface Connector P1

P1–1:
Pin 1 is connected to Logic ground.

P1–2:
A connection to Analog Ground is made on Pin 2.

P1–3:
Analog input signal, VS1, is connected to pin 3. When connected to an ASB201, ASB202, ASB205, or ASB210 plug–in module, VS1 is the analog pressure signal. This signal is buffered and connected to A/D mux. AN2.

P1–4:
Analog input signal, VS2, is connected to pin 4. When connected to an ASB201, ASB202, ASB205, or ASB210 plug–in module, VS2 is the analog temperature signal. This signal is buffered and connected to A/D mux. AN1.

P1–5:
Regulated +5 VDC from linear regulator VR1 is supplied on pin 5.

P1–6:
A control signal, $\overline{\text{CNTL}}$, is supplied on pin 6. It is a logic level buffered output from the microprocessor's PORT A, bit 0.

P1–7:
An identification bit, STAT_0, is a logic input that is pulled up, buffered, and routed to the microprocessor's PORT C, bit 2. On plug–in modules ASB201 and ASB202 this bit is grounded. On plug–in modules ASB205 and 210 it is open, and pulled up to a logic 1.

P1–8:
An identification bit, STAT_1, is a logic input that is pulled up, buffered, and routed to the microprocessor's PORT C, bit 3. On plug–in modules ASB201 and ASB205 this bit is grounded. On plug–in modules ASB202 and 210 it is open, and pulled up to a logic 1.

P1–9:
B+ from screw terminal JT2 is connected to pin 9.

Screw Connector JT1

Connections for +5, VS1, VS2, KGND, & GND are wired in parallel with DB–9 connector P1.

DB–9 Female RS–232 Connector P2

P2–1:
Pin 1 is connected to an RS–232 Handshake line, that is also connected to pins P2–4 and P2–6.

P2–2:
Pin 2 is routed to the RS–232 signal output.

P2–3:
Pin 3 is routed to the RS–232 signal input.

P2–4:
Pin 4 is connected to an RS–232 Handshake line, that is also connected to P2–1 and P2–6.

P2–5:
Pin 5 connects to ground.

P2–6:
Pin 6 is connected to an RS–232 Handshake line that is also connected to P2–4 and P2–1.

P2–7:
Pin 7 is connected to an RS–232 Handshake line, that is also connected to P2–8.

P2–8:
Pin 8 is connected to an RS–232 Handshake, that is also line connected to P2–7.

P2–9:
Not connected.

Test Points

Test points TP1 and TP2 provide access to buffered inputs VS1 and VS2, connected to A/D inputs AN2 and AN1 respectively. When connected to an ASB201, ASB202, ASB205, or ASB210 plug–in module, VS1 is the analog pressure signal, and VS2 is the analog temperature signal.

Switches

SW1:
SW1 is an 8 position dip switch that sets mode of operation. It controls autozero, full scale or zero calibration, inputs sensor type, selects Engineering units, and also has a position for restoring factory calibration. The operation section of this document explains switch settings in detail.

SW2:
SW2 is used for calibration and for restoring factory EEPROM calibration values.

SW3:
SW3 provides a processor RESET function to restart the program residing in the 68HC705JP7 microprocessor.

OPERATION

An example, shown in Figure 3, illustrates connections to an ASB202 plug–in module. This arrangement can be run stand alone, or the ASB200 can be connected to an MMDS05 or MMEVS05 emulator system for code development. The two boards are designed such that their P1 connectors mate directly. A short straight–through cable with male and female

DB–9 connectors on the ends may be used between the controller and the plug–in module. Once the two boards are connected together, power supply voltage B⁺ should be set to the range referenced in Table 1 for the plug–in module that is being used. With switch SW1 set up as shipped, when power is turned on, "dLy" will appear on the display for a short time while autozeroing is performed. Once a zero appears, the system is ready for operation. The system has two modes of operation. They are non–terminal and terminal modes. Non–terminal mode is discussed first.
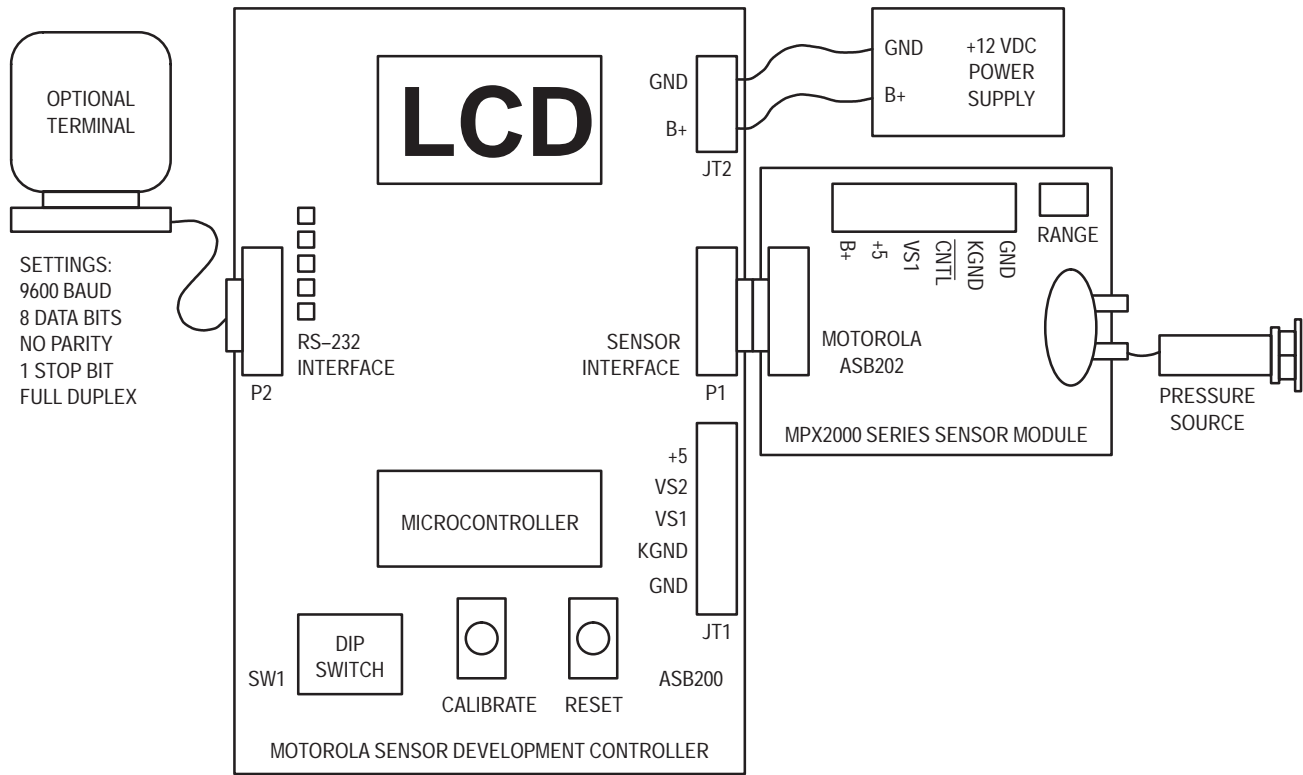
Figure 3. Connections

Non–Terminal Mode

The software looks for several pieces of information. In non–terminal mode, that information is picked–up from the dip–switch SW1. Figure 4 takes a close up look at switch SW1. Position 1 controls the autozero function. In the up position autozero is performed at reset, in the down position autozero is not performed. Switch position two controls calibration. In the up position, full scale is calibrated when the calibrate switch is pushed; and when down, zero is calibrated when the calibrate switch is pushed. Positions 3 through 6 select full scale pressure, select temperature, and contain a switch position for restoring factory calibration values. Positions 7 and 8 on switch SW1 set display units. The choices are inches of water column, kilo Pascals (kPa), and pounds per square inch. As shipped, switch positions are set for autozero, 10 kPa sensors, and kPa. It is not necessary to set switch positions for plug–in module type. The plug–in module is sensed from pins 7 & 8 on connector P1. Table 3 identifies switch SW1 settings.
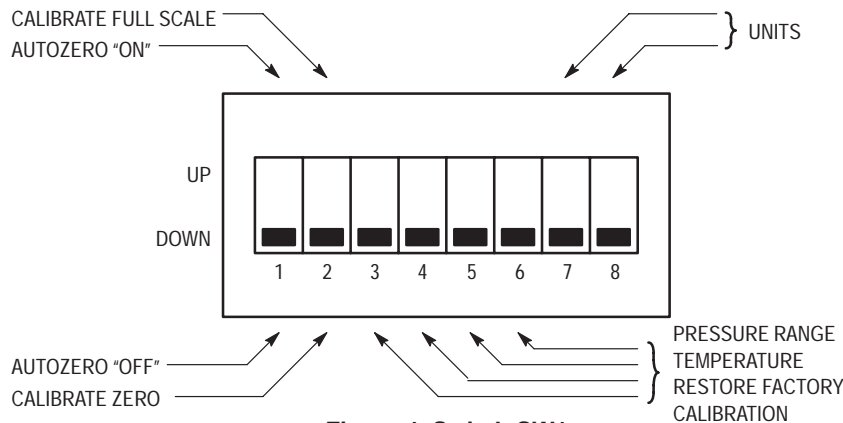

Figure 4. Switch SW1

Table 3A. DIP Switch SW1 Positions 1 & 2

SW1–1	SW1–2	Function
DOWN	—	AUTOZERO "OFF"
UP	—	AUTOZERO "ON"
—	DOWN	CALIBRATE ZERO
—	UP	CALIBRATE FULL SCALE

Table 3B. DIP Switch SW1 Positions 3–6

SW1–3	SW1–4	SW1–5	SW1–6	Sensor
DOWN	DOWN	DOWN	DOWN	6 kPa: MPX5006
DOWN	DOWN	DOWN	UP	10 kPa: MPX10, MPX2010, MPX5010
DOWN	DOWN	UP	DOWN	50 kPa: MPX50, MPX2050, MPX5050
DOWN	DOWN	UP	UP	100 kPa: MPX100, MPX2100, MPX5100
DOWN	UP	DOWN	DOWN	200 kPa: MPX200, MPX2200
DOWN	UP	DOWN	UP	700 kPa: MPX5700
DOWN	UP	UP	DOWN	1000 kPa: MPX5999
DOWN	UP	UP	UP	2.5 kPa: ASB210 with MPX2010 Sensor
UP	UP	UP	DOWN	Temperature
UP	UP	UP	UP	Restore Factory Calibration

Table 3C. DIP Switch SW1 Positions 7 & 8

SW1–7	SW1–8	Display Units
DOWN	DOWN	"H_2O
DOWN	UP	kPa
UP	DOWN	PSI

Calibration

Calibration is a simple process, once dip–switch SW1 is set up for the correct sensor and engineering units. To calibrate zero pressure, set dip–switch SW1 position 2 to the down position, apply zero pressure to the pressure sensor, and press and release the "CALIBRATE" push–button. The display will output "dLy" while the "CALIBRATE" switch is depressed. (Depressing the "CALIBRATE" switch more than once is OK). The EEPROM location, for that sensor family, now has a measured offset calibration value specific to the sensor and sensor module that is being used. When using MPX2000 or MPX5000 series sensors this procedure or autozero is all that is needed for a good measurement.

For the most accurate measurement, full scale can also be calibrated. To calibrate full scale pressure first calibrate zero pressure, then set dip–switch SW1 position 2 to the up position, apply full scale pressure to the pressure sensor, and press and release the "CALIBRATE" push–button. The display will output "dLy" while the "CALIBRATE" switch is depressed. (Again, depressing the "CALIBRATE" switch more than once is OK). The EEPROM location, for that sensor family, now has a measured full scale calibration value specific to the sensor and sensor module that is being used. Full scale is the full scale rating of the sensor type that has been selected, with the exception of ASB210 plug–in modules. For the ASB210, full scale is the full scale pressure rating of the module, which is 10 inches of water. Since calibration values are stored in EEPROM they are retained when power is removed. **NOTE, THAT FOR BEST RESULTS IT IS NECESSARY TO CALIBRATE ZERO PRESSURE BEFORE CALIBRATING FULL SCALE**. That's all there is to it, calibration is complete at this point.

Autozero

Autozero is controlled by dip–switch SW1 position 1. That switch is read at RESET/POWER–UP time. In the up position autozero is performed at power up, in the down position it is not. With SW1 position 1 up at power up, the software will read the sensors output and store its analog value in the EEPROM. As long as SW1 position 1 is in the up position, that "auto–zero" value will be used as the sensor's offset in lieu of any previously stored calibration values. When SW1 position 1 is placed in the down position, the value from the previously described calibration procedure will be used. To force a new "auto–zero" value into EEPROM, set SW1 position 1 up, and depress the "RESET" push–button, or power the system down and back up. A new "auto–zero" value will be written to the EEPROM. You will notice a delay in system start–up when the SW1–1 (auto–zero switch) is in the up position. The display

will read "dLy" during the "auto–zero" sequence. If a terminal is connected to the system, it will output "Waiting for AUTO ZERO to complete", followed by "DONE". The display will then begin to function, based on the configuration of SW1.

Temperature Display

To display temperature, set dip switch SW1 positions 3 through 5 up and position 6 down. With this setting, analog voltage VS2 is used as the input, and degrees Celsius will be displayed. Table 4 contains input voltage, VS2, versus temperature in five degree Celsius increments from 0 to 75 degrees C. The software performs a segmented straight line interpolation of these values. The thermister used in plug–in modules ASB201, ASB202, ASB205, & ASB210 is a Keystone Thermometrics part number MS97 (also available through Digi–Key as part number KC003T).

Table 4. VS2 vs Temperature

Temperature °C	R_T Ohms	VS2 Volts	Temperature °C	R_T Ohms	VS2 Volts
0	32773	1.17	40	5323	3.26
5	25456	1.41	45	4365	3.48
10	19932	1.67	50	3599	3.68
15	15725	1.94	55	2983	3.85
20	12497	2.22	60	2486	4.00
25	10000	2.50	65	2082	4.14
30	8055	2.77	70	1753	4.25
35	6528	3.03	75	1482	4.35

Restoring Factory Calibration Constants/Troubleshooting

To restore default factory calibration constants, set dip switches SW1–1 and SW1–2 in the down position, and SW1–3 through SW1–6 in the up position. Press and release the "CALIBRATE" push–button, located in the lower right of the ASB200 PC board. The display will output "dLy" while the "CALIBRATE" switch is depressed. (Depressing the "CALIBRATE" switch more than once is OK.) The EEPROM now has factory calibration constants transferred to it. **Note that this is the first thing to do when readings don't seem to make sense.** Other items to check include power supply voltage B+, and display units setting. B+ should be in spec, per Table 1, for the plug–in module that is being used. SW1–7 and SW1–8 should be set for the units that you are expecting per Table 3C.

Terminal Mode

The ASB200 serial port P2, labeled RS–232 TERMINAL INTERFACE is always enabled and monitored for activity. Terminal emulation software running on a Personal Computer (PC), will communicate with this port. Settings are listed in Table 5.

Table 5. Terminal Settings

Baud	Data Bits	Parity	Stop Bits	Duplex
9600	8	NO	1	FULL

When commanded to do so, via the terminal, the ASB200 can be switched to TERMINAL MODE, where most control of the system is performed by keyboard menu entries. When TERMINAL MODE is activated, the system continues to use dip switch SW1 position 1 for auto–zero and SW1 positions 3 through 6 for sensor type.

Connecting the ASB200 to an IBM Compatible PC

1. With power removed from the ASB200, and the PC powered off, connect a 9 conductor straight–through cable from the ASB200 connector P2, labeled "RS–232 TERMINAL INTERFACE" to the COM1 or COM2 serial port on the PC.

2. Restore power to the PC.

3. If you are using DOS based communications software such Procomm, set the COM port to COM1 or COM2 depending on which PC port you have cabled to ASB200 connector P2. Set the BAUD rate to 9600, the number of data bits to 8, the number of stop bits to 1 and the parity to NONE. Set the communications mode to full duplex.

4. Restore power to the ASB200 board. The system will start in the non–terminal mode. To activate terminal mode, depress any key on the terminal keyboard. (SW1 must be set per Table 3 when entering terminal mode or the display will display "Err". The error will occur if SW1 was set to display temperature or in the restore factory calibration mode when the system was put in terminal mode). A "Main Menu" will appear on the terminal's display. The menu is shown in Figure 5. Menu choices are driven by a single keystroke. Depressing the "Enter" key on the keyboard is unnecessary.

Follow the instructions on the PC's display while in terminal mode.

Terminal Mode Main Menu

The main menu as shown in Figure 5 allows the following command options:

1. Display the pressure applied to the pressure sensor.

2. Display the temperature of the thermister, located on the pressure sensor plug–in module.

3. Calibrate the system for the sensor's zero pressure offset calibration.

4. Calibrate the system for the sensor's full scale input calibration.

5. Dump the contents of EEPROM. The EEPROM contains the calibration results of menu items 3 and 4, auto–zero values, as well as the display units used in terminal mode. The values displayed are in percent of full scale times 10, i.e., if the one of the values in the EEPROM reads 123, that value indicates an A/D value of 12.3% of V_{ref} or 12.3% of 5 volts.

6. The choices of engineering display units for the pressure sensor are pounds per square inch, kilo Pascal's and inches of water column.

7. You can exit terminal mode by depressing the numeric 7 key on the terminal's keyboard.

8. Factory calculated calibration constants can be reloaded into EEPROM by depressing the 0 numeric key. These constants are approximations of calibration values for the various pressure sensors supported by the system. These constants will overlay any user calibrations that have previously been performed.
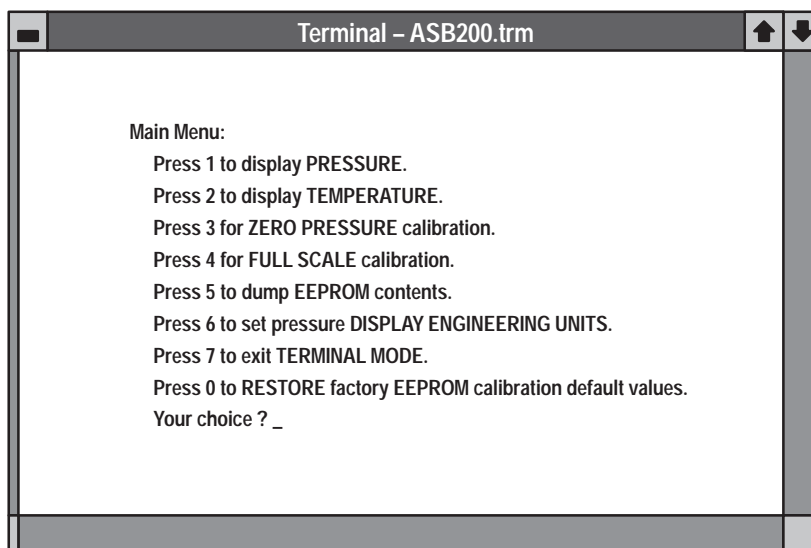


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Terminal – ASB200.trm

Main Menu:
    Press 1 to display PRESSURE.
    Press 2 to display TEMPERATURE.
    Press 3 for ZERO PRESSURE calibration.
    Press 4 for FULL SCALE calibration.
    Press 5 to dump EEPROM contents.
    Press 6 to set pressure DISPLAY ENGINEERING UNITS.
    Press 7 to exit TERMINAL MODE.
    Press 0 to RESTORE factory EEPROM calibration default values.
    Your choice ? _
```

Figure 5. ASB200 Main Menu

DESIGN CONSIDERATIONS

The MC68HC705JP7 microcontroller was chosen for a pressure measurement system reference design because of its 10+ bit A/D converter resolution and its low cost. From a hardware point of view, this microcontroller facilitates a relatively simple design.

Given the ASB200's intended use as a development tool, all inputs and outputs, both analog and digital, are buffered. Analog inputs are buffered with MC33502 operational amplifiers configured for unity gain. These buffers provide a high input impedance, and also present a low source impedance to the JP7's A/D converter inputs. Low impedance at the A/D converter inputs is an important consideration, since the A/D converter's input impedance is nominally 120K ohms, as configured by the ASB200's software. Digital buffering, to and from connector P1, is performed with an MC74HC125 bus driver IC.

The LCD driver, MC145453, is an SIOP compatible peripheral, however, it has no chip select. Due to the lack of a chip select on the LCD driver, a software emulated SIOP was constructed using two I/O lines from the microcontroller.

An SIOP/SPI compatible UART, MAX3100, was added for communications to an optional terminal. A UART could have been software generated by using two I/O lines from the microcontroller. However, due to the amount of interrupt driven functions in the A/D software driver, it made sense to add a true UART to the system.

A small EEPROM is included in the design as a convenient way to store calibration information for the system.

Last but not least, board layout is an important design consideration. In particular, how grounds are tied together influences noise immunity. In order to maximize noise immunity, two grounds are used. Digital ground (GND) is common to the power supply return and serves as a general purpose ground. An analog ground (KGND) ties the analog input return, op amp U1's signal grounds, and C1's ground together before connecting with digital ground at only one point. KGND also runs as a separate trace to P1–2 and the screw terminal labeled KGND on screw connector JT1.

SOFTWARE FUNCTIONAL OVERVIEW

Basic operating software is programmed into the microcontroller supplied with the ASB200 printed circuit board. The software, provides for calibration, reads pressure, reads temperature, and displays the results on a Liquid Crystal Display (LCD). It also provides an output signal, labeled $\overline{CNTL}$, that lights the "RANGE" light on ASB201, ASB202, and ASB205 plug–in modules when full scale pressure is exceeded. When the presence of an ASB210 low pressure module is detected with logic highs at pins 7 and 8 of DB–9 connector P1, this signal is used to control power to the sensor.

Three source modules, a link command file (ASB200.lnk), an I/O file (IO.h), a read me file, and a batch file (ASB200.bat) for compiling and linking the code are contained on a 3.5″ floppy diskette that is included with the ASB200 board. They are in a folder labeled, JP7code. The three source files are asb200.c, crt.s, and vector.c. File asb200.c is a single 'C' source file containing the code that operates the system. File crt.s is an assembly language file containing startup code required by the system, and vector.c is a 'C' source file containing reset and interrupt vector information. These modules are compiled by a compiler from:

Cosmic Software
100 Tower Office Park, Suite C
Woburn, MA 01801
(781) 932–2556

Some source code changes will likely be necessary for compilation with compilers from other vendors. To compile the files, consult the readme.doc file on the diskette. A brief description of each module follows:

<u>crt.s</u>
crt.s is an assembly startup module that zeros RAM, places an op–code in RAM that is used by the C' compiler's runtime support, and calls the main routine.

<u>vector.c</u>
vector.c is a C' source file, containing reset and interrupt vectors.

<u>asb200.c</u>
The following functions are contained in file asb200.c:

p_timer
p_timer is the interrupt service routine used by the input capture hardware. It serves as an A/D completion interrupt for the A/D subsystem. The ramp time for the integrating capacitor is computed here and saved for use by the interrupt routine, c_timer.

c_timer
c_timer is the CPU core's real time interrupt service routine. This routine sets–up the next analog multiplexer address, computes the unknown analog inputs on AN1 and AN2 based on the internal Vdd reference, initiates the next A/D conversion, and performs an infinite impulse filter on conversion results. It also handles analog time–out, if one occurs.

init_io
init_io sets–up the processors I/O ports, switches the oscillator to the external crystal, sets–up the processor's real time interrupt, powers–up the A/D comparators, sets–up the input capture edge, initializes the first A/D mux address, configures the UART driver, configures the LCD driver, and performs an auto zero if requested by dip switch SW1 position 1.

wr_write_siop
wr_write_siop writes a byte to the Simple Synchronous I/O Interface (SIOP) and returns the input data from that port.

write_siop
write_siop writes a byte to the Simple Synchronous I/O Interface (SIOP).

cvt_bin_dec
cvt_bin_dec formats and writes data to the liquid crystal display.

write_lcd
write_lcd writes 8 bits of clock and data to the MC145453 LCD driver IC.

read_temperature
read_temperature computes the temperature based upon the value of analog signal VS2 connected to A/D converter input AN1.

display
display determines which output device receives computed A/D results. The choice is the LCD, UART or both.

ee_wren
ee_wren sends a code enabling data writes to EEPROM.

ee_write
ee_write writes 16 bits of data to the EEPROM at a specified address.

ee_read
ee_read reads a 16 bit word from a specified address in the EEPROM.

config_uart
config_uart configures the UART for 9600 baud, no party, and 2 stop bits. The 2 stop bits are for slow terminals.

read_uart
read_uart reads a character from the terminal. If no character is available, 0 is returned.

write_uart
write_uart writes a character to the terminal.

out_2uart
out_2uart formats and writes integer data to the terminal.

read_pressure
read_pressure computes pressure from the analog voltage, VS1, connected to A/D converter input AN2. Scaling, based on display units and the sensor type, is computed here as well.

dump_eeprom
dump_eeprom outputs the contents of the EEPROM. Calibration contents for the various sensors are displayed as percent of full A/D scale times 10, i.e., the output 400 equals 40% full scale. All values are ratiometric to the +5 volts that is applied to the microcontroller.

print_text

print_text outputs a text string to the terminal until a null (0) character is detected in the string.

restore_eeprom

restore_eeprom transfers factory calibration constants from the program into the EEPROM. These factory constants are approximations of the analog output from the various sensor boards.

menu

menu reads the UART and parses terminal commands.

display_temperature

display_temperature directs temperature values to the terminal, LCD, or both, based on terminal or non–terminal mode.

display_pressure

display_pressure directs pressure values to the terminal, LCD, or both, based on terminal or non–terminal mode.

get_sensor_type

get_sensor_type parses the dip switch, SW1 positions 3 through 6, and returns a sensor type code.

get_eeprom_cal_address

get_eeprom_cal_address retrieves calibration values for the sensor type picked–up by get_sensor_type and the "board ID".

calibrate

calibrate saves the empirical value of the analog voltage from the pressure sensor to the address appropriate for that sensor and board type in EEPROM. This function is used in the non–terminal mode. The calculation for the address of the offset or full scale of the sensor is picked–up from dip switch SW1 position 2.

zero_cal

zero_cal saves the empirical value of the analog offset voltage to the address appropriate for that sensor and board type in EEPROM. This function is used in terminal mode.

full_scale_cal

full_scale_cal saves the empirical value of the full scale analog voltage to the address appropriate for that sensor and

board type in EEPROM. This function is used in the terminal mode.

check_valid_config

check_valid_config uses the "board ID" and dip switch SW1 positions 3 through 6 to determine the validity of the combination. In other words, it looks for invalid sensor type and "board ID" combinations. If an error is detected, the LCD will display "Err" until the error is corrected.

write_lcd_text

write_lcd_text writes a limited text string to the LCD. The string is blank the LCD, "Err" , or "dLy".

main

main checks for a valid sensor type/"board ID" combination and outputs pressure or temperature to the LCD in non–terminal mode. In terminal mode, main outputs the menu message to the terminal, and passes control to the menu routine.

PSPICE Models

In addition to HC05 code, PSPICE models that describe Uncompensated, MPX2000, and MPX5000 pressure sensors are included in a folder labeled MODELS. These models use compound temperature coefficients to describe DC behavior over a −40 to +125 degree Celsius temperature range. Due to extensive use of PSPICE's .PARAMETER function, these models are specific to PSPICE. In addition to the sensors, the instrumentation amplifiers used in ASB201, ASB202, and ASB210 plug–in models are also modeled.

CONCLUSION

The ASB200 Sensor Development Controller is part of a systems development tool set for pressure sensors. It provides an HC05 based platform for reading pressure and developing code. Pressure signals are received from ASB201, ASB202, ASB205, and ASB210 plug–in modules. Together with MMDS & MMEVS software development tools, these products provide a comprehensive tool set that facilitates code development for pressure sensor systems without the necessity for building hardware.

NOTES

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