A parallel breakout box for I/O monitoring

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The construction and use of a parallel breakout box for input/output (I/O) monitoring is discussed. A standard chip for I/O is used along with circuitry, light-emitting diodes, and switches to allow researchers to simulate the running of computer-controlled experiments.

Interfacing a microcomputer to experimental apparatus is often done through a parallel port. The ease of interfacing is due largely to the use of programmable large-scale integrated circuit (LSI) interface chips, which can handle different applications, and to the fact that changes and corrections can be made in software rather than by rewiring. Two of the more popular LSI interface chips that can be used with the 6502 microprocessor are the 6821 peripheral interface adapter (PIA, available from California Computer Systems, 250 Caribbean Dr., Sunnyvale, CA 94086) and the 6522 versatile interface adapter (VIA, available from J. Bell Engineering, P.O. Box 338, Redwood City, CA 94064). Here we discuss the construction and use of a parallel interface breakout box designed

Figure 1. A diagram of the parallel breakout box.

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Table 1
Parts List

Number	Part	Approximate Cost
4	4049 CMOS hex inverters	\$ 2.00
6	Grayhill toggle dip switches No. 76STCOA	12.00
24	Red LED	3.00
24	1 k Ω .25 W	.25
1	Hammond box 1444-10	2.00
1	7805 5-V regulator TO-220 package	1.00
1	500- μ 25-V electrolytic capacitor	.50
1	.1- μ 10-V tantalum capacitor	.75
1	.25-A fuse	.20
1	Fuse block panel mount	.50
1	DB-25 connector (male)	2.50
1	3-conductor power cable with molded plug	2.00
1	Strain relief for power cable	.10
1	Vero wirewrap board (3.75 $\times$ 5.75 in.)	.50
6	Standoffs .5 in. with mounting hardware	.10
Many	T44DP wirewrap posts to mount leads, resistors, etc.	
7	16 pin wirewrap dip sockets	2.00
6	14 pin wirewrap dip sockets	1.50
1	1-A 50-V bridge rectifier	1.50
1	Hammond transformer model 166G6	6.00
Total		\$38.40

Figure 2. Schematics for construction of the parallel breakout box.

specifically for use with the CCS 7720. The box is readily adaptable for use with the VIA parallel interface.

The parallel breakout box is a simple input/output (I/O) monitoring device to enable Apple II users to quickly determine the PIA card setup. More importantly, it allows a researcher to simulate running an experiment with or without the external devices attached. This allows quick determination of software applicability and the detection of equipment malfunction. Inclusion of a breakout box at each computer workstation of different apparatus allows quick and easy attachment to the computer.

The design approach is based on the simplicity of the PIA itself (Leventhal, 1979). The device contains two 8-bit I/O ports and four individual control lines. Thus, the

breakout box should be able to monitor a minimum of 20 TTL I/O lines. We chose to monitor the output status by use of light-emitting diodes (LEDs). With bit switches, any bit pattern (16 bits maximum) can be input to the PIA by the breakout box. The four control lines can also be controlled by the bit switches. Connections are made via the standard DB25 pin connector and 16 pin DIPS. The breakout box is illustrated in Figure 1.

CONSTRUCTION OF THE BREAKOUT BOX

The electronics (Figure 2) are simply replicated for each of the 20 lines coming from the PIA. All that is needed is a hex inverter (4049), 1-k Ω resistor, switch, and LED

for each line. The electronics are mounted directly on a wirewrap Vero board that is then enclosed in a Hammond 1444-10 aluminum case. By the use of standoffs, the board is mounted so that all the LEDs and Grayhill toggle DIP switches protrude through the front panel. To make the box versatile, a DB25 connector is also mounted on the side panel of the case. Access to the PIA I/O lines is also possible via 16 pin DIP sockets on the front panel. Power for the interface comes from the host computer or suitable supply. A parts list is presented in Table 1.

USE OF THE PARALLEL BREAKOUT BOX

Software support for the breakout box is listed in the Appendix. One can either determine a bit pattern to send out to the box or read the information from the bit pattern of switches. Thus, prior to running an experiment, the apparatus can be tested by simply connecting to the breakout box. Similarly, the software to control experimental apparatus can be run without the actual apparatus. In this case, the breakout box simply simulates the apparatus.

REFERENCE

LEVENTHAL, L. A. (1979). *Assembly language programming*. Berkeley, CA: Osborne/McGraw-Hill.

APPENDIX

Software Support for the Breakout Box

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1  REM ***** PARALLEL BREAKOUT BOX *****
2  REM R MASKELL, D GOODMAN
3  REM DEPT OF KINESIOLOGY
4  REM S.F.U., BURNABY, B.C., V5A 1S6
5  REM MAY 1984
10 ZZ = 49312
11 REM ZZ IS THE SLOT ADDRESS FOR THE PIA CARD. SLOT 2 IS USED.
12 REM TO UNDERSTAND THE ADDRESSING OF THE PIA 6821 CHIP OBTAIN A DATA SHEET
20 HS = "0123456789ABCDEF": DIM N(2,60):K = 7:L = 48: DIM BS(2)
30 OS = CHR$(4)
100 HOME: PRINT TAB(6); "PIA/BREAKOUT BOX TESTER"
110 PRINT
120 PRINT "*****"
130 PRINT
140 PRINT "MENU FOR TEST"
150 PRINT: PRINT
160 PRINT "1/ PIA TEST"
170 PRINT "2/ P18 TEST"
180 PRINT "3/ P1C TEST"
190 PRINT "4/AUTOMATIC TEST"
200 PRINT: PRINT
210 INPUT "SELECT TEST MODE (1-4):";NN
215 GOSUB 1000
220 ON NN GOTO 500,600,700,800
500 PRINT "PIA TEST": PRINT
505 IF TS = "I" THEN 550
510 GOSUB 2000
515 INPUT A1: IF A1 = 256 THEN 100
530 POKE ZZ,A1
540 QS = STR$(A1): GOSUB 4320
545 GOTO 515
550 GOSUB 3000
560 A1 = PEEK(ZZ)
570 QS = STR$(A1)
575 GOSUB 4320
580 INPUT AS: IF VAL(AS) = 256 THEN 100
595 GOTO 560
600 PRINT "P18 TEST": PRINT: PRINT

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605 IF TS = "I" THEN 650
610 GOSUB 2000
615 INPUT A1: IF A1 = 256 THEN 100
620 POKE ZZ + 2,A1
630 QS = STR$(A1): GOSUB 4320
635 GOTO 615
650 GOSUB 3000
660 A1 = PEEK(ZZ + 2)
670 QS = STR$(A1): GOSUB 4320
680 INPUT AS: IF VAL(AS) = 256 THEN 100
690 GOTO 660
800 PRINT "AUTOMATIC TEST"
812 GOSUB 820
816 GOSUB 820
818 GOTO 100
820 FOR QQ = 1 TO 255
825 A1 = 255 - QQ
830 POKE Z,A1
835 PRINT QQ
840 FOR W = 1 TO 100
850 NEXT W
860 NEXT QQ
870 RETURN
1000 REM INPUT OR OUTPUT TEST
1010 PRINT: PRINT
1020 INPUT "INPUT OR OUTPUT TEST (I-O)";TS
1025 HOME
1030 IF TS = "O" THEN 1100
1035 PRINT TAB(12); "INPUT TESTING": PRINT
1040 POKE ZZ + 1,0
1041 POKE ZZ,0
1042 POKE ZZ + 1,4
1043 POKE ZZ + 3,0
1044 POKE ZZ + 2,0
1045 POKE ZZ + 3,4
1050 RETURN
1100 POKE ZZ + 1,0
1101 POKE ZZ,255
1102 POKE ZZ + 1,4
1103 POKE ZZ + 3,0
1104 POKE ZZ + 2,255
1105 POKE ZZ + 3,4
1106 PRINT TAB(12); "OUTPUT TESTING": PRINT
1110 RETURN
2000 REM INPUT FOR OUTPUT CODES TEST
2010 PRINT "KEYBOARD IN CODE (0-255,256 EXITS)"
2030 RETURN
3000 REM INPUT CODE PROMPT
3010 PRINT "SET BOX DIP SWITCHES TO BINARY CODE"
3015 PRINT "KEYBOARD 256 EXITS"
3020 RETURN
4000 BS(1) = "": BS(2) = ""
4020 FL = 0: Q = LEN(QS): FOR T = 1 TO Q: N = ASC(MID$(QS,T,(T+1)))
4030 W = N - (K * (N > 64)) - L: IF N < 0 THEN 4290
4040 N(I,T) = N: NEXT T: IF FL THEN 4060
4050 QS = QS + "+" : GOTO 4020
4060 S = 0: B = 0: FOR T = Q TO PA + 1 STEP - 1: GOSUB 4280: NEXT T
4070 A = B: B = 0: S = 0: FOR T = PA - 1 TO 1 STEP - 1: GOSUB 4280: NEXT T
4080 AA = A: IF SS THEN AA = -A
4090 MIS = "": IF (B + AA) < 0 THEN MIS = "-"
4100 C = ABS(B + AA): IF C < > 0 THEN 4120
4110 BS(1) = "0": BS(2) = "0": GOTO 4200
4120 Z = 1: QP = 2: C = GOSUB 4140: HB = H: QP = 16: Z = 2: GOSUB 4140: HB = H
4130 GOTO 4170
4140 H = INT((LOG(Q) / LOG(QP)) + 1): FOR U = 1 TO H: T = 1 + H - U
4150 HP = QP ^ T
4152 LP = QP ^ (T - 1)
4153 QA = ((Q / HP) - INT(Q / HP)) * HP
4154 QB = ((Q / LP) - INT(Q / LP)) * LP
4155 N(Z,U) = (QA - QB) / LP
4160 NEXT U: RETURN
4170 FOR Z = 1 TO 2: F = HB: IF Z = 2 THEN F = HH
4180 FOR T = 1 TO F: Q = N(Z,T) + 1: LS = MID$(HS,Q,1)
4190 BS(Z) = BS(Z) + LS: NEXT T: NEXT Z
4200 W = LEN(BS(1)): IF W = 8 THEN 4220
4210 FOR W1 = 1 TO 8 - W: BS(1) = "0" + BS(1): NEXT W1
4220 W = LEN(BS(2)): IF W = 2 THEN 4240
4230 BS(2) = "0" + BS(2)
4240 PRINT TAB(4); C;
4250 PRINT TAB(16); BS(2);
4260 PRINT TAB(22); BS(1): PRINT
4270 RETURN
4280 B = B + ((N(I,T) * (P ^ S))) : S = S + 1: RETURN
4290 IF N < - 3 THEN 4310
4300 SS = (N = - 3): PA = T: FL = 1: GOTO 4040
4310 PRINT: PRINT "ENTRY ERROR": PRINT: GOTO 4240
4320 REM NOW AT LINE 20
4325 MS = "D": D = 1: H = 0: B = 0
4350 P = 2 + (8 * D) + (14 * H)
4360 PRINT: PRINT "DECIMAL" HEX BINARY"
4380 GOTO 4000

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