JOHN BELL ENGINEERING, INC.

6522 PARALLEL INTERFACE

79-295

JOHN BELL ENGINEERING'S 6522 PARALLEL INTERFACE FOR THE APPLE II® COMPUTER PLUGS DIRECTLY INTO ANY SLOT 1 THROUGH 7 IN THE APPLE®. THIS CARD INCORPORATES TWO 6522 VERSATILE INTERFACE ADAPTERS. EACH 6522 PROVIDES:

* TWO 8 BIT BIDIRECTIONAL I/O PORTS
* TWO 16 BIT PROGRAMMABLE TIMER/COUNTERS
* SERIAL SHIFT REGISTERS
* HANDSHAKING

FOUR 16 PIN SOCKETS PROVIDE EASY CONNECTION TO PERIPHERAL DEVICES. (DIP JUMPERS WITH RIBBON CABLES ARE ALSO AVAILABLE FROM JOHN BELL ENGINEERING).

THE 6522 PARALLEL I/O CARD INTERFACES TO THE JBE A-D AND D-A CONVERTER, SOLID STATE SWITCHES AND EPROM PROGRAMMER.

THE EPROM PROGRAMMER, PARALLEL I/O CARD AND APPLE II® COMPUTER CONSTITUTE A COMPLETE DEVELOPMENT SYSTEM FOR THE JBE 6502 CONTROL COMPUTER. YOU CAN DEVELOPE YOUR PROGRAMS ON THE APPLE® AND PROGRAM EITHER 2716S OR 2532S FOR USE IN THE CONTROLLER (JBE PART #80-153).

INCLUDED IN THE DOCUMENTATION FOR THE PARALLEL I/O CARD ARE A SCHEMATIC DIAGRAM, 6522 DATA SHEET, REGISTER AND ADDRESSING DATA, SAMPLE PROGRAM AND STEP BY STEP EXPLAINATION OF CARD USE.

THERE IS A SOLDER JUMPER ON THE BACK OF THE CARD TO PROVIDE 12V FOR THE EPROM PROGRAMMER AND OTHER PERIPHERAL CARDS. NMI AND IRQ FEED THROUGHS ARE ALSO PROVIDED.

PARTS LIST

INTEGRATED CIRCUITS

U1, U2	6522
U3	74LS05

CAPACITORS

C1, C2, C3	.1 DISC
C4	10 PF DISC

RESISTORS 5% ¼ WATT

R1,R2	1K
R3,R4	4,7K

SOCKETS

2	40 PIN
4	16 PIN
1	14 PIN

1 79-295 CIRCUIT BOARD

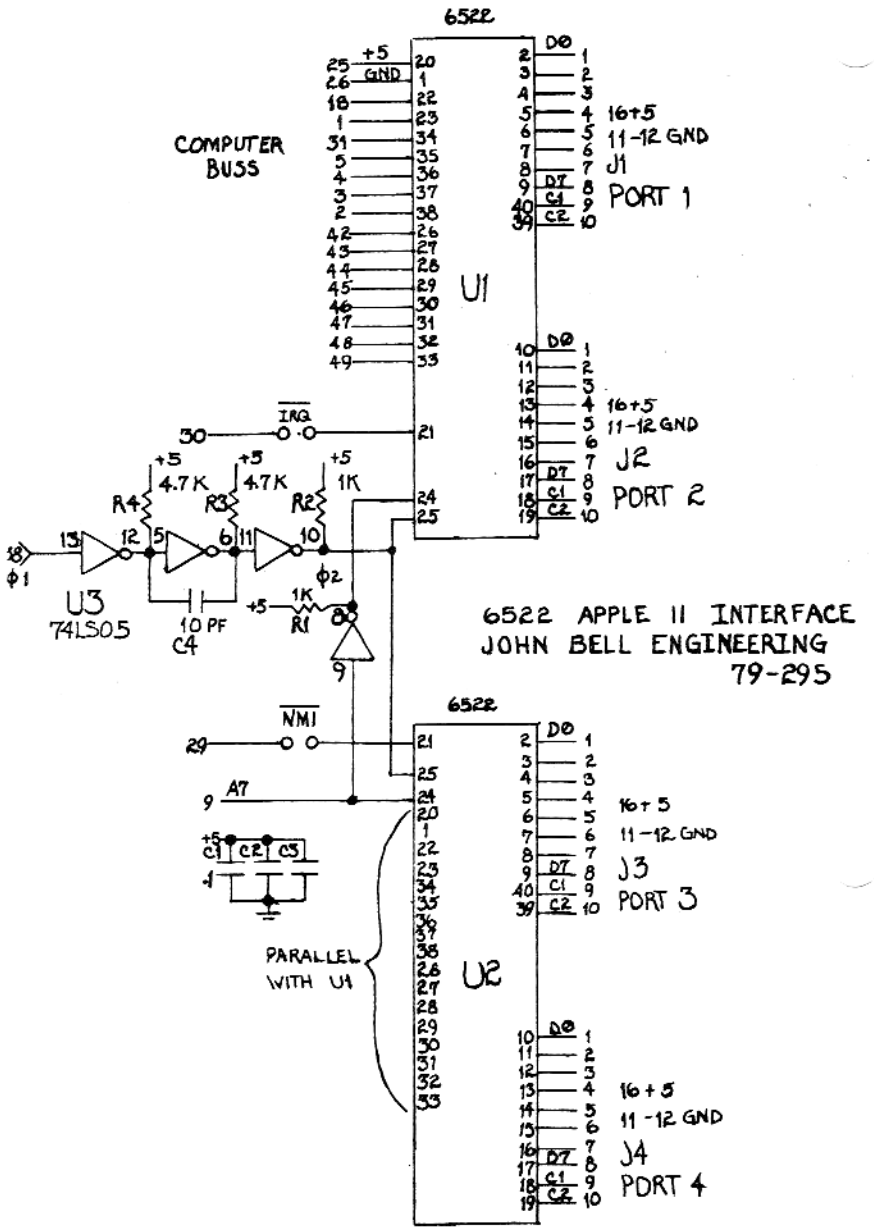
REGISTER ADDRESSSING

U1 - 6522

00 - ORB, IRB (PORT 2)
*01 - ORA, IRA (PORT 1)
02 - DDRB (DATA DIR. PORT 2)
03 - DDRA (DATA DIR. PORT 1)
04 - T1L-L
05 - T1C-H
06 - T1L-L
07 - T1L-H
08 - T2L-L, T2C-L
09 - T2C-H
0A - SR
0B - ACR
0C - PCR
0D - IFR
0E - IER
0F - ORA

U2 - 6522

80 - ORB, IRB (PORT 4)
81 - ORA, IRA (PORT 3)
82 - DDRB (DATA DIR. PORT 4)
83 - DDRA (DATA DIR. PORT 3)
84 - T1L-L
85 - T1C-H
86 - T1L-L
87 - T1L-H
88 - T2L-L, T2C-L
89 - T2C-H
8A - SR
8B - ACR
8C - PCR
8D - IFR
8E - IER
8F - ORA



CIRCUIT DESCRIPTION

THIS CIRCUIT USES A PAIR OF 6522 VIAS EACH HAVING TWO PARALLEL PORTS. THIS GIVES A TOTAL OF FOUR 8 BIT I/O PORTS. THESE PORTS ARE CONNECTED TO CONNECTORS J1, J2, J3 & J4. THEY ARE LABELED PORT 1, PORT 2, PORT 3 AND PORT 4 (SEE BELOW). THESE CONNECTORS ARE 16 PIN DUAL IN-LINE CONNECTORS THAT CONNECT TO A STANDARD RIBBON CABLE. EACH CONNECTOR HAS 8 DATA LINES, 2 HANDSHAKING LINES, +5 AND GROUND. THE APPLE® BUS DOES NOT NORMALLY WORK WITH 6522 VIAS BECAUSE OF TIMING ERRORS IN THE BUS. A 74LS05 WAS ADDED TO SHIFT THE ENABLE TIMING FOR THE 6522. THE 74LS05 ALSO TAKES CARE OF ADDITIONAL ADDRESSING REQUIRED TO KEEP THE 6522S FROM INTERFERING WITH EACH OTHER.

I/O PORT CONNECTORS

J1 - PORT 1
J2 - PORT 2
J3 - PORT 3
J4 - PORT 4

PIN #	SIGNAL
1	0 DATA LINE
2	1 " "
3	2 " "
4	3 " "
5	4 " "
6	5 " "
7	6 " "
8	7 " "
9	CA1, CB1
10	CA2, CB2
11-12	GND
16	+5

NMI AND IRQ JUMPERS CAN BE INSTALLED.

THE FOLLOWING DISCUSSES HOW TO OPERATE THE CIRCUIT BOARD USING PORT 1 AS AN INPUT PORT AND PORT 2 AS AN OUTPUT PORT. IT MUST FIRST BE DECIDED WHERE TO PUT THE CIRCUIT BOARD. THE APPLE II® HAS 8 SLOTS NUMBERED 0 THROUGH 7. THE PARALLEL INTERFACE CARD WILL ONLY WORK IN SLOTS 1 THROUGH 7. FOR THIS EXAMPLE WE WILL USE SLOT 1 WHICH IS THE SECOND SLOT FROM THE LEFT IN YOUR COMPUTER.

WITH THE COMPUTER OFF, INSERT THE PARALLEL I/O CARD IN SLOT NUMBER 1. BY LOOKING AT THE ADDRESSING DATA CHART YOU CAN SEE THAT IN SLOT 1 THE ADDRESS OF THE BOARD IS C1XX. C1 IS THE BASE HIGH ORDER ADDRESS OF THE CIRCUIT BOARD. DURING THIS DISCUSSION IT IS IMPORTANT THAT YOU INDERSTAND THE OPERATION OF THE APPLE® SYSTEM MONITOR COMMANDS WHICH CAN BE REVEIWED ON PAGE 68 OF THE RED APPLE II REFERENCE MANUAL.

NOW TURN THE COMPUTER ON. HIT RESET, THIS RESETS THE COMPUTER AND THE I/O CARD. WHEN THE I/O CARD IS RESET, ALL OF THE PORTS BECOME INPUT PORTS. IN OUR EXAMPLE WE WANT PORT 1 TO BE AN INPUT PORT AND PORT 2 TO BE AN OUTPUT PORT. WE MUST THEREFORE CHANGE SOME DATA IN THE 16 REGISTERS IN THAT 6522.

IF YOU LOOK AT THE REGISTER ADDRESSING OF U1 ON PAGE 2 OF THE DOCUMENTATION, YOU WILL SEE THE 16 REGISTERS IN THAT 6522. REGISTERS 0 AND 1 ARE INPUT/OUTPUT REGISTERS. REGISTERS 2 AND 3 ARE DIRECTION REGISTERS FOR PORT NUMBER 2 AND 1 RESPECTIVELY. IF YOU TYPE C100.C103 INTO THE COMPUTER, IT WILL LIST OUT THE DATA IN THOSE REGISTERS. BECAUSE THERE IS NOTHING CONNECTED TO THOSE PORTS AND THE COMPUTER WAS JUST RESET, THE INPUT PORTS 0 AND 1 WILL BOTH HAVE FF IN THEIR REGISTERS AND THE DATA DIRECTION PORTS WILL BOTH BE 00 INDICATING INPUT PORTS. WITH NOTHING CONNECTED TO THE INPUT PORTS, THE INPUTS NORMALLY FLOAT TO A LOGIC 1 LEVEL. THIS IS WHY YOU GET THE FF IN THE INPUT PORT ADDRESSES.

TO MAKE PORT 2 AN OUTPUT PORT, WE HAVE TO CHANGE THE DATA IN THE DATA DIRECTION REGSTR WHICH IS REGISTER 2. BY LOADING THE REGISTER WITH THE NUMBER FF WE WILL MAKE ALL 8 LINES OF PORT 2 BE OUTPUTS. THIS OPERATION WOULD NORMALLY BE DONE BY A PROGRAM WRITTEN FOR THIS PURPOSE. FOR PURPOSES OF DEMONSTRATION, WE WILL DO THIS MANUALLY.

THE SYSTEM MONITOR COMMAND TO CHANGE THE DATA IN MEMORY LOCATION IS THE ADDRESS, THEN THE COLON, THEN THE DATA, THEN CARRIAGE RETURN. IN THIS CASE, THE ADDRESS IS C102. YOU SHOULD THEREFORE TYPE C102:FF THEN A CARRIGAE RETURN. NOW LOOK AT THE REGISTERS BY TYPING C100.C103 CARRIAGE RETURN. YOU SHOULD SEE C100-00 FF FF 00 ON THE SCREEN. THIS INDICATES THAT REGISTER 0 HAS 0 IN IT, REGISTER 1 HAS FF IN IT, REGISTER 2 HAS FF IN IT AND REGISTER 3 HAS 0 IN IT. AT J2 WHICH IS THE OUTPUT PORT 2, ALL THE 8 DATA LINES ARE AT THE LOGIC 0 LEVEL. ANY DATA TO COME OUT OF PORT 2 J2 CAN BE LOADED INTO C100 AND IT WILL APPEAR AT PORT 2.

NOW LOAD THE NUMBER 55 INTO THE OUTPUT PORT 2. TO DO THIS YOU TYPE C100: 55 CARRIAGE RETURN. THE REASON FOR USING THE NUMBER 55 IS THAT IF YOU WERE TO CHECK THE DATA BITS AT THE OUTPUT PORT YOU WOULD SEE THAT PIN 1 OF J1 IS LOGIC LEVEL 1 AND PIN 2 IS LOGIC LEVEL 0. PIN 3 IS LOGIC LEVEL 1, PIN 4 IS LOGIC 0, PIN 5 IS LOGIC 1, PIN 6 IS LOGIC 0, PIN 7 IS LOGIC 1 AND PIN 8 IS LOGIC 0. YOU CAN VERIFY THIS BY TYPING C100.C103 CARRIAGE RETURN. ON THE SCREEN YOU SHOULD SEE C100- 55 FF FF 00. THESE REGISTERS CAN ALSO BE ACCESSED USING APPLE II INTEGER BASIC. WHEN USING INTEGER BASIC, YOU MUST REMEMBER THAT THIS IS AN 8 BIT COMPUTER INDICATING 256 DIFFERENT COMBINATIONS RANGING FROM 0 TO 255. ANY POKE COMMANDS OUT OF THIS RANGE WILL CAUSE A GREATER THAN 255 ERROR.

THE FOLLOWING IS A LISTING OF THE INTEGER BASIC PROGRAM WHICH OUTPUTS THE NUMBERS 0 THROUGH 255 INCREMENTING ONE A TIME OVER AND OVER AGAIN. THIS PROGRAM OUTPUTS ON PORT 2 WHICH IS CONNECTOR J2:

```
10 POKE -16126,255
20 FOR X=0 TO 255
30 POKE -16128,X
40 NEXT X
50 GOTO 20
```

LINE 10 SAYS PORT 2 TO BE AN OUTPUT PORT.
LINE 20 & 40 ARE FOR NEXT LOOP TO KEEP INCREMENTING THE VALUE OUTPUT TO THE PORT.
LINE 30 ACTUALLY OUTPUTS THE DATA TO THE PORT.
LINE 50 STARTS THE WHOLE PROCESS AGAIN.

WHAT IS HEXIDECIMAL?

HEXIDECIMAL IS A NUMBERING SYSTEM WITH A BASE OF 16. IT USES THE NUMBERS 0 THROUGH 9 AND THE LETTERS A THROUGH F. THE REASON FOR USING HEXIDECIMAL NUMBERS (HEX NUMBERS) IS TO MAKE IT EASIER TO WRITE ADDRESSES AND DATA IN A MICROCOMPUTER SYSTEM. THE 6502 PROCESSOR HAS 16 ADDRESS LINES AND 8 DATA LINES. IF WE USE BINARY, WHICH IS WHAT THE COMPUTER USES TO COMPUTE WITH, EACH ADDRESS WOULD BE 16 DIGITS LONG AND CONTAIN ONLY ONES AND ZEROS. EACH MEMORY LOCATION WOULD HAVE 8 DIGITS ALL BEING ONES AND ZEROS. ONE HEX DIGIT REPRESENTS 4 BINARY DIGITS. FOR EXAMPLE, THE HEX DIGIT 8 REPRESENTS 1000 IN BINARY AND THE HEX DIGIT F REPRESENTS THE BINARY NUMBER 1111. CONSEQUENTLY, BY USING THE HEX NUMBERING SYSTEM, WE CAN NOW REPRESENT A 16 BIT ADDRESS WITH ONLY 4 HEX DIGITS. WE CAN ALSO REPRESENT AN 8 BIT MEMORY LOCATION USING ONLY 2 HEX DIGITS. THE JBE I USES THE HEX NUMBERING SYSTEM AND REQUIRES ALL 4 DIGITS FOR START AND END ADDRESSES AND 2 DIGITS FOR THE DATA.

THE FOLLOWING IS DECIMAL TO HEX TO BINARY CONVERSION CHART:

DECIMAL	HEX	BINARY
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

CONVERSION TABLE - HEXIDECIMAL TO BASIC

HEX	BASIC	HEX	BASIC	HEX	BASIC	HEX	BASIC	HEX	BASIC
C100	-16128	C200	-15872	C300	-15616	C400	-15360	C500	-15104
C101	-16127	C201	-15871	C301	-15615	C401	-15359	C501	-15103
C102	-16126	C202	-15870	C302	-15614	C402	-15358	C502	-15102
C103	-16125	C203	-15869	C303	-15613	C403	-15357	C503	-15101
C104	-16124	C204	-15868	C304	-15612	C404	-15356	C504	-15100
C105	-16123	C205	-15867	C305	-15611	C405	-15355	C505	-15099
C106	-16122	C206	-15866	C306	-15610	C406	-15354	C506	-15098
C107	-16121	C207	-15865	C307	-15609	C407	-15353	C507	-15097
C108	-16120	C208	-15864	C308	-15608	C408	-15352	C508	-15096
C109	-16119	C209	-15863	C309	-15607	C409	-15351	C509	-15095
C10A	-16118	C20A	-15862	C30A	-15606	C40A	-15350	C50A	-15094
C10B	-16117	C20B	-15861	C30B	-15605	C40B	-15349	C50B	-15093
C10C	-16116	C20C	-15860	C30C	-15604	C40C	-15348	C50C	-15092
C10D	-16115	C20D	-15859	C30D	-15603	C40D	-15347	C50D	-15091
C10E	-16114	C20E	-15858	C30E	-15602	C40E	-15346	C50E	-15090
C10F	-16113	C20F	-15857	C30F	-15601	C40F	-15345	C50F	-15089
C180	-16000	C280	-15744	C380	-15488	C480	-15232	C580	-14976
C181	-15999	C281	-15743	C381	-15487	C481	-15231	C581	-14975
C182	-15998	C282	-15742	C382	-15486	C482	-15230	C582	-14974
C183	-15997	C283	-15741	C383	-15485	C483	-15229	C583	-14973
C184	-15996	C284	-15740	C384	-15484	C484	-15228	C584	-14972
C185	-15995	C285	-15739	C385	-15483	C485	-15227	C585	-14971
C186	-15994	C286	-15738	C386	-15482	C486	-15226	C586	-14970
C187	-15993	C287	-15737	C387	-15481	C487	-15225	C587	-14969
C188	-15992	C288	-15736	C388	-15480	C488	-15224	C588	-14968
C189	-15991	C289	-15735	C389	-15479	C489	-15223	C589	-14967
C18A	-15990	C28A	-15734	C38A	-15478	C48A	-15222	C58A	-14966
C18B	-15989	C28B	-15733	C38B	-15477	C48B	-15221	C58B	-14965
C18C	-15988	C28C	-15732	C38C	-15476	C48C	-15220	C58C	-14964
C18D	-15987	C28D	-15731	C38D	-15475	C48D	-15219	C58D	-14963
C18E	-15986	C28E	-15730	C38E	-15474	C48E	-15218	C58E	-14962
C18F	-15985	C28F	-15729	C38F	-15473	C48F	-15217	C58F	-14961

SLOT 1 SLOT 2 SLOT 3 SLOT 4 SLOT 5

HEX	BASIC	HEX	BASIC
C600	-14848	C700	-14592
C601	-14847	C701	-14591
C602	-14846	C702	-14590
C603	-14845	C703	-14589
C604	-14844	C704	-14588
C605	-14843	C705	-14587
C606	-14842	C706	-14586
C607	-14841	C707	-14585
C608	-14840	C708	-14584
C609	-14839	C709	-14583
C60A	-14838	C70A	-14582
C60B	-14837	C70B	-14581
C60C	-14836	C70C	-14580
C60D	-14835	C70D	-14579
C60E	-14834	C70E	-14578
C60F	-14833	C70F	-14577
C680	-14720	C780	-14464
C681	-14719	C781	-14463
C682	-14718	C782	-14462
C683	-14717	C783	-14461
C684	-14716	C784	-14460
C685	-14715	C785	-14459
C686	-14714	C786	-14458
C687	-14713	C787	-14457
C688	-14712	C788	-14456
C689	-14711	C789	-14455
C68A	-14710	C78A	-14454
C68B	-14709	C78B	-14453
C68C	-14708	C78C	-14452
C68D	-14707	C78D	-14451
C68E	-14706	C78E	-44550
C68F	-14705	C78F	-14449

SLOT 6 SLOT 7