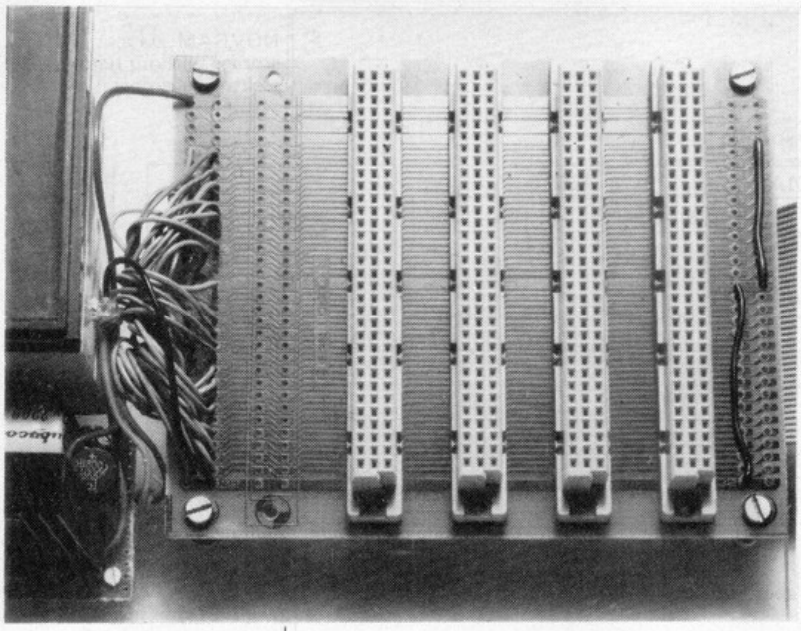


What TRS-80, LNW 80, Video-Genie, Atom, Junior Computer, Ohio owner has never dreamed of being able to connect some specialized circuit to his computer? And what about a design borrowed from another member of his micro computer club? Just think of the possibilities that opens up. That would have to be very complicated, you say. Not necessarily . . . read on and find out more.

bus extension

for the TRS-80 and other personal computers

It is no secret to anybody that there is a price war raging in the market for home computers. Every manufacturer tries to establish as wide a range as possible in order to sell the maximum number of extensions (their prices have fallen also, but not to the same extent as the actual computers). This can make it difficult to connect peripherals to a computer without having to buy as many connectors and cables as circuits. When we came up against this problem we decided it was time to see how the Elektor bus board could be used with other (non-Elektor) equipment.

Many specialized shops (and magazines) supply all sorts of different equipment, and

Table 1

ACORN ATOM	TRS 80 MI LNW 80/I Vidéo Genie I/II	6809	Z80	6502	SC/MP INS 8060 INS 8070	(seen from below)	SC/MP INS 8060 INS 8070	6502	Z80	6809	TRS 80 MI LNW 80/I Vidéo Genie I/II	ACORN ATOM
+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	c b a	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V
NC	NC	NC	NC	NC	ØE00-ØFFF [1]	1 • • 1	Ø600-Ø7FF [1]	NC	NC	NC	NC	$\overline{BLK\emptyset}$
	(−12 V)	−12 V	−12 V	−12 V	−12 V	2 • • 2	−12 V	−12 V	−12 V	−12 V	(−12 V)	(−12 V)
⊥	⊥	⊥	⊥	⊥	⊥	3 • • 3	⊥	⊥	⊥	⊥	⊥	⊥
RDY	$\overline{WAIT}$	MRDY	$\overline{WAITEX}$	RDY	N HOLD	4 • • 4	NRST	RES	$\overline{PWCL}$	$\overline{RESET}$	$\overline{SYSRES}$	NRST
NC	NC	NC	NC	NC	Ø800-Ø9FF [1]	5 • • 5	NBREQ	NC	NC	$\overline{DMA/BREQ}$	NC	NC
DØ	DBØØ	DBØØ	DBØØ	DBØØ	DBØØ	6 • • 6	DBØ1	DBØ1	DBØ1	DBØ1	DBØ1	D1
D2	DBØ2	DBØ2	DBØ2	DBØ2	DBØ2	7 • • 7	DBØ3	DBØ3	DBØ3	DBØ3	DBØ3	D3
D4	DBØ4	DBØ4	DBØ4	DBØ4	DBØ4	8 • • 8	DBØ5	DBØ5	DBØ5	DBØ5	DBØ5	D5
D6	DBØ6	DBØ6	DBØ6	DBØ6	DBØ6	9 • • 9	DBØ7	DBØ7	DBØ7	DBØ7	DBØ7	D7
NC	NC	$\overline{HALT}$	NC	NC	CONT [1]	10 • • 10	NENIN	DD (OSI)	$\overline{BUSRQ}$	NC	$\overline{TEST}$	NC
NMI	NC	$\overline{NMI}$	$\overline{NMI}$	NMI	SA	11 • • 11	SB	$\overline{IRQ}$	$\overline{INT}$	$\overline{IRQ}$	$\overline{INT}$	IRQ
NC	$\overline{IN}$	NC	NC/BB2,4 [4]	NC	SIN [1]	12 • • 12	SOUT [1]	NC	NC	NC	$\overline{OUT}$	NC
SO	NC	NC	NC	SO	FØ	13 • • 13	F1	K7	NC	NC	NC	NC
NC	NC	NC	NC	K6	F2	14 • • 14	Ø400-Ø5FF [2]	K5	NC	NC	NC	NC
⊥	⊥	⊥	⊥	⊥	⊥	15 • • 15	⊥	⊥	⊥	⊥	⊥	NC
NC	NC	+12 V	+12 V	+12 V	+12 V/NC	16 • • 16	NC [2]	K4	NC	BS [2][3]	NC	NC
NC	NC	BA	$\overline{BUSAK}$	K3	NENOUT	17 • • 17	NC/−5 V	−5 V	−5 V	−5 V	(−5 V)	(−5 V)
A14	AD14	AD14	AD14	AD14	AD14	18 • • 18	AD15	AD15	AD15	AD15	AD15	A15
A12	AD12	AD12	AD12	AD12	AD12	19 • • 19	AD13	AD13	AD13	AD13	AD13	A13
A10	AD10	AD10	AD10	AD10	AD10	20 • • 20	AD11	AD11	AD11	AD11	AD11	A11
A8	AD08	AD08	AD08	AD08	AD08	21 • • 21	AD09	AD09	AD09	AD09	AD09	A9
A6	AD06	AD06	AD06	AD06	AD06	22 • • 22	AD07	AD07	AD07	AD07	AD07	A7
A4	AD04	AD04	AD04	AD04	AD04	23 • • 23	AD05	AD05	AD05	AD05	AD05	A5
A2	AD02	AD02	AD02	AD02	AD02	24 • • 24	AD03	AD03	AD03	AD03	AD03	A3
AØ	AD00	AD00	AD00	AD00	AD00	25 • • 25	AD01	AD01	AD01	AD01	AD01	A1
NC	NC	E	$\overline{MREQ}$	NC	NWDS+NRDS	26 • • 26	X1	Φ2	PHIEX	E	(Φ)	Φ2
NC	$\overline{RAS}$	NC	RAS	K2	ØA00-ØBFF [1]	27 • • 27	−7/+5 V	NC	NC	NC	NC	NC
R/$\overline{W}$	NC	NC	$\overline{M1}$	R/$\overline{W}$	$\overline{CE}$ RAM	28 • • 28	ØC00-ØDFF [1]	K1	NC	NC	$\overline{INTAK}$	NC
NC	NC	NC	$\overline{IORQ}$	EX	CARDEN	29 • • 29	NADS [1]	Φ1	$\overline{RFRSH}$	Q	NC	SYNC
NRDS	$\overline{RD}$	E · R/$\overline{W}$	$\overline{RD}$	NC	NRDS	30 • • 30	NWDS	RAM-R/$\overline{W}$	$\overline{WR}$	R/$\overline{W}$	$\overline{WR}$	NWDS
⊥	⊥	⊥	⊥	⊥	⊥	31 • • 31	⊥	⊥	⊥	⊥	⊥	⊥
						32 • • 32 c b a						

Notes:
)1 not used by INS 8070
)2 15a reserved for A17
17a reserved for A16
)3 subject to change
)4 BB 2.4 = battery back-up + 2.4 V
These pin designations are the universally accepted standards (taking note 3 into account, of course).

83135

1

64-way connector	TRS-80 signals			TRS-80 signals	64-way connector
5a	SYSRES*	2	1	RAS*	28c
21c	A10	4	3	NC[1]	NC
20a	A13	6	5	A12	20c
32a, c	GND	8	7	A15	19a
19c	A14	10	9	A11	21a
13a	OUT*	12	11	A8	22c
29a	INTAK*	14	13	WR*	31a
NC	NC	16	15	RD*	31c
9c	D4	18	17	A9	22a
10a	D7	20	19	IN*	13c
7a	D1	22	21	INT*	12a
10c	D6	24	23	TEST*	11a
8a	D3	26	25	A0	26c
9a	D5	28	27	A1	26a
7c	D0	30	29	GND	4a,c/16a,c
8c	D2	32	31	A4	24c
25a	A3	34	33	WAIT*	5c
23a	A7	36	35	A5	24a
23c	A6	38	37	GND	4a,c/16a,c
25c	A2	40	39	+5 V	1a, c

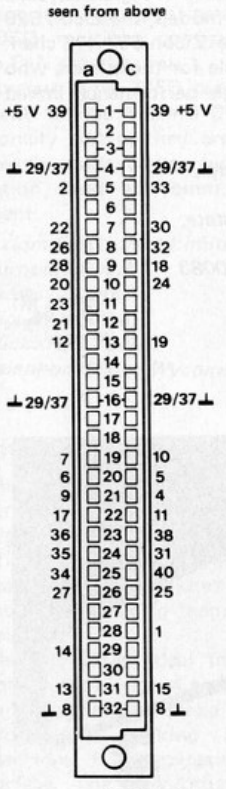
Note:
* indicates negative logic (an input or output is 'true' at the low logic level)
[1] CAS for the LNW80

83135-1

Figure 1. These are the signals available at the TRS-80 keyboard output connector. The LNW80 has an extra signal, CAS, at pin 3.

Figure 2. This shows an example of how the bus extension can be adapted for a TRS-80. Some of the a and c pins are connected together in this design to reduce resistance in the power supply lines (earth, +5 V and −12 V).

2



83135-2

Table 1. Here we list the relation between the pins of a 64-way connector and the signals available on some microprocessor or microcomputer buses.

each circuit is more sophisticated than the next. The very sight of them is enough to bring out the 'experimenter' in every one of us. To make proper experimentation feasible, what is really needed is a bus board, which has several connectors to accept one or a number of cards, and preferably with its own on-board supply.

What is a bus?

Obviously everybody could design their own bus, to suit their own particular needs, but this would almost certainly rule out the possibility of borrowing a circuit from somebody else with a similar computer.
This is why Elektor designed a bus board in mid 1978 for the first microprocessor to appear in any of our circuits, the SC/MP. Gradually, as new micros started to appear (the 6502, Z80 and 6809), the number of lines needed began to increase. Originally the bus was intended only for one computer, the SC/MP. Eventually the Junior Computer arrived and the bus was used for this also. As the TRS-80 is still a very popular micro we decided that some rationalization was in order to make it compatible with the Elektor bus. The same applies for several other computers and the most recent addition to our list is the Acorn Atom.
What we have in mind is more than simply a modified and renewed bus. Since its inception, about five years ago, many micro computer buffs have used the Elektor bus for their computer system, whether that is Elektor's SC/MP or Junior Computer or something completely different. The layout suggested here has the advantage that it allows almost all the cards published by Elektor to be used without any modification; cards published elsewhere will also fit the format defined by the bus. Some of our cards have proved very popular, among them the universal memory card, the EPROM programmer and the floppy disk interface. Depending on what microprocessor the system is based on, the various cards can be used either without modification (6502), or with a certain number of modifications for some of them (Z80). Most of the Elektor cards can very easily be adapted to almost any system. Table 1 is a summary of the conventions used by various systems.

Applications

This extension can be used with any personal computer (possibly with some modification with some of those we have not mentioned), but it is *absolutely imperative* that the output bus of the computer is buffered (with a 74LS367 in the case of the TRS-80 model I).
It would be impossible to try to list all the possible circuits that could be plugged into the connectors of this bus extension. Some of the more interesting are: a speech synthesizer (SC01), sound synthesizer (1 . . . 3 AY-5-8910), EPROM programmer, all sorts of converters, real-time clock, circuit emulator. Often these various circuits have a large current consumption so it is a good idea to give the bus extension its own supply so that it can cope with these power-hungry cards. Circumstances dictate the characteristics of the supply (+ and −5 V, + and −12 V).
If such a supply is added only the earth line should be connected to the computer because the voltages supplied by the regulators will probably be slightly different and this could cause problems.
Nothing is more descriptive than an example, and we chose the TRS-80 as our guinea-pig. The signals available at the TRS-80 keyboard output connector are given in figure 1. The corresponding connections on the bus extension are illustrated in the drawing of figure 2.
Using this example you should be able to adapt this extension to any computer with a buffered output bus.
The simplest way of making this bus extension is to use a suitable printed circuit board, either the one described in the article 'new bus board for microprocessors' (January 1980, page 1-31), or the one described elsewhere in this issue. In the first case up to five connectors can be used, in the second this goes up to seven. In either case it is important that the components should be carefully located on the plug-in cards, to ensure that they can all be fitted.