ELECTRONICS

1. EPROM PROGRAMMER/RAM EXPANSION UNIT

2. SWITCHED FAULT UNIT

L.J. ELECTRONICS LIMITED,
9, Francis Way,
Bowthorpe Industrial Estate,
Norwich. NR5 9JA
Tel: (0603) 746340
Telex: 975504

1. EPROM PROGRAMMER/RAM EXPANSION UNIT

This unit provides the circuitry for programming a 2716, 2,048-byte EPROM. This circuitry includes data and address bus latches, and a monostable circuit to generate the 50ms programming pulse. A preset resistor is adjusted during factory tests to provide the 50ms timing. No further adjustment of this resistor should be necessary.

This expansion board provides an additional 2K of RAM, with sockets for a further 2K. The board requires 5V at 200mA approximately, and +24V at 30mA approximately. This 24V supply is used only for EPROM programming and need not be provided when no programming is being performed.

EPROM PROGRAMMER

The EPROM Programmer/RAM Expansion board is based on a 9" x 6" p.c.b. The board provides 2K of RAM, at addresses 5000 to 57FF. Sockets are provided for a further 2K of RAM, at addresses 5800 to 5FFF.

The EPROM socket accepts a 2716, 2K EPROM which will appear at address 6000 to 67FF.

Using the EPROM Programmer:-

Programming 2716 EPROMS is accomplished by writing to addresses in the range 6000 - 67FF. This causes the relay to close and, 20ms later, a 50ms pulse is applied to the $\overline{E}$/PGM pin of the 2716. The arrival of this pulse disables any more read or write operations for the full duration of the pulse. The programmed location may be verified immediately $\overline{E}$/PGM goes low by reading the location back and comparing with the data sent. If all is well, the next or any other location may be programmed, or, if not, the same location may be programmed repeatedly until verification is obtained (but one attempt is almost always sufficient). The monostable closing the relay has a pulse-width of about 200ms and is retriggerable, so if write operations are performed at intervals of 75 - 200 ms the relay will remain closed. Note that programming is not directly possible via the keyboard and any attempt to do so may well result in corruption of previously programmed addresses (but no damage will result). If the EPROM socket on the programmer board is not required for programming it becomes available for a further 2K EPROM to be added to the 'EMMA' system. (Addresses 6000 - 67FF as before). Alternatively, with no EPROM in the socket, the 8 - way connector to the right of it becomes an input port by reading any address in the range 6000 - 67FF. It may also be used as an output port with the 'EPROM supply' switch off, but output data will only be valid for 50ms after writing to 6000 - 67FF, after which the port will return to input mode. The programming pulse can be used to latch output data in external devices.

Use of "EPROM Supply" Switch

This removes Vcc and Vpp from the 2716 and relay driver to prevent possible damage to the EPROM or relay when inserting or removing from the socket. It should only be switched on when the EPROM is securely in its socket. The EPROM must never be disturbed with both the switch and the Vpp l.e.d on as almost certain damage will result.

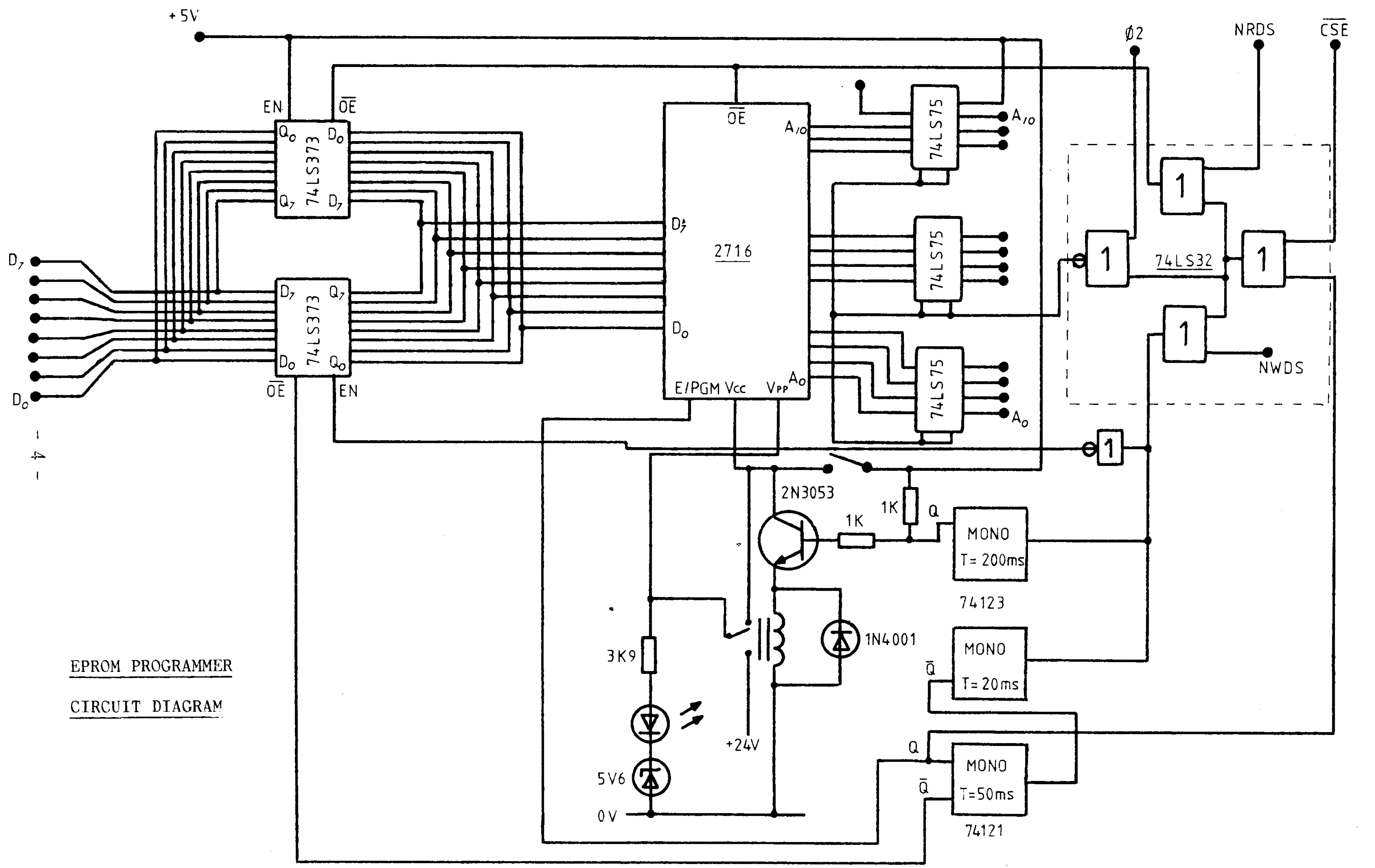
EPROM PROGRAMMER ROUTINE

This programs 2716 EPROMS in 256-BYTE Blocks. Load the following locations:

```
00FB    Low Byte  \ Address from which data is
  FC    High Byte / to be transferred to EPROM.
  FD    Low Byte  \ Address from which data is to be
  FE    High Byte / programmed (in range 6000-67FF).
  FF    Number of Bytes, in hex, to be programmed.
```

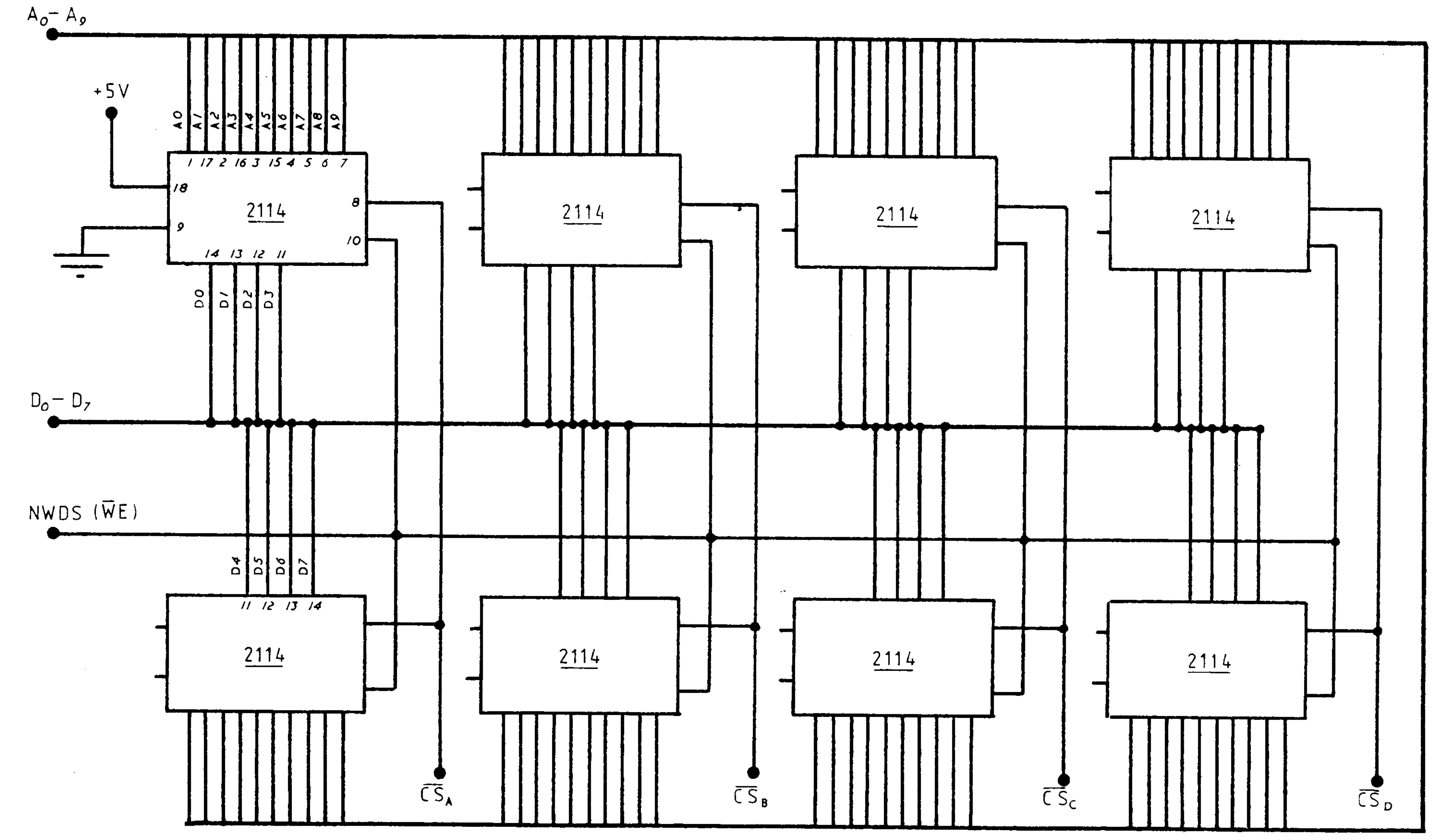
```
0020  A0,00       LDY *00
      B1,FB       LDA(FB),Y
      91,FD       STA(FD),Y
      A9,20       LDA *20
      85,FA       STA FA
      A9,00       LDA *00
      85,F9       STA F9
      C6,F9       DEC F9
      D0,FC       BNE-4
      C6,FA       DEC FA
      D0,F8       BNE-8
      B1,FD       LDA(FD),Y
      D1,FB       CMP(FB),Y
      D0,E6       BNE-26
      C8          INY
      C4,FF       CPY FF
      D0,E1       BNE-31
      4C,F3,FE    JMP FEF3
```

Go from 0020. Programming takes approximately 17 seconds for 256 Bytes. If dots do not re-appear after this time, then EPROM is either faulty or, more probably, it has been programmed before and not totally erased.

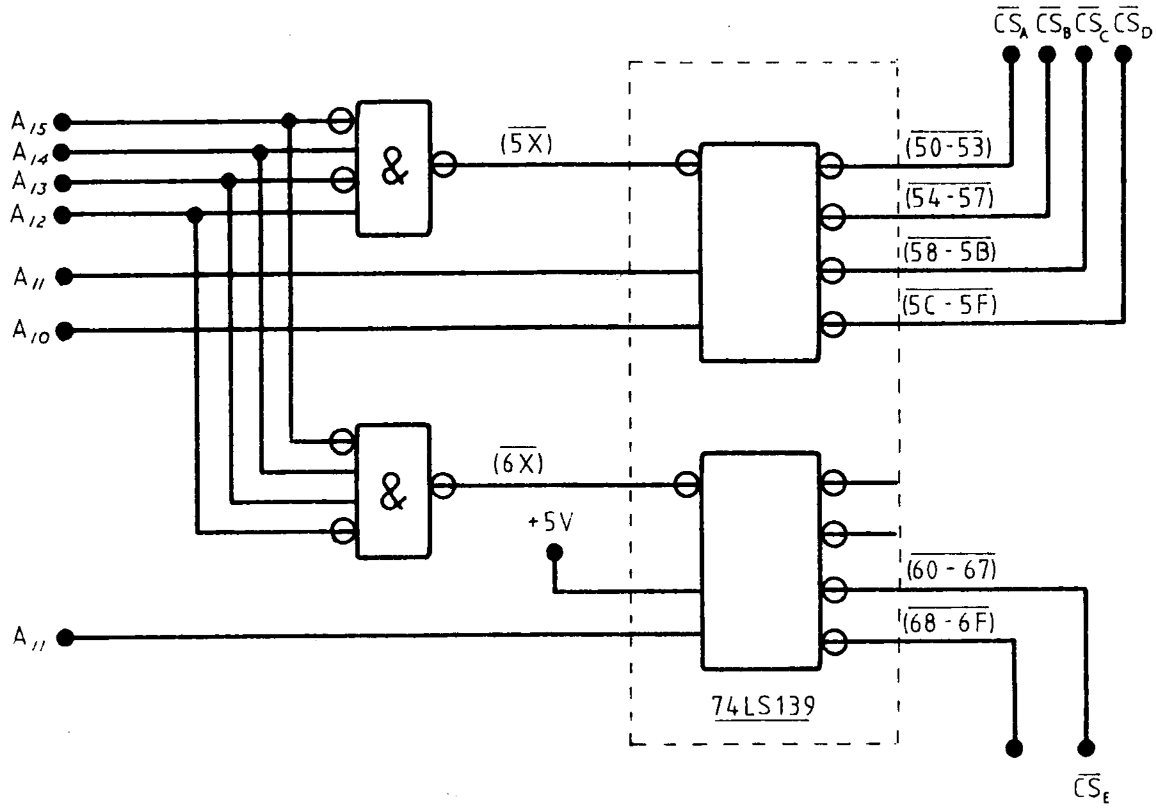


EPROM PROGRAMMER

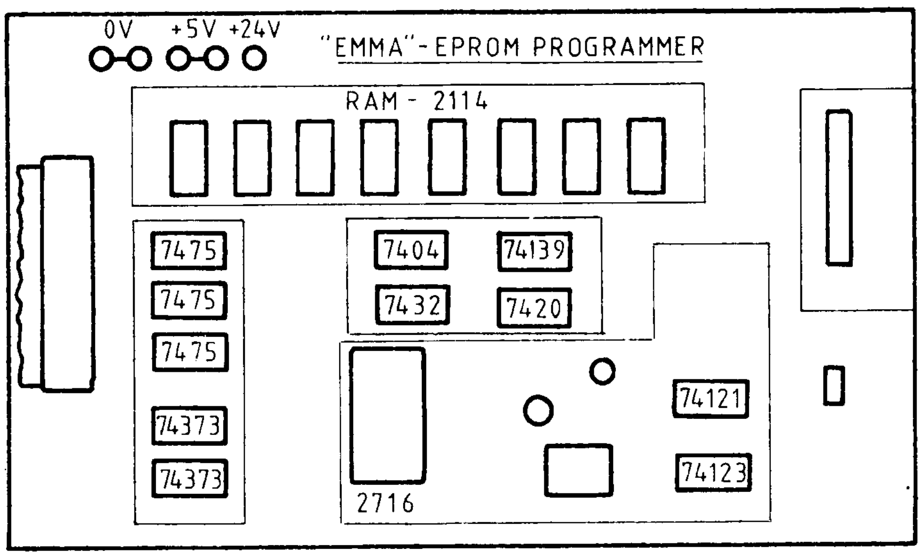
CIRCUIT DIAGRAM



RAM EXPANSION



ADDRESS DECODING



MODULE LAY-OUT

2. EMMA SWITCHED FAULT UNIT

This unit plugs into the expansion connector of the EMMA board. It enables ten short circuit faults to be switched into the system, each of which results in different failure symptoms.

Faults 1 to 4 involve system control signals and careful monitoring with an oscilloscope should allow a student to find these faults. Faults 5 to 10 involve data and address buses and will require multi-channel monitoring. It is suggested that a Logic Analyser should be used for these bus faults.

NOTE: Whilst short circuit faults alone do not allow representation of all faults possible to occur in a system, using the oscilloscope and Logic Analyser to observe the system performance will give the student familiarity with all bus and control signals and will provide the confidence required to tackle actual problems.

FAULT NO.1

$\emptyset_2$ to 0V.

a) FAULT NOT PRESENT - Check with oscilloscope $\emptyset_2$ clock is a square wave with period 1us and amplitude approximately 3.5V peak-to-peak. Rise-time and ringing depends on oscilloscope probe used.

b) FAULT PRESENT - 'EMMA' will not operate at all without this signal, with oscilloscope on 1us/cm and 0.5V/cm, $\emptyset_2$ will be a series of ringing spikes of up to 0.75V amplitude.

FAULT NO.2

$\overline{\text{RESET}}$ to 0V.

a) FAULT NOT PRESENT - Oscilloscope shows $\overline{\text{RESET}}$ to be a signal of +5V, falling to 0V when $\overline{\text{RESET}}$ button is pressed. There may be up to a volt of ringing when $\overline{\text{RESET}}$ is at 0V.

b) FAULT PRESENT - Oscilloscope shows $\overline{\text{RESET}}$ to be at 0V with the ringing mentioned above. Internal registers (including P.C.) and buses can be in any condition whilst the $\overline{\text{RESET}}$ is held low, therefore no sensible sequence occurs on the logic analyser.

FAULT NO.3

$\overline{\text{NMI}}$ to 0V.

a) FAULT NOT PRESENT - $\overline{\text{NMI}}$ will be at +5V with User $\overline{\text{NMI}}$ vectors (001C and 001D) set to B3, FF, and P.C. recalculation byte (001B) set to 00, the display should throw up a set of numbers when $\overline{\text{NMI}}$ is momentarily shorted to 0V. If the User tries to run a program in RAM with the single-step switch on, normal single-stepping will occur.

b) FAULT PRESENT - With vectors set up as above, shorting $\overline{\text{NMI}}$ to 0V. will have no effect. With single step switch on, single-stepping will not occur. A program not using $\overline{\text{NMI}}$ will run normally.

FAULT NO.4

$\overline{\text{RESET}}$ to D_0

a) FAULT NOT PRESENT - $\overline{\text{RESET}}$ will function as normal, being at +5V until $\overline{\text{RESET}}$ button is pressed, falling to 0V when pressed. D_0 will show a complicated pattern of pulses of around 4V amplitude.

b) FAULT PRESENT - Pulse waveform appears on $\overline{\text{RESET}}$ and D_0, decimal points will not appear on the display. The pulses will have an amplitude of between 3V and 5V, with a mark:space ratio of about 4:1.

FAULT NO.5

A_{15} to 5V

Connect LSB, MSB of logic analyser to (A_0 - A_7), (A_8 - A_{15}) of address bus. Connect yellow probe to $\emptyset_2$ and blue trigger qualifier to $\overline{\text{RESET}}$. Set trigger word to FFFC (the lower $\overline{\text{RESET}}$ vector) and enable. Set clock qualifier to X, clock edge to 1 and trigger qualifier to 1. Press $\overline{\text{RESET}}$ button, hold it down and arm the analyser. Release $\overline{\text{RESET}}$ button and the analyser will display some numbers. Use INC or DEC to get display to +00, XXXX

a) FAULT NOT PRESENT - Using INC key of analyser, step through the analyser's memory. The sequence (which represents the state of the address bus) should be:

FFFC, FFFD, FEF3, FEF4, FEF5, FEF6, FEF6, FEF7, FEF8, 0E23, FEF9,
FEFA, 000E, FEFB, FEFC, FEFD, FEFE, FEFF, FF00, 000E, 0017, FF01,
FF02, FF02, FF03, FF04, FFFF, FEFF, FF00, 000E, 0016, FF01, FF02,
FF02, FF03, FF04, FFFF, FEFF, FF00, 000E, 0015, FF01, FF02, FF02,
FF03, FF04, FFFF, FEFF, FF00, 000E, 0014, FF01, FF02, FF02, FF03,
FF04, FFFF, FEFF, FF00, 000E, 0013, FF01, FF02, FF02

This comprises the stack initialisation sequence and the little routine which writes *80 (segment code of a dot) into locations 0017 to 0013. (These locations are later accessed by the display routine to give the familiar row of dots.)

b) FAULT PRESENT - Display will not $\overline{\text{RESET}}$ to show the row of dots. When the analyser is armed as above, the sequence stored now differs as follows:

Location	Fault Absent	Fault Present
+09	0E23	8E23
+12	000E	800E
+19	000E	800E
+20	0017	8017
+29	000E	800E
+30	0016	8016
+39	000E	800E
+40	0015	8015
+49	000E	800E
+50	0014	8014
+59	000E	800E
+60	0013	8013

If the MSB is displayed on an oscilloscope, A_{15} will be seen to remain high at all times.

FAULT NO.6

A_{10} to A_{11}

a) FAULT NOT PRESENT - When calling up address of I/O port (0900-0903) during test routine, these locations contain FF,FF,00,00 after resetting (i.e. port A and B initialised to inputs), they will then respond to data applied to the output ports.

b) FAULT PRESENT - I/O port will not work; since accessing locations 0900 - 090F actually accesses locations 0100 - 010F in the stack. (If A_{10} <u>or</u> A_{11} goes low, it will hold the other address line low).

FAULT NO.7

D_0 to D_1

a) FAULT NOT PRESENT - Connect the analyser to the oscilloscope as for Fault No.5. Connect LSB to (D_0 - D_7), MSB to (A_0 - A_7). Trigger qualifier to $\overline{RESET}$ and clock to ϕ_2. Set trigger word to F,C,F,3. Correct start-up sequence is:

FCF3, FDFE, F3A2, F4FF, F59A, F68E, F68E, F723, F80E, 23FF, F986, FA0E, 0EFF, FBA0, FC80, FDA2, FE09, FF94, 000E, 0EFF etc.

b) FAULT PRESENT - 'EMMA' will not find FE, F3 at $\overline{RESET}$ vectors; instead it will find FC, F3. Therefore, with analyser armed with F,C,F,3 display will show the following differences and oscilloscope will show D_0 and D_1 always the same.

01	:	FDFC	06	:	F68C	12	:	0CFF
02	:	F3A0	08	:	F80C	15	:	FDA0
04	:	F598	10	:	F984	16	:	FE08
05	:	F68C	11	:	FA0C	18	:	000C

FAULT NO.8

D_2 to 0V

Set up the analyser and oscilloscope as for Fault No.7.

FAULT PRESENT - Sequence stored in analyser memory differs from the correct sequence in the following locations:

01 : FDFA, 03 : F4FB, 05 : F68A, 06 : F68A, 08 : F723, 09 : F80A

Following bytes will also contain data in which D_2 is always low, and oscilloscope display will show D_2 always at 0V.

FAULT NO.9

D_1 to A_3

Set up analyser as for Fault No.7.

FAULT PRESENT - Reset sequence stored in analyser memory is now:

FCF3, FDFE, F3A0, F400, F598, FE8C, F60C, F700, 00FC, F7F8, FE37, F639, FFFF, 39AA, 3245, 3245, 3BF7, F709.

This fault is not obvious by looking at the oscilloscope display unless the display is repeatedly switched between MSB and LSB, when D_1 will be seen to have the same sequence as A3.

FAULT NO.10

A_{15} to D_7

Set up analyser as for Fault No.7.

FAULT PRESENT - $\overline{\text{RESET}}$ sequence stored in analyser memory is:

FCF3, FDFE, F3A2, F4FF, F59A, F68E, F68E, F723, F80E, A3FF, F986, FA0E, 0E7F, F8A0, FC80, FDA2, FE09, FF94, etc.

However, this fault will not be displayed on the oscilloscope unless the MSB lead is connected to (A_8 - A_{15}), and then only by switching between MSB and LSB.

Warranty

The Manufacturer warrants these modules to be free from defects in material and workmanship, where the modules are used for their proper purpose. This warranty obligation is limited to making good these modules, (which shall be returned intact, carriage paid to them, or their authorised agents, and which examination shall disclose to their satisfaction to have been defective as claimed).

Any unauthorised prior repairs or adjustments will invalidate this warranty.

This warranty is valid for a period of one year from receipt.

Maintenance

Whilst frequent maintenance is unlikely, every care is taken in the design of all modules to facilitate easy maintenance. All component parts are easily accessible and replacements are readily available from a variety of suppliers.

In addition, replacements for all parts are available from L. J. Electronics Ltd.