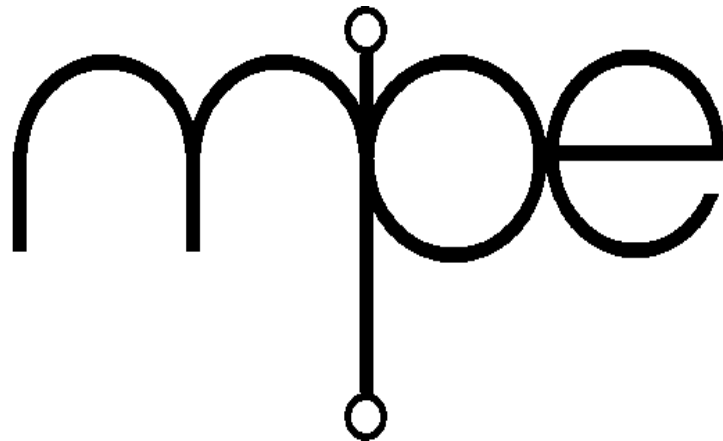


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# Forth Stamp

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## Forth Stamp User Manual





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# Forth Stamp

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## Forth Stamp Manual

Manual revision 1.000

Date 24 July 2000

## Software

Software and Hardware version 2.000

<b>Package</b>	<b>Number:</b>	
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## Acknowledgements

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Paul Richards, Harry Coul, Stephen Pelc

Forth Stamp  
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# Licence Terms

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# 1

# Introduction

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The Forth Stamp is a fully featured plug-in microcontroller development board designed for writing applications in Forth or assembler. The Forth Stamp is small and has its own 48 pin Forth Stamp connector. This makes it an ideal solution for a wide range of embedded systems. By implementing an in-system programming interface the Forth Stamp can be programmed, tested and debugged onsite, which can save a considerable amount of time and effort.

The Forth Stamp has been designed so that it can be used as a prototype and be used as part of a final hardware design. It can be used to prototype designs standalone and it can be also plugged into other hardware to form part of a larger embedded system. This is due to its compactness, its in-system programming facility and its 48 pin IC DIP compatible Forth Stamp Connector.

The Forth Stamp can be programmed using the Forth 6 Cross Compiler or with the AT89 Programming Utility. By using the Umbilical Forth link on the Forth 6 Cross Compiler a fully interactive session between the Forth Stamp and the host PC can be implemented. Any other assemblers or compilers that can produce memory image files can be used with the Forth Stamp.

---

# 2

# Setup and Configuration

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## Overview

The Forth Stamp requires a 5V DC power supply and a link to a host PC in order to perform a download or an upload.

The Forth Stamp can be used in two different configurations:

- Simple Prototyping Configuration.
- Full Development Configuration.

Both configurations can be used in conjunction with the AT89 Programming Utility and the Forth 6 Cross Compiler.

## Simple Prototyping Configuration

This is the quickest and easiest way in which to test some code. In this configuration The Forth Stamp requires use of the power connector and the SPI In-system Programming Connector.

### Making the SPI In-system Programming Cable

This cable links the Forth Stamp to the host PC to enable uploading or downloading. For this you will need the following:

- 5+5 IDC 2.54mm pitch Female ribbon cable connector for the Forth Stamp.
- 25 way male D-connector with solder buckets and cover for the PC printer port
- A length of 10 way ribbon cable to connect the two together.

By following the table below solder the relevant wires to the relevant pins. It's probably best to use a vice and secure the IDC connector to the ribbon cable first.

Pin Name	Forth Stamp SPI in-system programming connector	PC printer port
VCC	1	Not connected
!SS	2	3
MOSI	3	4
MISO	4	10
GND	5	18
GND	6	Not Connected
SCK	7	5
RST	8	6
GND	9	Not Connected
GND	10	Not Connected

**Table 1:** SPI in-system programming interface

N.B. VCC and the three extra ground pins (6,9,10) have been included if the user requires them.

N.B. ! = Active low

Once all soldering is complete check that all wires have been soldered correctly and add the cover to the 25 way D-Connector to protect it.

## Connecting Power

The Forth Stamp requires a 5V DC supply from a suitable power supply.

Connect wires from the power supply to a suitable two pin female connector and plug it into the power connector located on the topside of the Forth Stamp.

<b>Pin 1</b>	GND
<b>Pin 2</b>	VCC +5VDC

**Table 2:** Power Connector

## Full Development Configuration

This configuration is designed for the Forth Stamp to be used as a plug-in controller.

If the onboard serial port is needed or external hardware is needed then this configuration must be used. External hardware could be in the form of ADC's, DAC's, LCD devices, relays for power circuits, sensors etc.

In this configuration the only connector that is needed is the 48 pin Stamp Connector. This connector contains the power pins, SPI in-system programming pins, address bus, data bus, port pins etc. The Stamp Connector is size compatible with a standard 48 pin DIP .6" type IC socket.

Please note that even though the Stamp Connector includes the SPI in-system programming pins and the power pins, you can still use the onboard connectors instead. This reduces wiring and the need to make up special cables. The pin out for the 48 pin Stamp Connector is shown below, with the pins numbered as for a 48 pin DIP connector:

Pin Number	Pin Function	Pin Number	Pin Function
1	SCK	48	VCC
2	!SS	47	P1.0
3	MISO	46	P1.1
4	MOSI	45	P1.2
5	TX	44	P1.3
6	RX	43	P1.4
7	RST	42	P1.5
8	A0	41	P1.6
9	A1	40	P1.7
10	A2	39	P3.5/T1
11	A3	35	P3.4/T0
12	A4	37	P3.3/!INT1
13	A5	36	P3.2/!INT0
14	A6	35	!WE
15	A7	34	!OE
16	A8	33	!CE
17	A9	32	D0
18	A10	31	D1
19	A11	30	D2
20	A12	29	D3
21	A13	28	D4
22	A14	27	D5
23	A15	26	D6
24	GND	25	D7

**Table 3:** 48 pin Stamp Connector.

N.B. ! = Active low

---

## Configuring the Solder Pads

The Forth Stamp contains 2 blocks of solder pads; the only user configurable solder pad block is block 1.

Block 1 is used to configure the voltage levels of the pins P3.2/!INT0 and P3.4/T0. They can either be set to TTL voltage levels or to RS232 voltage levels. Please note block1 only comes into effect when the Forth Stamp is fitted with an RS232 line driver.

By default all pads are left unsoldered meaning pins P3.2/!INT0 and P3.4/T0 from the microcontroller are NOT connected to the 48 pin Stamp Connector.

If you require the use of these pins as either TTL levels or RS232 levels you must bridge the relevant pads according to the table below.

Pin	Voltage Level	Bridged Pads
P3.2/!INT0	TTL	8&9, 10&11
P3.2/!INT0	RS232	7&8, 11&12
P3.4/T0	TTL	2&3, 4&5
P3.4/T0	RS232	1&2, 5&6

**Table 4:** The configurations of block1 solder pads.

N.B. If all solder pads on block1 are left open then P3.2 /!INT0 and P3.4/T0 will not be connected to the 48 pin Stamp Connector.

## Making Sure Everything Works

To make sure everything works there is a simple test program included which will flash the onboard LED's on the Forth Stamp.

Connect the in-system programming connector to the PC printer port and connect up power the to the Forth Stamp.

To test some code you can use download the file 'test.img' to the Forth Stamp by running the AT89 Programming Utility (AT89prog.exe). Before you run AT89prog.exe make sure that you are either in the directory of where AT89prog.exe has been installed or use the full pathname. The default path for AT89prog.exe is:

```
. . .\stamp51\compiler\AT89prog.exe
```

Now download the file 'test.img' by executing the following line from a DOS prompt:

```
AT89prog.exe test.img /LPT n /v
```

Where n is the address in hex of your PC printer port.

This will use the AT89 Programming Utility to download the code into the Forth Stamp. The '/v' will perform a verify after the download. If this fails then there is probably a cable fault. If the verify passes then the code should run and will perform two tests.

The test program will first test the LED's and then the serial port. To allow serial port testing you will need to connect the lines TX and RX.

The LED test simply turns on the red LED, then the green LED and then turns both LED's off.

The serial port test involves sending a character from the transmit buffer to the receive buffer (this is why the link is necessary). If the transmitted and received characters are the same the green LED lights, if not the red LED lights. The serial port test is carried out twice, first with the character \$A5 and then with \$5A.

Every new Forth Stamp has the testcode already written into the FLASH. As soon as the Forth Stamp is powered up it will execute the test routines. The source code and image file is included if you need to re-write the testcode in at a later date or modify the original for a specific testing purpose.

If any of the tests fail please consult the Troubleshooting section at the end of this manual.

---

# 3

# The Forth Stamp Compiler

---

## Overview

Once the hardware is fully connected and working, the next thing to do is to run the Forth Stamp Cross Compiler to start building and running code. To do this you will need to run AIDE (MPE's IDE).

## AIDE

AIDE is a modular integrated development environment that provides a fast and easy way to build Forth code and applications using the Forth Stamp Cross Compiler and other MPE Cross Compilers.

You can find the executable for AIDE in `...\stamp51\aide\aide.exe`. By clicking on "stamp51" from the tools menu or the red '51' icon at the top of the screen, you can compile the current control file. The default control file is called `ftampSPI.ctl` and can be found in the `...\stamp51\8051\configs` directory. The Cross Compiler will compile the code and included files within the control file. Any files you wish to include must be referenced in the control file. If the code is only small then it's just as easy to add the definitions directly into the control file.

All information regarding the current status of the compilation is shown on the 'tool capture display' window.

Once the code has been compiled you will have the option to download it to the Forth Stamp. Make sure you have power to the Forth Stamp and the ISP lead is connected.

Providing there are no unexpected unresolved words, forward references, word redefinitions or errors then press 'Y' to download the code. If an error occurred at this point you can press 'N', then type 'BYE' to exist from the compiler, check and re-save your code and recompile.

For information regarding the use and configuration of control files please see the 8051 cross compiler manual.

## Compilation Errors

There are three main errors that you might see when compiling your code, these are:

- Unresolved words – These are words that are not properly defined.
- Forward References – These are words that are used in your code, which have no entry in the dictionary.
- Redefinitions – These are words that have been defined more than once. Only the latest copy will exist in the dictionary.

## **Documentation Included**

In the `...\stamp51\docs` directory there are a number of useful documents in either Adobe Acrobat format or HTML format. The following documents are included:

- Generic Forth 6 Cross Compiler manual – `XC610man.pdf`
- The 8051 Cross compiler manual – `8051.pdf`
- The AIDE manual – `aide.pdf`.

Various manufacturers' data sheets regarding 8051 products can be found in the `...\stamp51\docs\8051`.

The full ANS Forth specification is also include in html format and can be found in `...\stamp51\docs\ANS`.

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# 4 Hardware Description

---

## AT89S8252

At the heart of the Forth Stamp is an Atmel AT89S8252 running at 24Mhz crystal.

### Features

- Compatible with MCS-51™ Products
- 8K Bytes of In-System Reprogrammable Downloadable Flash Memory
  - SPI Serial Interface for Program Downloading
  - Endurance: 1,000 Write/Erase Cycles
- 2K Bytes EEPROM
  - Endurance: 100,000 Write/Erase Cycles
- 2.7V to 6V Operating Range
- Fully Static Operation: 0 Hz to 24 MHz
- Three-Level Program Memory Lock
- 256 x 8 bit Internal RAM
- 32 Programmable I/O Lines
- Three 16 bit Timer/Counters
- Nine Interrupt Sources
- Programmable UART Serial Channel
- SPI Serial Interface
- Low Power Idle and Power Down Modes
- Interrupt Recovery From Power Down
- Programmable Watchdog Timer
- Dual Data Pointer
- Power Off Flag

### Description

The AT89S8252 is a low-power, high performance CMOS 8-bit microcomputer with 8K bytes of downloadable Flash programmable and erasable read only memory and 2K bytes of EEPROM. The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout. The on-chip downloadable Flash allows the program memory to be reprogrammed in system through an SPI serial interface or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with downloadable Flash on a monolithic chip, the Atmel AT89S8252 is a powerful microcomputer, which provides a highly flexible and cost effective solution to many embedded control applications.

The AT89S8252 provides the following standard features: 8K bytes of downloadable Flash, 2K bytes of EEPROM, 256 bytes of RAM, 32 I/O lines, programmable watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S8252 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

The downloadable Flash can be changed a single byte at a time and is accessible through the SPI serial interface. Holding RESET active forces the SPI bus into a serial programming interface and allows the program memory to be written to or read from unless Lock Bit 2 has been activated.

## RS232 Line Driver

This provides RS232 signal levels to the TX, RX and optionally pins P3.2/!INT0 and P3.4/T0. The chip and its associated capacitors are an optional fit during manufacture. If the chip is fitted, link block 1 is available and both link pads of block 2 must be open.

The pins P3.2/!INT0 and P3.4/T0 can be configured to use RS232 voltage levels or TTL voltage levels. When the pins P3.2/!INT0 and P3.4/T0 are configured as RS232 voltage levels they can be used as the serial port lines RTS and CTS respectively. To configure the pins P3.2/!INT0 and P3.4/T0 to use RS232 levels or TTL levels see the links and connectors section for details.

RTS and CTS lines can be accessed or controlled by software using the standard port pin programming to access or control them. However RTS can be used to trigger an !INT0 (interrupt 0). This interrupt will trigger on a high to low transition.

If the RS232 line driver is fitted then the default is for TX and RX are to use RS232 levels. If the RS232 line driver is not fitted then the relevant solder pads will be bridged – see the links and connectors section for details.

The default for the pins P3.2/!INT0 and P3.4/T0 is to be NOT connected to the 48 pin Stamp Connector. This gives the full flexibility of choosing to set these pins to TTL or RS232 levels without having to de-solder any solder pads the first time the Forth Stamp is used – for information on solder pad configuration see the links and connectors section.

## Latch (74HCT573)

The data bus and the low eight address lines are multiplexed on the AT89S8252. The latch separates these lines so they can be used as standard busses if required.

## Quad NAND (74HCT00)

This generates the !CE signal on the 48 pin Stamp Connector from the AT89S8252. !CE is active (low) when either !RD or !WR are active. The !CE signal can be used as a peripheral chip select signal when a MOVX instruction is used for XDATA access to external memory.

## LED's

There are two LED's onboard the Forth Stamp, one green and one red. These are used to indicate either in-system programming activity or port pin activity on P1.2 and P1.3 respectively. Please note that the LED's are lit when the port pins are low.

---

# 5 Links and Connectors

---

## Overview

The Forth Stamp has three connectors, a two pin power connector, a ten pin programming connector and a 48 pin Forth Stamp Connector. There are also two blocks of solder pads for configuring the RS232 line driver.

## Power

This is a two pin header located on the topside of the board for connecting The Forth Stamp to an external power supply if required. The Forth Stamp requires a 5V DC supply.

The 48 pin Stamp connector has its own power supply pins and so there is no need to use the power connector if the 48 pin Stamp connector is being used.

<b>Pin 1</b>	GND
<b>Pin 2</b>	VCC +5VDC

**Table 5:** The pinouts for power.

## SPI In-system Programming

This is a 10 pin connector which is located on the topside of the board allows the Forth Stamp to be programmed by connecting it to a standard 25 D-Connector type PC printer port for use with either the AT89 programming utility or the Forth 6 Cross Compiler. MPE's Forth 6 Cross Compiler gives fully interactive programming and testing in both Forth and 8051 family assembler.

<b>Pin Name</b>	<b>Forth Stamp SPI in-system programming connector</b>	<b>PC printer port</b>
VCC	1	Not connected
!SS	2	3
MOSI	3	4
MISO	4	10
GND	5	18
GND	6	Not Connected
SCK	7	5
RST	8	6
GND	9	Not Connected
GND	10	Not Connected

**Table 6:** SPI in-system programming interface.

N.B. VCC and the three extra ground pins (6,9,10) have been included if the user requires them.

N.B. ! = Active low.

## 48 pin Stamp Connector

This is a 48 pin connector located on the underside of the board and pins-out all the useful busses and lines from the microcontroller. Using this connector the 48 pin Stamp Connector is size compatible with any standard 48 pin IC DIP socket.

Pin Number	Pin Function	Pin Number	Pin Function
1	SCK	48	VCC
2	!SS	47	P1.0
3	MISO	46	P1.1
4	MOSI	45	P1.2
5	TX	44	P1.3
6	RX	43	P1.4
7	RST	42	P1.5
8	A0	41	P1.6
9	A1	40	P1.7
10	A2	39	P3.5/T1
11	A3	35	P3.4/T0
12	A4	37	P3.3/!INT1
13	A5	36	P3.2/!INT0
14	A6	35	!WE
15	A7	34	!OE
16	A8	33	!CE
17	A9	32	D0
18	A10	31	D1
19	A11	30	D2
20	A12	29	D3
21	A13	28	D4
22	A14	27	D5
23	A15	26	D6
24	GND	25	D7

**Table 7:** 48 pin Stamp Connector.

!CE = Chip enable – will go active low when either !WE or !OE is low.

!WE = Write enable.

!OE = Output enable.

N.B. != Active low.

## Solder Pads

The Forth Stamp contains two blocks of solder pads, block 1 is user configurable and block 2 is set at manufacture and should not be altered by the user. Block1 only comes into effect when the Forth Stamp is fitted with an RS232 line driver.

### Block 1 (user configurable)

Block 1 contains 12 solder pads (1-12) and configures the voltage levels/functions of the I/O lines P3.2/!INT0 and P3.4/T0 on the 48 pin Stamp Connector. The lines can either be configured to use standard TTL voltage levels or to use RS232 voltage levels. When set to use RS232 voltage levels the lines P3.2/!INT0 and P3.4/T0 are designed to act as serial port lines RTS and CTS respectively. The pads are by default left unsoldered meaning the pins P3.2/!INT0 and P3.4/T0 are not connected to the 48 pin Stamp Connector. This gives the full flexibility of choosing to set these pins to TTL or RS232 levels without having to de-solder any solder pads the first time the Forth Stamp is used. For configuring the pins P3.2/!INT0 and P3.4/T0 see Table 8.

Pin	Voltage Level	Bridged Pads
P3.2/!INT0	TTL	8&9, 10&11
P3.2/!INT0	RS232	7&8, 11&12
P3.4/T0	TTL	2&3, 4&5
P3.4/T0	RS232	1&2, 5&6

**Table 8:** The configurations of block 1 solder pads.

N.B. If all solder pads on block 1 are left open then P3.2 /!INT0 and P3.4/T0 will not be connected to the 48 pin Stamp Connector.

### **Block 2 (non-user configurable)**

Block 2 contains two pairs of solder pads (13 –16) which configure the lines TX and RX from the serial port. These pads are configured at manufacture only. Any attempt by the user to change the state of these solder pads could result in permanent damage to the Forth Stamp and any other hardware attached.

If the solder pads are connected then there will be no RS232 line driver fitted. The I/O lines TX and RX from the serial port will be standard TTL voltage levels.

If the solder pads are left open then a RS232 line driver will be fitted. The I/O lines TX and RX will be at RS232 voltage levels.

# 6 Schematics and Layouts

## Forth Stamp Schematic Circuit Diagram

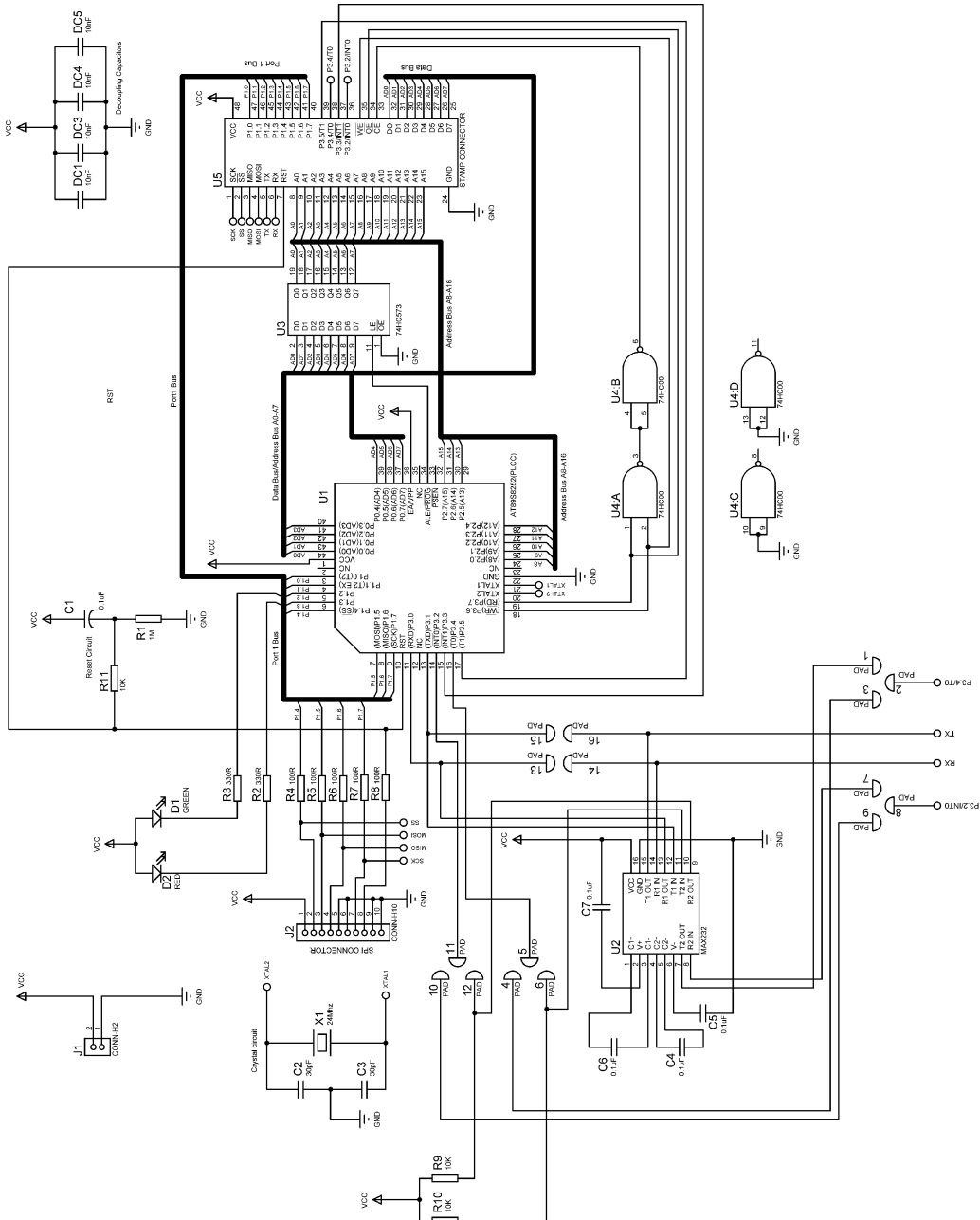
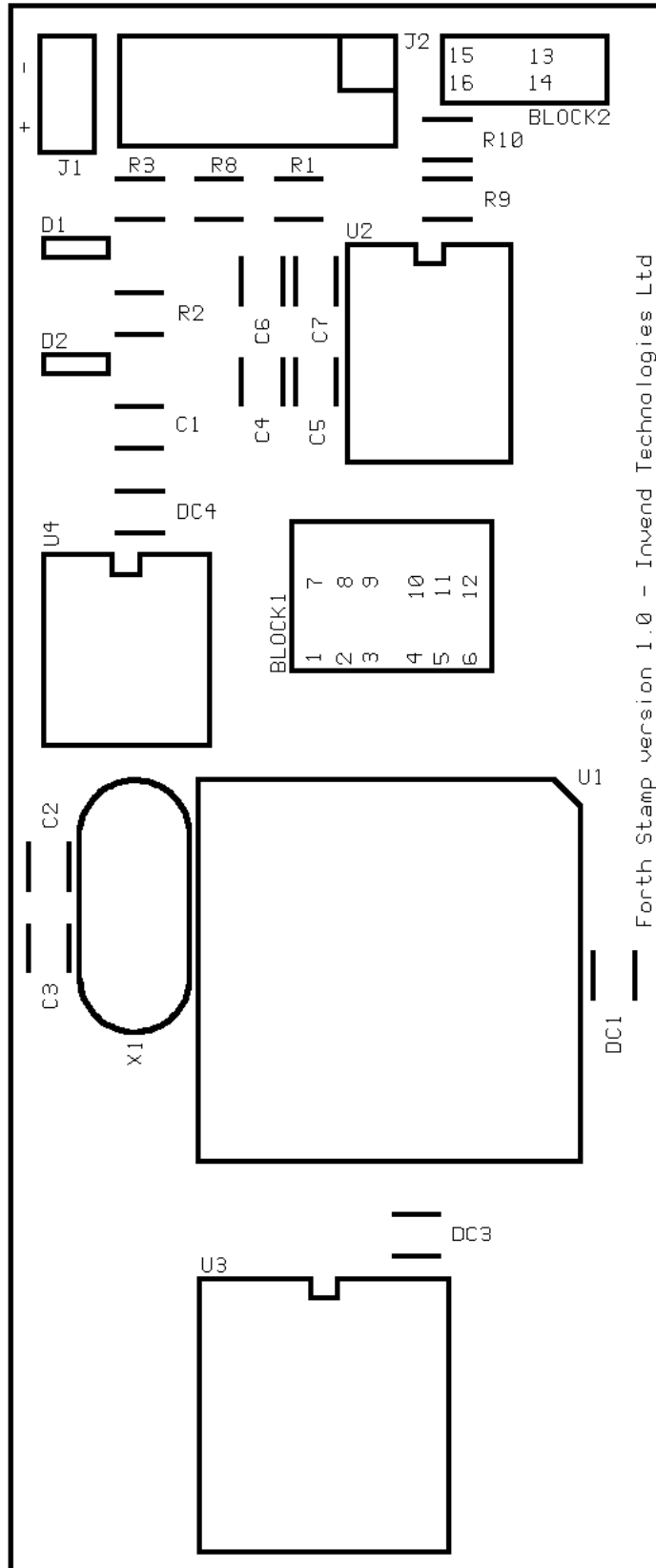


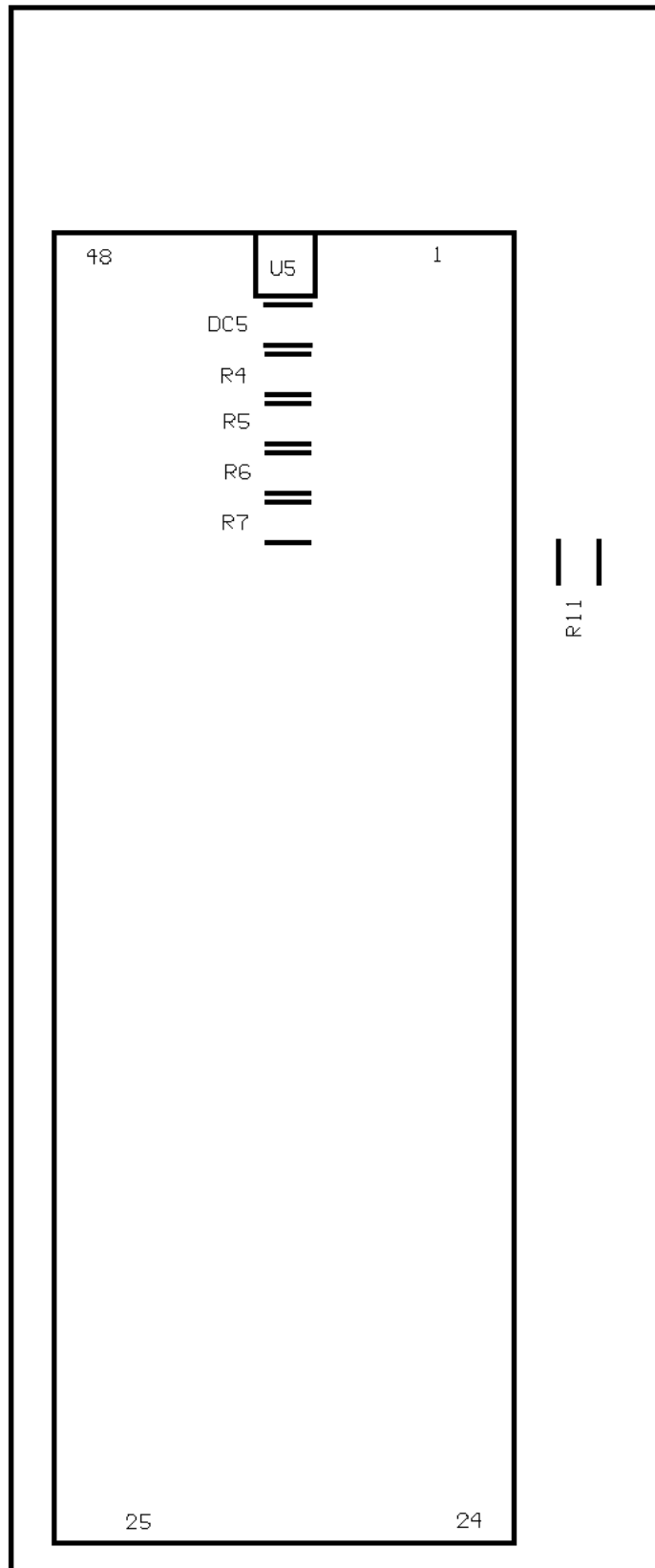
Figure 1: Circuit diagram.

## Forth Stamp Topside Component Layout



**Figure 2:** The Forth Stamp topside component layout viewed from looking down on the topside of the board. This diagram is not to scale.

### Forth Stamp Underside Component Layout



**Figure 3:** The Forth Stamp underside component layout viewed from looking down on the underneath of the board. This diagram is not to scale.



## Forth Stamp List of Components

Part Name	Value
R1	1M
R2	330R
R3	330R
R4	100R
R5	100R
R6	100R
R7	100R
R8	100R
R9	10K
R10	10K
R11	10K
C1	0.1uF
C2	30pF
C3	30pF
C4	0.1uF
C5	0.1uF
C6	0.1uF
C7	0.1uF
DC1	10nF
DC3	10nF
DC4	10nF
DC5	10nF
D1	Green LED
D2	Red LED
X1	24MHz
U1	AT89S8252
U2	MAX232ACSE
U3	74HCT573 (Latch)
U4	74HCT00 (Quad NAND)
U5 (48 pin Stamp Connector)	2*24 SIL Header
J1 (Power Connector)	2 SIL Header
J2 (SPI In-system Programming Connector)	5+5 DIL Header

**Table 9:** Component list and values.

---

# 7 Software Utilities

---

## Overview

The Forth Stamp can be programmed with the Forth 6 Cross Compiler for full interactivity. Programs can also be downloaded with the MPE AT89 Programming Utility. For details about using the Forth 6 Cross Compiler, please refer to the Forth 6 Cross Compiler manual.

## The AT89 Programming Utility

The AT89 programming utility (AT89prog.exe) is a tool for reading and writing program code (8K FLASH) or data (2K EEPROM) in raw binary to and from the Atmel AT89S8252 using its built in SPI interface. The binary file for downloading can come from any origin that is capable of producing a raw binary image.

## How to Use the AT89 Programming Utility

Use the following format to run AT89 programming Utility:

```
AT89prog.exe <filename> /switch1 /switch2 ...
```

The filename should include the full path of the file that you are either downloading from or uploading to. Please note the download file has to be in a raw binary format. Similarly code or data that has been uploaded will be in a raw binary format too. Make sure that you are either in the directory of where AT89prog.exe has been installed or use the full pathname. The default path for AT89prog.exe is:

```
... \stamp51\compiler\AT89prog.exe
```

## The Command Line Switches

/lpt1	Select LPT1 (378 hex) printer port address.
/lpt2	Select LPT2 (278 hex) printer port address.
/lpt n	Select printer port address 'n' is port address in hex. This is the same value as set in the BIOS.
/download	Download a file from the PC to the Forth Stamp.
/upload	Upload an area of memory from the Forth Stamp to a file on the PC.
/s n	Set the size of data/code to upload, 'n' is a decimal number in bytes. This option has no affect if downloading.
/t n	Select the start address of the code or data to upload/download to or from the AT89, 'n' is the address in hex.
/c	Select code space - this is the 8K onboard FLASH.

`/d`                    Select data space - this is the 2K onboard EEPROM.  
`/v`                    Verify a download/upload. This is useful if there is a cable fault.  
`/h`                    Display the help screen.

The default options are: `/download /c /lpt 378 /t 0 /s 0`.

NB: `/s` only has an affect when used in conjunction with the `/upload` switch.

Example: `AT89prog.exe c:\leds.img /lpt 378 /c /t FF`

This will download the contents of the file `'c:\leds.img'` to code space (8K FLASH) at the start address `FF` hex using the printer port address `378` hex.

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# 8 Troubleshooting

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This section is designed to help you self diagnose any problems and rectify them. Please use this guide first before contacting your supplier.

<b>Fault Description</b>	<b>Possible Cause</b>	<b>Solution</b>
Verify fails after running the AT89 Programming Utility.	No power.	Check power is connected and on.
	Cable fault.	Check that the SPI In-system Programming Cable is plugged in correctly.
		Check that the SPI In-system Programming Cable is wired up correctly.
Wrong printer port address selected.	Check address of printer port from BIOS. Check that the printer port is not being used by anything else.	
Verify passes but the LED flash test program fails to work correctly.	The binary file has become corrupt.	Recompile the source code 'leds.fth' from the '. . . \Compilers\Stamp51\chip' directory and download again.
	Another device is trying to write to the printer port at the same time the test program is running.	After downloading disconnect the SPI In-system Programming Cable from the Forth Stamp.

**Table 9:** Troubleshooting guide.