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FS2003

Portable ISP Programmer

User Guide

EQUINOX

TECHNOLOGIES

EQUINOX TECHNOLOGIES UK LIMITED

The Embedded Solutions Company

Contents

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Equinox Warranty Information

This product is guaranteed by Equinox Technologies (UK) Limited for a period of 12 months (1 year) after the date of purchase against defects due to faulty workmanship or materials. One guarantee covers both parts and labour. Service under the guarantee is only provided upon presentation of reasonable evidence that the date of the claim is within the guarantee period (e.g. completed registration/guarantee card or a purchase receipt).

The guarantee is not valid if the defect is due to accidental damage, misuse or neglect and in the case of alterations or repair carried out by unauthorised persons. A number of exceptions to the warranty are listed in the 'Exceptions to warranty' section below. Service (during and after guarantee period) is available in all countries where the product is distributed by Equinox Technologies UK Limited.

Exceptions to warranty

➢ **Over-voltage damage**
This warranty does not cover damage to the programmer due to voltages beyond the specified voltage limits being applied to the 'DC Power Input' (CON1) or any of the ISP Headers. The user must ensure that sufficient care is taken to avoid over-voltage and static conditions on any of the 'ISP Header' I/O pins.

➢ **Over-current damage**
This warranty does not cover damage to the programmer due to excessive current being drawn from the programmer power supply. The user must ensure that there is sufficient over-current protection within the test fixture to protect against short circuit loads.

➢ **Short-circuit damage**
This warranty does not cover damage to the programmer due to short-circuit loads being placed across programmer I/O lines.

➢ **Damage to the Programmer Line Driver Circuitry**
This warranty does not cover damage to the programmer 'Line Driver Circuitry' due to over-voltage, over-current or short-circuit of any of the programmer I/O lines. It is the responsibility of the user to make sure that sufficient precautions are taken before plugging the ISP Cable into a Target System.

Warning!
Any damage caused to the programmer by Electrostatic Discharge (ESD) through inadequate earthing is not covered under the warranty of the product.

Disclaimer

Whilst every effort has been made to ensure that programming algorithms are correct at the time of their release, it is always possible that programming problems may be encountered, especially when new devices and their associated algorithms are initially released. It is Equinox's Company Policy to endeavour to rectify any programming issues as quickly as possible after a validated fault report is received.

It is recommended that high-volume users always validate that a sample of a devices has been programmed correctly, before programming a large batch. Equinox Technologies UK Ltd. can not be held responsible for any third party claims which arise out of the use of this programmer including 'consequential loss' and 'loss of profit'.

Equinox Technologies UK Ltd. cannot be held responsible for any programming problems which are 'out of our control'. This type of problem is usually listed in the 'Errata Sheet' for the particular device being programmed and is available from the silicon vendor.

Information contained in this manual is for guidance purposes only and is subject to change. E&OE.

Electromagnetic Compatibility (EMC) Compliance

The '**FS2003 Programmer**' is a CE Approved Product. It is designed for use in an ESD controlled environment i.e. development or production. This means, therefore, that the user must ensure that there is no possibility of damage from electrostatic discharge (ESD). Since the devices and equipment to which this product is likely to be connected may well themselves be susceptible to ESD, this should not pose any difficulty.

For example, if you are handling microcontrollers and EEPROMS etc. then you will already be used to appropriate precautions, such as the use of anti-static mats, wrist straps and so on. You should treat your '**FS2003 Programmer**' with the same care as you would these types of devices. Always ensure that you are not yourself carrying a static charge before handling the product. Wearing an earthed anti-static wrist strap is recommended.

Equinox have taken great care in designing this product to be compliant with the European EMC directive. When using the equipment be sure to follow the instructions provided. Although RF emissions are within prescribed limits, care should be taken if you are using the product near to sensitive apparatus. If you experience any difficulty please refer to Equinox Technical Support.

ESD Points to remember

- Work in a static-free environment.
- Wear an earthed wrist strap when handling either the programmer and/or any programmable device.
- Ensure that the PC, programmer and Target system are connected to the same EARTH (0V) potential.
- Do NOT plug the ISP cable of the programmer into a Target System when the Target power is ON.

Warning!
Any damage caused to the programmer by Electrostatic Discharge (ESD) through inadequate earthing is not covered under the warranty of the product.

Technical Support

It is often the case that users experience problems when installing or using a product for the first time.

If you have a technical support problem, please consult the following list for help:

➢ **Manual**

➢ **On-line help**
Press <F1> for help at any time when running EQTools or ISP-PRO.

The help system is context-sensitive. Simply press <F1> on any error message and the possible causes of the error should be listed. This help system is updated on a regular basis. Please see software update details for information on keeping up-to-date with software revisions.

➢ **Internet Web Site**
The support page for all Equinox ISP Programmers can be found at:
http://www.equinox-tech.com/products/downloadsearch.asp

➢ **E-mail**
Please e-mail any technical support questions about this product to:
support@equinox-tech.com

➢ **Fax**
Please fax any technical support questions about this product to: +44 (0) 1942 844181

Equinox will try our best to answer your questions about this product as quickly as possible. However, we cannot promise an immediate reply. Please consult our web site for new software updates as the problem that you are enquiring about may have already been fixed in a new version.

Product Documentation

This manual provides an overview of the contents of the FS2003 Programming System plus associated hardware and software. References may be made to other hardware and software products which are not covered in detail in this manual. Please refer to the table below for a list of sources of documentation and/or browse to http://www.equinox-tech.com

Software:	
EQTools	**EQTools Script Builder – Manual** This software is used to create and upload 'Programming Projects' to the programmer. The following sources of documentation are available for this software: • Installation and Getting Started Guide (pdf manual) • Help file
ASCII TEXT MODE ABCDEFGHIJKLMNOPQRSTUVWXYZ	**ASCII Text Communications Protocol – Application Note** This protocol can be used to control the programmer from an external controller via RS-232. The following sources of documentation are available for this protocol: • Application Note – AN110 for a full description.
ISPPRO	**ISP Pro – Manual** This software is used to control the programmer in a production environment. It is not supplied as standard with this programmer. The following sources of documentation are available for this software: • Installation and User Manual • Help File
Upload Wizard	**Upload Wizard - Standalone Project Upload Utility** This software utility is used to upload Programming Projects to any Equinox programmer. These projects can then be used in Standalone Mode, i.e. without a PC. • Please follow the on-screen instructions within the Upload Wizard utility itself.

	Configit – Firmware Upgrade Utility
CONFIGIT	This utility is used to upgrade the firmware of the programmer if the firmware version is < 3.00. A firmware update may be required to add support for new devices and to correct any firmware issues.
LabMEW®	**Labview – Remote Application Control – Application Note**
	This upgrade allows a production facility to control a single programmer from a 'Labview for Windows' application. The Application note describes how to control the programmer using a custom Labview (from National Instruments) application.
	The following sources of documentation are available for this software:
	• Application Note - Remote Application Control of ISP-PRO
REMOTE APPLICATION Control	**Remote Application Control – Application Note**
	Describes how to control the programmer using a custom Remote Application written in e.g. Visual Basic, C++, C Builder, Delphi etc.
ConsoleEDS	**ConsoleEDS Pro – Application note**
	This software utility allows any Equinox programmer to be controlled via simple Command Line instructions from a Command Window within Windows.
	The following sources of documentation are available for this software:
	• Application Note 111 – ConsoleEDS Manual
JTAG ATmega ISP	**JTAG In-System (ISP) Upgrade – Application Note**
	This license upgrade enables the FS2003 Programmer to support high-speed In-System Programming (ISP) of the Atmel ATmega microcontroller family using the JTAG algorithm.
	The following sources of documentation are available for this software:
	• Application Note 101
ERROR MESSAGES	**Error Message Descriptions**
	This document lists all the possible error messages which can be generated by the EQTools / ISP-PRO applications.

Downloading up-to-date documentation and software:

In line with our policy of continuous improvement, the software and associated documentation for this product are updated on a regular basis. Please refer to the 'Downloads Page' for this product on our website at http://www.equinox-tech.com/products/downloadsearch.asp for the most up-to-date information for this product.

Browse to http://www.equinox-tech.com
- o Click / select the <Downloads> tab → the 'Downloads Search Page' will appear.
- o Type in the name of the programmer e.g. FS2003 into the 'Product Name' field
- o Click the <Search> button
    - → a list of all the software and documentation available for this product are displayed.
- o Click the <Info> button next to an individual item to see the details of the downloadable file
- o Click the <Download> button to download the file

Please note:

You may be asked to register your programmer before downloading certain files. Equinox use the registration information to send you up-to-date information about new software releases etc.
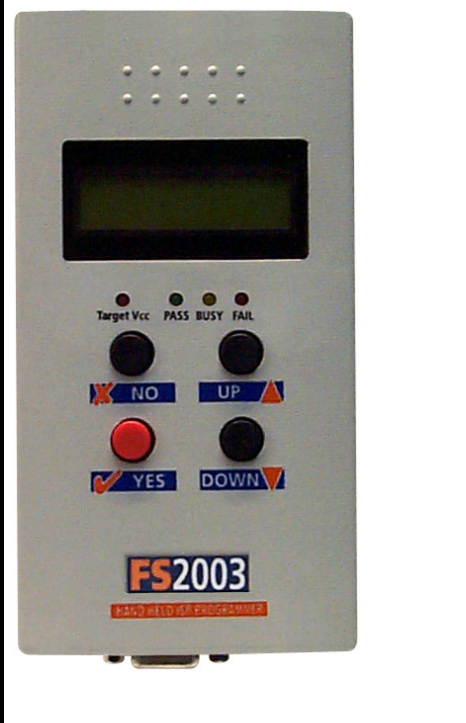
1.0 Programmer Overview / Specifications

1.1 System Contents

The FS2003 programmer comes compete with an external mains power supply, PC Driver Software and cables. Please see the full contents list detailed below.

Hardware

- FS2003 ISP Programmer
- External Power Supply Adaptor (9V DC regulated @ 300mA)

Cables

- DC Power Cable (jack to bare wires)
- 9-way Female to 9-way Male Serial Cable
- 25-way Female to 9-way Male Serial Adaptor
- 10 way ISP Cable
- 6 way ISP Cable

Miscellaneous

- 2 x Jumper Links

Software
(Supplied on an Equinox CD-ROM)

- EQTools
  (Project Management Utility for Equinox Production ISP Programmers)

Documentation

- FS2003 - User Guide

1.2 Hardware Overview (external layout)

	Top Panel
	ISP Cable Slot ISP cable plugs into relevant ISP Header internally and then exits the case through this slot.

	Front Panel	
		<Target Vcc> LED - Indicates when 'Target Vcc' is ON - Does not indicate 'Programmer Power' unless Jumper J9 is fitted. **Status LED's:** **<PASS> LED** **<BUSY> LED** **<FAIL> LED**
		<NO> Button - Used to cancel a programming operation.
		<YES> Button - Used to start an 'autoprogram' operation.

	Bottom Panel 1. RS-232 port (J5) 2. External DC Power Supply Input (CON1)

1.3 Hardware Overview (internal layout)
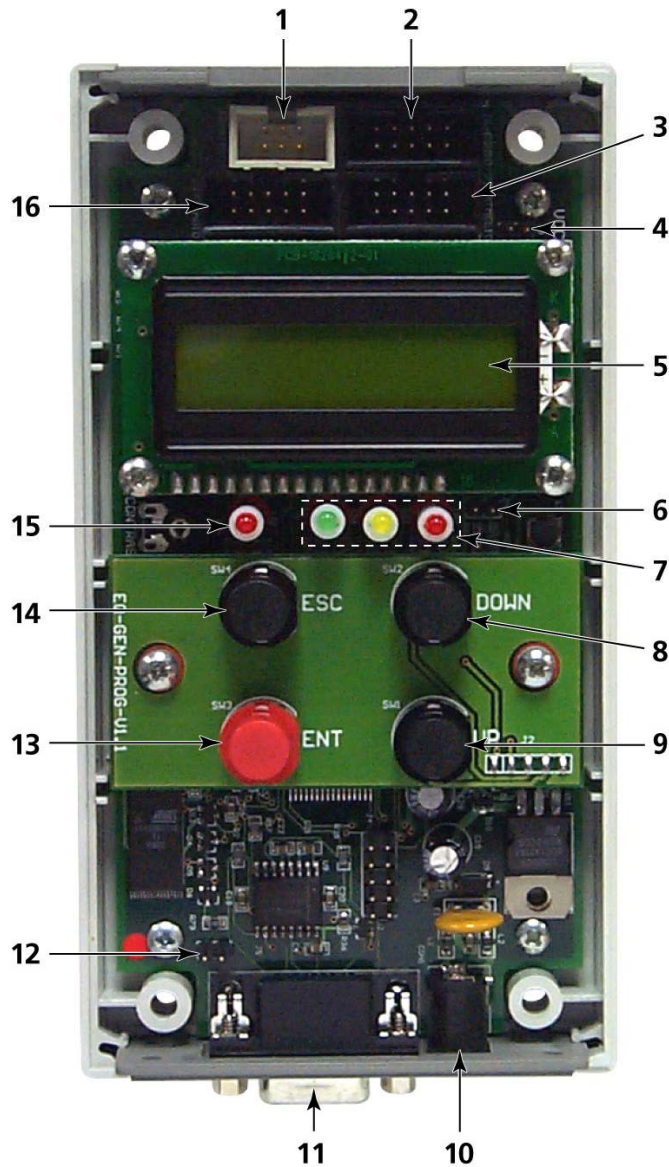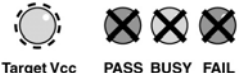
Hardware

1. Atmel 6-way ISP (SPI) Header (J3)
2. Equinox 10-way ISP (SPI / UART) Header (J6)
3. Atmel 10-way ISP (SPI) Header (J7)
4. Jumper (J9) – Vcc Link
5. Liquid Crystal Display (LCD)
6. Enable LCD Backlight Jumper (J10)
7. Status LED's
8. <Down> Key
9. <Up> Key
10. External DC Power Supply Input (CON1)
11. RS-232 port (J5)
12. Firmware Update Jumper 2 (J11)
13. <YES> Key
14. <No> Key
15. Target Vcc Present – LED
16. Atmel 10-way JTAG Header

1.4 Programmer Specifications Overview

The table below details the hardware specifications for the programmer. Please refer to the stated section for further information about any specific parameter.

#	Parameter	Description / comment	Refer to sect
1	Target Device Support	See Device Support List	1.5.1
2	Target Device Programming Interfaces	The programmer supports the following programming interfaces: • Atmel Low Voltage SPI • Atmel High Voltage SPI (+12V Vpp) • Atmel AVR JTAG (chargeable update) • Atmel (formerly Temic) 8051 Boot loader ISP • Philips (NXP) 8051 - Boot Loader ISP	1.5.2
3	Operating modes	The programmer supports the following operating modes: As standard: • Development Mode (PC controlled) • Project Upload Mode using Upload Wizard (PC controlled) • Standalone Mode - Keypad + LCD operation • Standalone Mode – Run Target • ConsoleEDS EVAL – Command Line control Optional chargeable upgrades: • Standalone Mode - Remote Controlled via 'ASCII Text Communications' RS-232 Serial Protocol • PC controlled via ISP-PRO software (chargeable upgrade) • ConsoleEDS PRO – Command Line control	3.4
4	On-board FLASH Memory Store	32 Mbits (4 MBytes) FLASH Memory	
5	Project storage in Memory Store	64 x Independent Programming Projects	
6	Keypad entry	4 x Push Button - <YES>, <NO>, <UP>, <Down>	
7	Status LED's	3 x Status LED's located on the programmer: <PASS>, <BUSY>, <FAIL> These LED's indicate the current status of the programmer.	
8	Programmer Display	2 x 16 character Back-lit LCD (backlight configurable)	
9	Target Vcc	• Target Vcc LED will illuminate when Target Vcc voltage is	

	Voltage Detection LED Target Vcc PASS BUSY FAIL	detected. • Threshold detection voltage: approx 3.1V	
10	**PC Control Software**	The programmer can be controlled using: As standard: • EQTools • Upload Wizard (integrated with EQTools) • ConsoleEDS EVAL – Command Line control Optional chargeable upgrades: • ASCII Text Communications Mode • ISP-PRO • Standalone Upload Wizard • ConsoleEDS PRO – Command Line control	3.1
11	**EQTools / ISP-PRO PC requirements**	PC running Windows 95 / 98 / 2000 / ME / NT4 / XP	
12	**Power Supply Options**	There are 3 possible modes for powering the Programmer / Target System: • Programmer is powered from the Target System (3.0 – 5.0V) • Programmer powers the Target System (+5.0V only) • Programmer and Target System are independently powered (Programmer at 9.0 -12V, Target System at 3.0 – 5.0V)	2.3
13	**Voltage range**	• Device Programming voltage range: 3.0 – 5.0V • Programmer Internal Vcc Voltage: 5.0V • Possible Target System voltage range: 3.0 – 5.0V	
14	**Vpp Voltage Generator**	On Board +12.0V Vpp Voltage Generator (Applies +12.0V to RESET pin for Atmel ATtiny HV programming)	
15	**DC Power Connector (jack socket)**	DC Power Connector • 2.5 mm Jack Socket – Centre Positive • 9.0 – 12.0V DC regulated @ 500mA (worst case) • Mates with Power Supply Adaptor supplied with programmer • DC Power Lead also supplied with programmer if a customer power supply is to be used.	
16	**Target Voltage measurement**	• The programmer can measure the Target Voltage in either EDS or Standalone Mode. • Measurement Voltage range: 3.0 – 5.0 Tolerance: +/-3%	
17	**Max. current through programmer**	This refers to the maximum current which the programmer can supply from the internal Vcc rail	

		Max current = 300 mA.	
18	**Target SPI Frequency**	The programmer supports three SPI speeds: • SLOW SPI: 0 – 490.2 kHz (user selectable) • MEDIUM SPI: 0 – 490.2 kHz (user selectable) • FAST SPI: Disabled (SPI speeds are estimations only due to uneven mark/space ratio and non-continuous waveforms)	
19	**Target JTAG Frequency**	The programmer supports a user-defined JTAG frequency: • SLOW: 0 – 833 kHz	
20	**Target UART Speed**	• This is the Communications Speed (BAUD rate) from the programmer to the Target Device when communicating via a Boot Loader. • The BAUD rate is configurable from 1,200 to 115 kBaud. • This settings is completely independent from the BAUD rate settings for the PC communicating with the programmer.	
21	**ISP Headers**	The programmer support all the popular ISP Header as standard: • Atmel 10-way (SPI) • Atmel 6-way (SPI) • Atmel 10-way (JTAG) • Equinox 10-way (SPI+UART)	4.0
22	**Frequency generator output (SCK2)**	The FS2003 is capable of outputting a continuous square wave at various frequencies on the programmer SCK2 pin. The following pre-set frequencies can be selected via the EQTools Programming Project: 1.8432 MHz, 921.6 kHz, 614.4 kHz, 460.9 kHz, 386.6 kHz, 307.6 kHz, 230.4 kHz,167.6 kHz, 102.4 kHz, 51.2 kHz This clock frequency could be used for the following purposes: • To toggle the STROBE pin on a Watchdog Timer IC to stop the IC from timing out during the In-System Programming operation. • To provide a clock to an Atmel ATmega microcontroller to resurrect a device which has an incorrectly configured Internal Oscillator. Please refer to the 'EQTools – Getting Started Guide' for full details of setting up the SCK2 oscillator.	
23	**Target Run**	The programmer is capable of automatically running firmware which has been programmed into a Target Device and waiting until the MISO pin is asserted by the Target Device.	
24	**Pre-Programming State Machine**	The programmer has 5-state 'Pre-programming State Machine' which allows the I/O lines of the programmer to be sequenced in order to place the Target Device into Serial Programming Mode.	
25	**PC Connection**	**RS232 – Single Programmer Channel Control** • 9-way Female D Connector	1.8

		• Connects to spare PC COM port • All 9 connections must be made in serial cable. • Baud rate: 38,400 (fixed)	
26	**Temperature range**	0 to 50 deg. C	
27	**Dimensions**	189H x 80L x 31D mm	
28	**Shipped Weight**	0.75 kg	

1.5 Device Support

1.5.1 Devices supported by the programmer

The programmer supports the following devices (at the time of this manual going to press):

#	Silicon vendor	Family	Programming algorithm	Device support	
1	**Atmel**	AT89S	LV SPI	- AT89(L)S8252/53 - AT89(L)S51/52 (including 'L' versions) - AT89S 2051 / 4051 - AT89S8253	S
2	**Atmel**	AT90S (AVR)	LV SPI	- AT90(L)S1200(A) / 2313 / 2333 / 4433 / 2323 / 2343 / 4414 / 8515 / 4434 / 8535 (including 'L' versions)	S
3	**Atmel**	AT90CAN	LV SPI	AT90CAN128 / AT90CAN64 / AT90CAN32	S
4	**Atmel**	AT90CAN	JTAG (AVR)	AT90CAN128 / AT90CAN64 / AT90CAN32	U
5	**Atmel**	AT90USB	LV SPI	AT90USB1286/ AT90USB1287/ AT90USB162/ AT90USB646/ AT90USB647/ AT90USB82	S
6	**Atmel**	AT90USB	JTAG (AVR)	AT90USB1286, AT90USB1287, AT90USB646, AT90USB647	U
7	**Atmel**	ATmega (AVR)	LV SPI	- ATmega 8 / 16 / 32 / 48 / 88 / 64 / 103 / 128 / 1280 / 1281 / 168 / 169(V) / 169PV / 323 / 325 / 329 / 2560 / 2561 2561V / 8515 / 8535 (including 'L' versions)	S
8	**Atmel**	ATmega (AVR)	JTAG (AVR)	ATmega 8515 / 8535 / 32 / 64 / 128 / 1280 / 1281 / 161 / 162 / 163 / 169 / 323 / 325 / 329 / 3290(V) 406 / 640(V) / 2560 / 2561 (including 'L' versions)	U
9	**Atmel**	ATtiny (AVR)	LV SPI	ATtiny 12 / 13 / 15L / 22 / 24*/ 25 / 26 / 45 / 85 / 2313 (including 'L' versions)	S
10	**Atmel**	ATtiny (AVR)	HV SPI (+12V VPP)	ATtiny 11 / 12 / 15L (including 'L' versions – Vcc must be +5V with a +12V Vpp applied to the RESET pin) HV ISP support for the ATtiny13, 25, 45 etc is not currently available.	S
11	**Atmel (Temic)**	T89C51Rx2	UART Boot Loader	T89C51 RB2 / RC2 / RD2 T89C51 IB2 / IC2 T89C51CC01 (Support for the AT89Cxxxx devices is not currently available)	S
12	**NXP (Philips)**	T89C51Rx2	UART Boot Loader	P89C51 RB2 / RC2 / RD2 P89C 660 / 662 / 664 / 668	S
13	**Zensys**	ZW series	LV SPI	ZW0102 / ZW0201 / ZW0301	S

Key:

S – Device supported as standard

U – Chargeable license upgrade required

* – Support to be announced – please contact Equinox for a Support Date

For an up-to-date Device Support list, please refer to the 'Device Support' section for this programmer on the Equinox Website.

Important note:

Please refer to the relevant Application Note for details of how to connect the programmer to the Target Device on the Target System. The Application Notes can be found on the FS2003 - Download Page on the Equinox website.

1.5.2 Programming Interface to Target Device

➢ **The programmer supports the following programming interfaces to the Target Device:**

#	Programming Interface	Family	Description / Comment
1	LV SPI	AT89S AT90S AT90USB AT90CAN ATmega ATtiny Zensys	**Atmel Low Voltage Serial Programming Mode** • Atmel 3-wire SPI interface (SCK, MOSI, MISO) • Target Device RESET • Works at target voltage (no Vpp required)
2	HV SPI (+12V Vpp)	ATtiny	**Atmel High Voltage Serial Programming Mode** • Atmel 4-wire SPI Interface (SCK, MOSI, MISO, MOSI2) • +12V Vpp is applied to the RESET pin to enter High Voltage Serial Programming Mode • Requires different connections to Target Device compared with LV SPI. • Requires all pins of target device to be accessible by the programmer.
3	UART Boot Loader	T89C51Rx2 P89X51Rx2	**Atmel / Philips UART Boot Loader Interface** • Uses RXD, TXD, PSEN, and Target Device RESET pin • TTL Levels from programmer to Target System
4	JTAG (Atmel AVR)	ATmega AT90USB AT90CAN	**Atmel ATmega AVR – JTAG ISP Interface** • Uses same connector as Atmel JTAG ICE • A chargeable license upgrade is required to enable the ATmega JTAG ISP libraries.

Please note:

A chargeable license upgrade is required to enable the ATmega JTAG ISP libraries.

1.6 DC Power Input Connector (CON1)

It is possible to power the programmer from an external power supply by plugging the DC Power Cable supplied with the programmer into CON1. This connector is a 2.5mm jack socket.

Fig. 1.6.1 CON1 – pin-out

Description	Voltage
Centre pin	+9.0V to +12.0V from external power supply
Outer	0V (Ground connection)

1.7 DC Power Cable Specification

➢ The programmer is supplied with a DC power cable which plugs into CON1. The other end of this cable is supplied with bare wire ends for connecting to an external power supply e.g. bench PSU**.**

Cable Specification:
- One end features a female 2.5mm DC jack plug
- The other end of the cable is supplied with bare wire ends for connecting to an external power supply e.g. bench PSU.
- The black lead with the white stripe is the +VE cable.
- The all black lead is the GROUND cable.
- The external voltage applied to CON1 must be between 9.0 and 12.0V!
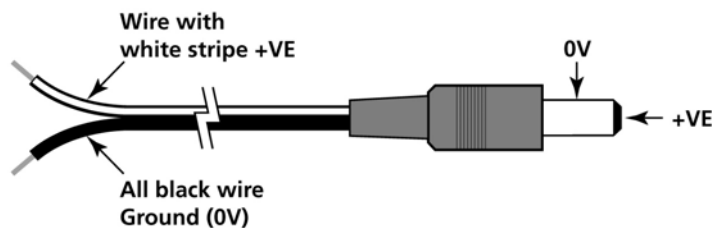
1.8 J5 – RS-232 Communications Port & Serial Cables

1.8.1 Connecting the programmer to the PC COM port

The programmer communicates with a PC via the RS-232 Communications Port (J5). A suitable 9-way to 9-way serial cable is supplied with the programmer.

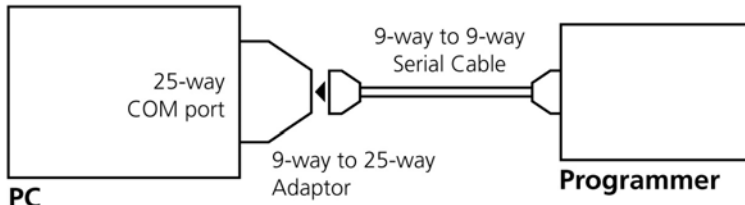The programmer is supplied with the following PC Serial Cables / Adaptors:

1. **9-way D (female) to 9-way D (Male) Serial Cable**
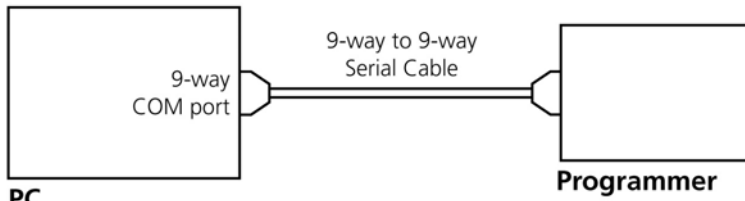
Programmer to 9-way PC Serial Port Connection

This cable should be connected between the 9-way D-connector on the programmer and a spare 9-way RS-232 COM port on your PC.

2. **9-way D (female) to 25-way D (Female) adaptor**

Programmer to 25-way PC Serial Port Connection

 If your PC has a 25-way D connector, you will need to plug the 9-25 way adapter onto the end of the 9-9 way Serial Cable as shown in the diagram below.

1.8.2 Serial Cable Length

The serial cable supplied with the programmer is approximately 2m in length. If you wish to make your own longer cable, please ensure that you connect all 9 pins at each end in a straight-through pin-to-pin fashion. See fig. 1.7.3 for the pin-out specifications. The programmer features an ESD protected full RS-232 specification driver chipset and so should operate reliably when driving serial cables up to 10m in length. However, it is recommended to keep the serial cable as short as possible to enhance EMI immunity and reduce EMI emissions.

Important note:
The programmer uses ALL of the NINE pins of the COM port for different purposes. It is therefore imperative that the cable used to connect between the programmer and the PC COM port has all NINE cables connected. Failure to do this will result in the programmer not operating correctly.

1.8.3 Serial Cable Pin-outs

Fig. 1.8.3.1 Pin-out of J5 - RS-232 Communications Port

Pin No.	RS232 pin	Description
1	DCD	Not Connected
2	RXD	Receive
3	TXD	Transmit
4	DTR	Not Connected
5	0 Volt	0V
6	DSR	Not Connected
7	RTS	Not Connected
8	CTS	Not Connected
9	RING	Not Connected

Fig. 1.8.3.2 Connections for 9-way to 9-way Serial Cable (Straight through cable)

9-way (Male)	9-way (Female)
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Fig. 1.8.3.3 Connections for 9-way to 25-way Adaptor

25-way (Female)	9-way (Male)
8	1
3	2
2	3
20	4
7	5
6	6
4	7
5	8
22	9

2.0 Hardware Installation

2.1 Overview

This section details how to set up the programmer hardware including Power Supply, Earthing Requirements, PC Serial Port Connection and ISP Header Selection.

2.2 ESD Precautions

	• Work in a static-free environment. • Wear an earthed wrist strap when handling either the programmer and/or any programmable device. • Ensure that the PC, programmer and Target system are connected to the same EARTH (0V) potential. • Do NOT plug the ISP cable of the programmer into a Target System when the Target power is ON. • The programmer I/O lines are ESD protected, but it always good practice to take proper ESD precautions. This can help to avoid ESD damage to either the programmer or Target System.