AVRDUDE

A program for download/uploading AVR microcontroller flash and eeprom.

by Brian S. Dean
Send comments on AVRDUDE to avrdude-dev@nongnu.org.
Use http://savannah.nongnu.org/bugs/?group=avrdude to report bugs.

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1 Introduction

AVRDUDE - AVR Downloader Uploader - is a program for downloading and uploading the on-chip memories of Atmel’s AVR microcontrollers. It can program the Flash and EEPROM, and where supported by the serial programming protocol, it can program fuse and lock bits. AVRDUDE also supplies a direct instruction mode allowing one to issue any programming instruction to the AVR chip regardless of whether AVRDUDE implements that specific feature of a particular chip.

AVRDUDE can be used effectively via the command line to read or write all chip memory types (eeprom, flash, fuse bits, lock bits, signature bytes) or via an interactive (terminal) mode. Using AVRDUDE from the command line works well for programming the entire memory of the chip from the contents of a file, while interactive mode is useful for exploring memory contents, modifying individual bytes of eeprom, programming fuse/lock bits, etc.

AVRDUDE supports the following basic programmer types: Atmel’s STK500, Atmel’s AVRISP and AVRISP mkII devices, Atmel’s STK600, Atmel’s JTAG ICE (the original one, mkII, and 3, the latter two also in ISP mode), appnote avr910, appnote avr109 (including the AVR Butterfly), serial bit-bang adapters, and the PPI (parallel port interface). PPI represents a class of simple programmers where the programming lines are directly connected to the PC parallel port. Several pin configurations exist for several variations of the PPI programmers, and AVRDUDE can be be configured to work with them by either specifying the appropriate programmer on the command line or by creating a new entry in its configuration file. All that’s usually required for a new entry is to tell AVRDUDE which pins to use for each programming function.

A number of equally simple bit-bang programming adapters that connect to a serial port are supported as well, among them the popular Ponyprog serial adapter, and the DASA and DASA3 adapters that used to be supported by uisp(1). Note that these adapters are meant to be attached to a physical serial port. Connecting to a serial port emulated on top of USB is likely to not work at all, or to work abysmally slow.

If you happen to have a Linux system with at least 4 hardware GPIOs available (like almost all embedded Linux boards) you can do without any additional hardware - just connect them to the MOSI, MISO, RESET and SCK pins on the AVR and use the linuxgpio programmer type. It bitbangs the lines using the Linux sysfs GPIO interface. Of course, care should be taken about voltage level compatibility. Also, although not strictly required, it is strongly advisable to protect the GPIO pins from overcurrent situations in some way. The simplest would be to just put some resistors in series or better yet use a 3-state buffer driver like the 74HC244. Have a look at http://kolev.info/avrdude-linuxgpio for a more detailed tutorial about using this programmer type.

The STK500, JTAG ICE, avr910, and avr109/butterfly use the serial port to communicate with the PC. The STK600, JTAG ICE mkII/3, AVRISP mkII, USBasp, avrftdi (and derivatives), and USBtinyISP programmers communicate through the USB, using libusb as a platform abstraction layer. The avrftdi adds support for the FT2232C/D, FT2232H, and FT4232H devices. These all use the MPSSE mode, which has a specific pin mapping. Bit 1 (the lsb of the byte in the config file) is SCK. Bit 2 is MOSI, and Bit 3 is MISO. Bit 4 usually reset. The 2232C/D parts are only supported on interface A, but the H parts can be either A or B (specified by the usbdev config parameter). The STK500, STK600, JTAG ICE, and avr910 contain on-board logic to control the programming of the target
device. The avr109 bootloader implements a protocol similar to avr910, but is actually implemented in the boot area of the target’s flash ROM, as opposed to being an external device. The fundamental difference between the two types lies in the protocol used to control the programmer. The avr910 protocol is very simplistic and can easily be used as the basis for a simple, home made programmer since the firmware is available online. On the other hand, the STK500 protocol is more robust and complicated and the firmware is not openly available. The JTAG ICE also uses a serial communication protocol which is similar to the STK500 firmware version 2 one. However, as the JTAG ICE is intended to allow on-chip debugging as well as memory programming, the protocol is more sophisticated. (The JTAG ICE mkII protocol can also be run on top of USB.) Only the memory programming functionality of the JTAG ICE is supported by AVRDUDE. For the JTAG ICE mkII/3, JTAG, debugWire and ISP mode are supported, provided it has a firmware revision of at least 4.14 (decimal). See below for the limitations of debugWire. For ATxmega devices, the JTAG ICE mkII/3 is supported in PDI mode, provided it has a revision 1 hardware and firmware version of at least 5.37 (decimal).

The Atmel-ICE (ARM/AVR) is supported (JTAG, PDI for Xmega, debugWIRE, ISP modes).

Atmel’s XplainedPro boards, using EDBG protocol (CMSIS-DAP compliant), are supported by teh “jtag3” programmer type.

The AVR Dragon is supported in all modes (ISP, JTAG, PDI, HVSP, PP, debugWire). When used in JTAG and debugWire mode, the AVR Dragon behaves similar to a JTAG ICE mkII, so all device-specific comments for that device will apply as well. When used in ISP and PDI mode, the AVR Dragon behaves similar to an AVRISP mkII (or JTAG ICE mkII in ISP mode), so all device-specific comments will apply there. In particular, the Dragon starts out with a rather fast ISP clock frequency, so the -B bitclock option might be required to achieve a stable ISP communication. For ATxmega devices, the AVR Dragon is supported in PDI mode, provided it has a firmware version of at least 6.11 (decimal).

Wiring boards are supported, utilizing STK500 V2.x protocol, but a simple DTR/RTS toggle to set the boards into programming mode. The programmer type is “wiring”.

The Arduino (which is very similar to the STK500 1.x) is supported via its own programmer type specification “arduino”.

The BusPirate is a versatile tool that can also be used as an AVR programmer. A single BusPirate can be connected to up to 3 independent AVRs. See the section on extended parameters below for details.

The USBasp ISP and USBtinyISP adapters are also supported, provided AVRDUDE has been compiled with libusb support. They both feature simple firmware-only USB implementations, running on an ATmega8 (or ATmega88), or ATtiny2313, respectively.

The Atmel DFU bootloader is supported in both, FLIP protocol version 1 (AT90USB* and ATmega*U* devices), as well as version 2 (Xmega devices). See below for some hints about FLIP version 1 protocol behaviour.

1.1 History and Credits

AVRDUDE was written by Brian S. Dean under the name of AVRPROG to run on the FreeBSD Operating System. Brian renamed the software to be called AVRDUDE when
interest grew in a Windows port of the software so that the name did not conflict with AVRPROG.EXE which is the name of Atmel’s Windows programming software.

The AVRDUDE source now resides in the public CVS repository on savannah.gnu.org (http://savannah.gnu.org/projects/avrdude/), where it continues to be enhanced and ported to other systems. In addition to FreeBSD, AVRDUDE now runs on Linux and Windows. The developers behind the porting effort primarily were Ted Roth, Eric Weddington, and Joerg Wunsch.

And in the spirit of many open source projects, this manual also draws on the work of others. The initial revision was composed of parts of the original Unix manual page written by Joerg Wunsch, the original web site documentation by Brian Dean, and from the comments describing the fields in the AVRDUDE configuration file by Brian Dean. The texi formatting was modeled after that of the Simulavr documentation by Ted Roth.
2 Command Line Options

2.1 Option Descriptions

AVRDUDE is a command line tool, used as follows:

```
avrdude -p partno options ...
```

Command line options are used to control AVRDUDE’s behaviour. The following options are recognized:

- `p partno` This is the only mandatory option and it tells AVRDUDE what type of part (MCU) that is connected to the programmer. The `partno` parameter is the part’s id listed in the configuration file. Specify `-p ?` to list all parts in the configuration file. If a part is unknown to AVRDUDE, it means that there is no config file entry for that part, but it can be added to the configuration file if you have the Atmel datasheet so that you can enter the programming specifications. Currently, the following MCU types are understood:

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(*) The AT90S2323 and ATtiny22 use the same algorithm.
(**) Flash addressing above 128 KB is not supported by all programming hardware. Known to work are jtag2, stk500v2, and bit-bang programmers.
(***) The ATtiny11 can only be programmed in high-voltage serial mode.
(****) The ISP programming protocol of the AT90S1200 differs in subtle ways from that of other AVRs. Thus, not all programmers support this device. Known to work are all direct bitbang programmers, and all programmers talking the STK500v2 protocol.

**-b baudrate**
Override the RS-232 connection baud rate specified in the respective programmer’s entry of the configuration file.

**-B bitclock**
Specify the bit clock period for the JTAG interface or the ISP clock (JTAG ICE only). The value is a floating-point number in microseconds. The default value of the JTAG ICE results in about 1 microsecond bit clock period, suitable for target MCUs running at 4 MHz clock and above. Unlike certain parameters in the STK500, the JTAG ICE resets all its parameters to default values when the
Chapter 2: Command Line Options

programming software signs off from the ICE, so for MCUs running at lower clock speeds, this parameter must be specified on the command-line. It can also be set in the configuration file by using the `default_bitclock` keyword.

```
-c programmer-id
```

Specify the programmer to be used. AVRDUCE knows about several common programmers. Use this option to specify which one to use. The `programmer-id` parameter is the programmer’s id listed in the configuration file. Specify `-c ?` to list all programmers in the configuration file. If you have a programmer that is unknown to AVRDUCE, and the programmer is controlled via the PC parallel port, there’s a good chance that it can be easily added to the configuration file without any code changes to AVRDUCE. Simply copy an existing entry and change the pin definitions to match that of the unknown programmer. Currently, the following programmer ids are understood and supported:

- 2232HIO: FT2232H based generic programmer
- 4232h: FT4232H based generic programmer
- 89isp: Atmel at89isp cable
- abcmi: ABCmini Board, aka Dick Smith HOTCHIP
- arduino: Arduino
- arduino-ft232r: Arduino: FT232R connected to ISP
- atisp: AT-ISP V1.1 programming cable for AVR-SDK1 from [http://micro-research.co.th/](http://micro-research.co.th/)
- atmelice: Atmel-ICE (ARM/AVR) in JTAG mode
- atmelice_dw: Atmel-ICE (ARM/AVR) in debugWIRE mode
- atmelice_isp: Atmel-ICE (ARM/AVR) in ISP mode
- atmelice_pdi: Atmel-ICE (ARM/AVR) in PDI mode
- avr109: Atmel AppNote AVR109 Boot Loader
- avr910: Atmel Low Cost Serial Programmer
- avr911: Atmel AppNote AVR911 AVROSP
- avrftdi: FT2232D based generic programmer
- avrisp: Atmel AVR ISP
- avrisp2: Atmel AVR ISP mkII
- avrispmkII: Atmel AVR ISP mkII
- avrispv2: Atmel AVR ISP V2
- bascom: Bascom SAMPLE programming cable
- blaster: Altera ByteBlaster
- buspirate: The Bus Pirate
- buspirate_bb: The Bus Pirate (bitbang interface, supports TPI)
- butterfly: Atmel Butterfly Development Board
- butterfly_mk: Mikrokopter.de Butterfly
- bwmega: BitWizard ftdi_atmega builtin programmer
- C232HM: FT232H based module from FTDI and Glyn.com.au
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<td>Direct AVR Parallel Access cable</td>
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<td>diecimila</td>
<td>alias for arduino-ft232r</td>
</tr>
<tr>
<td>dragon_dw</td>
<td>Atmel AVR Dragon in debugWire mode</td>
</tr>
<tr>
<td>dragon_hvsp</td>
<td>Atmel AVR Dragon in HVSP mode</td>
</tr>
<tr>
<td>dragon_isp</td>
<td>Atmel AVR Dragon in ISP mode</td>
</tr>
<tr>
<td>dragon_jtag</td>
<td>Atmel AVR Dragon in JTAG mode</td>
</tr>
<tr>
<td>dragon_pdi</td>
<td>Atmel AVR Dragon in PDI mode</td>
</tr>
<tr>
<td>dragon_pp</td>
<td>Atmel AVR Dragon in PP mode</td>
</tr>
<tr>
<td>dt006</td>
<td>Dontronics DT006</td>
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<tr>
<td>ere-isp-avr</td>
<td>ERE ISP-AVR</td>
</tr>
<tr>
<td>flip1</td>
<td>FLIP USB DFU protocol version 1 (doc7618)</td>
</tr>
<tr>
<td>flip2</td>
<td>FLIP USB DFU protocol version 2 (AVR4023)</td>
</tr>
<tr>
<td>frank-stk200</td>
<td>Frank STK200</td>
</tr>
<tr>
<td>ft232r</td>
<td>FT232R Synchronous BitBang</td>
</tr>
<tr>
<td>ft245r</td>
<td>FT245R Synchronous BitBang</td>
</tr>
<tr>
<td>futurlec</td>
<td>Futurlec.com programming cable.</td>
</tr>
<tr>
<td>jtag1</td>
<td>Atmel JTAG ICE (mkI)</td>
</tr>
<tr>
<td>jtag1slow</td>
<td>Atmel JTAG ICE (mkI)</td>
</tr>
<tr>
<td>jtag2</td>
<td>Atmel JTAG ICE mkI</td>
</tr>
<tr>
<td>jtag2avr32</td>
<td>Atmel JTAG ICE mkI in AVR32 mode</td>
</tr>
<tr>
<td>jtag2dw</td>
<td>Atmel JTAG ICE mkII in debugWire mode</td>
</tr>
<tr>
<td>jtag2fast</td>
<td>Atmel JTAG ICE mkII</td>
</tr>
<tr>
<td>jtag2isp</td>
<td>Atmel JTAG ICE mkII in ISP mode</td>
</tr>
<tr>
<td>jtag2pdi</td>
<td>Atmel JTAG ICE mkII PDI mode</td>
</tr>
<tr>
<td>jtag2slow</td>
<td>Atmel JTAG ICE mkII</td>
</tr>
<tr>
<td>jtag3</td>
<td>Atmel AVR JTAGICE3 in JTAG mode</td>
</tr>
<tr>
<td>jtag3dw</td>
<td>Atmel AVR JTAGICE3 in debugWIRE mode</td>
</tr>
<tr>
<td>jtag3isp</td>
<td>Atmel AVR JTAGICE3 in ISP mode</td>
</tr>
<tr>
<td>jtag3pdi</td>
<td>Atmel AVR JTAGICE3 in PDI mode</td>
</tr>
<tr>
<td>jtagkey</td>
<td>Amontec JTAGKey, JTAGKey-Tiny and JTAGKey2</td>
</tr>
<tr>
<td>jtagmkI</td>
<td>Atmel JTAG ICE (mkI)</td>
</tr>
<tr>
<td>jtagmkII</td>
<td>Atmel JTAG ICE mkII</td>
</tr>
<tr>
<td>jtagmkII_avr32</td>
<td>Atmel JTAG ICE mkII in AVR32 mode</td>
</tr>
<tr>
<td>lm3s811</td>
<td>Luminary Micro LM3S811 Eval Board (Rev. A)</td>
</tr>
<tr>
<td>mib510</td>
<td>Crossbow MIB510 programming board</td>
</tr>
<tr>
<td>mkbutterfly</td>
<td>Mikrokopter.de Butterfly</td>
</tr>
<tr>
<td>nibobee</td>
<td>NIBObee</td>
</tr>
<tr>
<td>o-link</td>
<td>O-Link, OpenJTAG from <a href="http://www.100ask.net">www.100ask.net</a></td>
</tr>
</tbody>
</table>
openmoko  Openmoko debug board (v3)
pavr     Jason Kyle’s pAVR Serial Programmer
pickit2  MicroChip’s PICkit2 Programmer
picoweb  Picoweb Programming Cable, http://www.picoweb.net/
pony-stk200  Pony Prog STK200
ponyser  design ponyprog serial, reset=!txd sck=rtx mosi=dtr
                      miso=cts
siprog   Lancos SI-Prog <http://www.lancos.com/siprogsch.html>
sp12     Steve Bolt’s Programmer
stk200   STK200
stk500   Atmel STK500
stk500hvsp  Atmel STK500 V2 in high-voltage serial program-
              ming mode
stk500pp  Atmel STK500 V2 in parallel programming mode
stk500v1  Atmel STK500 Version 1.x firmware
stk500v2  Atmel STK500 Version 2.x firmware
stk600   Atmel STK600
stk600hvsp  Atmel STK600 in high-voltage serial program-
              ming mode
stk600pp  Atmel STK600 in parallel programming mode
UM232H   FT232H based module from FTDI and Glyn.com.au
usbasp   USBasp, http://www.fischl.de/usbasp/
usbasp-clone  Any usbasp clone with correct VID/PID
usbtiny  USBTiny simple USB programmer, http://www.ladyada.net/make/usbtinyisp/
wiring   Wiring
xil      Xilinx JTAG cable
xplainedpro  Atmel AVR XplainedPro in JTAG mode

-C config-file
Use the specified config file for configuration data. This file contains all pro-
grammer and part definitions that AVRDUDE knows about. If you have a 
programmer or part that AVRDUDE does not know about, you can add it to 
the config file (be sure and submit a patch back to the author so that it can 
be incorporated for the next version). If not specified, AVRDUDE reads the 
configuration file from /usr/local/etc/avrdude.conf (FreeBSD and Linux). See 
Appendix A for the method of searching for the configuration file for Windows. 

If config-file is written as +filename then this file is read after the system wide 
and user configuration files. This can be used to add entries to the configuration 
without patching your system wide configuration file. It can be used several 
times, the files are read in same order as given on the command line.

-D Disable auto erase for flash. When the -U option with flash memory is speci-
fied, avrdude will perform a chip erase before starting any of the programming 
operations, since it generally is a mistake to program the flash without per-
forming an erase first. This option disables that. Auto erase is not used for
ATxmega devices as these devices can use page erase before writing each page
so no explicit chip erase is required. Note however that any page not affected
by the current operation will retain its previous contents.

-e
Causes a chip erase to be executed. This will reset the contents of the flash ROM
and EEPROM to the value ‘0xff’, and clear all lock bits. Except for ATxmega
devices which can use page erase, it is basically a prerequisite command before
the flash ROM can be reprogrammed again. The only exception would be if the
new contents would exclusively cause bits to be programmed from the value ‘1’
to ‘0’. Note that in order to reprogram EEPROM cells, no explicit prior chip
erase is required since the MCU provides an auto-erase cycle in that case before
programming the cell.

-E exitspec[…]
By default, AVRDUDE leaves the parallel port in the same state at exit as it
has been found at startup. This option modifies the state of the ‘/RESET’
and ‘Vcc’ lines the parallel port is left at, according to the exitspec arguments
provided, as follows:

reset The ‘/RESET’ signal will be left activated at program exit, that
is it will be held low, in order to keep the MCU in reset state
afterwards. Note in particular that the programming algorithm for
the AT90S1200 device mandates that the ‘/RESET’ signal is active
before powering up the MCU, so in case an external power supply
is used for this MCU type, a previous invocation of AVRDUDE
with this option specified is one of the possible ways to guarantee
this condition.

noreset The ‘/RESET’ line will be deactivated at program exit, thus al-
lowing the MCU target program to run while the programming
hardware remains connected.

vcc This option will leave those parallel port pins active (i. e. high)
that can be used to supply ‘Vcc’ power to the MCU.

novcc This option will pull the ‘Vcc’ pins of the parallel port down at
program exit.

d_high This option will leave the 8 data pins on the parallel port active (i.
e. high).

d_low This option will leave the 8 data pins on the parallel port inactive
(i. e. low).

Multiple exitspec arguments can be separated with commas.

-F
Normally, AVRDUDE tries to verify that the device signature read from the
part is reasonable before continuing. Since it can happen from time to time that
a device has a broken (erased or overwritten) device signature but is otherwise
operating normally, this options is provided to override the check. Also, for
programmers like the Atmel STK500 and STK600 which can adjust parameters
local to the programming tool (independent of an actual connection to a target controller), this option can be used together with \(-t\) to continue in terminal mode.

\(-i\) delay For bitbang-type programmers, delay for approximately delay microseconds between each bit state change. If the host system is very fast, or the target runs off a slow clock (like a 32 kHz crystal, or the 128 kHz internal RC oscillator), this can become necessary to satisfy the requirement that the ISP clock frequency must not be higher than 1/4 of the CPU clock frequency. This is implemented as a spin-loop delay to allow even for very short delays. On Unix-style operating systems, the spin loop is initially calibrated against a system timer, so the number of microseconds might be rather realistic, assuming a constant system load while AVRDUDE is running. On Win32 operating systems, a preconfigured number of cycles per microsecond is assumed that might be off a bit for very fast or very slow machines.

\(-l\) logfile Use logfile rather than stderr for diagnostics output. Note that initial diagnostic messages (during option parsing) are still written to stderr anyway.

\(-n\) No-write - disables actually writing data to the MCU (useful for debugging AVRDUDE).

\(-O\) Perform a RC oscillator run-time calibration according to Atmel application note AVR053. This is only supported on the STK500v2, AVRISP mkII, and JTAG ICE mkII hardware. Note that the result will be stored in the EEPROM cell at address 0.

\(-P\) port Use port to identify the device to which the programmer is attached. Normally, the default parallel port is used, but if the programmer type normally connects to the serial port, the default serial port will be used. See Appendix A, Platform Dependent Information, to find out the default port names for your platform. If you need to use a different parallel or serial port, use this option to specify the alternate port name.

On Win32 operating systems, the parallel ports are referred to as lpt1 through lpt3, referring to the addresses 0x378, 0x278, and 0x3BC, respectively. If the parallel port can be accessed through a different address, this address can be specified directly, using the common C language notation (i. e., hexadecimal values are prefixed by 0x).

For the JTAG ICE mkII, if AVRDUDE has been built with libusb support, port may alternatively be specified as usb[:serialno]. In that case, the JTAG ICE mkII will be looked up on USB. If serialno is also specified, it will be matched against the serial number read from any JTAG ICE mkII found on USB. The match is done after stripping any existing colons from the given serial number, and right-to-left, so only the least significant bytes from the serial number need to be given. For a trick how to find out the serial numbers of all JTAG ICES attached to USB, see Section 2.3 [Example Command Line Invocations], page 19.

As the AVRISP mkII device can only be talked to over USB, the very same method of specifying the port is required there.
For the USB programmer "AVR-Doper" running in HID mode, the port must be specified as avrdoper. Libusb support is required on Unix but not on Windows. For more information about AVR-Doper see http://www.obdev.at/avrusb/avrdoper.html.

For the USBtinyISP, which is a simplicistic device not implementing serial numbers, multiple devices can be distinguished by their location in the USB hierarchy. See Appendix B [Troubleshooting], page 42, for examples.

For programmers that attach to a serial port using some kind of higher level protocol (as opposed to bit-bang style programmers), port can be specified as net:host:port. In this case, instead of trying to open a local device, a TCP network connection to (TCP) port on host is established. The remote endpoint is assumed to be a terminal or console server that connects the network stream to a local serial port where the actual programmer has been attached to. The port is assumed to be properly configured, for example using a transparent 8-bit data connection without parity at 115200 Baud for a STK500.

This feature is currently not implemented for Win32 systems.

-q Disable (or quell) output of the progress bar while reading or writing to the device. Specify it a second time for even quieter operation.

-u Disables the default behaviour of reading out the fuses three times before programming, then verifying at the end of programming that the fuses have not changed. If you want to change fuses you will need to specify this option, as avrdude will see the fuses have changed (even though you wanted to) and will change them back for your "safety". This option was designed to prevent cases of fuse bits magically changing (usually called safemode).

If one of the configuration files contains a line

default_safemode = no;

safemode is disabled by default. The -u option's effect is negated in that case, i. e. it enables safemode.

Safemode is always disabled for AVR32, Xmega and TPI devices.

-s Disable safemode prompting. When safemode discovers that one or more fuse bits have unintentionally changed, it will prompt for confirmation regarding whether or not it should attempt to recover the fuse bit(s). Specifying this flag disables the prompt and assumes that the fuse bit(s) should be recovered without asking for confirmation first.

-t Tells AVRDUDE to enter the interactive “terminal” mode instead of up- or downloading files. See below for a detailed description of the terminal mode.

-\U memtype:op:filename[:format]

Perform a memory operation. Multiple -\U options can be specified in order to operate on multiple memories on the same command-line invocation. The memtype field specifies the memory type to operate on. Use the -v option on the command line or the part command from terminal mode to display all the memory types supported by a particular device. Typically, a device's memory configuration at least contains the memory types flash and eeprom. All memory types currently known are:
calibration
One or more bytes of RC oscillator calibration data.

eprom
The EEPROM of the device.

efuse
The extended fuse byte.

flash
The flash ROM of the device.

fuse
The fuse byte in devices that have only a single fuse byte.

hfuse
The high fuse byte.

lfuse
The low fuse byte.

lock
The lock byte.

signature
The three device signature bytes (device ID).

fuseN
The fuse bytes of ATxmega devices, \( N \) is an integer number for each fuse supported by the device.

application
The application flash area of ATxmega devices.

apptable
The application table flash area of ATxmega devices.

boot
The boot flash area of ATxmega devices.

prodsig
The production signature (calibration) area of ATxmega devices.

usersig
The user signature area of ATxmega devices.

The \( op \) field specifies what operation to perform:

r
read the specified device memory and write to the specified file

w
read the specified file and write it to the specified device memory

v
read the specified device memory and the specified file and perform a verify operation

The \( filename \) field indicates the name of the file to read or write. The \( format \) field is optional and contains the format of the file to read or write. Possible values are:

i
Intel Hex

s
Motorola S-record

r
raw binary; little-endian byte order, in the case of the flash ROM data

e
ELF (Executable and Linkable Format), the final output file from the linker; currently only accepted as an input file

m
immediate mode; actual byte values specified on the command line, separated by commas or spaces in place of the \( filename \) field of the \( -u \) option. This is useful for programming fuse bytes without
having to create a single-byte file or enter terminal mode. If the number specified begins with 0x, it is treated as a hex value. If the number otherwise begins with a leading zero (0) it is treated as octal. Otherwise, the value is treated as decimal.

**a**  
auto detect; valid for input only, and only if the input is not provided at stdin.

**d**  
decimal; this and the following formats are only valid on output. They generate one line of output for the respective memory section, forming a comma-separated list of the values. This can be particularly useful for subsequent processing, like for fuse bit settings.

**h**  
hexadecimal; each value will get the string 0x prepended.

**o**  
octal; each value will get a 0 prepended unless it is less than 8 in which case it gets no prefix.

**b**  
binary; each value will get the string 0b prepended.

The default is to use auto detection for input files, and raw binary format for output files.

Note that if filename contains a colon, the format field is no longer optional since the filename part following the colon would otherwise be misinterpreted as format.

As an abbreviation, the form -U filename is equivalent to specifying -U flash:w:filename:a. This will only work if filename does not have a colon in it.

**-v**  
Enable verbose output. More -v options increase verbosity level.

**-V**  
Disable automatic verify check when uploading data.

**-x extended_param**  
Pass extended_param to the chosen programmer implementation as an extended parameter. The interpretation of the extended parameter depends on the programmer itself. See below for a list of programmers accepting extended parameters.
2.2 Programmers accepting extended parameters

JTAG ICE mkII/3

When using the JTAG ICE mkII/3 or AVR Dragon in JTAG mode, the following extended parameter is accepted:

`jtagchain=UB,UA,BB,BA`

Setup the JTAG scan chain for *UB* units before, *UA* units after, *BB* bits before, and *BA* bits after the target AVR, respectively. Each AVR unit within the chain shifts by 4 bits. Other JTAG units might require a different bit shift count.

AVR910

The AVR910 programmer type accepts the following extended parameter:

`devcode=VALUE`

Override the device code selection by using *VALUE* as the device code. The programmer is not queried for the list of supported device codes, and the specified *VALUE* is not verified but used directly within the T command sent to the programmer. *VALUE* can be specified using the conventional number notation of the C programming language.

`no_blockmode`

Disables the default checking for block transfer capability. Use `no_blockmode` only if your ‘AVR910’ programmer creates errors during initial sequence.

BusPirate

The BusPirate programmer type accepts the following extended parameters:

`reset=cs,aux,aux2`

The default setup assumes the BusPirate’s CS output pin connected to the RESET pin on AVR side. It is however possible to have multiple AVRs connected to the same BP with MISO, MOSI and SCK lines common for all of them. In such a case one AVR should have its RESET connected to BusPirate’s CS pin, second AVR’s RESET connected to BusPirate’s AUX pin and if your BusPirate has an AUX2 pin (only available on BusPirate version v1a with firmware 3.0 or newer) use that to activate RESET on the third AVR.

It may be a good idea to decouple the BusPirate and the AVR’s SPI buses from each other using a 3-state bus buffer. For example 74HC125 or 74HC244 are some good candidates with the latches driven by the appropriate reset pin (cs, aux or aux2). Otherwise the SPI traffic in one active circuit may interfere with programming the AVR in the other design.

`spifreq=0..7`

0 30 kHz (default)
1  125 kHz
2  250 kHz
3  1 MHz
4  2 MHz
5  2.6 MHz
6  4 MHz
7  8 MHz

‘\texttt{rawfreq=0..3}’
Sets the SPI speed and uses the Bus Pirate’s binary “raw-wire” mode instead of the default binary SPI mode:

0  5 kHz
1  50 kHz
2  100 kHz (Firmware v4.2+ only)
3  400 kHz (v4.2+)

The only advantage of the “raw-wire” mode is that different SPI frequencies are available. Paged writing is not implemented in this mode.

‘\texttt{ascii}’
Attempt to use ASCII mode even when the firmware supports BinMode (binary mode). BinMode is supported in firmware 2.7 and newer, older FW’s either don’t have BinMode or their BinMode is buggy. ASCII mode is slower and makes the above ‘\texttt{reset=}’, ‘\texttt{spifreq=}’ and ‘\texttt{rawfreq=}’ parameters unavailable. Be aware that ASCII mode is not guaranteed to work with newer firmware versions, and is retained only to maintain compatibility with older firmware versions.

‘\texttt{nopagedwrite}’
Firmware versions 5.10 and newer support a binary mode SPI command that enables whole pages to be written to AVR flash memory at once, resulting in a significant write speed increase. If use of this mode is not desirable for some reason, this option disables it.

‘\texttt{nopagedread}’
Newer firmware versions support in binary mode SPI command some AVR Extended Commands. Using the “Bulk Memory Read from Flash” results in a significant read speed increase. If use of this mode is not desirable for some reason, this option disables it.

‘\texttt{cpufreq=}125..4000’
This sets the AUX pin to output a frequency of n kHz. Connecting the AUX pin to the XTAL1 pin of your MCU, you can provide it a clock, for example when it needs an external clock because of wrong fuses settings. This setting is only available in ASCII mode. (The lower limit was chosen so the CPU frequency is at least for four times the SPI frequency which is in ASCII mode 30kHz.)
'serial_recv_timeout=f...'
This sets the serial receive timeout to the given value. The timeout
happens every time avrdude waits for the BusPirate prompt. Es-
pecially in ascii mode this happens very often, so setting a smaller
value can speed up programming a lot. The default value is 100ms.
Using 10ms might work in most cases.

**Wiring**

When using the Wiring programmer type, the following optional extended pa-
rameter is accepted:

‘snooze=0..32767’
After performing the port open phase, AVRDUDE will
wait/snooze for snooze milliseconds before continuing to the
protocol sync phase. No toggling of DTR/RTS is performed if
snooze > 0.

**PICkit2**

Connection to the PICkit2 programmer:

(AVR) (PICkit2)
RST VPP/MCLR (1)
VDD VDD Target (2) --
    possibly optional if
        AVR self powered
GND GND (3)
MISO PGD (4)
SCLK PDC (5)
OSI AUX (6)

Extended commandline parameters:

‘clockrate=rate’
Sets the SPI clocking rate in Hz (default is 100kHz). Alternately
the -B or -i options can be used to set the period.

‘timeout=usb-transaction-timeout’
Sets the timeout for USB reads and writes in milliseconds (default
is 1500 ms).
2.3 Example Command Line Invocations

Download the file diag.hex to the ATmega128 chip using the STK500 programmer connected to the default serial port:

```bash
% avrdude -p m128 -c stk500 -e -U flash:w:diag.hex

avrdude: AVR device initialized and ready to accept instructions

Reading | ################################################## | 100% 0.03s

avrdude: Device signature = 0x1e9702
avrdude: erasing chip
avrdude: done.

avrdude: performing op: 1, flash, 0, diag.hex
avrdude: reading input file "diag.hex"

avrdude: input file diag.hex auto detected as Intel Hex

avrdude: writing flash (19278 bytes):

Writing | ################################################## | 100% 7.60s

avrdude: 19456 bytes of flash written
avrdude: verifying flash memory against diag.hex:

avrdude: load data flash data from input file diag.hex:

avrdude: input file diag.hex auto detected as Intel Hex

avrdude: input file diag.hex contains 19278 bytes

avrdude: reading on-chip flash data:

Reading | ################################################## | 100% 6.83s

avrdude: verifying ...

avrdude: 19278 bytes of flash verified

avrdude: safemode: Fuses OK

avrdude done. Thank you.

%
Upload the flash memory from the ATmega128 connected to the STK500 programmer and save it in raw binary format in the file named `c:/diag flash.bin`:

```
% avrdude -p m128 -c stk500 -U flash:r:"c:/diag flash.bin":r

avrdude: AVR device initialized and ready to accept instructions
Reading | ################################### | 100% 0.03s

avrdude: Device signature = 0x1e9702
avrdude: reading flash memory:
Reading | ################################### | 100% 46.10s

avrdude: writing output file "c:/diag flash.bin"
avrdude: safemode: Fuses OK
avrdude done. Thank you.
%
```
Using the default programmer, download the file diag.hex to flash, eeprom.hex to EEPROM, and set the Extended, High, and Low fuse bytes to 0xff, 0x89, and 0x2e respectively:

```bash
% avrdude -p m128 -u -U flash:w:diag.hex
> -U eeprom:w:eeprom.hex
> -U efuse:w:0xff:m
> -U hfuse:w:0x89:m
> -U lfuse:w:0x2e:m

avrdude: AVR device initialized and ready to accept instructions

Reading | ################################################## | 100% 0.03s

avrdude: Device signature = 0x1e9702
avrdude: NOTE: FLASH memory has been specified, an erase cycle will be performed
To disable this feature, specify the -D option.
avrdude: erasing chip
avrdude: reading input file "diag.hex"
avrdude: input file diag.hex auto detected as Intel Hex
avrdude: writing flash (19278 bytes):

Writing | ################################################## | 100% 7.60s

avrdude: 19456 bytes of flash written
avrdude: verifying flash memory against diag.hex:
avrdude: load data flash data from input file diag.hex:
avrdude: input file diag.hex auto detected as Intel Hex
avrdude: input file diag.hex contains 19278 bytes
avrdude: reading on-chip flash data:

Reading | ################################################## | 100% 6.84s

avrdude: verifying ...
avrdude: 19278 bytes of flash verified

[ ... other memory status output skipped for brevity ... ]

avrdude done. Thank you.
%
Connect to the JTAG ICE mkII which serial number ends up in 1C37 via USB, and enter terminal mode:

```
% avrdude -c jtag2 -p m649 -P usb:1c:37 -t
avrdude: AVR device initialized and ready to accept instructions
Reading | ################################################## | 100% 0.03s
avrdude: Device signature = 0x1e9603
[ ... terminal mode output skipped for brevity ... ]
avrdude done. Thank you.
```

List the serial numbers of all JTAG ICEs attached to USB. This is done by specifying an invalid serial number, and increasing the verbosity level.

```
% avrdude -c jtag2 -p m128 -P usb:xx -v
[...] Using Port : usb:xxx
Using Programmer : jtag2
avrdude: usbdev_open(): Found JTAG ICE, serno: 00A000001C6B
avrdude: usbdev_open(): Found JTAG ICE, serno: 00A000001C3A
avrdude: usbdev_open(): Found JTAG ICE, serno: 00A000001C30
avrdude: usbdev_open(): did not find any (matching) USB device "usb:xxx"
```
3 Terminal Mode Operation

AVRDUDE has an interactive mode called terminal mode that is enabled by the -t option. This mode allows one to enter interactive commands to display and modify the various device memories, perform a chip erase, display the device signature bytes and part parameters, and to send raw programming commands. Commands and parameters may be abbreviated to their shortest unambiguous form. Terminal mode also supports a command history so that previously entered commands can be recalled and edited.

3.1 Terminal Mode Commands

The following commands are implemented:

- **dump memtype addr nbytes**
  Read nbytes from the specified memory area, and display them in the usual hexadecimal and ASCII form.

- **dump**
  Continue dumping the memory contents for another nbytes where the previous dump command left off.

- **write memtype addr byte1 ... byteN**
  Manually program the respective memory cells, starting at address addr, using the values byte1 through byteN. This feature is not implemented for bank-addressed memories such as the flash memory of ATmega devices.

- **erase**
  Perform a chip erase.

- **send b1 b2 b3 b4**
  Send raw instruction codes to the AVR device. If you need access to a feature of an AVR part that is not directly supported by AVRDUDE, this command allows you to use it, even though AVRDUDE does not implement the command. When using direct SPI mode, up to 3 bytes can be omitted.

- **sig**
  Display the device signature bytes.

- **spi**
  Enter direct SPI mode. The pgmled pin acts as slave select. *Only supported on parallel bitbang programmers.*

- **part**
  Display the current part settings and parameters. Includes chip specific information including all memory types supported by the device, read/write timing, etc.

- **pgm**
  Return to programming mode (from direct SPI mode).

- **verbose [level]**
  Change (when level is provided), or display the verbosity level. The initial verbosity level is controlled by the number of -v options given on the commandline.

- **? help**
  Give a short on-line summary of the available commands.

- **quit**
  Leave terminal mode and thus AVRDUDE.
In addition, the following commands are supported on the STK500 and STK600 programmer:

vtarg voltage
   Set the target’s supply voltage to voltage Volts.

varef [channel] voltage
   Set the adjustable voltage source to voltage Volts. This voltage is normally used to drive the target’s Aref input on the STK500 and STK600. The STK600 offers two reference voltages, which can be selected by the optional parameter channel (either 0 or 1).

fosc freq[M|k]
   Set the master oscillator to freq Hz. An optional trailing letter M multiplies by 1E6, a trailing letter k by 1E3.

fosc off
   Turn the master oscillator off.

sck period
   STK500 and STK600 only: Set the SCK clock period to period microseconds.
   JTAG ICE only: Set the JTAG ICE bit clock period to period microseconds. Note that unlike STK500 settings, this setting will be reverted to its default value (approximately 1 microsecond) when the programming software signs off from the JTAG ICE. This parameter can also be used on the JTAG ICE mkII/3 to specify the ISP clock period when operating the ICE in ISP mode.

parms
   STK500 and STK600 only: Display the current voltage and master oscillator parameters.
   JTAG ICE only: Display the current target supply voltage and JTAG bit clock rate/period.

### 3.2 Terminal Mode Examples

Display part parameters, modify eeprom cells, perform a chip erase:
Program the fuse bits of an ATmega128 (disable M103 compatibility, enable high speed external crystal, enable brown-out detection, slowly rising power). Note since we are working with fuse bits the -u (unsafe) option is specified, which allows you to modify the fuse bits. First display the factory defaults, then reprogram:
% avrdude -p m128 -u -c stk500 -t

avrdude: AVR device initialized and ready to accept instructions
avrdude: Device signature = 0x1e9702
avrdude: current erase-rewrite cycle count is 52 (if being tracked)

avrdude> d efuse
0000 fd |

avrdude> d hfuse
0000 99 |

avrdude> d lfuse
0000 e1 |

avrdude> w efuse 0 0xff
>>> w efuse 0 0xff

avrdude> w hfuse 0 0x89
>>> w hfuse 0 0x89

avrdude> w lfuse 0 0x2f
>>> w lfuse 0 0x2f

avrdude>
4 Configuration File

AVRDUDE reads a configuration file upon startup which describes all of the parts and programmers that it knows about. The advantage of this is that if you have a chip that is not currently supported by AVRDUDE, you can add it to the configuration file without waiting for a new release of AVRDUDE. Likewise, if you have a parallel port programmer that is not supported by AVRDUDE, chances are good that you can copy and existing programmer definition, and with only a few changes, make your programmer work with AVRDUDE.

AVRDUDE first looks for a system wide configuration file in a platform dependent location. On Unix, this is usually `/usr/local/etc/avrdude.conf`, while on Windows it is usually in the same location as the executable file. The name of this file can be changed using the `-C` command line option. After the system wide configuration file is parsed, AVRDUDE looks for a per-user configuration file to augment or override the system wide defaults. On Unix, the per-user file is `.avrduderc` within the user’s home directory. On Windows, this file is the `avrdude.rc` file located in the same directory as the executable.

4.1 AVRDUDE Defaults

default_parallel = "default-parallel-device";
Assign the default parallel port device. Can be overridden using the -P option.

default_serial = "default-serial-device";
Assign the default serial port device. Can be overridden using the -P option.

default_programmer = "default-programmer-id";
Assign the default programmer id. Can be overridden using the -c option.

default_bitclock = "default-bitclock";
Assign the default bitclock value. Can be overridden using the -B option.

4.2 Programmer Definitions

The format of the programmer definition is as follows:

```
programmer
    parent <id>
    id     = <id1> [, <id2> [, <id3>] ...] ;  # <id> is a quoted string
    desc   = <description> ;  # quoted string
    type   = "par" | "stk500" | ... ;  # programmer type (see below for a list)
    baudrate = <num> ;  # baudrate for serial ports
    vcc    = <num1> [, <num2> ... ] ;  # pin number(s)
    buff   = <num1> [, <num2> ... ] ;  # pin number(s)
    reset  = <num> ;  # pin number
    sck    = <num> ;  # pin number
    mosi   = <num> ;  # pin number
    miso   = <num> ;  # pin number
    errled = <num> ;  # pin number
    rdyled = <num> ;  # pin number
    pgmled = <num> ;  # pin number
    vfyled = <num> ;  # pin number
    usbvid = <hexnum> ;  # USB VID (Vendor ID)
    usbpid = <hexnum> [, <hexnum> ...] ;  # USB PID (Product ID)
```

usbdev = <interface>;  # USB interface or other device info
usbvendor = <vendorname>;  # USB Vendor Name
usbproduct = <productname>;  # USB Product Name
usbsn = <serialno>;  # USB Serial Number
;
If a parent is specified, all settings of it (except its ids) are used for the new programmer. These values can be changed by new setting them for the new programmer.

To invert a bit in the pin definitions, use = ~ <num>.

Not all programmer types can handle a list of USB PIDs.

Following programmer types are currently implemented:

- **arduino** | Arduino programmer
- **avr910** | Serial programmers using protocol described in application note AVR910
- **avrtfdi** | Interface to the MPSSE Engine of FTDI Chips using libftdi.
- **buspirate** | Using the Bus Pirate’s SPI interface for programming
- **buspirate_bb** | Using the Bus Pirate’s bitbang interface for programming
- **butterfly** | Atmel Butterfly evaluation board; Atmel AppNotes AVR109, AVR911
- **butterfly_mk** | Mikrokopter.de Butterfly
- **dragon_dw** | Atmel AVR Dragon in debugWire mode
- **dragon_hvsp** | Atmel AVR Dragon in HVSP mode
- **dragon_isp** | Atmel AVR Dragon in ISP mode
- **dragon_jtag** | Atmel AVR Dragon in JTAG mode
- **dragon_pdi** | Atmel AVR Dragon in PDI mode
- **dragon_pp** | Atmel AVR Dragon in PP mode
- **flip1** | FLIP USB DFU protocol version 1 (doc7618)
- **flip2** | FLIP USB DFU protocol version 2 (AVR4023)
- **ftdi_syncbb** | FT245R/FT232R Synchronous BitBangMode Programmer
- **jtagmkii** | Atmel JTAG ICE mkII
- **jtagmkii_avr32** | Atmel JTAG ICE mkII in AVR32 mode
- **jtagmkii_dw** | Atmel JTAG ICE mkII in debugWire mode
- **jtagmkii_isp** | Atmel JTAG ICE mkII in ISP mode
- **jtagmkii_pdi** | Atmel JTAG ICE mkII in PDI mode
- **jtagice3** | Atmel JTAGICE3
- **jtagice3_pdi** | Atmel JTAGICE3 in PDI mode
- **jtagice3_dw** | Atmel JTAGICE3 in debugWire mode
- **jtagice3_isp** | Atmel JTAGICE3 in ISP mode
- **linuxgpio** | GPIO bitbanging using the Linux sysfs interface (not available)
- **par** | Parallel port bitbanging
pickit2  Microchip’s PICkit2 Programmer
serbb   Serial port bitbanging
stk500  Atmel STK500 Version 1.x firmware
stk500generic  Atmel STK500, autodetect firmware version
stk500v2  Atmel STK500 Version 2.x firmware
stk500hvsp  Atmel STK500 V2 in high-voltage serial programming mode
stk500pp  Atmel STK500 V2 in parallel programming mode
stk600  Atmel STK600
stk600hvsp  Atmel STK600 in high-voltage serial programming mode
stk600pp  Atmel STK600 in parallel programming mode
usbasp   USBasp programmer, see http://www.fischl.de/usbasp/
usbtiny  Driver for "usbtiny"-type programmers
wiring   http://wiring.org.co/, Basically STK500v2 protocol, with some glue to trigger the bootloader.

4.3 Part Definitions

part
   id = <id> ;  # quoted string
   desc = <description> ;  # quoted string
   has_jtag = <yes/no> ;  # part has JTAG i/f
   has_debugwire = <yes/no> ;  # part has debugWire i/f
   has_pdi = <yes/no> ;  # part has PDI i/f
   has_tpi = <yes/no> ;  # part has TPI i/f
   devicecode = <num> ;  # numeric
   stk500_devcode = <num> ;  # numeric
   avr910_devcode = <num> ;  # numeric
   signature = <num> <num> <num> ;  # signature bytes
   usbpid = <num> ;  # DFU USB PID
   reset = dedicated | io;
   retry_pulse = reset | sck;
   pgm_enable = <instruction format> ;
   chip_erase = <instruction format> ;
   chip_erase_delay = <num> ;  # micro-seconds
# STK500 parameters (parallel programming IO lines)
   pagel = <num> ;  # pin name in hex, i.e., OxD7
   bs2 = <num> ;  # pin name in hex, i.e., OxA0
   serial = <yes/no> ;  # can use serial downloading
   parallel = <yes/no/pseudo> ;  # can use par. programming
# STK500v2 parameters, to be taken from Atmel’s XML files
   timeout = <num> ;
   stabdelay = <num> ;
   cmdexedelay = <num> ;
   synchloops = <num> ;
   bytedelay = <num> ;
   pollvalue = <num> ;
   pollindex = <num> ;
   predelay = <num> ;
   postdelay = <num> ;
   pollmethod = <num> ;
   mode = <num> ;
delay = <num> ;
blocksize = <num> ;
readsize = <num> ;
hvspcmdedelay = <num> ;
# STK500v2 HV programming parameters, from XML
pp_controlstack = <num>, <num>, ...; # PP only
hvsp_controlstack = <num>, <num>, ...; # HVSP only
hventerstabledelay = <num>;
progmoredelay = <num> ; # PP only
latchcycles = <num> ;
toglevtg = <num> ;
poweroffdelay = <num> ;
resetdelayms = <num> ;
resetdelayus = <num> ;
hvleavestabledelay = <num> ;
resetdelay = <num> ;
synccycles = <num> ; # HVSP only
chiperasepulsewidth = <num> ; # PP only
chiperasepolltimeout = <num> ;
chiperasetime = <num> ; # HVSP only
programfusepulsewidth = <num> ; # PP only
programfusepolltimeout = <num> ;
programlockpulsewidth = <num> ; # PP only
programlockpolltimeout = <num> ;
# JTAG ICE mkII parameters, also from XML files
allowfullpagebitstream = <yes/no> ;
enablepageprogramming = <yes/no> ;

idr = <num> ; # IO addr of IDR (OCD) reg.
rampz = <num> ; # IO addr of RAMPZ reg.
spmcr = <num> ; # mem addr of SPMC[S]R reg.
ecr = <num> ; # mem addr of EECR reg.

is_at90s1200 = <yes/no> ; # AT90S1200 part
is_avr32 = <yes/no> ; # AVR32 part

memory <memtype>
paged = <yes/no> ; # yes / no
size = <num> ; # bytes
page_size = <num> ; # bytes
num_pages = <num> ; # numeric
min_write_delay = <num> ; # micro-seconds
max_write_delay = <num> ; # micro-seconds
readback_p1 = <num> ; # byte value
readback_p2 = <num> ; # byte value
pwroff_after_write = <yes/no> ; # yes / no
read = <instruction format> ;
write = <instruction format> ;
read_lo = <instruction format> ;
read_hi = <instruction format> ;
write_lo = <instruction format> ;
write_hi = <instruction format> ;
loadpage_lo = <instruction format> ;
loadpage_hi = <instruction format> ;
writepage = <instruction format> ;

;
### 4.3.1 Parent Part

Parts can also inherit parameters from previously defined parts using the following syntax. In this case specified integer and string values override parameter values from the parent part. New memory definitions are added to the definitions inherited from the parent.

```plaintext
part parent <id> # quoted string
  id = <id> ; # quoted string
  <any set of other parameters from the list above>
```

### 4.3.2 Instruction Format

Instruction formats are specified as a comma separated list of string values containing information (bit specifiers) about each of the 32 bits of the instruction. Bit specifiers may be one of the following formats:

- **1**: The bit is always set on input as well as output
- **0**: The bit is always clear on input as well as output
- **x**: The bit is ignored on input and output
- **a**: The bit is an address bit, the bit-number matches this bit specifier’s position within the current instruction byte
- **aN**: The bit is the Nth address bit, bit-number = N, i.e., a12 is address bit 12 on input, a0 is address bit 0.
- **i**: The bit is an input data bit
- **o**: The bit is an output data bit

Each instruction must be composed of 32 bit specifiers. The instruction specification closely follows the instruction data provided in Atmel’s data sheets for their parts. For example, the EEPROM read and write instruction for an AT90S2313 AVR part could be encoded as:

```plaintext
read = "1 0 1 0 0 0 0 0 x x x x x x x x",
"x a6 a5 a4 a3 a2 a1 a0 o o o o o o o o";
write = "1 1 0 0 0 0 0 0 x x x x x x x x",
"x a6 a5 a4 a3 a2 a1 a0 i i i i i i i i";
```

### 4.4 Other Notes

- The `devicecode` parameter is the device code used by the STK500 and is obtained from the software section (`avr061.zip`) of Atmel’s AVR061 application note available from [http://www.atmel.com/dyn/resources/prod_documents/doc2525.pdf](http://www.atmel.com/dyn/resources/prod_documents/doc2525.pdf).
- Not all memory types will implement all instructions.
- AVR Fuse bits and Lock bits are implemented as a type of memory.
- Example memory types are: `flash`, `eeprom`, `fuse`, `lfuse` (low fuse), `hfuse` (high fuse), `efuse` (extended fuse), `signature`, `calibration`, `lock`.
- The memory type specified on the AVRDUDE command line must match one of the memory types defined for the specified chip.
• The `pwoff_after_write` flag causes AVRDUDE to attempt to power the device off and back on after an unsuccessful write to the affected memory area if VCC programmer pins are defined. If VCC pins are not defined for the programmer, a message indicating that the device needs a power-cycle is printed out. This flag was added to work around a problem with the at90s4433/2333’s; see the at90s4433 errata at:  

• The boot loader from application note AVR109 (and thus also the AVR Butterfly) does not support writing of fuse bits. Writing lock bits is supported, but is restricted to the boot lock bits (BLBxx). These are restrictions imposed by the underlying SPM instruction that is used to program the device from inside the boot loader. Note that programming the boot lock bits can result in a “shoot-into-your-foot” scenario as the only way to unprogram these bits is a chip erase, which will also erase the boot loader code.

The boot loader implements the “chip erase” function by erasing the flash pages of the application section.

Reading fuse and lock bits is fully supported.

Note that due to the inability to write the fuse bits, the safemode functionality does not make sense for these boot loaders.
5 Programmer Specific Information

5.1 Atmel STK600

The following devices are supported by the respective STK600 routing and socket card:

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<th>Socket card</th>
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ATmega16P ATmega168PA ATmega328P
ATmega64 ATmega64A ATmega128
ATmega128A ATmega1281 ATmega2561
AT90CAN32 AT90CAN64 AT90CAN128

STK600-RC064M-9 STK600-TQFP64
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ATmega169PA ATmega325 ATmega325P
ATmega329 ATmega329P ATmega645 ATmega649

STK600-RC100M-11 STK600-TQFP100
ATmega640 ATmega1280 ATmega2560
ATmega2560

STK600-RC100M-18 STK600-TQFP100
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ATmega3290P ATmega6450 ATmega6490

STK600-RC032U-20 STK600-TQFP32
AT90USB82 AT90USB162 ATmega8U2
ATmega16U2 ATmega32U2

STK600-RC044U-25 STK600-TQFP44
ATmega32U4 ATmega32U4

STK600-RC064U-17 STK600-TQFP64
ATmega32U6 AT90USB646 AT90USB1286
AT90USB647 AT90USB1287

STK600-RCPWM-19 STK600-SOIC
ATmega32C1 ATmega64C1 ATmega16M1
ATmega32M1 ATmega64M1

STK600-RCPWM-22 STK600-SOIC
AT90PWM2 AT90PWM3 AT90PWM2B
AT90PWM3B AT90PWM316

STK600-RCPWM-26 STK600-SOIC
AT90PWM81

STK600-RC044M-24 STK600-TSSOP44
ATmega16HVB ATmega32HVB

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QT16

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ATXmega128D3 ATXmega192D3
ATXmega256D3

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<tr>
<td></td>
<td>AT32UC3C064</td>
</tr>
<tr>
<td>STK600-RCUC3C1-39</td>
<td>AT32UC3C1512</td>
</tr>
<tr>
<td></td>
<td>AT32UC3C1256</td>
</tr>
<tr>
<td></td>
<td>AT32UC3C1128</td>
</tr>
<tr>
<td></td>
<td>AT32UC3C164</td>
</tr>
<tr>
<td>STK600-RCUC3C2-41</td>
<td>AT32UC3C2512</td>
</tr>
<tr>
<td></td>
<td>AT32UC3C2256</td>
</tr>
<tr>
<td></td>
<td>AT32UC3C2128</td>
</tr>
<tr>
<td></td>
<td>AT32UC3C264</td>
</tr>
<tr>
<td>STK600-RCUC3L0-34</td>
<td>AT32UC3L064</td>
</tr>
<tr>
<td></td>
<td>AT32UC3L032</td>
</tr>
<tr>
<td></td>
<td>AT32UC3L016</td>
</tr>
<tr>
<td>QT600-AT32UC3L-QM64</td>
<td>AT32UC3L064</td>
</tr>
</tbody>
</table>

Ensure the correct socket and routing card are mounted before powering on the STK600. While the STK600 firmware ensures the socket and routing card mounted match each other (using a table stored internally in nonvolatile memory), it cannot handle the case where a wrong routing card is used, e.g., the routing card **STK600-RC040M-5** (which is meant for 40-pin DIP AVRs that have an ADC, with the power supply pins in the center of the package) was used but an ATmega8515 inserted (which uses the “industry standard” pinout with Vcc and GND at opposite corners).

Note that for devices that use the routing card **STK600-RC008T-2**, in order to use ISP mode, the jumper for **AREFO** must be removed as it would otherwise block one of the ISP signals. High-voltage serial programming can be used even with that jumper installed.

The ISP system of the STK600 contains a detection against shortcuts and other wiring errors. AVRDUDE initiates a connection check before trying to enter ISP programming mode, and display the result if the target is not found ready to be ISP programmed.
High-voltage programming requires the target voltage to be set to at least 4.5 V in order to work. This can be done using Terminal Mode, see Chapter 3 [Terminal Mode Operation], page 23.

5.2 Atmel DFU bootloader using FLIP version 1

Bootloaders using the FLIP protocol version 1 experience some very specific behaviour.

These bootloaders have no option to access memory areas other than Flash and EEPROM.

When the bootloader is started, it enters a security mode where the only acceptable access is to query the device configuration parameters (which are used for the signature on AVR devices). The only way to leave this mode is a chip erase. As a chip erase is normally implied by the -U option when reprogramming the flash, this peculiarity might not be very obvious immediately.

Sometimes, a bootloader with security mode already disabled seems to no longer respond with sensible configuration data, but only 0xFF for all queries. As these queries are used to obtain the equivalent of a signature, AVRDUDE can only continue in that situation by forcing the signature check to be overridden with the -F option.

A chip erase might leave the EEPROM unerased, at least on some versions of the bootloader.
Appendix A  Platform Dependent Information

A.1 Unix

A.1.1 Unix Installation
To build and install from the source tarball on Unix like systems:

$ gunzip -c avrdude-6.1.tar.gz | tar xf -
$ cd avrdude-6.1
$ ./configure
$ make
$ su root -c 'make install'

The default location of the install is into /usr/local so you will need to be sure that /usr/local/bin is in your PATH environment variable.

If you do not have root access to your system, you can do the the following instead:

$ gunzip -c avrdude-6.1.tar.gz | tar xf -
$ cd avrdude-6.1
$ ./configure --prefix=$HOME/local
$ make
$ make install

A.1.1.1 FreeBSD Installation
AVRDUDE is installed via the FreeBSD Ports Tree as follows:

% su - root
# cd /usr/ports/devel/avrdude
# make install

If you wish to install from a pre-built package instead of the source, you can use the following instead:

% su - root
# pkg_add -r avrdude

Of course, you must be connected to the Internet for these methods to work, since that is where the source as well as the pre-built package is obtained.

A.1.1.2 Linux Installation
On rpm based Linux systems (such as RedHat, SUSE, Mandrake, etc), you can build and install the rpm binaries directly from the tarball:

$ su - root
# rpmbuild -tb avrdude-6.1.tar.gz
# rpm -Uvh /usr/src/redhat/RPMS/i386/avrdude-6.1-1.i386.rpm

Note that the path to the resulting rpm package, differs from system to system. The above example is specific to RedHat.
A.1.2 Unix Configuration Files

When AVRDUDE is built using the default --prefix configure option, the default configuration file for a Unix system is located at /usr/local/etc/avrdude.conf. This can be overridden by using the -C command line option. Additionally, the user’s home directory is searched for a file named .avrduderc, and if found, is used to augment the system default configuration file.

A.1.2.1 FreeBSD Configuration Files

When AVRDUDE is installed using the FreeBSD ports system, the system configuration file is always /usr/local/etc/avrdude.conf.

A.1.2.2 Linux Configuration Files

When AVRDUDE is installed using from an rpm package, the system configuration file will be always be /etc/avrdude.conf.

A.1.3 Unix Port Names

The parallel and serial port device file names are system specific. The following table lists the default names for a given system.

<table>
<thead>
<tr>
<th>System</th>
<th>Default Parallel Port</th>
<th>Default Serial Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>FreeBSD</td>
<td>/dev/ppi0</td>
<td>/dev/cuad0</td>
</tr>
<tr>
<td>Linux</td>
<td>/dev/parport0</td>
<td>/dev/ttyS0</td>
</tr>
<tr>
<td>Solaris</td>
<td>/dev/printers/0</td>
<td>/dev/term/a</td>
</tr>
</tbody>
</table>

On FreeBSD systems, AVRDUDE uses the ppi(4) interface for accessing the parallel port and the sio(4) driver for serial port access.

On Linux systems, AVRDUDE uses the ppdev interface for accessing the parallel port and the tty driver for serial port access.

On Solaris systems, AVRDUDE uses the ecpp(7D) driver for accessing the parallel port and the asy(7D) driver for serial port access.

A.1.4 Unix Documentation

AVRDUDE installs a manual page as well as info, HTML and PDF documentation. The manual page is installed in /usr/local/man/man1 area, while the HTML and PDF documentation is installed in /usr/local/share/doc/avrdude directory. The info manual is installed in /usr/local/info/avrdude.info.

Note that these locations can be altered by various configure options such as --prefix.

A.2 Windows

A.2.1 Installation

A Windows executable of avrdude is included in WinAVR which can be found at http://sourceforge.net/projects/winavr. WinAVR is a suite of executable, open source software development tools for the AVR for the Windows platform.

There are two options to build avrdude from source under Windows. The first one is to use Cygwin (http://www.cygwin.com/).

To build and install from the source tarball for Windows (using Cygwin):
$ set PREFIX=<your install directory path>
$ export PREFIX
$ gunzip -c avrdude-6.1.tar.gz | tar xf -
$ cd avrdude-6.1
$ ./configure LDFLAGS="-static" --prefix=$PREFIX --datadir=$PREFIX --sysconfdir=$PREFIX/bin --enable-versioned-doc=no
$ make
$ make install

Note that recent versions of Cygwin (starting with 1.7) removed the MinGW support from the compiler that is needed in order to build a native Win32 API binary that does not require to install the Cygwin library cygwin1.dll at run-time. Either try using an older compiler version that still supports MinGW builds, or use MinGW (http://www.mingw.org/) directly.

A.2.2 Configuration Files

A.2.2.1 Configuration file names

AVRDUDE on Windows looks for a system configuration file name of avrdude.conf and looks for a user override configuration file of avrdude.rc.

A.2.2.2 How AVRDUDE finds the configuration files.

AVRDUDE on Windows has a different way of searching for the system and user configuration files. Below is the search method for locating the configuration files:

1. The directory from which the application loaded.
2. The current directory.
3. The Windows system directory. On Windows NT, the name of this directory is SYSTEM32.
4. Windows NT: The 16-bit Windows system directory. The name of this directory is SYSTEM.
5. The Windows directory.
6. The directories that are listed in the PATH environment variable.

A.2.3 Port Names

A.2.3.1 Serial Ports

When you select a serial port (i.e. when using an STK500) use the Windows serial port device names such as: com1, com2, etc.

A.2.3.2 Parallel Ports

AVRDUDE will accept 3 Windows parallel port names: lpt1, lpt2, or lpt3. Each of these names corresponds to a fixed parallel port base address:

lpt1 0x378
lpt2 0x278
lpt3 0x3BC
On your desktop PC, lpt1 will be the most common choice. If you are using a laptop, you might have to use lpt3 instead of lpt1. Select the name of the port that corresponds to the base address of the parallel port that you want.

If the parallel port can be accessed through a different address, this address can be specified directly, using the common C language notation (i.e., hexadecimal values are prefixed by 0x).

**A.2.4 Using the parallel port**

**A.2.4.1 Windows NT/2K/XP**

On Windows NT, 2000, and XP user applications cannot directly access the parallel port. However, kernel mode drivers can access the parallel port. giveio.sys is a driver that can allow user applications to set the state of the parallel port pins.

Before using AVRDUDE, the giveio.sys driver must be loaded. The accompanying command-line program, loaddrv.exe, can do just that.

To make things even easier there are 3 batch files that are also included:
1. install.giveio.bat Install and start the giveio driver.
2. status.giveio.bat Check on the status of the giveio driver.
3. remove.giveio.bat Stop and remove the giveio driver from memory.

These 3 batch files calls the loaddrv program with various options to install, start, stop, and remove the driver.

When you first execute install.giveio.bat, loaddrv.exe and giveio.sys must be in the current directory. When install.giveio.bat is executed it will copy giveio.sys from your current directory to your Windows directory. It will then load the driver from the Windows directory. This means that after the first time install.giveio is executed, you should be able to subsequently execute the batch file from any directory and have it successfully start the driver.

Note that you must have administrator privilege to load the giveio driver.

**A.2.4.2 Windows 95/98**

On Windows 95 and 98 the giveio.sys driver is not needed.

**A.2.5 Documentation**

AVRDUDE installs a manual page as well as info, HTML and PDF documentation. The manual page is installed in /usr/local/man/man1 area, while the HTML and PDF documentation is installed in /usr/local/share/doc/avrdude directory. The info manual is installed in /usr/local/info/avrdude.info.

Note that these locations can be altered by various configure options such as --prefix and --datadir.

**A.2.6 Credits.**

Thanks to:

- Dale Roberts for the giveio driver.
- Paula Tomlinson for the loaddrv sources.
• Chris Liechti <cliechti@gmx.net> for modifying loaddrv to be command line driven and for writing the batch files.
Appendix B Troubleshooting

In general, please report any bugs encountered via http://savannah.nongnu.org/bugs/?group=avrdude.

- Problem: I’m using a serial programmer under Windows and get the following error: `avrdude: serial_open(): can’t set attributes for device "com1"`, Solution: This problem seems to appear with certain versions of Cygwin. Specifying "/dev/com1" instead of "com1" should help.

- Problem: I’m using Linux and my AVR910 programmer is really slow.
  Solution (short): `setserial port low_latency`
  Solution (long): There are two problems here. First, the system may wait some time before it passes data from the serial port to the program. Under Linux the following command works around this (you may need root privileges for this).
  ```
  setserial port low_latency
  ```
  Secondly, the serial interface chip may delay the interrupt for some time. This behaviour can be changed by setting the FIFO-threshold to one. Under Linux this can only be done by changing the kernel source in `drivers/char/serial.c`. Search the file for `UART_FCR_TRIGGER_8` and replace it with `UART_FCR_TRIGGER_1`. Note that overall performance might suffer if there is high throughput on serial lines. Also note that you are modifying the kernel at your own risk.

- Problem: I’m not using Linux and my AVR910 programmer is really slow.
  Solutions: The reasons for this are the same as above. If you know how to work around this on your OS, please let us know.

- Problem: Updating the flash ROM from terminal mode does not work with the JTAG ICEs.
  Solution: None at this time. Currently, the JTAG ICE code cannot write to the flash ROM one byte at a time.

- Problem: Page-mode programming the EEPROM (using the -U option) does not erase EEPROM cells before writing, and thus cannot overwrite any previous value != 0xff.
  Solution: None. This is an inherent feature of the way JTAG EEPROM programming works, and is documented that way in the Atmel AVR datasheets. In order to successfully program the EEPROM that way, a prior chip erase (with the EESAVE fuse unprogrammed) is required. This also applies to the STK500 and STK600 in high-voltage programming mode.

- Problem: How do I turn off the DWEN fuse?
  Solution: If the DWEN (debugWire enable) fuse is activated, the /RESET pin is not functional anymore, so normal ISP communication cannot be established. There are two options to deactivate that fuse again: high-voltage programming, or getting the JTAG ICE mkII talk debugWire, and prepare the target AVR to accept normal ISP communication again.

  The first option requires a programmer that is capable of high-voltage programming (either serial or parallel, depending on the AVR device), for example the STK500. In high-voltage programming mode, the /RESET pin is activated initially using a
12 V pulse (thus the name high voltage), so the target AVR can subsequently be reprogrammed, and the DWEN fuse can be cleared. Typically, this operation cannot be performed while the AVR is located in the target circuit though.

The second option requires a JTAG ICE mkII that can talk the debugWire protocol. The ICE needs to be connected to the target using the JTAG-to-ISP adapter, so the JTAG ICE mkII can be used as a debugWire initiator as well as an ISP programmer. AVRDUDE will then be activated using the jtag2isp programmer type. The initial ISP communication attempt will fail, but AVRDUDE then tries to initiate a debugWire reset. When successful, this will leave the target AVR in a state where it can accept standard ISP communication. The ICE is then signed off (which will make it signing off from the USB as well), so AVRDUDE has to be called again afterwards. This time, standard ISP communication can work, so the DWEN fuse can be cleared.

The pin mapping for the JTAG-to-ISP adapter is:

<table>
<thead>
<tr>
<th>JTAG pin</th>
<th>ISP pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>

- Problem: Multiple USBasp or USBtinyISP programmers connected simultaneously are not found.

Solution: The USBtinyISP code supports distinguishing multiple programmers based on their bus:device connection tuple that describes their place in the USB hierarchy on a specific host. This tuple can be added to the -P usb option, similar to adding a serial number on other USB-based programmers.

The actual naming convention for the bus and device names is operating-system dependent; AVRDUDE will print out what it found on the bus when running it with (at least) one -v option. By specifying a string that cannot match any existing device (for example, -P usb:xxx), the scan will list all possible candidate devices found on the bus.

Examples:

```
avrdude -c usbtiny -p atmega8 -P usb:003:025 (Linux)
avrdude -c usbtiny -p atmega8 -P usb:/dev/usb:/dev/ugen1.3 (FreeBSD 8+)
avrdude -c usbtiny -p atmega8 \
-P usb:bus-0:\.\libusb0-0001--0x1781-0x0c9f (Windows)
```

- Problem: I cannot do ... when the target is in debugWire mode.

Solution: debugWire mode imposes several limitations.

The debugWire protocol is Atmel’s proprietary one-wire (plus ground) protocol to allow an in-circuit emulation of the smaller AVR devices, using the /RESET line. DebugWire mode is initiated by activating the DWEN fuse, and then power-cycling the target. While this mode is mainly intended for debugging/emulation, it also offers limited programming capabilities. Effectively, the only memory areas that can be read or programmed in this mode are flash ROM and EEPROM. It is also possible to read out the signature. All other memory areas cannot be accessed. There is no chip erase functionality in debugWire mode; instead, while reprogramming the flash ROM, each
flash ROM page is erased right before updating it. This is done transparently by the JTAG ICE mkII (or AVR Dragon). The only way back from debugWire mode is to initiate a special sequence of commands to the JTAG ICE mkII (or AVR Dragon), so the debugWire mode will be temporarily disabled, and the target can be accessed using normal ISP programming. This sequence is automatically initiated by using the JTAG ICE mkII or AVR Dragon in ISP mode, when they detect that ISP mode cannot be entered.

- Problem: I want to use my JTAG ICE mkII to program an Xmega device through PDI. The documentation tells me to use the \textit{XMEGA PDI adapter for JTAGICE mkII} that is supposed to ship with the kit, yet I don’t have it.

Solution: Use the following pin mapping:

<table>
<thead>
<tr>
<th>JTAGICE mkII probe</th>
<th>Target pins</th>
<th>Squid cable colors</th>
<th>PDI header</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (TCK)</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 (GND)</td>
<td>GND</td>
<td>White</td>
<td>6</td>
</tr>
<tr>
<td>3 (TDO)</td>
<td>Grey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 (VRef)</td>
<td>VRef</td>
<td>Purple</td>
<td>2</td>
</tr>
<tr>
<td>5 (TMS)</td>
<td>Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 (nSRST)</td>
<td>PDI_CLK</td>
<td>Green</td>
<td>5</td>
</tr>
<tr>
<td>7 (N.C.)</td>
<td>Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 (nTRST)</td>
<td>Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 (TDI)</td>
<td>PDI_DATA</td>
<td>Red</td>
<td>1</td>
</tr>
<tr>
<td>10 (GND)</td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Problem: I want to use my AVR Dragon to program an Xmega device through PDI.

Solution: Use the 6 pin ISP header on the Dragon and the following pin mapping:

<table>
<thead>
<tr>
<th>Dragon ISP Header</th>
<th>Target pins</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (MISO)</td>
<td>PDI_DATA</td>
</tr>
<tr>
<td>2 (VCC)</td>
<td>VCC</td>
</tr>
<tr>
<td>3 (SCK)</td>
<td></td>
</tr>
<tr>
<td>4 (MOSI)</td>
<td></td>
</tr>
<tr>
<td>5 (RESET)</td>
<td>PDI_CLK / RST</td>
</tr>
<tr>
<td>6 (GND)</td>
<td>GND</td>
</tr>
</tbody>
</table>

- Problem: I want to use my AVRISP mkII to program an ATtiny4/5/9/10 device through TPI. How to connect the pins?

Solution: Use the following pin mapping:

<table>
<thead>
<tr>
<th>AVRISP connector</th>
<th>Target pins</th>
<th>ATtiny pin #</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (MISO)</td>
<td>TPIDATA</td>
<td>1</td>
</tr>
<tr>
<td>2 (VRef)</td>
<td>Vcc</td>
<td>5</td>
</tr>
<tr>
<td>3 (SCK)</td>
<td>TPICLK</td>
<td>3</td>
</tr>
<tr>
<td>4 (MOSI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 (RESET)</td>
<td>/RESET</td>
<td>6</td>
</tr>
<tr>
<td>6 (GND)</td>
<td>GND</td>
<td>2</td>
</tr>
</tbody>
</table>
• Problem: I want to program an ATtiny4/5/9/10 device using a serial/parallel bitbang programmer. How to connect the pins?
Solution: Since TPI has only 1 pin for bi-directional data transfer, both MISO and MOSI pins should be connected to the TPIDATA pin on the ATtiny device. However, a 1K resistor should be placed between the MOSI and TPIDATA. The MISO pin connects to TPIDATA directly. The SCK pin is connected to TPICLK.
In addition, the Vcc, /RESET and GND pins should be connected to their respective ports on the ATtiny device.

• Problem: How can I use a FTDI FT232R USB-to-Serial device for bitbang programming?
Solution: When connecting the FT232 directly to the pins of the target Atmel device, the polarity of the pins defined in the programmer definition should be inverted by prefixing a tilde. For example, the dasa programmer would look like this when connected via a FT232R device (notice the tildes in front of pins 7, 4, 3 and 8):

```c
programmer
    id = "dasa_ftdi";
    desc = "serial port banging, reset=rts sck=dtr mosi=txd miso=cts";
    type = serbb;
    reset = ~7;
    sck = ~4;
    mosi = ~3;
    miso = ~8;
);
```
Note that this uses the FT232 device as a normal serial port, not using the FTDI drivers in the special bitbang mode.

• Problem: My ATtiny4/5/9/10 reads out fine, but any attempt to program it (through TPI) fails. Instead, the memory retains the old contents.
Solution: Mind the limited programming supply voltage range of these devices.
In-circuit programming through TPI is only guaranteed by the datasheet at Vcc = 5 V.

• Problem: My ATxmega...A1/A2/A3 cannot be programmed through PDI with my AVR Dragon. Programming through a JTAG ICE mkII works though, as does programming through JTAG.
Solution: None by this time (2010 Q1).
It is said that the AVR Dragon can only program devices from the A4 Xmega sub-family.

• Problem: when programming with an AVRISPmkII or STK600, AVRDUDE hangs when programming files of a certain size (e.g. 246 bytes). Other (larger or smaller) sizes work though.
Solution: This is a bug caused by an incorrect handling of zero-length packets (ZLPs) in some versions of the libusb 0.1 API wrapper that ships with libusb 1.x in certain Linux distributions. All Linux systems with kernel versions < 2.6.31 and libusb >= 1.0.0 < 1.0.3 are reported to be affected by this.
See also: http://www.libusb.org/ticket/6
• Problem: after flashing a firmware that reduces the target’s clock speed (e.g. through the CLKPR register), further ISP connection attempts fail.
Solution: Even though ISP starts with pulling /RESET low, the target continues to run at the internal clock speed as defined by the firmware running before. Therefore, the ISP clock speed must be reduced appropriately (to less than 1/4 of the internal clock speed) using the -B option before the ISP initialization sequence will succeed.
As that slows down the entire subsequent ISP session, it might make sense to just issue a chip erase using the slow ISP clock (option -e), and then start a new session at higher speed. Option -D might be used there, to prevent another unneeded erase cycle.