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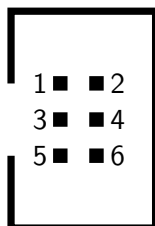
# ICSP/ISP/Spy-Bi-Wire Interfaces

## Programmer Pinouts

PICkit 2		MSP430 Spy Bi-Wire (14 pin header)	
1	VPP/ $\overline{\text{MCLR}}$	1	RESET (TDO/TDI)
2	VDD Target	2	VCC Tool
3	VSS (GND)	8	TEST
4	ICSPDAT/PGD	9	GND
5	ICSPCLK/PGC		
6	(Auxiliary)		

AVR ISP-6		AVR ISP-10		AVR JTAG		BusPirate Mapping	
1	MISO	1	MOSI	1	TCK	<b>BusPirate Name</b>	<b>ISP Name</b>
2	VCC	2	VCC	2	GND	MISO	MISO
3	SCK	3	(unused)	3	TDO	3.3 V/5.0 V/(none)	VCC
4	MOSI	4	GND	4	VREF	CLK	SCK
5	$\overline{\text{RESET}}$	5	$\overline{\text{RESET}}$	5	TRS	MOSI	MOSI
6	GND	6	GND	6	nSRST	CS	$\overline{\text{RESET}}$
		7	SCK	7	(unused)	GND	GND
		8	GND	8	nTRST		
		9	MISO	9	TDI		
		10	GND	10	GND		

## Generic Boxed Header Pinout



As seen from top; numbering is equivalent to mapping via IDC connector to ribbon cable.

- PICkit 2 Programmer/Debugger User's Guide,  
<http://ww1.microchip.com/downloads/en/DeviceDoc/51553E.pdf>
- AVR ISP Header Pinouts (Batsocks),  
[http://www.batsocks.co.uk/readme/isp\\_headers.htm](http://www.batsocks.co.uk/readme/isp_headers.htm)
- AVR JTAG header pinout (JTAGtest),  
<http://www.jtagtest.com/pinouts/avr>
- JTAG (MSP430),  
[http://processors.wiki.ti.com/index.php/JTAG\\_\(MSP430\)](http://processors.wiki.ti.com/index.php/JTAG_(MSP430))

# Key Hardware Specifications

## PIC 16F887

### Key Electrical Specifications

2.0–5.5	V	Operating voltage range, at reduced clock speed
4.5–5.5	V	Operating voltage range, at full clock speed
± 25	mA	Maximum current per pin (absolute maximum rating)
± 95	mA	Maximum current in/out, total (absolute maximum rating)

### External Components and Connections

2×	100 nF	ceramic cap	one per power input pin couple, widely considered best practice
2×	10 nF	ceramic cap	additionally if the ADC is used, one per power input pin couple

### Pinout

re3/ $\overline{\text{mclr}}$ /vpp	□ 1	40	□ rb7/icspd
ra0/an0/ulpwu/c12in0-	□ 2	39	□ rb6/icspcl
ra1/an1/c12in1-	□ 3	38	□ rb5/an13/ $\overline{\text{t1g}}$
ra2/an2/vref-/cvref/c2in+	□ 4	37	□ rb4/an11
ra3/an3/vref+/c1in+	□ 5	36	□ rb3/an9/pgm/c12in2-
ra4/t0cki/c1out	□ 6	35	□ rb2/an8
ra5/an4/ $\overline{\text{ss}}$ /c2out	□ 7	34	□ rb1/an10/c12in3-
re0/an5	□ 8	33	□ rb0/an12/int
re1/an6	□ 9	32	□ vdd
re2/an7	□ 10	31	□ vss
vdd	□ 11	30	□ rd7/p1d
vss	□ 12	29	□ rd6/p1c
ra7/osc1/clkin	□ 13	28	□ rd5/p1b
ra6/osc2/clkout	□ 14	27	□ rd4
rc0/t1oso/t1cki	□ 15	26	□ rc7/rx/dt
rc1/t1osi/ccp2	□ 16	25	□ rc6/tx/ck
rc2/p1a/ccp1	□ 17	24	□ rc5/sdo
rc3/sck/scl	□ 18	23	□ rc4/sdi/sda
rd0	□ 19	22	□ rd3
rd1	□ 20	21	□ rd2

• PIC16F882/883/884/886/887 Data Sheet  
<http://ww1.microchip.com/downloads/en/DeviceDoc/40001291H.pdf>

## ATmega 328P

### Key Electrical Specifications

1.8–5.5	V	Operating voltage range, at reduced clock speed
4.5–5.5	V	Operating voltage range, at full clock speed
± 40	mA	Maximum current per pin (absolute maximum rating)
± 200	mA	Maximum current in/out, total (absolute maximum rating)

### External Components and Connections

1×	10 kΩ	resistor	between RESET and VCC
1×	100 nF	ceramic cap	between VCC and GND
1×	100 nF	ceramic cap	between AREF and GND if ADC is used

- AVCC and VCC should be externally connected; if the ADC is actually used, use a low pass filter (see datasheet), otherwise connect directly.
- If the fuse bits are set accordingly, then an external clock source/oscillator/resonator may also be required to even program the device.

### Pinout

(pcint14/ $\overline{\text{reset}}$ )	pc6	□ 1	28	□ pc5 (adc5/scl/pcint13)
(pcint16/rxd)	pd0	□ 2	27	□ pc4 (adc4/sda/pcint12)
(pcint17/txd)	pd1	□ 3	26	□ pc3 (adc3/pcint11)
(pcint18/int0)	pd2	□ 4	25	□ pc2 (adc2/pcint10)
(pcint19/oc2b/int1)	pd3	□ 5	24	□ pc1 (adc1/pcint9)
(pcint20/xck/t0)	pd4	□ 6	23	□ pc0 (adc0/pcint8)
vcc	□ 7	22	□ gnd	
gnd	□ 8	21	□ aref	
(pcint6/xtal1/tosc1)	pb6	□ 9	20	□ avcc
(pcint7/xtal2/tosc2)	pb7	□ 10	19	□ pb5 (sck/pcint5)
(pcint21/oc0b/t1)	pd5	□ 11	18	□ pb4 (miso/pcint4)
(pcint22/oc0a/ain0)	pd6	□ 12	17	□ pb3 (mosi/oc2a/pcint3)
(pcint23/ain1)	pd7	□ 13	16	□ pb2 ( $\overline{\text{ss}}$ /oc1b/pcint2)
(pcint0/clko/icp1)	pb0	□ 14	15	□ pb1 (oc1a/pcint1)

- Datasheet Summary  
[http://www.atmel.com/Images/Atmel-42735-8-bit-AVR-Microcontroller-ATmega328-328P\\_Summary.pdf](http://www.atmel.com/Images/Atmel-42735-8-bit-AVR-Microcontroller-ATmega328-328P_Summary.pdf)
- Datasheet Complete  
[http://www.atmel.com/Images/Atmel-42735-8-bit-AVR-Microcontroller-ATmega328-328P\\_datasheet.pdf](http://www.atmel.com/Images/Atmel-42735-8-bit-AVR-Microcontroller-ATmega328-328P_datasheet.pdf)

## MSP430 G2553

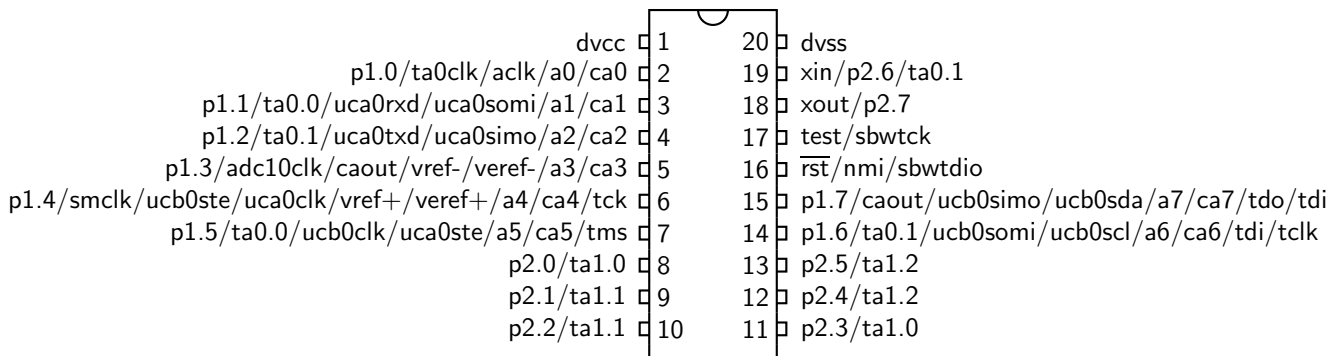
### Key Electrical Specifications

1.8–3.6	V	Operating voltage range, at full clock speed
± ???	mA	Maximum current per pin
± 48	mA	Maximum current in/out, total

### External Components and Connections

1×	47 kΩ	resistor	between RESET and VCC
1×	2.2 nF	ceramic cap	between RESET and GND
1×	100 nF	ceramic cap	between VCC and GND
1×	10 μF	electrolytic cap	between VCC and GND (only for ADC?)

### Pinout



- MSP430G2x53 MSP430G2x13 Mixed Signal Microcontroller Datasheet  
<http://www.ti.com/lit/ds/symlink/msp430g2553.pdf>
- MSP430x2xx Family User's Guide  
<http://www.ti.com/lit/ug/slau144j/slau144j.pdf>

## General Purpose I/O (GPIO)

- Always check the data sheets for individual processors!
- Individual bits within a byte or machine word are written as `<integer>:<bit index>` with the bit index starting at 0 for the least significant bit.

### Feature Table

Feature	PIC (PIC 16F887)	AVR (ATmega 328P)	MSP430 (MSP430 G2553)
Port Names	$x = A\dots$	$x = A\dots$	$n = 1\dots$
I/O Direction	TRIS $x:i$	DDR $x:i$	PnDIR $:i$
Bits Semantic	(0=out, 1=in)	(0=in, 1=out)	(0=in, 1=out)
Default Direction	Input (1)	Input (0)	Input (0)
Output	PORT $x:i$	PORT $x:i$	PnOUT $:i$
Input	PORT $x:i$	PIN $x:i$	PnIN $:i$
3.3 V Tolerant	(depends)	(depends)	(depends)
5 V Tolerant	(depends)	(depends)	<b>No</b>
Default Input Behaviour	Floating	Floating	Floating
Global Pull-Up Control	NOT_RBPU	MCUCR:PUD	N/A
Enable Pull-Up	WPU $x:i = 1$ N/A on some ports	PORT $x:i = 1$	PnOUT $:i = 1$ PnREN $:i = 1$
Enable Pull-Down	N/A	N/A	PnOUT $:i = 0$ PnREN $:i = 1$
Enable Floating	WPU $x:i = 0$ N/A on some ports	PORT $x:i = 0$	PnREN $:i = 0$

### Notes

- Depending on the MCU and pin you use, it may be necessary to configure that pin as a GPIO pin before using it as such. Example: PB:0 on the PIC16F887 is by default configured as an analog input pin and will always return 0 when read (until you clear ANSELH:4).
- On the PIC16F887: The  $\overline{\text{RBPU}}$  (register B pull-up) bit in the option register OPTION\_REG (accessible through a bit field/union combo and subsequently through a preprocessor macro as NOT\_RBPU) globally controls the pull-up resistors for register B on the PIC16F887 and by default is set (pull-ups globally disabled). For the other GPIOs, pull-ups are not available.
- On the ATmega 328P the pull-ups can be globally disabled by setting the PUD bit in the MCU control register (MCUCR). By default, this bit is unset (pull-ups are individually set).
- On the ATmega 328P, writing a 1 bit to PIN $x$  toggles the input/output behaviour of the associated pin.
- Input voltage tolerance largely depends on Vcc, and to a lesser degree on ambient conditions and device tolerances. For details, always check out the particular data sheets.