Contents

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ICSP/ISP/Spy-Bi-Wire Interfaces

Programmer Pinouts

PICkit 2

1	VPP/$\overline{\text{MCLR}}$
2	VDD Target
3	VSS (GND)
4	ICSPDAT/PGD
5	ICSPCLK/PGC
6	(Auxiliary)

MSP430 Spy Bi-Wire (14 pin header)

1	RESET (TDO/TDI)
2	VCC Tool
8	TEST
9	GND

AVR ISP-6

1	MISO
2	VCC
3	SCK
4	MOSI
5	$\overline{\text{RESET}}$
6	GND

AVR ISP-10

1	MOSI
2	VCC
3	(unused)
4	GND
5	$\overline{\text{RESET}}$
6	GND
7	SCK
8	GND
9	MISO
10	GND

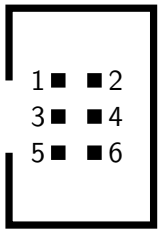
AVR JTAG

1	TCK
2	GND
3	TDO
4	VREF
5	TRS
6	nSRST
7	(unused)
8	nTRST
9	TDI
10	GND

BusPirate Mapping

BusPirate Name	ISP Name
MISO	MISO
3.3 V/5.0 V/(none)	VCC
CLK	SCK
MOSI	MOSI
CS	$\overline{\text{RESET}}$
GND	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`
- AVR JTAG header pinout (JTAGtest),
  `http://www.jtagtest.com/pinouts/avr`
- JTAG (MSP430),
  `http://processors.wiki.ti.com/index.php/JTAG_(MSP430)`

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Key Hardware Specifications

PIC 16F887

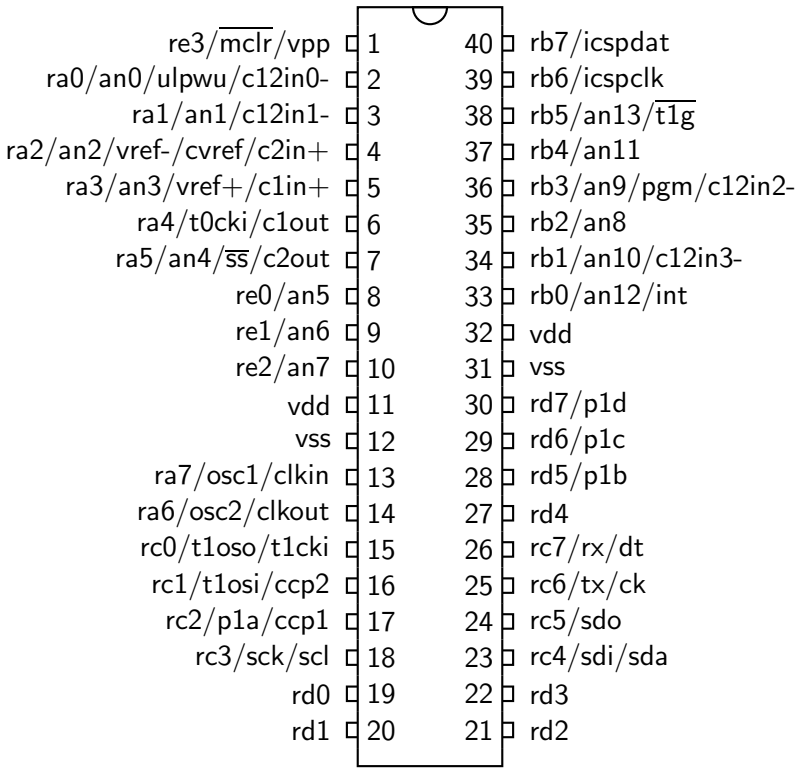
Key Electrical Specifications

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



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

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ATmega 328P

Key Electrical Specifications

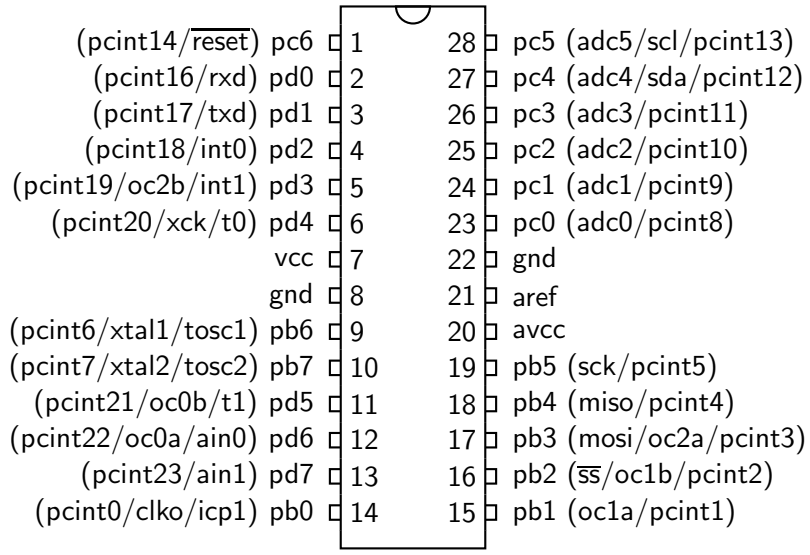
1.8–5.5	V	Operating voltage range, at reduced clock speed
4.5–5.5	V	Operating voltage range, at full clock speed
± 40	mA	Maximum current per pin (absolute maximum rating)
± 200	mA	Maximum current in/out, total (absolute maximum rating)

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



- Datasheet Summary
  `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`

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MSP430 G2553

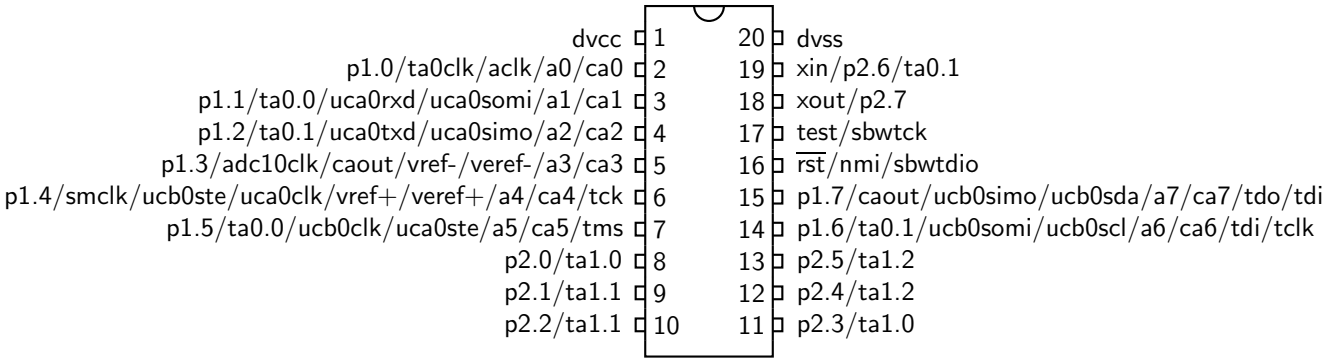
Key Electrical Specifications

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`

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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...`	x = `A...`	n = `1...`
I/O Direction	`TRIS`x`:`i	`DDR`x`:`i	`P`n`DIR:`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	`P`n`OUT:`i
Input	`PORT`x`:`i	`PIN`x`:`i	`P`n`IN:`i
3.3 V Tolerant	(depends)	(depends)	(depends)
5 V Tolerant	(depends)	(depends)	**No**
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`	`P`n`OUT:`i `= 1` `P`n`REN:`i `= 1`
Enable Pull-Down	N/A	N/A	`P`n`OUT:`i `= 0` `P`n`REN:`i `= 1`
Enable Floating	`WPU`x`:`i `= 0` N/A on some ports	`PORT`x`:`i `= 0`	`P`n`REN:`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 preproceessor 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.

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