



# **PIC16F631/677/685/687/689/690**

## **Data Sheet**

20-Pin Flash-Based, 8-Bit  
CMOS Microcontrollers with  
nanoWatt Technology

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# MICROCHIP PIC16F631/677/685/687/689/690

## 20-Pin Flash-Based, 8-Bit CMOS Microcontrollers with nanoWatt Technology

### High-Performance RISC CPU:

- Only 35 instructions to learn:
  - All single-cycle instructions except branches
- Operating speed:
  - DC – 20 MHz oscillator/clock input
  - DC – 200 ns instruction cycle
- Interrupt capability
- 8-level deep hardware stack
- Direct, Indirect and Relative Addressing modes

### Special Microcontroller Features:

- Precision Internal Oscillator:
  - Factory calibrated to  $\pm 1\%$
  - Software selectable frequency range of 8 MHz to 32 kHz
  - Software tunable
  - Two-Speed Start-up mode
  - Crystal fail detect for critical applications
  - Clock mode switching during operation for power savings
- Power-Saving Sleep mode
- Wide operating voltage range (2.0V-5.5V)
- Industrial and Extended Temperature range
- Power-on Reset (POR)
- Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Brown-out Reset (BOR) with software control option
- Enhanced low-current Watchdog Timer (WDT) with on-chip oscillator (software selectable nominal 268 seconds with full prescaler) with software enable
- Multiplexed Master Clear/Input pin
- Programmable code protection
- High Endurance Flash/EEPROM cell:
  - 100,000 write Flash endurance
  - 1,000,000 write EEPROM endurance
  - Flash/Data EEPROM retention: > 40 years
- Enhanced USART module:
  - Supports RS-485, RS-232 and LIN 2.0
  - Auto-Baud Detect
  - Auto-wake-up on Start bit

### Low-Power Features:

- **Standby Current:**
  - 50 nA @ 2.0V, typical
- Operating Current:
  - 11  $\mu$ A @ 32 kHz, 2.0V, typical
  - 220  $\mu$ A @ 4 MHz, 2.0V, typical
- Watchdog Timer Current:
  - <1  $\mu$ A @ 2.0V, typical

### Peripheral Features:

- 17 I/O pins and 1 input only pin:
  - High current source/sink for direct LED drive
  - Interrupt-on-Change pin
  - Individually programmable weak pull-ups
  - Ultra Low-Power Wake-up (ULPWU)
- Analog Comparator module with:
  - Two analog comparators
  - Programmable on-chip voltage reference (CVREF) module (% of VDD)
  - Comparator inputs and outputs externally accessible
  - SR Latch mode
  - Timer 1 Gate Sync Latch
  - Fixed 0.6V VREF
- A/D Converter:
  - 10-bit resolution and 12 channels
- Timer0: 8-bit timer/counter with 8-bit programmable prescaler
- Enhanced Timer1:
  - 16-bit timer/counter with prescaler
  - External Timer1 Gate (count enable)
  - Option to use OSC1 and OSC2 in LP mode as Timer1 oscillator if INTOSC mode selected
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Enhanced Capture, Compare, PWM+ module:
  - 16-bit Capture, max resolution 12.5 ns
  - Compare, max resolution 200 ns
  - 10-bit PWM with 1, 2 or 4 output channels, programmable "dead time", max frequency 20 kHz
  - PWM output steering control
- Synchronous Serial Port (SSP):
  - SPI mode (Master and Slave)
- I<sup>2</sup>C™ (Master/Slave modes):
  - I<sup>2</sup>C™ address mask
- In-Circuit Serial Programming™ (ICSP™) via two pins

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Device	Program Memory	Data Memory		I/O	10-bit A/D (ch)	Comparators	Timers 8/16-bit	SSP	ECCP+	EUSART
	Flash (words)	SRAM (bytes)	EEPROM (bytes)							
PIC16F631	1024	64	128	18	—	2	1/1	No	No	No
PIC16F677	2048	128	256	18	12	2	1/1	Yes	No	No
PIC16F685	4096	256	256	18	12	2	2/1	No	Yes	No
PIC16F687	2048	128	256	18	12	2	1/1	Yes	No	Yes
PIC16F689	4096	256	256	18	12	2	1/1	Yes	No	Yes
PIC16F690	4096	256	256	18	12	2	2/1	Yes	Yes	Yes

## PIC16F631 Pin Diagram

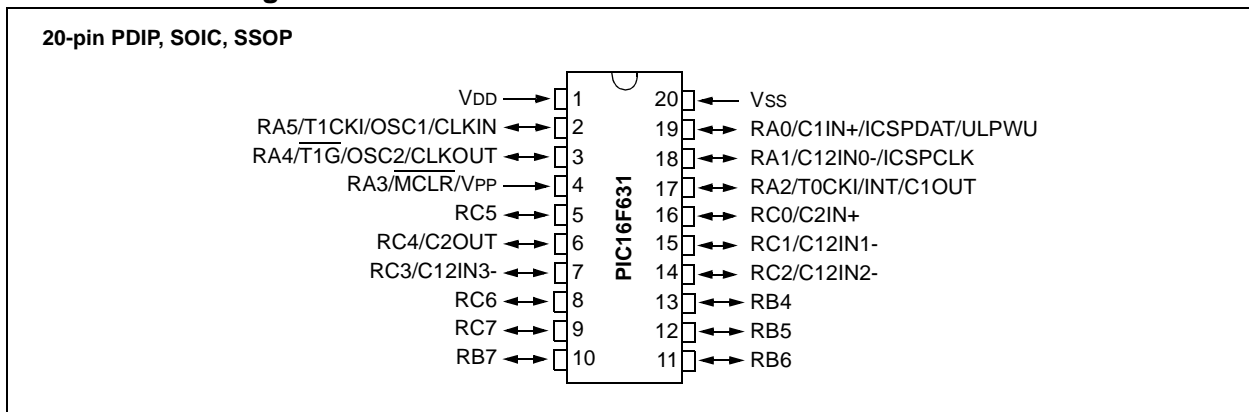


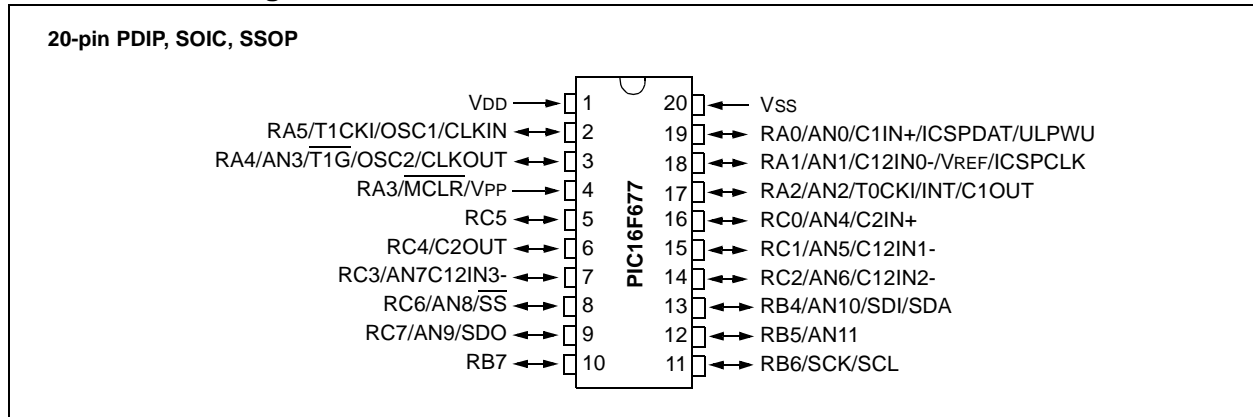
TABLE 1: PIC16F631 PIN SUMMARY

I/O	Pin	Analog	Comparators	Timers	Interrupt	Pull-up	Basic
RA0	19	AN0/ULPWU	C1IN+	—	IOC	Y	ICSPDAT
RA1	18	AN1	C12IN0-	—	IOC	Y	ICSPCLK
RA2	17	—	C1OUT	T0CKI	IOC/INT	Y	—
RA3	4	—	—	—	IOC	Y <sup>(1)</sup>	MCLR/VPP
RA4	3	—	—	T1G	IOC	Y	OSC2/CLKOUT
RA5	2	—	—	T1CKI	IOC	Y	OSC1/CLKIN
RB4	13	—	—	—	IOC	Y	—
RB5	12	—	—	—	IOC	Y	—
RB6	11	—	—	—	IOC	Y	—
RB7	10	—	—	—	IOC	Y	—
RC0	16	AN4	C2IN+	—	—	—	—
RC1	15	AN5	C12IN1-	—	—	—	—
RC2	14	AN6	C12IN2-	—	—	—	—
RC3	7	AN7	C12IN3-	—	—	—	—
RC4	6	—	C2OUT	—	—	—	—
RC5	5	—	—	—	—	—	—
RC6	8	—	—	—	—	—	—
RC7	9	—	—	—	—	—	—
—	1	—	—	—	—	—	VDD
—	20	—	—	—	—	—	VSS

Note 1: Pull-up enabled only with external MCLR configuration.

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## PIC16F677 Pin Diagram



**TABLE 2: PIC16F677 PIN SUMMARY**

I/O	Pin	Analog	Comparators	Timers	SSP	Interrupt	Pull-up	Basic
RA0	19	AN0/ULPWU	C1IN+	—	—	IOC	Y	ICSPDAT
RA1	18	AN1/VREF	C12IN0-	—	—	IOC	Y	ICSPCLK
RA2	17	AN2	C1OUT	T0CKI	—	IOC/INT	Y	—
RA3	4	—	—	—	—	IOC	Y <sup>(1)</sup>	MCLR/VPP
RA4	3	AN3	—	T1G	—	IOC	Y	OSC2/CLKOUT
RA5	2	—	—	T1CKI	—	IOC	Y	OSC1/CLKIN
RB4	13	AN10	—	—	SDI/SDA	IOC	Y	—
RB5	12	AN11	—	—	—	IOC	Y	—
RB6	11	—	—	—	SCL/SCK	IOC	Y	—
RB7	10	—	—	—	—	IOC	Y	—
RC0	16	AN4	C2IN+	—	—	—	—	—
RC1	15	AN5	C12IN1-	—	—	—	—	—
RC2	14	AN6	C12IN2-	—	—	—	—	—
RC3	7	AN7	C12IN3-	—	—	—	—	—
RC4	6	—	C2OUT	—	—	—	—	—
RC5	5	—	—	—	—	—	—	—
RC6	8	AN8	—	—	SS	—	—	—
RC7	9	AN9	—	—	SDO	—	—	—
—	1	—	—	—	—	—	—	VDD
—	20	—	—	—	—	—	—	VSS

**Note 1:** Pull-up activated only with external MCLR configuration.

# PIC16F631/677/685/687/689/690

## PIC16F685 Pin Diagram

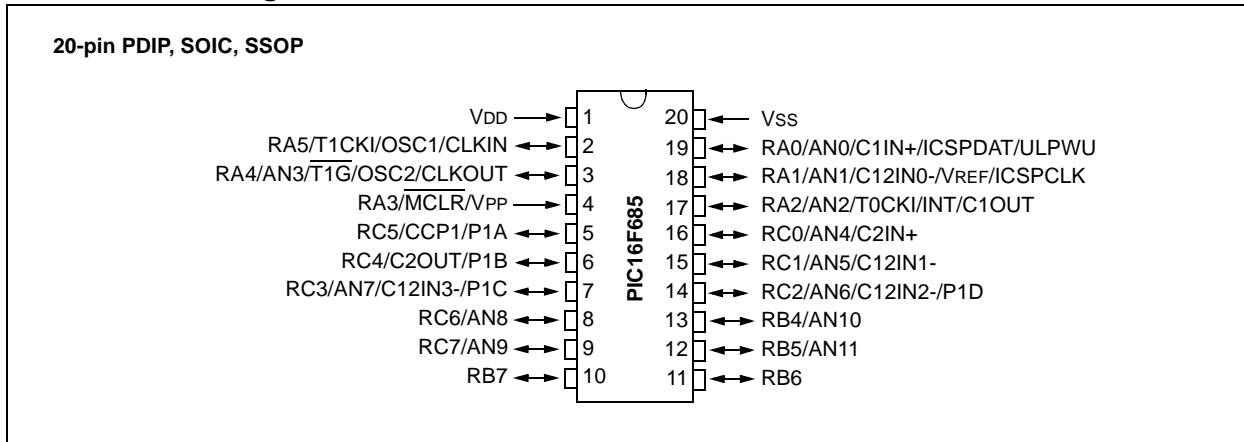


TABLE 3: PIC16F685 PIN SUMMARY

I/O	Pin	Analog	Comparators	Timers	ECCP	Interrupt	Pull-up	Basic
RA0	19	AN0/ULPWU	C1IN+	—	—	IOC	Y	ICSPDAT
RA1	18	AN1/VREF	C12IN0-	—	—	IOC	Y	ICSPCLK
RA2	17	AN2	C1OUT	T0CKI	—	IOC/INT	Y	—
RA3	4	—	—	—	—	IOC	Y <sup>(1)</sup>	MCLR/VPP
RA4	3	AN3	—	T1G	—	IOC	Y	OSC2/CLKOUT
RA5	2	—	—	T1CKI	—	IOC	Y	OSC1/CLKIN
RB4	13	AN10	—	—	—	IOC	Y	—
RB5	12	AN11	—	—	—	IOC	Y	—
RB6	11	—	—	—	—	IOC	Y	—
RB7	10	—	—	—	—	IOC	Y	—
RC0	16	AN4	C2IN+	—	—	—	—	—
RC1	15	AN5	C12IN1-	—	—	—	—	—
RC2	14	AN6	C12IN2-	—	P1D	—	—	—
RC3	7	AN7	C12IN3-	—	P1C	—	—	—
RC4	6	—	C2OUT	—	P1B	—	—	—
RC5	5	—	—	—	CCP1/P1A	—	—	—
RC6	8	AN8	—	—	—	—	—	—
RC7	9	AN9	—	—	—	—	—	—
—	1	—	—	—	—	—	—	VDD
—	20	—	—	—	—	—	—	VSS

Note 1: Pull-up activated only with external MCLR configuration.

# PIC16F631/677/685/687/689/690

## PIC16F687/689 Pin Diagram

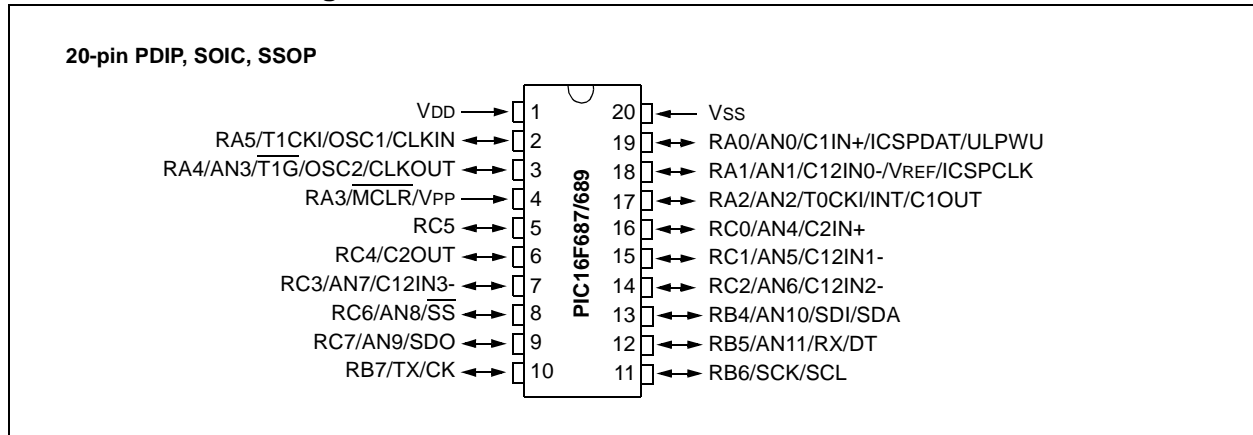


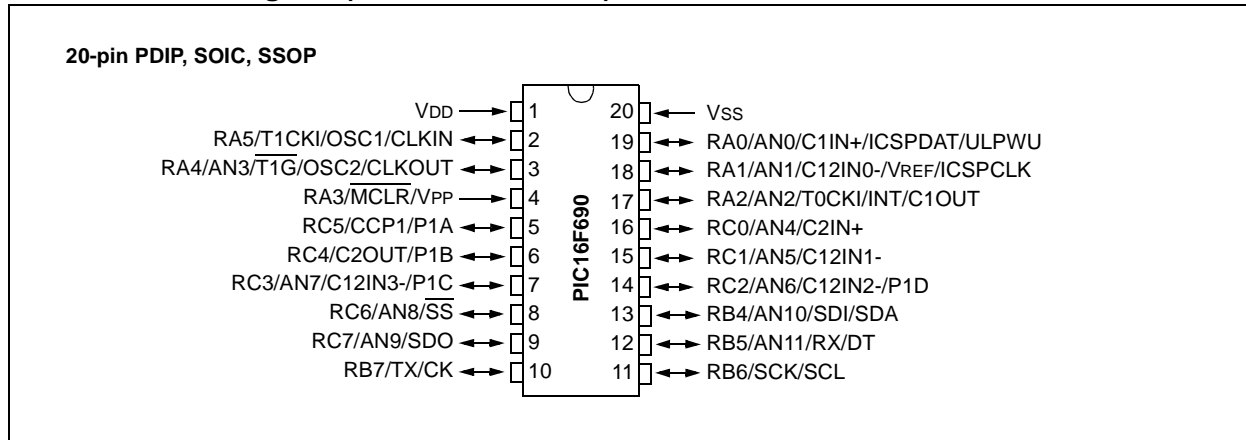
TABLE 4: PIC16F687/689 PIN SUMMARY

I/O	Pin	Analog	Comparators	Timers	EUSART	SSP	Interrupt	Pull-up	Basic
RA0	19	AN0/ULPWU	C1IN+	—	—	—	IOC	Y	ICSPDAT
RA1	18	AN1/VREF	C12IN0-	—	—	—	IOC	Y	ICSPCLK
RA2	17	AN2	C1OUT	T0CKI	—	—	IOC/INT	Y	—
RA3	4	—	—	—	—	—	IOC	Y <sup>(1)</sup>	$\overline{\text{MCLR}}/\text{VPP}$
RA4	3	AN3	—	$\overline{\text{T1G}}$	—	—	IOC	Y	OSC2/CLKOUT
RA5	2	—	—	T1CKI	—	—	IOC	Y	OSC1/CLKIN
RB4	13	AN10	—	—	—	SDI/SDA	IOC	Y	—
RB5	12	AN11	—	—	RX/DT	—	IOC	Y	—
RB6	11	—	—	—	—	SCL/SCK	IOC	Y	—
RB7	10	—	—	—	TX/CK	—	IOC	Y	—
RC0	16	AN4	C2IN+	—	—	—	—	—	—
RC1	15	AN5	C12IN1-	—	—	—	—	—	—
RC2	14	AN6	C12IN2-	—	—	—	—	—	—
RC3	7	AN7	C12IN3-	—	—	—	—	—	—
RC4	6	—	C2OUT	—	—	—	—	—	—
RC5	5	—	—	—	—	—	—	—	—
RC6	8	AN8	—	—	—	$\overline{\text{SS}}$	—	—	—
RC7	9	AN9	—	—	—	SDO	—	—	—
—	1	—	—	—	—	—	—	—	VDD
—	20	—	—	—	—	—	—	—	VSS

**Note 1:** Pull-up activated only with external  $\overline{\text{MCLR}}$  configuration.

# PIC16F631/677/685/687/689/690

## PIC16F690 Pin Diagram (PDIP, SOIC, SSOP)



**TABLE 5: PIC16F690 PIN SUMMARY**

I/O	Pin	Analog	Comparators	Timers	ECCP	EUSART	SSP	Interrupt	Pull-up	Basic
RA0	19	AN0/ULPWU	C1IN+	—	—	—	—	IOC	Y	ICSPDAT
RA1	18	AN1/VREF	C12IN0-	—	—	—	—	IOC	Y	ICSPCLK
RA2	17	AN2	C1OUT	T0CKI	—	—	—	IOC/INT	Y	—
RA3	4	—	—	—	—	—	—	IOC	Y <sup>(1)</sup>	MCLR/VPP
RA4	3	AN3	—	T1G	—	—	—	IOC	Y	OSC2/CLKOUT
RA5	2	—	—	T1CKI	—	—	—	IOC	Y	OSC1/CLKIN
RB4	13	AN10	—	—	—	—	SDI/SDA	IOC	Y	—
RB5	12	AN11	—	—	—	RX/DT	—	IOC	Y	—
RB6	11	—	—	—	—	—	SCL/SCK	IOC	Y	—
RB7	10	—	—	—	—	TX/CK	—	IOC	Y	—
RC0	16	AN4	C2IN+	—	—	—	—	—	—	—
RC1	15	AN5	C12IN1-	—	—	—	—	—	—	—
RC2	14	AN6	C12IN2-	—	P1D	—	—	—	—	—
RC3	7	AN7	C12IN3-	—	P1C	—	—	—	—	—
RC4	6	—	C2OUT	—	P1B	—	—	—	—	—
RC5	5	—	—	—	CCP1/P1A	—	—	—	—	—
RC6	8	AN8	—	—	—	—	SS	—	—	—
RC7	9	AN9	—	—	—	—	SDO	—	—	—
—	1	—	—	—	—	—	—	—	—	VDD
—	20	—	—	—	—	—	—	—	—	VSS

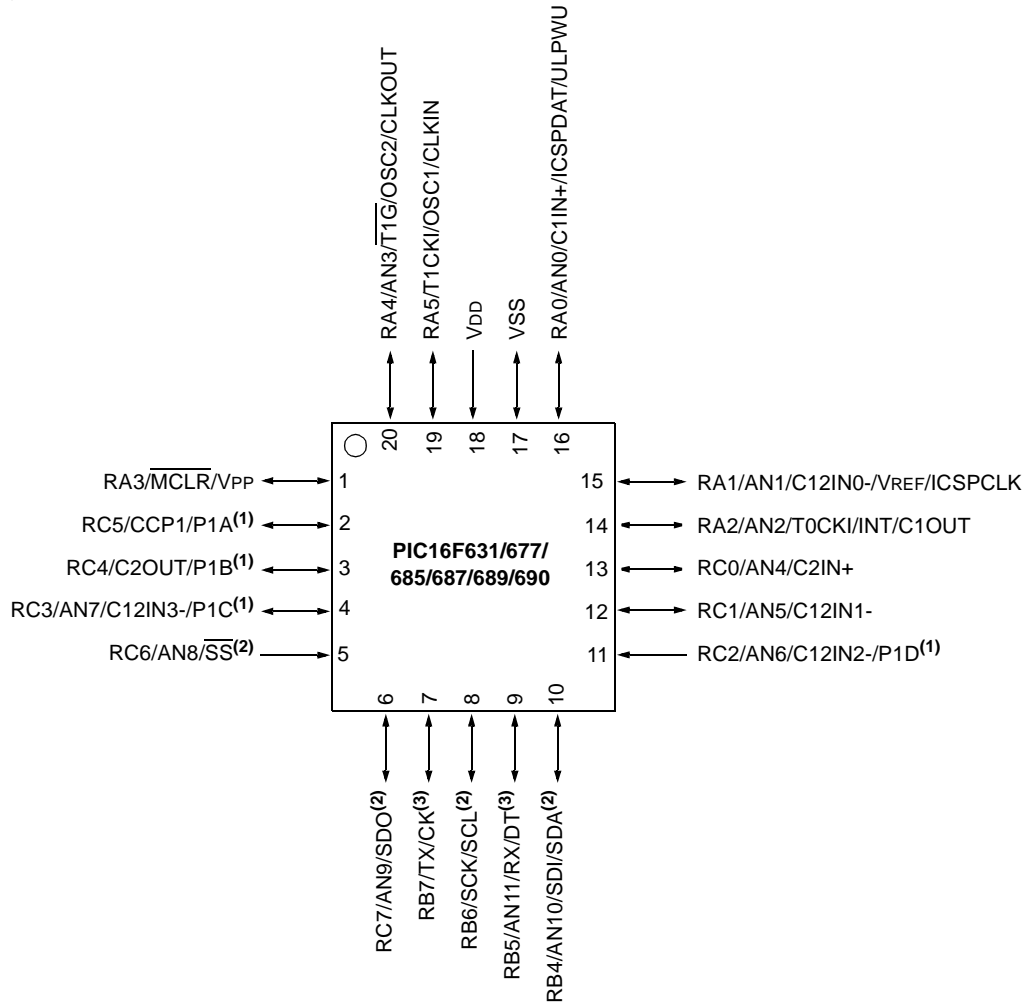
**Note 1:** Pull-up activated only with external MCLR configuration.



# PIC16F631/677/685/687/689/690

## PIC16F690 Pin Diagram (QFN)

20-pin QFN



- Note 1:** CCP1/P1A, P1B, P1C and P1D are available on PIC16F685/PIC16F690 only.
- Note 2:** SS, SDO, SDI/SDA and SCL/SCK are available on PIC16F677/PIC16F687/PIC16F689/PIC16F690 only.
- Note 3:** RX/DT and TX/CK are available on PIC16F687/PIC16F689/PIC16F690 only.