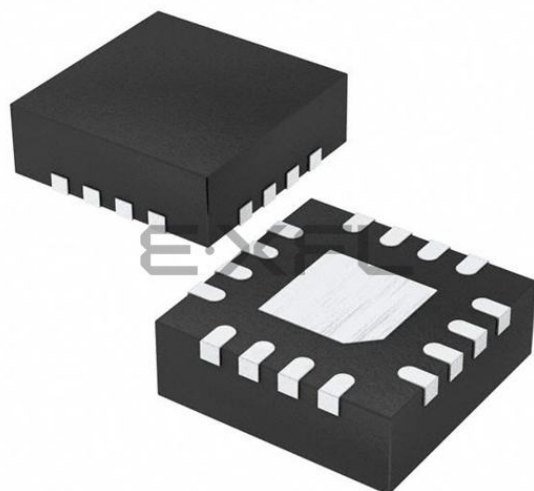




Welcome to [E-XFL.COM](#)

What is "[Embedded - Microcontrollers](#)"?

"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "[Embedded - Microcontrollers](#)"

Details

Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	32MHz
Connectivity	I ² C, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	12
Program Memory Size	14KB (8K x 14)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K x 8
Voltage - Supply (Vcc/Vdd)	2.3V ~ 5.5V
Data Converters	A/D 8x10b; D/A 1x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	16-VQFN Exposed Pad
Supplier Device Package	16-QFN (4x4)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16f1615-e-ml

8/14/20-Pin, 8-Bit Flash Microcontroller Product Brief

Description:

PIC12/16(L)F161X microcontrollers deliver on-chip features that are unique to the design for embedded control of small motors and general purpose applications in 8/14/20-pin count packages. Features like 10-bit A/D, CCP, 24-bit SMT and Zero-Cross Detection offer an excellent solution to the variety of applications. The product family also has a CRC+ memory scan and Windowed WDT to support safety-critical systems in home appliances, white goods and other end equipment.

Core Features:

- C Compiler Optimized RISC Architecture
- Only 49 Instructions
- Operating Speed:
 - DC – 32 MHz clock input
 - 125 ns minimum instruction cycle
- Interrupt Capability
- 16-Level Deep Hardware Stack
- Up to Four 8-bit Timers
- Up to Three 16-bit Timers
- Low Current Power-on Reset (POR)
- Configurable Power-up Timer (PWRT)
- Brown-out Reset (BOR) with Selectable Trip Point
- Window Watchdog Timer (WWDT):
 - Variable prescaler selection
 - Variable window size selection
 - All sources configurable in hardware or software

Memory:

- Up to 8 KW Flash Program Memory
- Up to 1024 Bytes Data SRAM Memory
- Direct, Indirect and Relative Addressing modes
- High-Endurance Flash Data Memory (HEF):
 - 128 B (nonvolatile), 100K Erase/Write Cycles

Operating Characteristics:

- Operating Voltage Range:
 - 1.8V to 3.6V (PIC16LF161X)
 - 2.3V to 5.5V (PIC16F161X)
- Temperature Range:
 - Industrial: -40°C to 85°C
 - Extended: -40°C to 125°C

eXtreme Low-Power (XLP) Features:

- Sleep mode: 50 nA @ 1.8V, typical
- Watchdog Timer: 500 nA @ 1.8V, typical
- Secondary Oscillator: 500 nA @ 32 kHz
- Operating Current:
 - 8 uA @ 32 kHz, 1.8V, typical
 - 32 uA/MHz @ 1.8V, typical

Digital Peripherals:

- Configurable Logic Cell (CLC):
 - Up to four CLCs
 - Integrated combinational and sequential logic
- Complementary Waveform Generator (CWG):
 - Rising and falling edge dead-band control
 - Full-bridge, half-bridge, 1-channel drive
 - Multiple signal sources
- Two Capture/Compare/PWM (CCP) modules
- PWM: Two 10-bit Pulse-Width Modulators
- Two Signal Measurement Timers (SMT):
 - 24-bit timer/counter with prescaler
 - Multiple gate and clock inputs
- Angular Timer:
 - Single pulse
 - Multiple pulses with missing pulse recovery
- Hardware Limit Timer (HLT):
 - 8-bit timer with prescaler
 - 8-bit period register and postscaler
 - Asynchronous H/W reset sources
- Math Accelerator:
 - Four operation modes
 - Add and multiply
 - Simple multiplier
 - Multiply and Accumulate (MAC)
 - Programmable PID controller
- Cyclic Redundancy Check with Memory Scan (CRC):
 - Software configurable
- Serial Communications:
 - Enhanced USART (EUSART)
 - SPI, I²C™, RS-232, RS-485, LIN compatible
 - Auto-Baud Detect, Auto-Wake-up on start
- Up to 18 I/O Pins:
 - Individually programmable pull-ups
 - Slew rate control
 - Interrupt-on-change with edge-select
- Peripheral Pin Select (PPS):
 - Enables pin mapping of digital I/O

PIC12/16(L)F161X

Intelligent Analog Peripherals:

- 10-Bit Analog-to-Digital Converter (ADC):
 - Up to 12 external channels
 - Conversion available during Sleep
- Two Comparators (CMP):
 - Low-Power/High-Speed mode
 - Up to three external inverting inputs
 - Fixed Voltage Reference at non-inverting input(s)
 - Comparator outputs externally accessible
- 8-Bit Digital-to-Analog Converter (DAC):
 - 8-bit resolution, rail-to-rail
 - Positive Reference Selection
- Voltage Reference:
 - Fixed Voltage Reference (FVR): 1.024V, 2.048V and 4.096V output levels
- Zero-Cross Detect (ZCD):
 - Detect when AC signal on pin crosses ground

Clocking Structure:

- 16 MHz Internal Oscillator:
 - $\pm 1\%$ at calibration
 - Selectable frequency range from 32 MHz to 31 kHz
- 31 kHz Low-Power Internal Oscillator
- 4x Phase-Locked Loop (PLL):
 - For up to 32 MHz internal operation
- External Oscillator Block with:
 - Three external clock modes up to 32 MHz

TABLE 1: PIC12/16(L)F161X FAMILY TYPES

Device	Data Sheet Index	Program Memory Flash (W)	Data SRAM (bytes)	I/O Pins	8-bit/16-bit Timers	Comparators	10-bit ADC (ch)	Zero-Cross Detect	CCP/10-bit PWM	CWG	CLC	SMT/HLT	Angular Timer	Window Watchdog Timer	CRC with Memory Scan	Math Accelerator	PPS	EUSART	I ² C™/SPI	Debug ⁽¹⁾
PIC12(L)F1612	(A)	2048	256	6	1/1	1	4	1	2/0	1	0	2/3	0	Y	Y	0	0	0	0	I/H
PIC16(L)F1613	(A)	2048	256	12	1/1	2	8	1	2/0	1	0	2/3	0	Y	Y	0	0	0	0	I/H
PIC16(L)F1614	(B)	4096	512	12	1/3	2	8	1	2/2	1	2	2/3	1	Y	Y	1	Y	1	1	I/H
PIC16(L)F1615	(C)	8192	1024	12	1/3	2	8	1	2/2	1	4	2/3	1	Y	Y	1	Y	1	1	I/H
PIC16(L)F1618	(B)	4096	512	18	1/3	2	12	1	2/2	1	2	2/3	1	Y	Y	1	Y	1	1	I/H
PIC16(L)F1619	(C)	8192	1024	18	1/3	2	12	1	2/2	1	4	2/3	1	Y	Y	1	Y	1	1	I/H

Note 1: Debugging Methods: (I) – Integrated on Chip; (H) – via ICD Header; E – using Emulation Product.

Data Sheet Index:

- A. DS40001737 [PIC12\(L\)F1612/16\(L\)F1613 Data Sheet, 8/14-Pin, 8-bit Flash Microcontrollers](#)
- B. Future Release [PIC16\(L\)F1614/8 Data Sheet, 14/20-Pin, 8-bit Flash Microcontrollers](#)
- C. Future Release [PIC16\(L\)F1615/9 Data Sheet, 14/20-Pin, 8-bit Flash Microcontrollers](#)

Note: For other small form-factor package availability and marking information, please visit <http://www.microchip.com/packaging> or contact your local sales office.

TABLE 2: PACKAGES

Packages	PDIP	SOIC	DFN	UDFN	TSSOP	QFN	UQFN	SSOP
PIC12(L)F1612	X	X	X	X				
PIC16(L)F1613	X	X			X	X	X	
PIC16(L)F1614	X	X			X	X		
PIC16(L)F1615	X	X			X	X		
PIC16(L)F1618	X	X				X		X
PIC16(L)F1619	X	X				X		X

Note: Pin details are subject to change.

PIN DIAGRAMS

FIGURE 1: 8-PIN PDIP, SOIC, DFN, UDFN

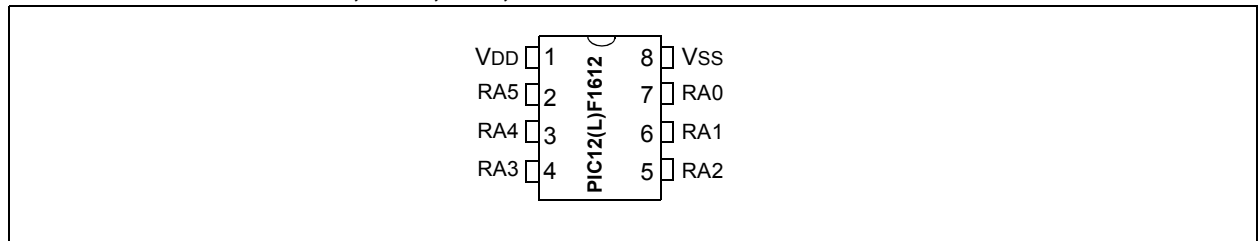


FIGURE 2: 14-PIN PDIP, SOIC, TSSOP

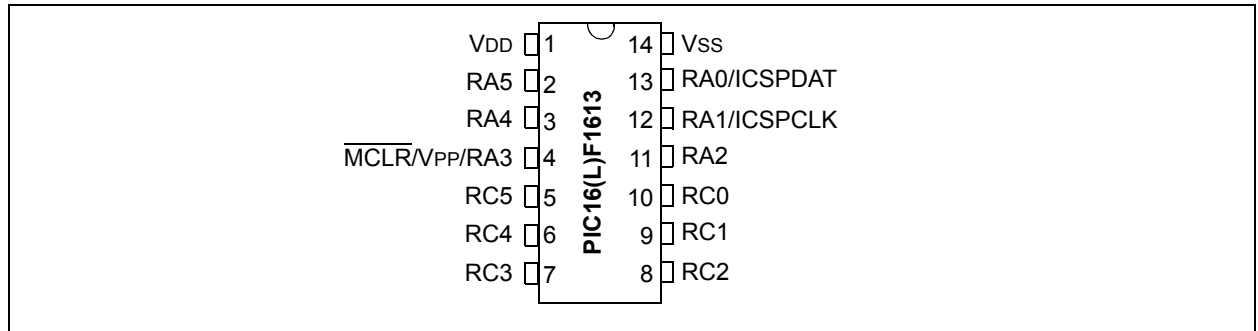
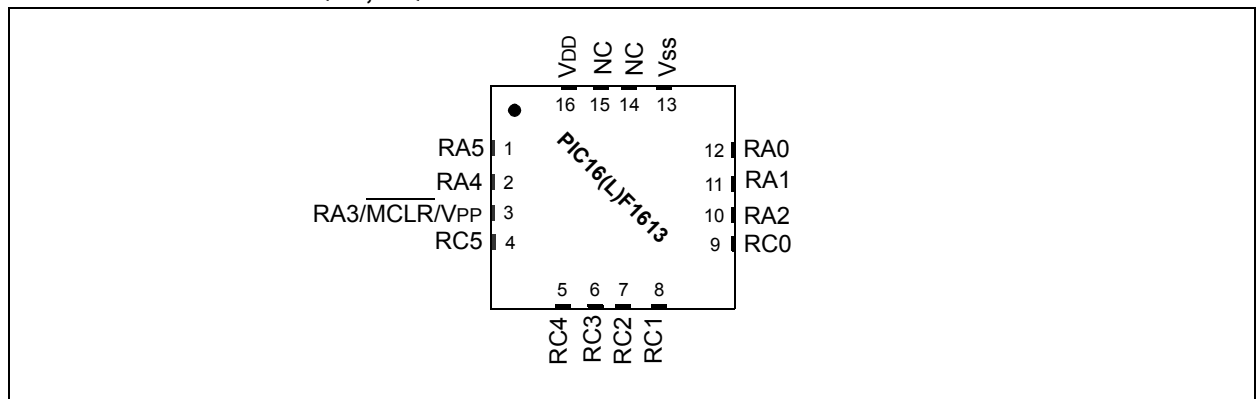


FIGURE 3: 16-PIN QFN, UQFN



PIC12/16(L)F161X

FIGURE 4: 14-PIN PDIP, SOIC, TSSOP

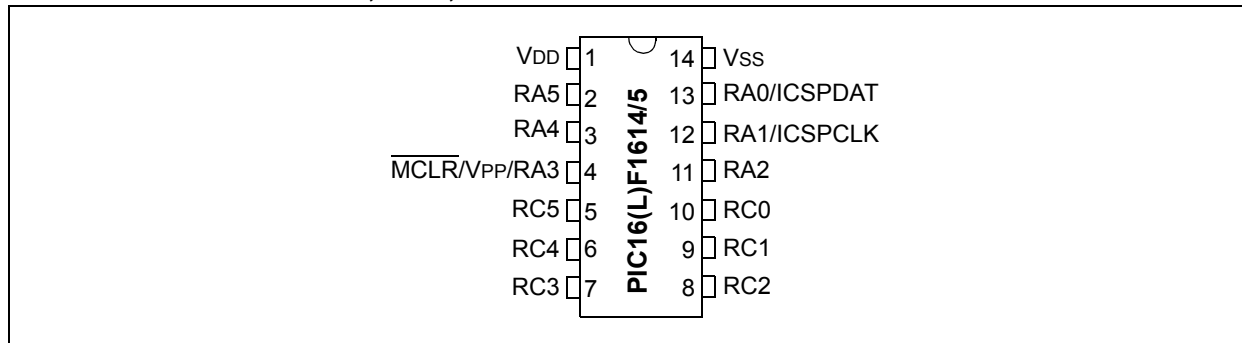


FIGURE 5: 16-PIN QFN

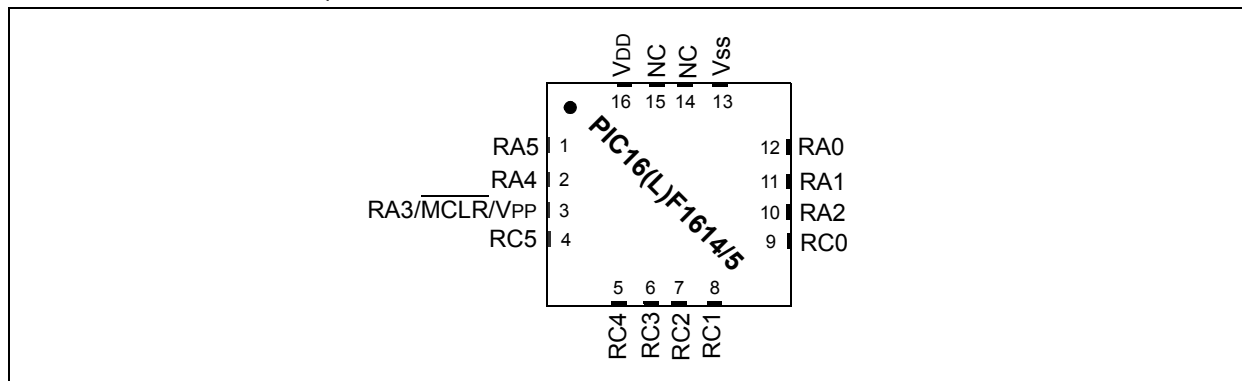


FIGURE 6: 20-PIN PDIP, SOIC, SSOP

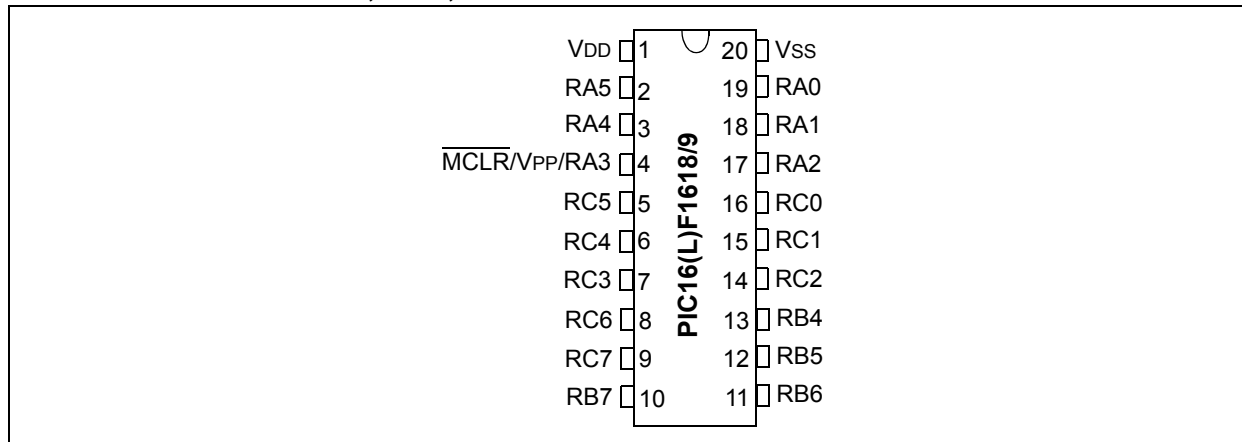
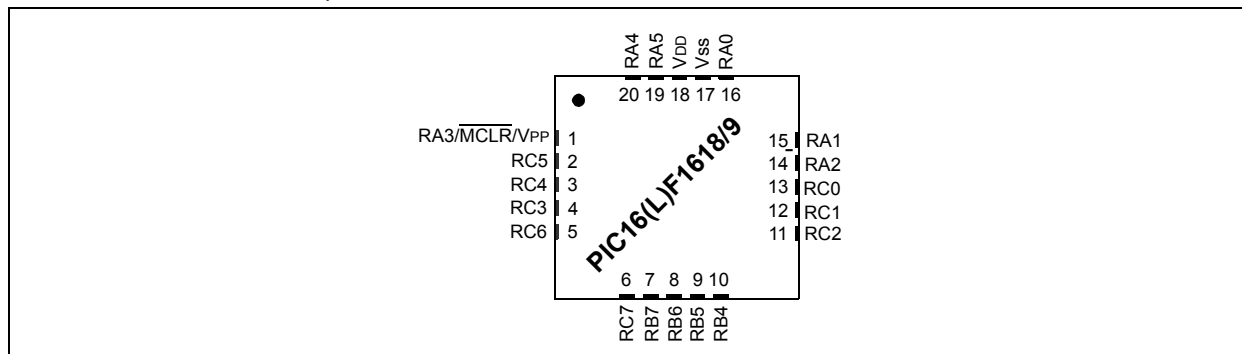


FIGURE 7: 20-PIN QFN



PIN ALLOCATION TABLES

TABLE 3: 8-PIN ALLOCATION TABLE (PIC12(L)F1612)

I/O	8-Pin PDIP, SOIC, DFN, UDFN	A/D	Reference	Comparator	Timers	CCP	CWG	ZCD	Interrupt	SMT	Pull-up	Basic
RA0	7	AN0	DAC1OUT1	C1IN+	—	CCP2	CWG1B	—	IOC	—	Y	ICSPDAT
RA1	6	AN1	VREF+	C1IN0-	—	—	—	ZCD1OUT	IOC	—	Y	ICSPCLK
RA2	5	AN2	—	C1OUT	T0CKI T4IN	CCP1	CWG1A CWG1IN	ZCD1IN	INT IOC	SMTSIG2	Y	—
RA3	4	—	—	—	T1G ⁽¹⁾ T6IN	—	—	—	IOC	SMTWIN2	Y	MCLR/VPP
RA4	3	AN3	—	C1IN1-	T1G	—	CWG1B ⁽¹⁾	—	IOC	SMTSIG1	Y	CLKOUT
RA5	2	—	—	—	T1CKI T2IN	CCP1 ⁽¹⁾	CWG1A ⁽¹⁾	—	IOC	SMTWIN1	Y	CLKIN
VDD	1	—	—	—	—	—	—	—	—	—	—	VDD
VSS	8	—	—	—	—	—	—	—	—	—	—	VSS

Note 1: Alternate pin function selected with the APFCON register.

TABLE 4: 14/16-PIN ALLOCATION TABLE (PIC16(L)F1613)

I/O	14-Pin PDIP, SOIC, TSSOP	16-Pin QFN, UQFN	A/D	Reference	Comparator	Timers	CCP	CWG	ZCD	Interrupt	SMT	Pull-up	Basic
RA0	13	12	AN0	DAC1OUT1	C1IN+	—	—	—	—	IOC	—	Y	ICSPDAT
RA1	12	11	AN1	VREF+	C1IN0- C2IN0-	—	—	—	ZCD1OUT	IOC	—	Y	ICSPCLK
RA2	11	10	AN2	—	C1OUT	T0CKI T4IN	—	CWG1IN	ZCD1IN	INT IOC	—	Y	—
RA3	4	3	—	—	—	T1G ⁽¹⁾ T6IN	—	—	—	IOC	SMTWIN2	Y	MCLR/VPP
RA4	3	2	AN3	—	—	T1G	—	—	—	IOC	SMTSIG1	Y	CLKOUT
RA5	2	1	—	—	—	T1CKI T2IN	CCP2 ⁽¹⁾	—	—	IOC	SMTWIN1	Y	CLKIN
RC0	10	9	AN4	—	C2IN+	—	—	—	—	IOC	—	Y	—
RC1	9	8	AN5	—	C1IN1- C2IN1-	T4IN	—	—	—	IOC	SMTSIG2	Y	—
RC2	8	7	AN6	—	C1IN2- C2IN2-	—	—	CWG1D	—	IOC	—	Y	—
RC3	7	6	AN7	—	C1IN3- C2IN3-	—	CCP2	CWG1C	—	IOC	—	Y	—
RC4	6	5	—	—	C2OUT	—	—	CWG1B	—	IOC	—	Y	—
RC5	5	4	—	—	—	—	CCP1	CWG1A	—	IOC	—	Y	—
VDD	1	16	—	—	—	—	—	—	—	—	—	—	VDD
VSS	14	13	—	—	—	—	—	—	—	—	—	—	VSS

Note 1: Alternate pin function selected with the APFCON register.

TABLE 5: 14/16-PIN ALLOCATION TABLE (PIC16(L)F1614/5)

I/O	14-Pin PDIP, SOIC, TSSOP	16-Pin QFN	A/D	Reference	Comparator	Timers	CCP	CWG	ZCD	CLC	EUSART	SMT	Angular Timer	MSSP	PWM	High Current I/O	Interrupt	Pull-up	Basic
RA0	13	12	AN0	DAC1OUT1	C1IN+	—	—	—	—	—	—	—	—	—	—	—	IOC	Y	ICSPDAT
RA1	12	11	AN1	VREF+	C1IN0- C2IN0-	—	—	—	—	—	—	—	—	—	—	—	IOC	Y	ICSPCLK
RA2	11	10	AN2	—	C2IN+	T0CKI ⁽¹⁾	—	CWG1IN ⁽¹⁾	ZCD1IN	—	—	—	—	—	—	—	INT IOC	Y	—
RA3	4	3	—	—	—	T6IN ⁽¹⁾	—	—	—	—	—	SMTWIN2 ⁽¹⁾	—	—	—	—	IOC	Y	MCLR/VPP
RA4	3	2	AN3	—	—	T1G ⁽¹⁾	—	—	—	—	—	SMTSIG1 ⁽¹⁾	—	—	—	—	IOC	Y	CLKOUT
RA5	2	1	—	—	—	T1CKI ⁽¹⁾ T2IN ⁽¹⁾	—	—	—	—	—	SMTWIN1 ⁽¹⁾	—	—	—	—	IOC	Y	CLKIN
RC0	10	9	AN4	—	C2IN+	T5CKI ⁽¹⁾	—	—	—	—	—	—	—	SCK ^(1,3)	—	—	IOC	Y	—
RC1	9	8	AN5	—	C1IN1- C2IN1-	T4IN ⁽¹⁾	—	—	—	—	—	SMTSIG2 ⁽¹⁾	—	SDI ⁽¹⁾	—	—	IOC	Y	—
RC2	8	7	AN6	—	C1IN2- C2IN2-	—	—	—	—	—	—	—	—	—	—	—	IOC	Y	—
RC3	7	6	AN7	—	C1IN3- C2IN3-	T5G ⁽¹⁾	CCP2 ⁽¹⁾	—	—	CLCIN0 ⁽¹⁾	—	—	ATCC ⁽¹⁾	SS ⁽¹⁾	—	—	IOC	Y	—
RC4	6	5	—	—	—	T3G ⁽¹⁾	—	—	—	CLCIN1 ⁽¹⁾	CK ⁽¹⁾	—	—	—	—	HIC4	IOC	Y	—
RC5	5	4	—	—	—	T3CKI ⁽¹⁾	CCP1 ⁽¹⁾	—	—	—	RX ^(1,3)	—	ATIN ⁽¹⁾	—	—	HIC5	IOC	Y	—
VDD	1	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	VDD
VSS	14	13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	VSS
OUT ⁽²⁾	—	—	—	—	C1OUT	—	CCP1	CWG1A	ZCD1OUT	CLC1OUT	DT ⁽³⁾	—	—	SDO	PWM3OUT	—	—	—	—
	—	—	—	—	C2OUT	—	CCP1	CWG1B	—	CLC2OUT	CK	—	—	SCK ⁽³⁾	PWM4OUT	—	—	—	—
	—	—	—	—	—	—	—	CWG1C	—	—	TX	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	CWG1D	—	—	—	—	—	—	—	—	—	—	—

- Note**
- 1: Default peripheral input. Input can be moved to any other pin with the PPS input selection registers.
 - 2: All pin outputs default to PORT latch data. Any pin can be selected as a digital peripheral output with the PPS output selection registers.
 - 3: These peripheral functions are bidirectional. The output pin selections must be the same as the input pin selections.

TABLE 6: 20-PIN ALLOCATION TABLE (PIC16(L)F1618/9)

I/O	20-Pin PDIP, SOIC, SSOP	20-Pin QFN	A/D	Reference	Comparator	Timers	CCP	CWG	ZCD	CLC	EUSART	SMT	Angular Timer	MSSP	PWM	High Current I/O	Interrupt	Pull-up	Basic
RA0	19	16	AN0	DAC1OUT	C1IN+	—	—	—	—	—	—	—	—	—	—	—	IOC	Y	ICSPDAT
RA1	18	15	AN1	VREF+	C1IN0- C2IN0-	—	—	—	—	—	—	—	—	—	—	—	IOC	Y	ICSPCLK
RA2	17	14	AN2	—	—	T0CKI ⁽¹⁾	—	CWG1IN ⁽¹⁾	—	—	—	—	—	—	—	—	INT IOC	Y	—
RA3	4	1	—	—	—	T6IN ⁽¹⁾	—	—	—	—	—	SMTWIN2 ⁽¹⁾	—	—	—	—	IOC	Y	MCLR V _{PP}
RA4	3	20	AN3	—	—	T1G ⁽¹⁾	—	—	—	—	—	SMTSIG1 ⁽¹⁾	—	—	—	—	IOC	Y	CLKOUT
RA5	2	19	—	—	—	T1CKI ⁽¹⁾ T2IN ⁽¹⁾	—	—	—	CLCIN3 ⁽¹⁾	—	SMTWIN1 ⁽¹⁾	—	—	—	—	IOC	Y	CLKIN
RB4	13	10	AN10	—	—	—	—	—	—	—	—	—	—	SDI ⁽¹⁾	—	—	IOC	Y	—
RB5	12	9	AN11	—	—	—	—	—	—	—	RX ^(1,3)	—	—	—	—	—	IOC	Y	—
RB6	11	8	—	—	—	—	—	—	—	—	—	—	—	SCK ^(1,3)	—	—	IOC	Y	—
RB7	10	7	—	—	—	—	—	—	—	—	CK ⁽¹⁾	—	—	—	—	—	IOC	Y	—
RC0	16	13	AN4	—	C2IN+	T5CKI ⁽¹⁾	—	—	—	—	—	—	—	—	—	—	IOC	Y	—
RC1	15	12	AN5	—	C1IN1- C2IN1-	T4IN ⁽¹⁾	—	—	—	CLCIN ⁽²⁾	—	SMTSIG2 ⁽¹⁾	—	—	—	—	IOC	Y	—
RC2	14	11	AN6	—	C1IN2- C2IN2-	—	—	—	—	—	—	—	—	—	—	—	IOC	Y	—
RC3	7	4	AN7	—	C1IN3- C2IN3-	T5G ⁽¹⁾	CCP2 ⁽¹⁾	—	—	CLCIN0 ⁽¹⁾	—	—	ATCC ⁽¹⁾	—	—	—	IOC	Y	—
RC4	6	3	—	—	—	T3G ⁽¹⁾	—	—	—	CLCIN1 ⁽¹⁾	—	—	—	—	—	HIC4	IOC	Y	—
RC5	5	2	—	—	—	T3CKI ⁽¹⁾	CCP2 ⁽¹⁾	—	—	—	—	—	ATIN ⁽¹⁾	—	—	HIC5	IOC	Y	—
RC6	8	5	AN8	—	—	—	—	—	—	—	—	—	—	SS ⁽¹⁾	—	—	IOC	Y	—
RC7	9	6	AN9	—	—	—	—	—	—	—	—	—	—	—	—	—	IOC	Y	—
V _{DD}	1	18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V _{SS}	20	17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

- Note**
- 1: Default peripheral input. Input can be moved to any other pin with the PPS input selection registers.
 - 2: All pin outputs default to PORT latch data. Any pin can be selected as a digital peripheral output with the PPS output selection registers.
 - 3: These peripheral functions are bidirectional. The output pin selections must be the same as the input pin selections.

TABLE 6: 20-PIN ALLOCATION TABLE (PIC16(L)F1618/9)

I/O	20-Pin PDIP, SOIC, SSOP	20-Pin QFN	A/D	Reference	Comparator	Timers	CCP	CWG	ZCD	CLC	EUSART	SMT	Angular Timer	MSSP	PWM	High Current I/O	Interrupt	Pull-up	Basic
OUT ⁽²⁾	—	—	—	—	C1OUT	—	CCP1	CWG1A	ZCD1OUT	CLC1OUT	DT ⁽³⁾	—	—	SDO	PWM3OUT	—	—	—	—
	—	—	—	—	C2OUT	—	CCP2	CWG1B	—	CLC2OUT	CK	—	—	SCK ⁽³⁾	PWM4OUT	—	—	—	—
	—	—	—	—	—	—	—	CWG1C	—	CLC3OUT	TX	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	CWG1D	—	CLC4OUT	—	—	—	—	—	—	—	—	—

- Note**
- 1: Default peripheral input. Input can be moved to any other pin with the PPS input selection registers.
 - 2: All pin outputs default to PORT latch data. Any pin can be selected as a digital peripheral output with the PPS output selection registers.
 - 3: These peripheral functions are bidirectional. The output pin selections must be the same as the input pin selections.

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, KEELOQ, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, PIC³² logo, rPIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MTP, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

Analog-for-the-Digital Age, Application Maestro, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Omniscent Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICTail, REAL ICE, rLAB, Select Mode, SQI, Serial Quad I/O, Total Endurance, TSHARC, UniWinDriver, WiperLock, ZENA and Z-Scale are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

GestIC and ULPP are registered trademarks of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2014, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.



Printed on recycled paper.

ISBN: 9781620779415

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
= ISO/TS 16949 =

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
<http://www.microchip.com/support>
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2401-1200
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Hangzhou
Tel: 86-571-2819-3187
Fax: 86-571-2819-3189

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880-3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Pforzheim
Tel: 49-7231-424750

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820