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## Full-Featured, Low Pin Count, High-Temperature Microcontrollers

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### Description

PIC16(L)F1615/9 microcontrollers deliver on-chip features that are unique to the design for embedded control of small motors and general purpose applications in 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 Watchdog Timer 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
- One 8-Bit Timer
- Four 16-bit Timers
- Low Current Power-on Reset (POR)
- Configurable Power-up Timer (PWRT)
- Brown-out Reset (BOR) with Selectable Trip Point
- Windowed Watchdog Timer (WWDT):
  - Variable prescaler selection
  - Variable window size selection
  - All sources configurable in hardware or software

### Memory

- 4 KW Flash Program Memory
- 512 Bytes Data SRAM
- Direct, Indirect and Relative Addressing modes
- High-Endurance Flash Data Memory (HEF):
  - 128 B of nonvolatile data storage
  - 100K erase/write cycles

### Operating Characteristics

- Operating Voltage Range:
  - 2.5V to 5.5V (PIC16LF1615/9)
- Temperature Range:
  - High Temp: -40°C to 150°C

### Digital Peripherals

- Configurable Logic Cell (CLC):
  - Two 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
- Two 10-bit Pulse-Width Modulators (PWM)
- 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
- 8-Bit Timers (TMR2+HLT/4/6):
  - Up to 3 Timer2/4/6 with Hardware Limit Timer (HLT)
  - Monitors Fault Conditions: Stall, Stop, etc.
  - Multiple modes
  - 8-bit timer/counter with prescaler
  - 8-bit period register and postscaler
  - Asynchronous H/W Reset sources
- Math Accelerator with Proportional-Integral-Derivative (PID):
  - Four operation modes
  - Add and multiply
  - Simple multiplier
  - Multiply and Accumulate
  - Programmable PID controller
- Cyclic Redundancy Check with Memory Scan (CRC/SCAN):
  - Software configurable
- Serial Communications:
  - Enhanced USART (EUSART)
  - SPI, I<sup>2</sup>C, RS-232, RS-485, LIN compatible
  - Auto-Baud Detect, Auto-Wake-up on start
- Up to 17 I/O Pins and One Input-only Pin:
  - Individually programmable pull-ups
  - Slew rate control
  - Interrupt-on-change with edge-select
  - Two High Current Drive pins
- Peripheral Pin Select (PPS):
  - Enables pin mapping of digital I/O

## Intelligent Analog Peripherals

- 10-Bit Analog-to-Digital Converter (ADC):
  - Up to 12 external channels
  - Conversion available during Sleep
- Two Comparators (COMP):
  - 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
- Two High-Current Drive Pins:
  - 100mA @ 5V

## 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

|                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Note:</b> This document is supplemented by the “PIC16(L)F1615/9 14/20-Pin, 8-Bit Flash Microcontroller” data sheet (DS40001770). See <a href="#">Section 1.0 “Device Overview”</a> . |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**TABLE 1: PIC12/16F161X FAMILY TYPES**

| Device                     | Data Sheet Index | Program Memory Flash (W) | Program Memory Flash (kB) | Data SRAM (bytes) | High Endurance Flash (bytes) | I/O Pins | 8-bit Timer with HLT | 16-bit Timer | Angular Timer | Windowed Watchdog Timer | 24-bit SMT | Comparators | 10-bit ADC (ch) | Zero-Cross Detect | CCP/10-bit PWM | CWG | CLC | CRC with Memory Scan | Math Accelerator with PID | High-Current I/O 100mA | PPS | EUSART | I <sup>2</sup> C/SPI |
|----------------------------|------------------|--------------------------|---------------------------|-------------------|------------------------------|----------|----------------------|--------------|---------------|-------------------------|------------|-------------|-----------------|-------------------|----------------|-----|-----|----------------------|---------------------------|------------------------|-----|--------|----------------------|
| <a href="#">PIC12F1612</a> | (A)              | 2048                     | 3.5                       | 256               | 256                          | 6        | 4                    | 1            | 0             | Y                       | 1          | 1           | 4               | 1                 | 2/0            | 1   | 0   | Y                    | 0                         | 0                      | N   | 0      | 0                    |
| <a href="#">PIC16F1613</a> | (A)              | 2048                     | 3.5                       | 256               | 256                          | 12       | 4                    | 1            | 0             | Y                       | 2          | 2           | 8               | 1                 | 2/0            | 1   | 0   | Y                    | 0                         | 0                      | N   | 0      | 0                    |
| <a href="#">PIC16F1614</a> | (B)              | 4096                     | 7                         | 512               | 512                          | 12       | 4                    | 3            | 1             | Y                       | 2          | 2           | 8               | 1                 | 2/2            | 1   | 2   | Y                    | 1                         | 2                      | Y   | 1      | 1                    |
| <a href="#">PIC16F1615</a> | (C)              | 8192                     | 14                        | 1024              | 128                          | 12       | 4                    | 3            | 1             | Y                       | 2          | 2           | 8               | 1                 | 2/2            | 1   | 4   | Y                    | 1                         | 2                      | Y   | 1      | 1                    |
| <a href="#">PIC16F1618</a> | (B)              | 4096                     | 7                         | 512               | 512                          | 18       | 4                    | 3            | 1             | Y                       | 2          | 2           | 12              | 1                 | 2/2            | 1   | 2   | Y                    | 1                         | 2                      | Y   | 1      | 1                    |
| <a href="#">PIC16F1619</a> | (C)              | 8192                     | 14                        | 1024              | 128                          | 18       | 4                    | 3            | 1             | Y                       | 2          | 2           | 12              | 1                 | 2/2            | 1   | 4   | Y                    | 1                         | 2                      | Y   | 1      | 1                    |

**Note 1:** Debugging Methods: (I) – Integrated on Chip; 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. DS40001769 [PIC16\(L\)F1614/8 Data Sheet, 14/20-Pin, 8-bit Flash Microcontrollers](#)
- C. DS40001770 [PIC16\(L\)F1615/9 Data Sheet, 14/20-Pin, 8-bit Flash Microcontrollers](#)

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### Errata

An errata sheet, describing minor operational differences from the data sheet and recommended workarounds, may exist for current devices. As device/documentation issues become known to us, we will publish an errata sheet. The errata will specify the revision of silicon and revision of document to which it applies.

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## 1.0 DEVICE OVERVIEW

This document contains device-specific information for the following devices, operating in an ambient temperature range between -40°C and 150°C:

- PIC16F1615
- PIC16F1619

**Note:** This data sheet documents only the devices' features and specifications that are in addition to the features and specifications of the non-specialty PIC16F1615/9 devices. For information on the features and specifications shared by this document's high-temperature devices and the non-specialty devices, see the "*PIC16(L)F1615/9 14/20-Pin, 8-Bit Flash Microcontroller*" data sheet (DS40001770).

The PIC16F1615/9 devices offer Core Independent Peripherals (CIPs), Intelligent Analog modules, and several other features that allow for high-performance, low-cost, and low-power applications.

The primary differentiating features and specifications of the high-temperature PIC16F1615/9 devices are:

- All AC timing specifications are increased by 30%  
This derating factor includes parameters, such as TPWRT
- Maximum HS frequency of operation is 20 MHz
- Oscillator tolerances and  $V_{DD}$  operation range are revised

**Note 1:** The test duration for AEC-Q100 reliability testing for devices operating at 150°C is 1,000 hours. Any design operating at 125°C to 150°C for longer than that period is not warranted without prior written approval from Microchip Technology Inc.

**2:** Writes are not allowed for Flash program memory above 125°C

**3:** The temperature range indicator in the catalog part number and device marking is "H" for -40°C and 150°C

Example: PIC16F1619T-H/SL indicates the device is shipped in tape and reel configuration in the SOIC package and is rated for operation from -40°C and 150°C

**4:** The low voltage versions of these devices PIC16LF1614 and PIC16LF1618 are not released for operation above 125°C

**5:** Only SOIC (SL), TSSOP (ST), SSOP (SS) and QFN (ML) packages will be offered, not PDIP or UQFN

## 2.0 DEVICE/REVISION ID REGISTERS

**Note:** For additional details on the Device ID, Revision ID or Configuration bits, refer to Section 5.0 “Device Configuration” in the “PIC16(L)F1615/9 14/20-Pin, 8-Bit Flash Microcontroller” data sheet (DS40001770). Device/Revision ID information presented in this section is for the high-temperature PIC16F1615/9 devices only.

### REGISTER 2-1: DEVID: DEVICE ID REGISTER

|           |   |   |       |   |   |
|-----------|---|---|-------|---|---|
| R         | R | R | R     | R | R |
| DEV<13:8> |   |   |       |   |   |
| bit 13    |   |   | bit 8 |   |   |

|          |   |   |   |       |   |   |   |
|----------|---|---|---|-------|---|---|---|
| R        | R | R | R | R     | R | R | R |
| DEV<7:0> |   |   |   |       |   |   |   |
| bit 7    |   |   |   | bit 0 |   |   |   |

#### Legend:

R = Readable bit      W = Writable bit      U = Unimplemented bit, read as '0'  
 -n = Value at POR      '1' = Bit is set      '0' = Bit is cleared      x = Bit is unknown

bit 13-0      **DEV<13:0>**: Device ID bits

| Device     | DEVID<13:0> Values        |
|------------|---------------------------|
| PIC16F1615 | 11 0000 0111 1100 (307Ch) |
| PIC16F1619 | 11 0000 0111 1101 (307Dh) |

**REGISTER 2-2: REVID: REVISION ID REGISTER 2**

|           |     |   |   |   |   |
|-----------|-----|---|---|---|---|
| R-1       | R-0 | R | R | R | R |
| REV<13:8> |     |   |   |   |   |
| bit 13    |     |   |   |   |   |
| bit 8     |     |   |   |   |   |

|          |   |   |   |   |   |   |   |
|----------|---|---|---|---|---|---|---|
| R        | R | R | R | R | R | R | R |
| REV<7:0> |   |   |   |   |   |   |   |
| bit 7    |   |   |   |   |   |   |   |
| bit 0    |   |   |   |   |   |   |   |

**Legend:**

R = Readable bit

W = Writable bit

U = Unimplemented bit, read as '0'

-n = Value at POR

'1' = Bit is set

'0' = Bit is cleared

x = Bit is unknown

bit 13-0

**DEV<13:0>:** Revision ID bits**Note:** The upper two bits of the Revision ID register will always read '10'.

## 3.0 ELECTRICAL CHARACTERISTICS

**Note:** Other than some basic data, this section documents only the high-temperature PIC16F1615/9 devices' specifications that differ from those of the non-specialty PIC16F1615/9 devices. For detailed information on the electrical specifications shared by the high-temperature and non-specialty devices, see the "PIC16(L)F1615/9 14/20-Pin, 8-Bit Flash Microcontroller" data sheet (DS40001770).

### 3.1 Absolute Maximum Ratings<sup>(†)</sup>

| Parameter                 | Condition  | Value           |
|---------------------------|------------|-----------------|
| Max. Current: VDD         | Source     | 15 mA           |
| Max. Current: VSS         | Sink       | 15 mA           |
| Max. Current: Pin         | Source     | 5 mA            |
| Max. Current: Pin         | Sink       | 5 mA            |
| Max. Storage Temperature  | —          | -65°C to +155°C |
| Max. Junction Temperature | Under Bias | +155°C          |
| Ambient Temperature       | Under Bias | -40°C to +150°C |

**Note 1:** Maximum current rating requires even load distribution across I/O pins. Maximum current rating may be limited by the device package power dissipation characterizations, see Table-35-6: "Thermal Characteristics" to calculate device specifications.

**2:** Power dissipation is calculated as follows:  $P_{DIS} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD} - V_{OH}) \times I_{OH}\} + \sum (V_{OL} \times I_{OL})$ .

† NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure above maximum rating conditions for extended periods may affect device reliability.

## 3.2 Standard Operating Conditions

The standard operating conditions for any device are defined as:

Operating Voltage:  $V_{DDMIN} \leq V_{DD} \leq V_{DDMAX}$

Operating Temperature:  $TA_{MIN} \leq TA \leq TA_{MAX}$

### V<sub>DD</sub> — Operating Supply Voltage

PIC16F1615/9

$V_{DDMIN}$  ( $F_{osc} \leq 16$  MHz)..... +2.5V

$V_{DDMIN}$  ( $F_{osc} > 32$  MHz)..... +2.5V

$V_{DDMAX}$  ..... +5.5V

### TA — Operating Ambient Temperature Range

High Temperature

$TA_{MIN}$  ..... -40°C

$TA_{MAX}$  ..... +150°C

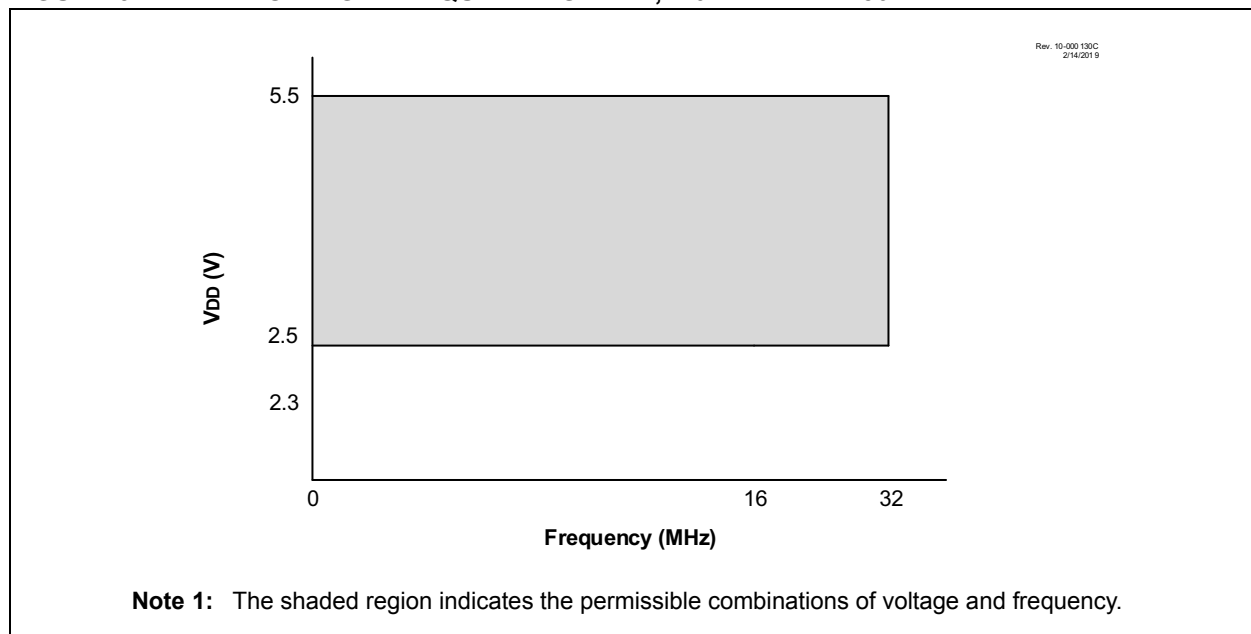
## 3.3 DC Characteristics

**TABLE 3-1: SUPPLY VOLTAGE ( $-40^{\circ}\text{C} \leq TA \leq +150^{\circ}\text{C}$ )**

| PIC16F1615/9          |                    |                                   | Standard Operating Conditions (unless otherwise stated) |      |      |       |                                                                                                                 |
|-----------------------|--------------------|-----------------------------------|---------------------------------------------------------|------|------|-------|-----------------------------------------------------------------------------------------------------------------|
| Param No.             | Symbol             | Characteristic                    | Min.                                                    | Typ. | Max. | Units | Conditions                                                                                                      |
| <b>Supply Voltage</b> |                    |                                   |                                                         |      |      |       |                                                                                                                 |
| D001                  | V <sub>DD</sub>    | Supply Voltage                    | 2.5                                                     | —    | 5.5  | V     | $F_{osc} \leq 16$ MHz<br>$F_{osc} \leq 32$ MHz                                                                  |
| D002                  | V <sub>DR</sub>    | RAM Data Retention Voltage        | 2.1                                                     | —    | —    | V     | Device in Sleep mode                                                                                            |
| D003A                 | V <sub>ADFVR</sub> | FVR Gain Voltage Accuracy for ADC | -10                                                     | —    | +10  | V     | 1x VFVR, $V_{DD} \geq 2.5\text{V}$<br>2x VFVR, $V_{DD} \geq 2.5\text{V}$<br>4x VFVR, $V_{DD} \geq 4.75\text{V}$ |

† Data in “Typ.” column is at 3.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

**FIGURE 3-1: VOLTAGE-FREQUENCY GRAPH,  $-40^{\circ}\text{C} \leq TA \leq +150^{\circ}\text{C}$**



**TABLE 3-2: DC CHARACTERISTICS: SUPPLY CURRENT<sup>(1,2)</sup>**

| PIC16F1615/9 |                        | Standard Operating Conditions (unless otherwise stated)<br>Operating Temperature: $-40^{\circ}\text{C} \leq \text{TA} \leq +150^{\circ}\text{C}$ for High Temperature |      |      |       |            |                                                             |
|--------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-------|------------|-------------------------------------------------------------|
| Param. No.   | Device Characteristics | Min.                                                                                                                                                                  | Typ† | Max. | Units | Conditions |                                                             |
|              |                        |                                                                                                                                                                       |      |      |       | VDD        | Note                                                        |
| D013         |                        | —                                                                                                                                                                     | —    | 135  | μA    | 2.5        | Fosc = 1 MHz,<br>External Clock (ECM),<br>Medium-Power mode |
|              |                        | —                                                                                                                                                                     | —    | 160  | μA    | 3.0        |                                                             |
|              |                        | —                                                                                                                                                                     | —    | 210  | μA    | 5.0        |                                                             |
| D014         |                        | —                                                                                                                                                                     | —    | 365  | μA    | 2.5        | Fosc = 4 MHz,<br>External Clock (ECM),<br>Medium-Power mode |
|              |                        | —                                                                                                                                                                     | —    | 420  | μA    | 3.0        |                                                             |
|              |                        | —                                                                                                                                                                     | —    | 530  | μA    | 5.0        |                                                             |
| D017*        |                        | —                                                                                                                                                                     | —    | 1100 | μA    | 2.5        | Fosc = 8 MHz,<br>HFINTOSC                                   |
|              |                        | —                                                                                                                                                                     | —    | 1300 | μA    | 3.0        |                                                             |
|              |                        | —                                                                                                                                                                     | —    | 1400 | μA    | 5.0        |                                                             |
| D018         |                        | —                                                                                                                                                                     | —    | 1600 | μA    | 2.5        | Fosc = 16 MHz,<br>HFINTOSC                                  |
|              |                        | —                                                                                                                                                                     | —    | 1900 | μA    | 3.0        |                                                             |
|              |                        | —                                                                                                                                                                     | —    | 2100 | μA    | 5.0        |                                                             |
| D020C        |                        | —                                                                                                                                                                     | —    | 65   | μA    | 2.5        | Fosc = 500 kHz,<br>External Clock (ECL),<br>Low-Power mode  |
|              |                        | —                                                                                                                                                                     | —    | 100  | μA    | 3.0        |                                                             |
|              |                        | —                                                                                                                                                                     | —    | 110  | μA    | 5.0        |                                                             |

\* These parameters are characterized but not tested.

† Data in “Typ” column is at 3.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

- Note 1:** The test conditions for all IDD measurements in active operation mode are: OSC1 = external square wave, from rail-to-rail; all I/O pins tri-stated, pulled to VSS; MCLR = VDD; WDT disabled.
- 2:** The supply current is mainly a function of the operating voltage and frequency. Other factors, such as I/O pin loading and switching rate, oscillator type, internal code execution pattern and temperature, also have an impact on the current consumption.

**TABLE 3-3: DC CHARACTERISTICS: POWER-DOWN CURRENTS (IPD)<sup>(1,2,3)</sup>**

| PIC16F1615/9 |        |                       | Standard Operating Conditions (unless otherwise stated)<br>VREPGM = 1 |       |                 |                                          |
|--------------|--------|-----------------------|-----------------------------------------------------------------------|-------|-----------------|------------------------------------------|
| Param No.    | Symbol | Device Characteristic | Max.<br>+150°C                                                        | Units | Conditions      |                                          |
|              |        |                       |                                                                       |       | V <sub>DD</sub> | Notes                                    |
| D023         |        |                       | 16                                                                    | μA    | 2.5             | WDT Current                              |
|              |        |                       | 20                                                                    | μA    | 3.0             |                                          |
|              |        |                       | 22                                                                    | μA    | 5.0             |                                          |
| D023A        |        |                       | 37                                                                    | μA    | 2.5             | FVR Current                              |
|              |        |                       | 38                                                                    | μA    | 3.0             |                                          |
|              |        |                       | 39                                                                    | μA    | 5.0             |                                          |
| D024A        |        |                       | —                                                                     | μA    | 2.5             | LPBOR Current                            |
|              |        |                       | 15                                                                    | μA    | 3.0             |                                          |
|              |        |                       | 17                                                                    | μA    | 5.0             |                                          |
| D026         |        |                       | 15                                                                    | μA    | 2.5             | ADC Current<br>No conversion in progress |
|              |        |                       | 17                                                                    | μA    | 3.0             |                                          |
|              |        |                       | 20                                                                    | μA    | 5.0             |                                          |
| D027         |        |                       | 37                                                                    | μA    | 2.5             | Comparator,<br>CxSP = 0                  |
|              |        |                       | 38                                                                    | μA    | 3.0             |                                          |
|              |        |                       | 45                                                                    | μA    | 5.0             |                                          |

† Data in "Typ." column is at 3.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

- Note 1:** The peripheral current is the sum of the base IPD and the additional current consumed when this peripheral is enabled. The peripheral Δ current can be determined by subtracting the base IDD or IPD current from this limit. Max. values should be used when calculating total current consumption.
- 2:** The power-down current in Sleep mode does not depend on the oscillator type. Power-down current is measured with the part in Sleep mode, with all I/O pins in high-impedance state and tied to V<sub>SS</sub>.
- 3:** All peripheral currents listed are on a per-peripheral basis if more than one instance of a peripheral is available.
- 4:** ADC clock source is ADCRC.

## 3.4 AC Characteristics

**TABLE 3-4: MEMORY PROGRAMMING REQUIREMENTS FOR PIC16F1615/9 (HIGH TEMP)**

| PIC16F16F1615/1619 |        |                       | Standard Operating Conditions (unless otherwise stated)<br>Operating Temperature: $-40^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$ for High Temperature |       |      |       |                                                                            |
|--------------------|--------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-------|----------------------------------------------------------------------------|
| Param No.          | Symbol | Device Characteristic | Min.                                                                                                                                                            | Typ.† | Max. | Units | Conditions                                                                 |
|                    |        | Program Flash Memory  |                                                                                                                                                                 |       |      |       |                                                                            |
| D121               | EP     | Cell Endurance        | —                                                                                                                                                               | —     | —    | —     | Programming the Flash memory above $+125^{\circ}\text{C}$ is not permitted |
| D124               | TRETD  | Data Retention        | —                                                                                                                                                               | 20    | —    | Years |                                                                            |

**Note:**

**TABLE 3-5: INTERNAL OSCILLATOR PARAMETERS FOR PIC16F1615/9 (HIGH TEMP)**

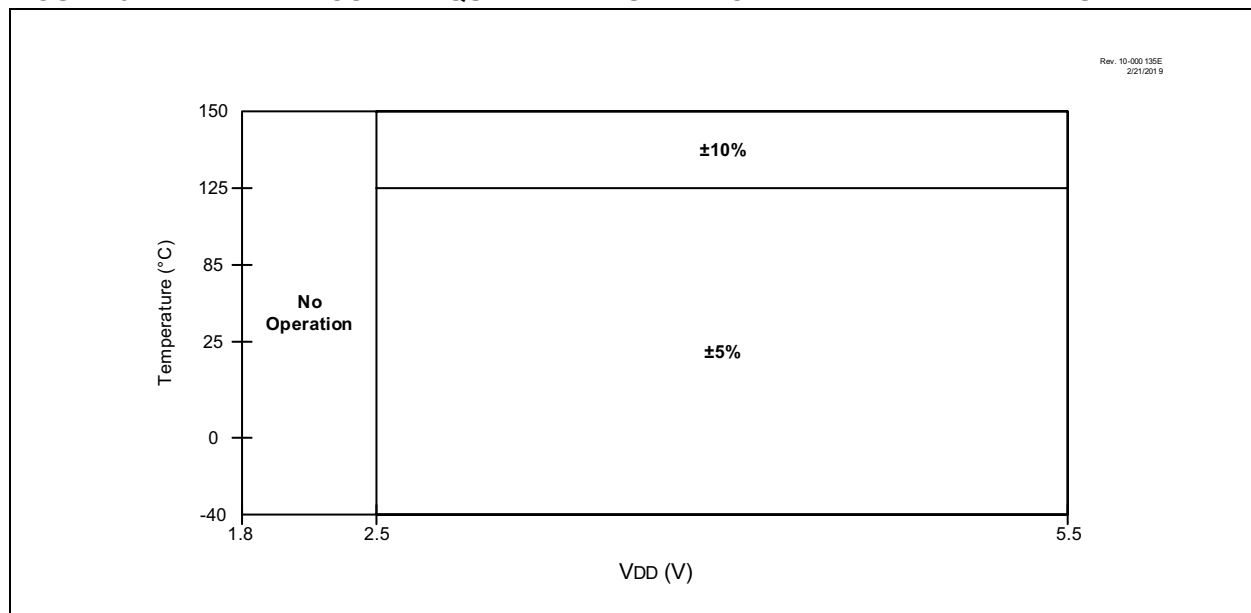
| PIC16F1615/1619 |        |                                        | Standard Operating Conditions (unless otherwise stated)<br>Operating Temperature: $-40^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$ for High Temperature |      |       |      |       |                                                                                      |
|-----------------|--------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|------|-------|--------------------------------------------------------------------------------------|
| Param No.       | Symbol | Device Characteristic                  | Frequency Tolerance                                                                                                                                             | Min. | Typ.† | Max. | Units | Conditions                                                                           |
| OS08            | HFosc  | Internal-Calibrated HFINTOSC Frequency | —                                                                                                                                                               | —    | 16    | —    | MHz   | $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$<br>$V_{DD} \geq 2.5\text{V}$ |
|                 |        |                                        | $\pm 10\%$                                                                                                                                                      | —    | 16    | —    | MHz   | $-40^{\circ}\text{C} \leq T_A \leq 150^{\circ}\text{C}$<br>$V_{DD} \geq 2.5\text{V}$ |
| OS09            | LFosc  | Internal LFINTOSC Frequency            | —                                                                                                                                                               | —    | 31    | —    | kHz   | $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$<br>$V_{DD} \geq 2.5\text{V}$ |
|                 |        |                                        | $\pm 35\%$                                                                                                                                                      | —    | 31    | —    | kHz   | $-40^{\circ}\text{C} \leq T_A \leq 150^{\circ}\text{C}$<br>$V_{DD} \geq 2.5\text{V}$ |

\* These parameters are characterized but not tested.

† Data in "Typ" column is at 3.0V,  $25^{\circ}\text{C}$  unless otherwise stated. These parameters are for design guidance only and are not tested.

**Note 1:** To ensure these oscillator frequency tolerances,  $V_{DD}$  and  $V_{SS}$  must be capacitively decoupled as close to the device as possible. 0.1  $\mu\text{F}$  and 0.01  $\mu\text{F}$  values in parallel are recommended.

**FIGURE 3-2: HFINTOSC FREQUENCY ACCURACY OVER  $V_{DD}$  AND TEMPERATURE**



**TABLE 3-6: RESET, WATCHDOG TIMER, OSCILLATOR START-UP TIMER, POWER-UP TIMER, BROWN-OUT TIMER AND LOW-POWER BROWN-OUT RESET SPECIFICATIONS**

| PIC16F1615/9 |        |                                          | Standard Operating Conditions (unless otherwise stated)<br>Operating Temperature: $-40^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$ for High Temperature |       |                |       |                                        |
|--------------|--------|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------|-------|----------------------------------------|
|              |        |                                          | Min.                                                                                                                                                            | Typ.† | Max.<br>+150°C | Units | Conditions                             |
| 31           | TWDTLP | Low-Power Watchdog Timer Time-out Period | 7                                                                                                                                                               |       | 33             | ms    | VDD = 3.3V-5V,<br>1:512 Prescaler used |
| 35           | VBOR   | Brown-out Reset Voltage                  | —                                                                                                                                                               | —     | 2.9            | V     | BORV = 0                               |
|              |        |                                          | —                                                                                                                                                               | —     | —              | —     | BORV = 1                               |

**TABLE 3-7: ANALOG-TO-DIGITAL CONVERTER (ADC) CHARACTERISTICS**

| Standard Operating Conditions (unless otherwise stated)<br>VDD = 3.0V, TA = 150°C |                  |                |      |       |      |       |             |
|-----------------------------------------------------------------------------------|------------------|----------------|------|-------|------|-------|-------------|
| Param. No.                                                                        | Sym.             | Characteristic | Min. | Typ.† | Max. | Units | Conditions  |
| AD04                                                                              | E <sub>OFF</sub> | Offset Error   | —    | —     | ±3.5 | LSB   | VREF = 3.0V |

**TABLE 3-8: COMPARATOR SPECIFICATIONS**

| Standard Operating Conditions (unless otherwise stated)<br>VDD = 3.0V, TA = 150°C |                   |                      |      |       |      |       |                                    |
|-----------------------------------------------------------------------------------|-------------------|----------------------|------|-------|------|-------|------------------------------------|
| Param. No.                                                                        | Sym.              | Characteristic       | Min. | Typ.† | Max. | Units | Conditions                         |
| CM01                                                                              | V <sub>IOFF</sub> | Input Offset Voltage | —    | —     | ±70  | mV    | CxSP = 1, V <sub>ICM</sub> = VDD/2 |

## APPENDIX A: REVISION HISTORY

### Revision A (2/2019)

Initial release of document.

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| <b>PART NO.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>[X]<sup>(1)</sup></b>    | <b>-</b> | <b>X</b>                 | <b>/XX</b>     | <b>XXX</b>     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------|--------------------------|----------------|----------------|
| <b>Device</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Tape and Reel Option</b> |          | <b>Temperature Range</b> | <b>Package</b> | <b>Pattern</b> |
| <div> <div> <b>Device:</b><br/> PIC16F1615,<br/> PIC16F1619 </div> <div> <b>Tape and Reel Option:</b><br/> Blank = Standard packaging (tube or tray)<br/> T = Tape and Reel<sup>(1)</sup> </div> <div> <b>Temperature Range:</b><br/> I = -40°C to +85°C (Industrial)<br/> E = -40°C to +125°C (Extended) </div> <div> <b>Package:<sup>(2)</sup></b><br/> ML = QFN (16-Lead and 20-Lead)<br/> P = Plastic DIP<br/> SL = SOIC (14-Lead)<br/> ST = TSSOP<br/> GZ = UQFN (20-Lead) </div> <div> <b>Pattern:</b><br/> QTP, SQTP, Code or Special Requirements<br/> (blank otherwise) </div> </div> |                             |          |                          |                |                |
| <b>Examples:</b><br>a) PIC16F1615T - I/SL<br>Tape and Reel,<br>Industrial temperature,<br>SOIC package<br>b) PIC16F1619 - I/P<br>Industrial temperature<br>PDIP package<br>c) PIC16F1619 - E/ML 298<br>Extended temperature,<br>QFN package<br>QTP pattern #298                                                                                                                                                                                                                                                                                                                                |                             |          |                          |                |                |
| <b>Note 1:</b> Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.<br><b>2:</b> For other small form-factor package availability and marking information, please visit <a href="http://www.microchip.com/packaging">www.microchip.com/packaging</a> or contact your local sales office.                                                                                       |                             |          |                          |                |                |

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