PIC16F18325/18345

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

Description

PIC16(L)F18325/18345 high-temperature microcontrollers feature Intelligent Analog, Core Independent Peripherals (CIPs) and Communication Peripherals, combined with an extended temperature range for a variety of general purpose applications. The Peripheral Pin Select (PPS) functionality enables pin mapping when using the digital peripherals Configurable Logic Cell (CLC), Complementary Waveform Generator (CWG), Capture/Compare/PWM (CCP), Pulse-Width Modulation (PWM), and communications to add flexibility to the application design.

Core Features

- C Compiler Optimized RISC Architecture
- Only 48 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)
- Power-up Timer (PWRT)
- Brown-out Reset (BOR)
- Low-Power BOR (LPBOR) Option
- Extended Watchdog Timer (WDT) with Dedicated On-Chip Oscillator for Reliable Operation
- Programmable Code Protection

Memory

- 14 Kbytes Program Flash Memory
- 1 KB Data SRAM Memory
- 256B of EEPROM
- Direct, Indirect and Relative Addressing modes

Operating Characteristics

- Operating Voltage Range:
  - 2.3V to 5.5V(PIC16F18325/18345)
- Temperature Range:
  - High-Temp: -40°C to 150°C

Power-Saving Functionality

- IDLE mode: ability to put the CPU core to Sleep from the system clock, while internal peripherals continue operating
- DOZE mode: ability to run the CPU core slower than the system clock used by the internal peripherals
- SLEEP mode: lowest power consumption
- Peripheral Module Disable (PMD): peripheral power disable hardware module to minimize power consumption of unused peripherals

Digital Peripherals

- Configurable Logic Cell (CLC):
  - Four CLCs
  - Integrated combinational and sequential logic
- Complementary Waveform Generator (CWG):
  - Two CWGs
  - Rising and falling edge dead-band control
  - Full-bridge, half-bridge, 1-channel drive
  - Multiple signal sources
- Capture/Compare/PWM (CCP) modules:
  - Four CCPs
  - 16-bit resolution for Capture/Compare modes
  - 10-bit resolution for PWM mode
- Pulse-Width Modulators (PWM)
  - Two 10-bit PWMs
- Numerically Controlled Oscillator (NCO):
  - Precision linear frequency generator (@50% duty cycle) with 0.0001% step size of source input clock
    - Input clock: 0 Hz < F_{NCO} < 32 MHz
    - Resolution: $F_{NCO}/2^{20}$

- Serial Communications:
  - EUSART
    - RS-232, RS-485, LIN compatible
    - Auto-Baud detect, auto-wake-up on start
  - Master Synchronous Serial Port (MSSP)
    - SPI
    - I^2C, SMBus, PMBus™ compatible
- Data Signal Modulator (DSM):
  - Modulates a carrier signal with digital data to create custom carrier synchronized output waveforms
- Up to 18 I/O Pins:
  - Individually programmable pull-ups
  - Slew rate control
  - Interrupt-on-change with edge-select
  - Input level selection control (ST or TTL)
  - Digital open-drain enable
- Peripheral Pin Select (PPS):
  - I/O pin remapping of digital peripherals
- Timer modules:
  - Timer0:
    - 8/16-bit timer/counter
    - Synchronous or asynchronous operation
    - Programmable prescaler/postscaler
    - Time base for capture/compare function
  - Timer1/3/5 with Gate Control:
    - 16-bit timer/counter
    - Programmable internal or external clock sources
    - Multiple gate sources
    - Multiple gate modes
    - Time base for capture/compare function
  - Timer2/4/6:
    - 8-bit timers
    - Programmable prescaler/postscaler
    - Time base for PWM function

Analog Peripherals

- 10-Bit Analog-to-Digital Converter (ADC):
  - 17 external channels
  - Conversion available during Sleep
- Comparator:
  - Two comparators
  - Fixed Voltage Reference at non-inverting input(s)
  - Comparator outputs externally accessible
- 5-Bit Digital-to-Analog Converter (DAC):
  - 5-bit resolution, rail-to-rail
  - Positive reference selection
  - Unbuffered I/O pin output
  - Internal connections to ADCs and comparators
- Voltage Reference:
  - Fixed Voltage Reference with 1.024V, 2.048V and 4.096V output levels

Flexible Oscillator Structure

- High-Precision Internal Oscillator:
  - Software-selectable frequency range up to 32 MHz
  - ±2% at nominal 4 MHz calibration point
- 4x PLL with External Sources
- Low-Power Internal 31 kHz Oscillator (LFINTOSC)
- External Low-Power 32 kHz Crystal Oscillator (SOSC)
- External Oscillator Block with:
  - Three Crystal/Resonator modes up to 20 MHz
  - Three External Clock modes up to 32 MHz
  - Fail-safe clock monitor
    - Detects clock source failure
  - Oscillator Start-up Timer (OST)
    - Ensures stability of crystal oscillator sources

Note: This document is supplemented by the "*PIC16(L)F18325/18345 Full-Featured, Low Pin Count Microcontrollers with XLP" Data Sheet* (DS40001795). See Section 1.0, Device Overview.

TABLE 1: PIC16(L)F183XX FAMILY TYPES

Device	Data Sheet Index	Program Flash Memory (Words)	Program Flash Memory (Kbytes)	Data Memory (bytes)	Data SRAM (bytes)	I/Os(2)	10-bit ADC (ch)	5-bit DAC	High-Speed/	CWG	Clock Ref	Timers	CCP	10-bit PWM	NCO	EUSART	I^2C/SPI	CLC	DSM	PPS	XLP	PMD	Idle and Doze	Debug(1)
PIC16(L)F18313	(1)	2048	3.5	256	256	6	5	1	1	1	1	2/1	2	2	1	1	1/1	2	1	Y	Y	Y	Y	I
PIC16(L)F18323	(1)	2048	3.5	256	256	12	11	1	2	1	1	2/1	2	2	1	1	1/1	2	1	Y	Y	Y	Y	I
PIC16(L)F18324	(2)	4096	7	256	512	12	11	1	2	2	1	4/3	4	2	1	1	1/1	4	1	Y	Y	Y	Y	I
PIC16(L)F18325	(3)	8192	14	256	1024	12	11	1	2	2	1	4/3	4	2	1	1	2/2	4	1	Y	Y	Y	Y	I
PIC16(L)F18326	(4)	16384	28	256	2048	12	15	1	2	2	1	4/3	4	2	1	1	2/2	4	1	Y	Y	Y	Y	I
PIC16(L)F18344	(2)	4096	7	256	512	18	17	1	2	2	1	4/3	4	2	1	1	1/1	4	1	Y	Y	Y	Y	I
PIC16(L)F18345	(3)	8192	14	256	1024	18	17	1	2	2	1	4/3	4	2	1	1	2/2	4	1	Y	Y	Y	Y	I
PIC16(L)F18346	(4)	16384	28	256	2048	18	21	1	2	2	1	4/3	4	2	1	1	2/2	4	1	Y	Y	Y	Y	I

Note 1: Debugging Methods: (I) – Integrated on Chip;

2: One pin is input-only.

Data Sheet Index: (Unshaded devices are described in this document.)

1. DS40001799 PIC16(L)F18313/18323 Data Sheet, Full-Featured, Low Pin Count Microcontrollers with XLP
2. DS40001800 PIC16(L)F18324/18344 Data Sheet, Full Featured, Low Pin Count Microcontrollers with XLP
3. DS40001795 PIC16(L)F18325/18345 Data Sheet, Full Featured, Low Pin Count Microcontrollers with XLP
4. DS40001839 PIC16(L)F18326/18346 Data Sheet, Full Featured, Low Pin Count Microcontrollers with XLP

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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:

- PIC16F18325
- PIC16F18345

> **Note:** This data sheet documents only the devices' features and specifications that are in addition to the features and specifications of the non-specialty PIC16(L)F18325/18345 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)F18325/18345 Full-Featured, Low Pin Count Microcontrollers with XLP" Data Sheet* (DS40001795).

The PIC16F18325/18345 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 PIC16F18325/18345 devices are:

- Above 125°C, the number of program Flash memory and EEPROM are significantly reduced (see **Section 3.0 "Electrical Characteristics"**)
- All AC timing specifications are increased by 30%

  This derating factor includes parameters, such as TPWRT
- Maximum HS frequency of operation is 20 MHz

> **Note:** 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.

2.0 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)F18325/18345 Full-Featured, Low Pin Count Microcontrollers with XLP" Data Sheet* (DS40001795)*"*. Device/Revision ID information presented in this section is for the high-temperature PIC16F18325/18345 devices only.

2.1 Device ID Registers

The Device and Revision ID registers are read-only registers. They identify the device type and revision for device programmers and can be read by firmware.

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
PIC16F18325	`11 0000 0011 1110` (303Eh)
PIC16F18345	`11 0000 0011 1111` (303Fh)

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 PIC16F18325/18345 devices' specifications that differ from those of the non-specialty PIC16F18325/18345 devices. For detailed information on the electrical specifications shared by the high-temperature and non-specialty devices, see the *"PIC16(L)F18325/18345 Full-Featured, Low Pin Count Microcontrollers with XLP" Data Sheet* (DS40001795).

3.1 Absolute Maximum Ratings[†]

Ambient temperature under bias .... -40°C to +150°C
Storage temperature .... -65°C to +155°C
Maximum junction temperature .... 155°C
Voltage on pins with respect to V_{SS}
- on V_{DD} pin
  - PIC16F18325/18345 .... -0.3V to +6.5V
- on $\overline{MCLR}$ pin .... -0.3V to + 9.0V
- on all other pins .... -0.3V to (V_{DD} + 0.3V)

Maximum current
- on V_{SS} pin[(1)]
  - $-40°C \leq T_A \leq +85°C$ .... 250 mA
  - $85°C < T_A \leq +125°C$ .... 85 mA
  - $125°C \leq T_A \leq +150°C$ .... 10 mA
- on V_{DD} pin[(1)]
  - $-40°C \leq T_A \leq +85°C$ .... 250 mA
  - $85°C < T_A \leq +125°C$ .... 85 mA
  - $125°C \leq T_A \leq +150°C$ .... 10 mA
- on any I/O pin .... ±5 mA

Clamp current, I_K ($V_{PIN} < V_{SS}$ or $V_{PIN} > V_{DD}$) .... ±20 mA
Total power dissipation[(2)] .... 800 mW

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 XX-Y to calculate device specifications.

2: Power dissipation is calculated as follows:

$$P_{DIS} = V_{DD} \times \{I_{DD} - \Sigma I_{OH}\} + \Sigma \{(V_{DD} - V_{OH}) \times I_{OH}\} + \Sigma (V_{OL} \times I_{OL})$$

† 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: VDDMIN ≤ VDD ≤ VDDMAX
Operating Temperature: TA_MIN ≤ TA ≤ TA_MAX

VDD — Operating Supply Voltage[1]

PIC16F18325/18345

VDDMIN (Fosc ≤ 16 MHz)........ +2.3V
VDDMIN (Fosc > 16 MHz)........ +2.7V
VDDMAX .... +5.5V

TA — Operating Ambient Temperature Range

High Temperature

TA_MIN .... -40°C
TA_MAX .... +150°C

Note 1: See Parameter Supply Voltage, DS Characteristics: Supply Voltage.

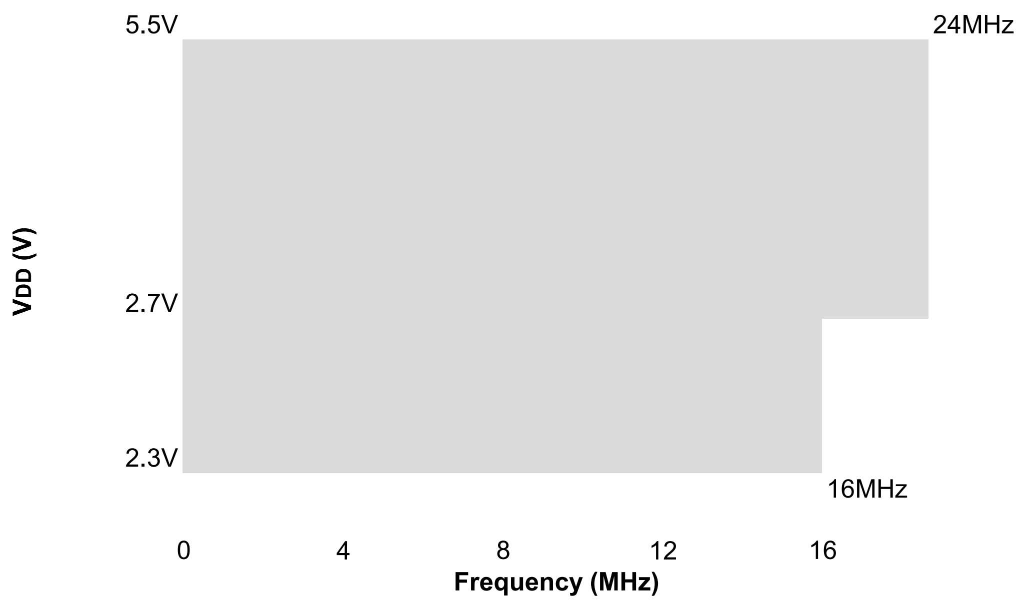
3.3 DC Characteristics

TABLE 3-1: SUPPLY VOLTAGE (HIGH TEMPERATURE)

PIC16F18325/18345			Standard Operating Conditions (unless otherwise stated)				
Param No.	Symbol	Characteristic	Min.	Typ.	Max.	Units	Conditions
Supply Voltage							
D002	VDD		2.3 **2.7**	— —	5.5 5.5	V	FOSC ≤ 16 MHz FOSC >16 MHz

† 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°C ≤ TA ≤ +150°C



Note 1: The shaded region indicates the permissible combinations of voltage and frequency.

TABLE 3-2: DC CHARACTERISTICS: SUPPLY CURRENT [1,2]

PIC16F18325/18345			Standard Operating Conditions (unless otherwise stated)			
			Max.	Units	Conditions	
Param No.	Symbol	Device Characteristic			VDD	Notes
D100	IDDXT4	XT = 4 MHz	**680**	uA	3.0V	
D101	IDDHFO16	HFO = 16 MHz	**2.0**	mA	3.0V	
D102	IDDHFOPLL	HFO = 24 MHz	**3.2**	mA	3.0V	
D103	IDDHSPLL32	HS+PLL = 24 MHz	**3.1**	mA	3.0V	
D104	IDDIDLE	Idle mode, HFO = 16 MHz	**1400**	uA	3.0V	

† 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 VDD; $\overline{MCLR}$=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)[1,2,3]

PIC16F18325/18345			Standard Operating Conditions (unless otherwise stated) VREPGM=1			
			Max. +150°C	Units	Conditions	
Param No.	Symbol	Device Characteristic			VDD	Notes
D200	IPD	IPD Base	**21.0**	uA	3.0V	
			35.0	uA	3.0V	
D201	IPD_WDT	Low Frequency Internal Oscillator/ WDT	**23.0**	uA	3.0V	VREGPM=0
D202	IPD_SOSC	Secondary Oscillator (SOSC)	**24.0**	uA	3.0V	
D203	IPD_FVR	FVR	**80.0**	uA	3.0V	
D204	IPD_BOR	Brown-out Reset (BOR)	**32.0**	uA	3.0V	
D207	IPD_ADCA	ADC – Non-converting	**21.0**	uA	3.0V	ADC not converting[4]
D208	IPD_CMP	Comparator	**60.0**	uA	3.0V	High-powering mode

† 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 ∆ current can be determined by substracting 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 VSS.

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: INTERNAL OSCILLATOR PARAMETERS(1)

PIC16F18325/18345			Standard Operating Conditions (unless otherwise stated)				
			Min. +150°C	Typ.†	Max. +150°C	Units	
OS20	FHFOSC	Precision-Calibrated HFINTOSC Frequency	**3.64** **7.28** **10.92** **14.56**	4 8 12 16	**4.36** **8.72** **13.08** **17.44**	MHz	See Figure 35-6
OS21	FHFOSCLP	Low-Power Optimized HFINTOSC Frequency	**0.83** **1.66**	1 2	**1.17** **2.34**	MHz	
OS24	THFOSCST	HFINTOSC Wake-up from Sleep Start-up Time	— —	11 50	— —	μs μs	VREGPM = 0 VREGPM = 1

* 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: To ensure these oscillator frequency tolerances, VDD and VSS must be capacitively decoupled as close to the device as possible. 0.1 μF and 0.01 μF values in parallel are recommended.

FIGURE 3-2: PRECISION-CALIBRATED HFINTOSC FREQUENCY ACCURACY OVER DEVICE VDD AND TEMPERATURE

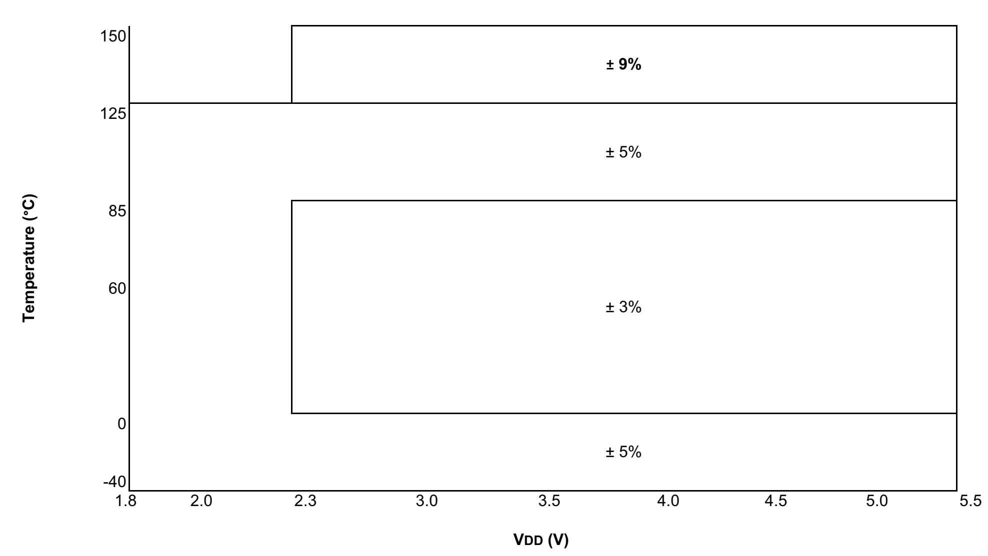


TABLE 3-5: RESET, WATCHDOG TIMER, OSCILLATOR START-UP TIMER, POWER-UP TIMER, BROWN-OUT TIMER AND LOW-POWER BROWN-OUT RESET SPECIFICATIONS

PIC16F18325/18345			Standard Operating Conditions (unless otherwise stated)				
			Min.	Typ.†	Max. +150°C	Units	
RST06	V_{BOR}	Brown-out Reset Voltage	**2.55** **2.30**	2.70 2.45	**2.85** **2.60**	V	BORV = 0 BORV = 1

TABLE 3-6: MEMORY SPECIFICATIONS (150°C)

Param. No.	Sym.	Characteristic	Min.	Typ.†	Max.	Units	Conditions
Data EEPROM Memory Specifications							
MEM20	E_D	DataEE Byte Endurance	1k	—	—	E/W	$125°C \le T_A \le 150°C$
Program Flash Memory Specifications							
MEM30	E_P	Flash Memory Cell Endurance	100	—	—	E/W	$125°C \le T_A \le 150°C$

APPENDIX A: REVISION HISTORY

Revision A (April 2018)

Original mini data sheet for the high-temperature devices in the PIC16F18325/18345 devices.

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PART NO.	[X][1]	X	/XX	XXX
Device	Tape and Reel Option	Temperature Range	Package	Pattern

Device:	PIC16F18325 PIC16F18345
Tape and Reel Option:	Blank = Standard packaging (tube or tray) T = Tape and Reel[1]
Temperature Range:	I = -40°C to +85°C (Industrial) E = -40°C to +125°C (Extended) H = -40°C to +150°C (High-Temperature)
Package:	ST = TSSOP ML = UQFN SO/SL = SOIC P = PDIP
Pattern:	QTP, SQTP, Code or Special Requirements (blank otherwise)

Examples:

a) PIC16F18325-E/P: Part number: PIC16F18325, Tape and Reel Option: Blank, Temperature Range: E, Package: P, Pattern: Blank

b) PIC16F18325T-I/ST: Part number: PIC16F18325, Tape and Reel Option: T, Temperature Range: I, Package: ST, Pattern: Blank

Note 1: 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.

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- 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.
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- Microchip is willing to work with the customer who is concerned about the integrity of their code.
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