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### 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             | AVR                                                                                                                                                           |
| Core Size                  | 8-Bit                                                                                                                                                         |
| Speed                      | 20MHz                                                                                                                                                         |
| Connectivity               | I <sup>2</sup> C, IrDA, LINbus, SPI, UART/USART                                                                                                               |
| Peripherals                | Brown-out Detect/Reset, POR, WDT                                                                                                                              |
| Number of I/O              | 18                                                                                                                                                            |
| Program Memory Size        | 8KB (8K x 8)                                                                                                                                                  |
| Program Memory Type        | FLASH                                                                                                                                                         |
| EEPROM Size                | 128 x 8                                                                                                                                                       |
| RAM Size                   | 512 x 8                                                                                                                                                       |
| Voltage - Supply (Vcc/Vdd) | 1.8V ~ 5.5V                                                                                                                                                   |
| Data Converters            | A/D 12x10b; D/A 1x8b                                                                                                                                          |
| Oscillator Type            | Internal                                                                                                                                                      |
| Operating Temperature      | -40°C ~ 105°C (TA)                                                                                                                                            |
| Mounting Type              | Surface Mount                                                                                                                                                 |
| Package / Case             | 20-SOIC (0.295", 7.50mm Width)                                                                                                                                |
| Supplier Device Package    | 20-SOIC                                                                                                                                                       |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/microchip-technology/attiny816-snr">https://www.e-xfl.com/product-detail/microchip-technology/attiny816-snr</a> |

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**AVR® Microcontroller with Core Independent Peripherals  
and picoPower® Technology**

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**Introduction**

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The ATtiny416/816 microcontrollers are using the high-performance low-power AVR® RISC architecture, and is capable of running at up to 20MHz, with up to 4/8KB Flash, 256/512bytes of SRAM and 128bytes of EEPROM in a 20-pin package. The series uses the latest technologies with a flexible and low power architecture including Event System and SleepWalking, accurate analog features and advanced peripherals. Capacitive touch interfaces with driven shield are supported with the integrated QTouch® peripheral touch controller.

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**Features**

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- CPU
  - AVR® 8-bit CPU
  - Running at up to 20MHz
  - Single Cycle I/O Access
  - Two-level Interrupt Controller
  - Two-cycle Hardware Multiplier
- Memories
  - 4/8KB In-system self-programmable Flash Memory
  - 128B EEPROM
  - 256/512B SRAM
- System
  - Power-on Reset (POR)
  - Brown-out Detection (BOD)
  - Clock Options:
    - 16/20MHz Low Power Internal RC Oscillator
    - 32.768kHz Ultra Low Power (ULP) Internal RC Oscillator
    - 32.768kHz External Crystal Oscillator
    - External Clock Input
  - Single Pin Unified Program Debug Interface (UPDI)
  - Three Sleep Modes:
    - Idle with All Peripherals Running and Mode for Immediate Wake Up Time
    - Standby
      - Configurable Operation of Selected Peripherals
      - SleepWalking Peripherals
    - Power Down with Wake-up Functionality

- Peripherals
  - 6-channel Event System
  - One 16-bit Timer/Counter Type A with Dedicated Period Register, Three Compare Channels (TCA)
  - One 16-bit Timer/Counter type B with Input Capture (TCB)
  - One 12-bit Timer/Counter type D Optimized for Control Applications (TCD)
  - One 16-bit Real Time Counter (RTC) Running from External Crystal or Internal RC Oscillator
  - One USART with Fractional Baud Rate Generator, Auto-baud, and Start-of-frame Detection
  - Master/Slave Serial Peripheral Interface (SPI)
  - Master/Slave TWI with Dual Address Match
    - Standard Mode (Sm, 100kHz)
    - Fast Mode (Fm, 400kHz)
    - Fast Mode Plus (Fm+, 1MHz)
  - Configurable Custom Logic (CCL) with Two Programmable Lookup Tables (LUT)
  - Analog Comparator (AC) with Low Propagation Delay
  - 10-bit 115ksps Analog to Digital Converter (ADC)
  - 8-bit Digital to Analog Converter (DAC)
  - Five Selectable Internal Voltage References: 0.55V, 1.1V, 1.5V, 2.5V and 4.3V
  - Automated CRC Memory Scan
  - Watchdog Timer (WDT) with Window Mode, with Separate On-chip Oscillator
  - Peripheral Touch Controller (PTC)<sup>(1)</sup>
    - Capacitive Touch Buttons, Sliders and Wheels
    - Wake-up on Touch
    - Driven Shield for Improved Moisture and Noise Handling Performance
    - Six Self-capacitance and Nine Mutual-capacitance Channels
  - External Interrupt on All General Purpose Pins
- I/O and Packages:
  - 18 Programmable I/O Lines
  - 20-pin VQFN 3x3 and SOIC300
- Temperature Ranges:
  - -40°C to 105°C
  - -40°C to 125°C Temperature Graded Device Options Available
- Speed Grades:
  - 0-5MHz @ 1.8V – 5.5V
  - 0-10MHz @ 2.7V – 5.5V
  - 0-20MHz @ 4.5V – 5.5V

**Note:**

1. Only Available in Devices with 8KB Flash.

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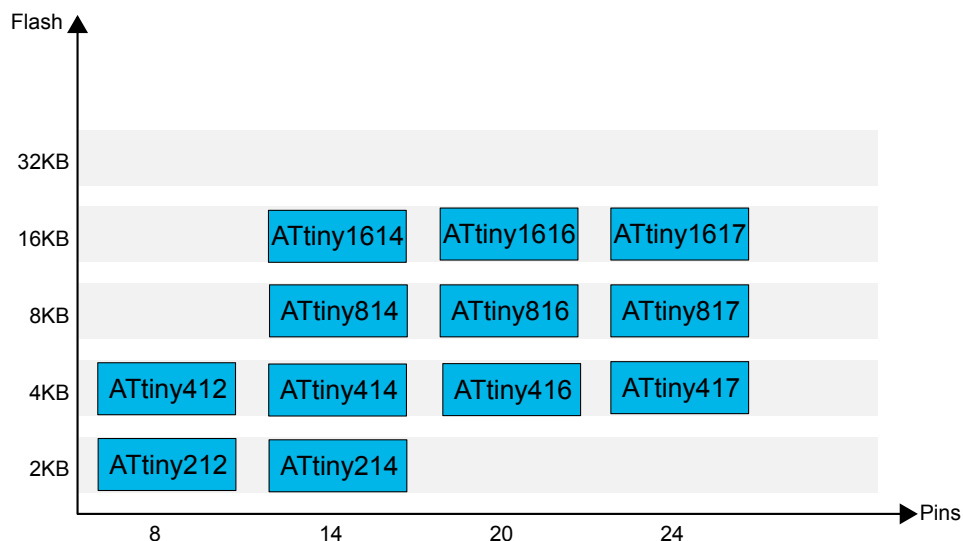
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## 1. tinyAVR® 1-Series Overview

The figure below shows the tinyAVR 1-series, laying out pin count variants and memory sizes:

- Vertical migration can be done upwards without code modification, since these devices are pin compatible and provide the same or even more features. Downward migration may require code modification due to fewer available instances of some peripherals.
- Horizontal migration to the left reduces the pin count and therefore also the available features.

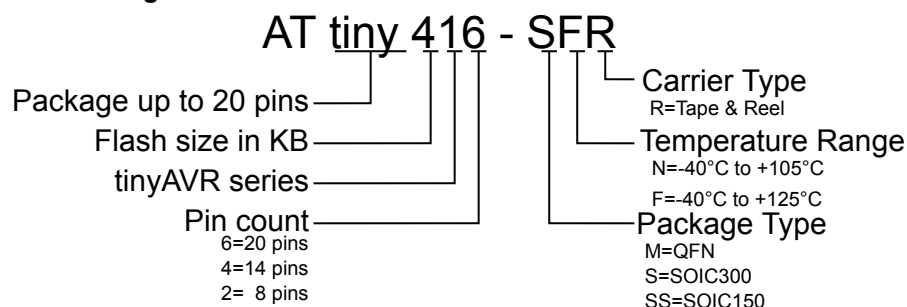
**Figure 1-1. tinyAVR®1-Series Overview**



Devices with different Flash memory size typically also have different SRAM and EEPROM.

The name of a device of the series contains information as depicted below:

**Figure 1-2. Device Designations**



## 1.1 Configuration Summary

### 1.1.1 Peripheral Summary

Table 1-1. Peripheral Summary

|                                                          | ATTiny416 | ATTiny816 |
|----------------------------------------------------------|-----------|-----------|
| Pins                                                     | 20        | 20        |
| SRAM                                                     | 256B      | 512B      |
| Flash                                                    | 4KB       | 8KB       |
| EEPROM                                                   | 128B      | 128B      |
| Max. frequency (MHz)                                     | 20        | 20        |
| 16-bit Timer/Counter type A (TCA)                        | 1         | 1         |
| 16-bit Timer/Counter type B (TCB)                        | 1         | 1         |
| 12-bit Timer/Counter type D (TCD)                        | 1         | 1         |
| Real Time Counter (RTC)                                  | 1         | 1         |
| USART                                                    | 1         | 1         |
| SPI                                                      | 1         | 1         |
| TWI (I <sup>2</sup> C)                                   | 1         | 1         |
| ADC                                                      | 1         | 1         |
| ADC channels                                             | 12        | 12        |
| DAC                                                      | 1         | 1         |
| AC                                                       | 1         | 1         |
| Peripheral Touch Controller (PTC) <sup>(1)</sup>         | No        | 1         |
| PTC number of self-capacitance channels <sup>(1)</sup>   | -         | 6         |
| PTC number of mutual-capacitance channels <sup>(1)</sup> | -         | 9         |
| Custom Logic/Configurable Lookup Tables                  | 1         | 1         |
| Window Watchdog                                          | 1         | 1         |
| Event System channels                                    | 6         | 6         |
| General purpose I/O                                      | 18        | 18        |
| External interrupts                                      | 18        | 18        |
| CRCSCAN                                                  | 1         | 1         |

**Note:**

1. The PTC takes control over the ADC while the PTC is used.

## 2. Ordering Information

### 2.1 ATtiny416

**Table 2-1. ATtiny416 Ordering Codes**

| Ordering Code <sup>(1)</sup> | Flash | Package Type (GPC) | Leads | Power Supply | Operational Range         | Carrier Type |
|------------------------------|-------|--------------------|-------|--------------|---------------------------|--------------|
| ATtiny416-MNR                | 4KB   | VQFN 3x3 (ZCL)     | 20    | 1.8V - 5.5V  | Industrial (-40°C +105°C) | Tape & Reel  |
| ATtiny416-MFR                | 4KB   | VQFN 3x3 (ZCL)     | 20    | 1.8V - 5.5V  | Industrial (-40°C +125°C) | Tape & Reel  |
| ATtiny416-SNR                | 4KB   | SOIC300 (SRJ)      | 20    | 1.8V - 5.5V  | Industrial (-40°C +105°C) | Tape & Reel  |
| ATtiny416-SFR                | 4KB   | SOIC300 (SRJ)      | 20    | 1.8V - 5.5V  | Industrial (-40°C +125°C) | Tape & Reel  |

1. Pb-free packaging complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

### 2.2 ATtiny816

**Table 2-2. ATtiny816 Ordering Codes**

| Ordering Code <sup>(1)</sup> | Flash | Package Type (GPC) | Leads | Power Supply | Operational Range         | Carrier Type |
|------------------------------|-------|--------------------|-------|--------------|---------------------------|--------------|
| ATtiny816-MNR                | 8KB   | VQFN 3x3 (ZCL)     | 20    | 1.8V - 5.5V  | Industrial (-40°C +105°C) | Tape & Reel  |
| ATtiny816-MFR                | 8KB   | VQFN 3x3 (ZCL)     | 20    | 1.8V - 5.5V  | Industrial (-40°C +125°C) | Tape & Reel  |
| ATtiny816-SNR                | 8KB   | SOIC300 (SRJ)      | 20    | 1.8V - 5.5V  | Industrial (-40°C +105°C) | Tape & Reel  |
| ATtiny816-SFR                | 8KB   | SOIC300 (SRJ)      | 20    | 1.8V - 5.5V  | Industrial (-40°C +125°C) | Tape & Reel  |

**Note:**

1. Pb-free packaging complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

### 3. Block Diagram

### Figure 3-1. ATtiny416 Block Diagram

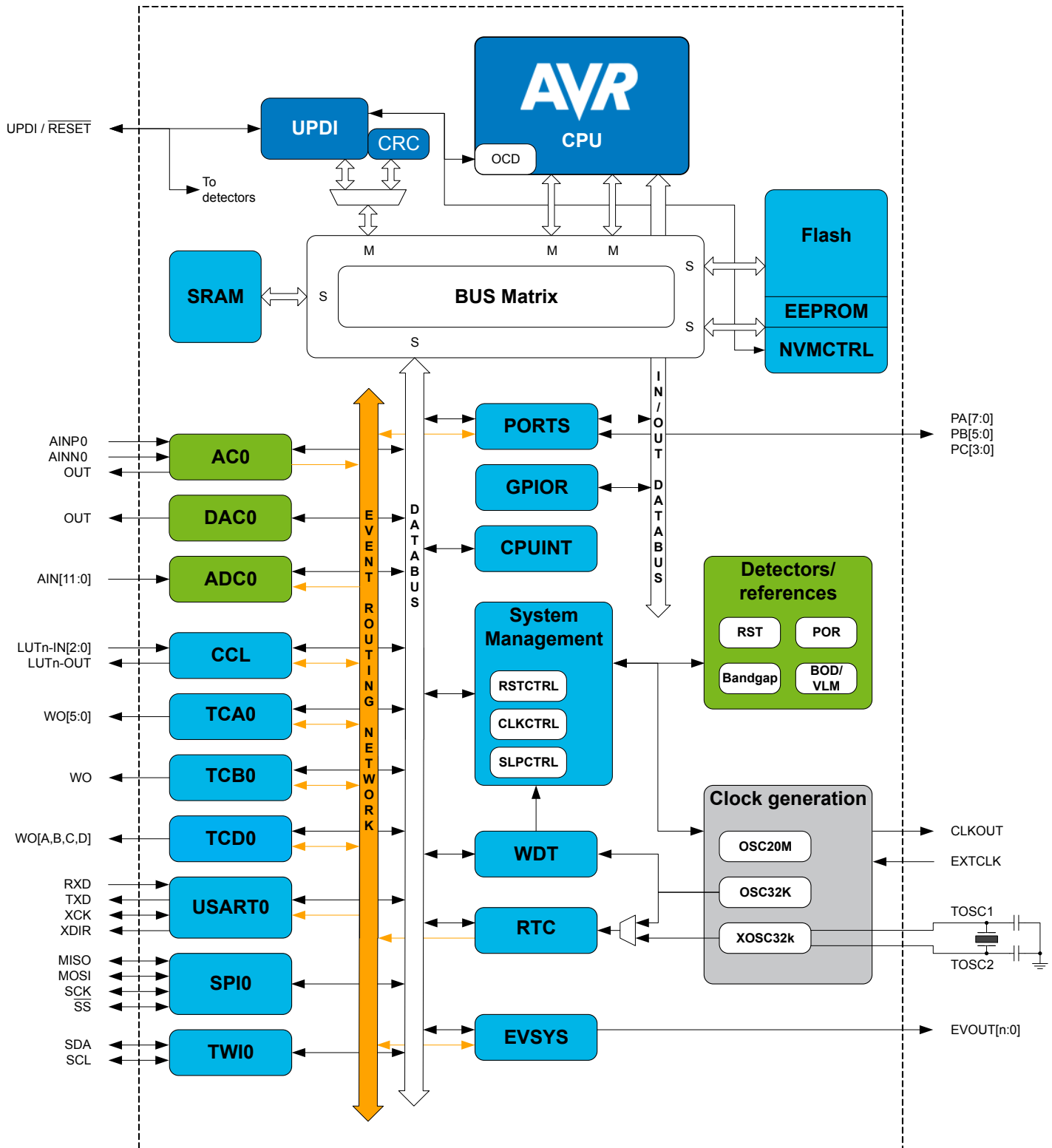
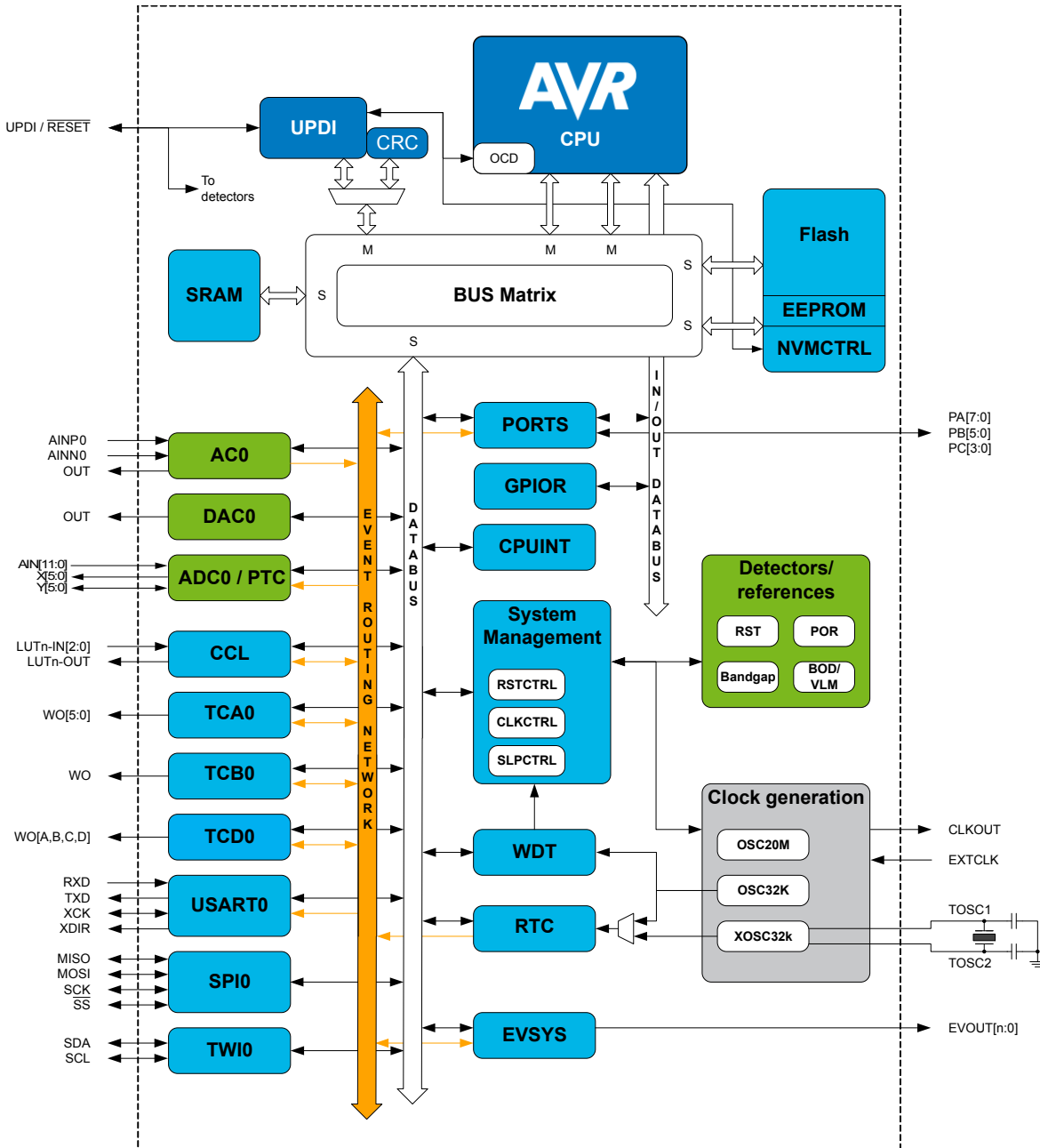
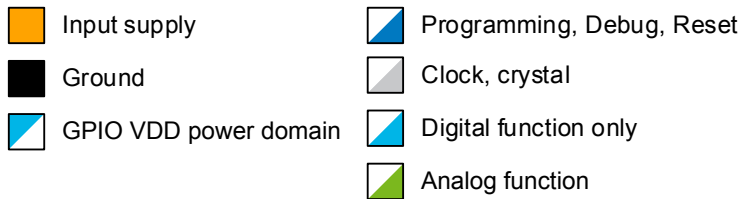
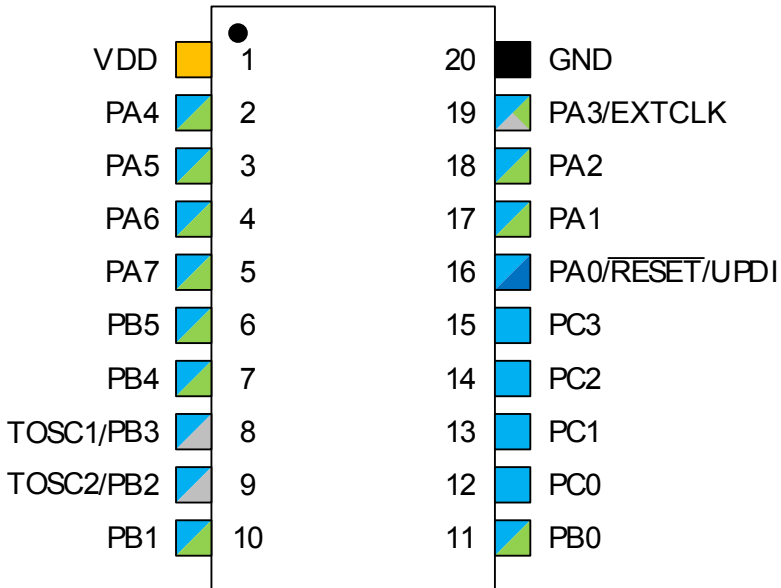


Figure 3-2. ATtiny816 Block Diagram

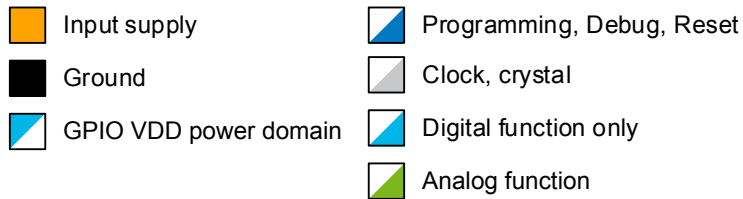
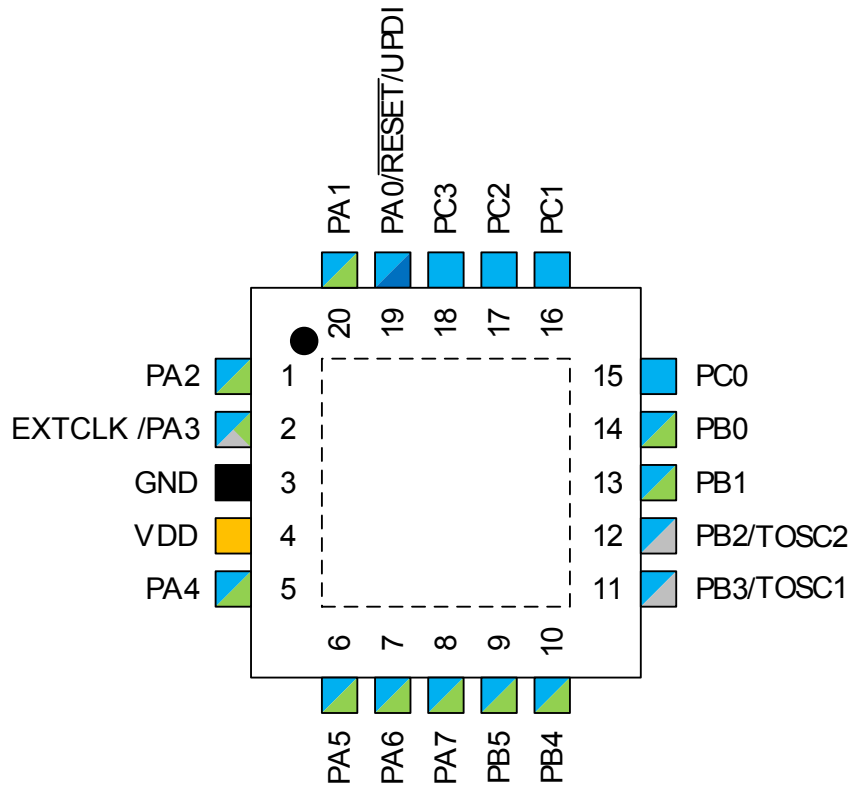


## 4. Pinout

### 4.1 20-pin SOIC



## 4.2 20-pin VQFN



## 5. I/O Multiplexing and Considerations

### 5.1 Multiplexed Signals

**Table 5-1. PORT Function Multiplexing**

| VQFN 20-pin | SOIC 20-pin | Pin Name <sup>(1,2)</sup> | Other/Special | ADC0  | PTC <sup>(3)</sup> | AC0   | DAC0 | USART0 | SPI0 | TWI0 | TCA0 | TCB0 | TCD0 | CCL      |
|-------------|-------------|---------------------------|---------------|-------|--------------------|-------|------|--------|------|------|------|------|------|----------|
| 19          | 16          | PA0                       | RESET<br>UPDI | AIN0  |                    |       |      |        |      |      |      |      |      | LUT0-IN0 |
| 20          | 17          | PA1                       | BREAK         | AIN1  |                    |       |      | TXD    | MOSI | SDA  |      |      |      | LUT0-IN1 |
| 1           | 18          | PA2                       | EVOUT0        | AIN2  |                    |       |      | RxD    | MISO | SCL  |      |      |      | LUT0-IN2 |
| 2           | 19          | PA3                       | EXTCLK        | AIN3  |                    |       |      | XCK    | SCK  |      | WO3  |      |      |          |
| 3           | 20          | GND                       |               |       |                    |       |      |        |      |      |      |      |      |          |
| 4           | 1           | VDD                       |               |       |                    |       |      |        |      |      |      |      |      |          |
| 5           | 2           | PA4                       |               | AIN4  | X0/Y0              |       |      | XDIR   | SS   |      | WO4  |      | WOA  | LUT0-OUT |
| 6           | 3           | PA5                       |               | AIN5  | X1/Y1              | OUT   |      |        |      |      | WO5  | WO   | WOB  |          |
| 7           | 4           | PA6                       |               | AIN6  | X2/Y2              | AINN0 | OUT  |        |      |      |      |      |      |          |
| 8           | 5           | PA7                       |               | AIN7  | X3/Y3              | AINP0 |      |        |      |      |      |      |      | LUT1-OUT |
| 9           | 6           | PB5                       | CLKOUT        | AIN8  |                    | AINP1 |      |        |      |      | WO2  |      |      |          |
| 10          | 7           | PB4                       |               | AIN9  |                    | AINN1 |      |        |      |      | WO1  |      |      | LUT0-OUT |
| 11          | 8           | PB3                       | TOSC1         |       |                    |       |      | RxD    |      |      | WO0  |      |      |          |
| 12          | 9           | PB2                       | TOSC2, EVOUT1 |       |                    |       |      | TxD    |      |      | WO2  |      |      |          |
| 13          | 10          | PB1                       |               | AIN10 | X4/Y4              |       |      | XCK    |      | SDA  | WO1  |      |      |          |
| 14          | 11          | PB0                       |               | AIN11 | X5/Y5              |       |      | XDIR   |      | SCL  | WO0  |      |      |          |
| 15          | 12          | PC0                       |               |       |                    |       |      |        | SCK  |      |      | WO   | WOC  |          |
| 16          | 13          | PC1                       |               |       |                    |       |      |        | MISO |      |      |      | WOD  | LUT1-OUT |
| 17          | 14          | PC2                       | EVOUT2        |       |                    |       |      |        | MOSI |      |      |      |      |          |
| 18          | 15          | PC3                       |               |       |                    |       |      |        | SS   |      | WO3  |      |      | LUT1-IN0 |

**Note:**

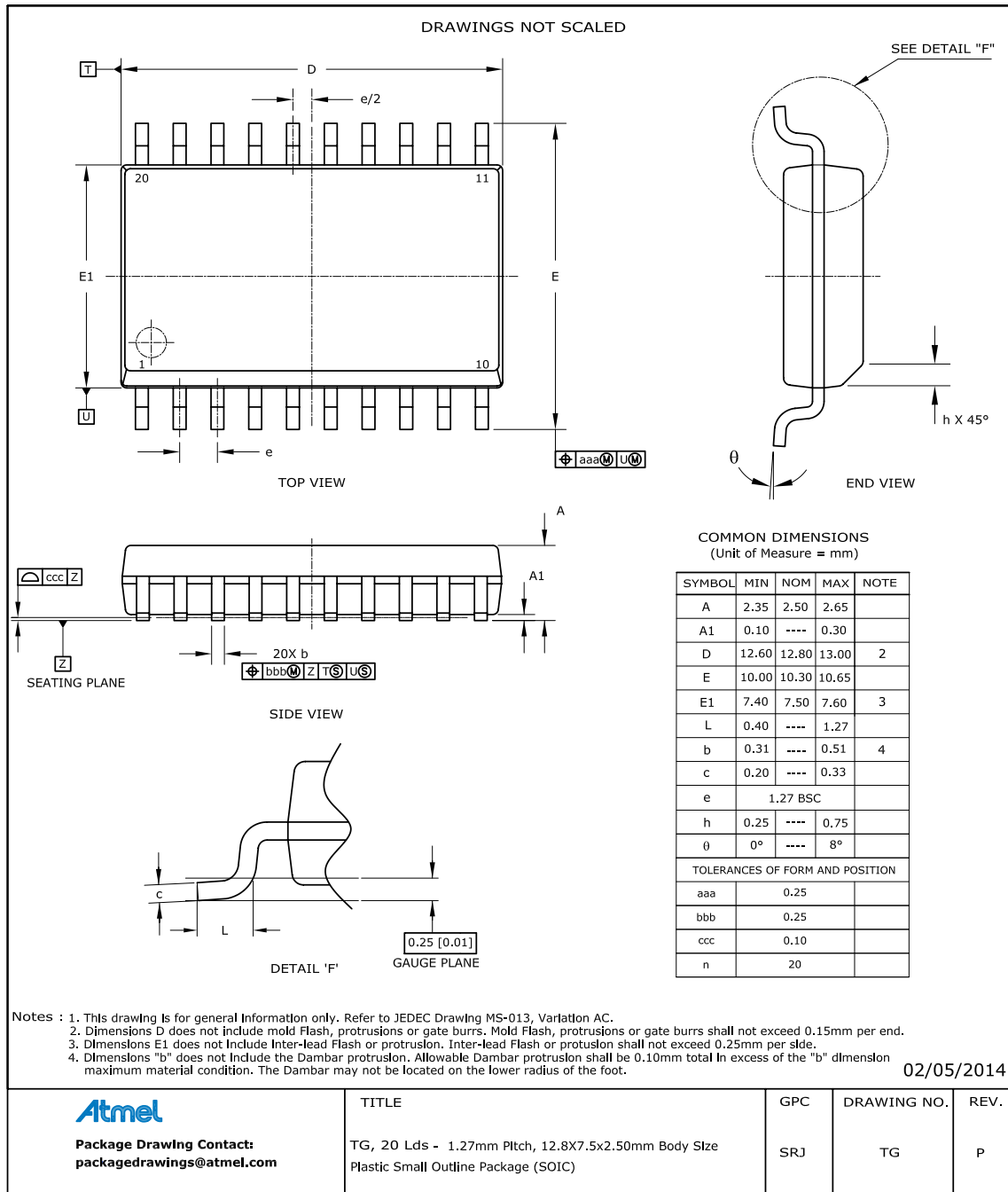
1. Pins names are of type P<sub>xn</sub>, with *x* being the PORT instance (A,B) and *n* the pin number. Notation for signals is PORT<sub>x</sub>\_PIN<sub>n</sub>. All pins can be used as event input.
2. All pins can be used for external interrupt, where pins P<sub>x2</sub> and P<sub>x6</sub> of each port have full asynchronous detection.
3. PTC is only available in devices with 8KB Flash (ATtiny816). Every PTC line can be configured as X-line or Y-line.



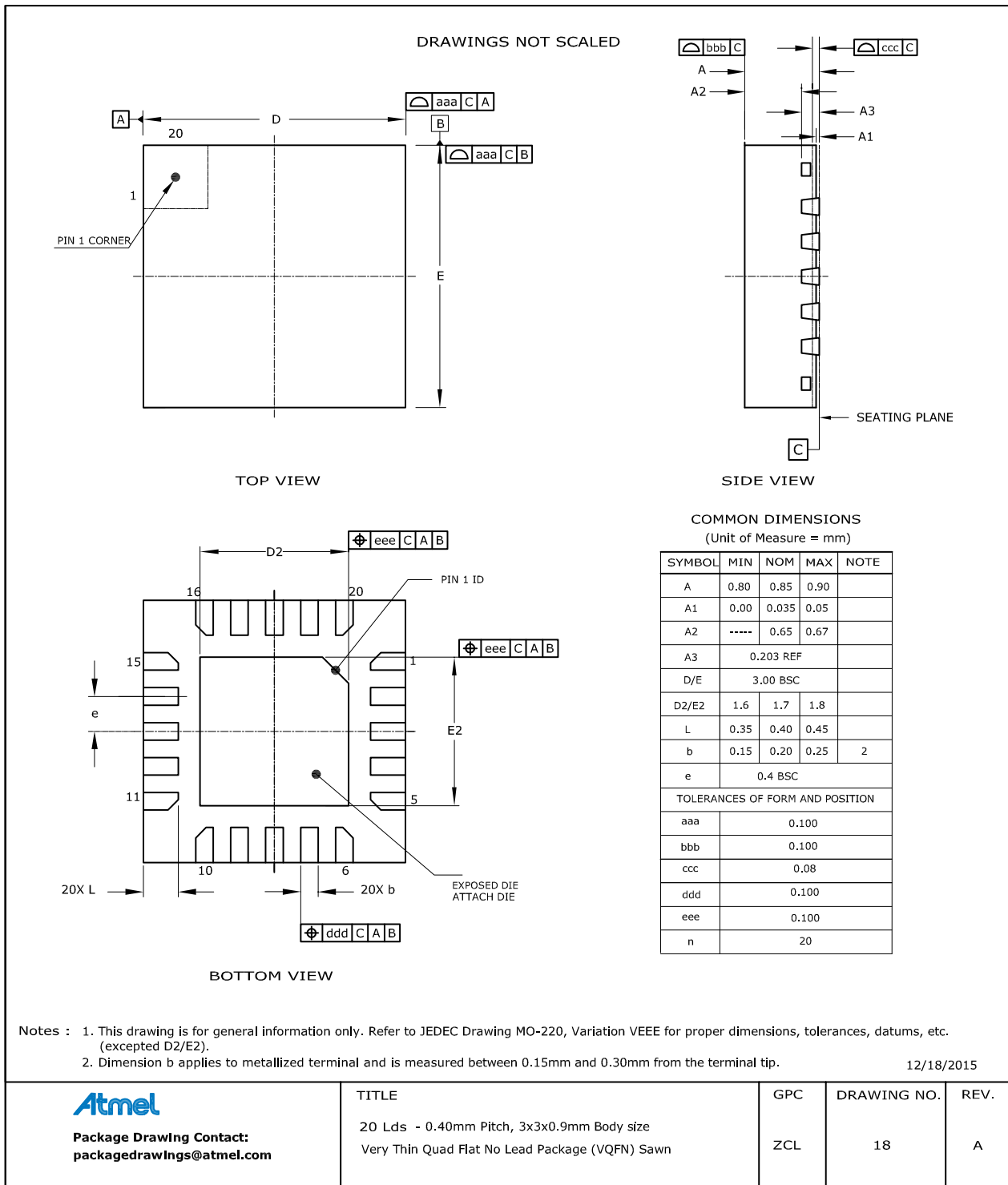
**Tip:** Signals on alternative pin locations are in `typewriter` font.

## 6. Package Drawings

### 6.1 20-pin SOIC



## 6.2 20-pin VQFN



## 7. Thermal Considerations

### 7.1 Thermal Resistance Data

The following table summarizes the thermal resistance data depending on the package.

**Table 7-1. Thermal Resistance Data**

| Package Type         | $\theta_{JA}$ [°C/W] | $\theta_{JC}$ [°C/W] |
|----------------------|----------------------|----------------------|
| 20-pin SOIC300 (SRJ) | 44                   | 21                   |
| 20-pin VQFN (ZCL)    | 79.7                 | 36                   |

#### Related Links

[Junction Temperature](#)

### 7.2 Junction Temperature

The average chip-junction temperature,  $T_J$ , in °C can be obtained from the following:

1.  $T_J = T_A + (P_D \times \theta_{JA})$
2.  $T_J = T_A + (P_D \times (\theta_{HEATSINK} + \theta_{JC}))$

where:

- $\theta_{JA}$  = Package thermal resistance, Junction-to-ambient (°C/W), see Thermal Resistance Data
- $\theta_{JC}$  = Package thermal resistance, Junction-to-case thermal resistance (°C/W), see Thermal Resistance Data
- $\theta_{HEATSINK}$  = Thermal resistance (°C/W) specification of the external cooling device
- $P_D$  = Device power consumption (W)
- $T_A$  = Ambient temperature (°C)

From the first equation, the user can derive the estimated lifetime of the chip and decide if a cooling device is necessary or not. If a cooling device is to be fitted on the chip, the second equation should be used to compute the resulting average chip-junction temperature  $T_J$  in °C.

#### Related Links

[Thermal Resistance Data](#)

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