Temperature Sensors

- Integrated Circuit Sensors
- Thermistors
- Thermocouples
PRECISION TEMPERATURE-TO-VOLTAGE CONVERTERS

FEATURES
- Linearized Temperature-to-Voltage Converters
- Direct Centigrade Output Voltage Scaling (TC03)
- Wide Temperature Measurement Range (TC02) – 20°C to +125°C
- Excellent Temperature Converter Linearity – 0.8°C Over Temperature
- High Temperature Converter Accuracy – ±2°C at 25°C Guaranteed
- Small Packages – TO-92-3 and SOT-23B-3

APPLICATIONS
- Power Supply Thermal Shut-Down
- Temperature-Controlled Fans
- Temperature Measurement/Instrumentation
- Temperature Regulators
- Consumer Electronics

GENERAL DESCRIPTION
The TC02/03 temperature sensors furnish a linearized output voltage directly proportional to measured temperature. The TC03 has a temperature measurement range of –20°C to +100°C. Its output voltage is directly calibrated in degrees Centigrade (i.e. \( V_{OUT} = 10 \text{mV/}°\text{C} \times \text{Temperature} \)). An external pull-down resistor to a negative voltage source is required for temperature measurement below 0°C.

The TC02 has a temperature measurement range of –20°C to +125°C, and operates with a single supply. It has the same output voltage slope with temperature as the TC03 (10mV/°C). The output voltage range is 300mV at –20°C to 1,750mV at +125°C.

Small size, low cost and low power operation make the TC02/03 suitable for a wide range of general purpose temperature measurement applications.

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Package</th>
<th>Output Voltage At 25°C</th>
<th>Temp. Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC02VNB</td>
<td>SOT-23B-3</td>
<td>750mV</td>
<td>– 20°C to +125°C</td>
</tr>
<tr>
<td>*TC02VZB</td>
<td>TO-92-3</td>
<td>750mV</td>
<td>– 20°C to +125°C</td>
</tr>
<tr>
<td>TC03VNB</td>
<td>SOT-23B-3</td>
<td>250mV</td>
<td>– 20°C to +100°C</td>
</tr>
<tr>
<td>TC03VZB</td>
<td>TO-92-3</td>
<td>250mV</td>
<td>– 20°C to +100°C</td>
</tr>
</tbody>
</table>

* Contact factory for availability.

NOTE: *SOT-23B-3 is equivalent to JEDEC (TO-236)
**TC02**

**TC03**

**ABSOLUTE MAXIMUM RATINGS** *

Supply Voltage .................................................. 15V
Input Voltage, Any Terminal .............. – 1.0 to (V CC +0.3V)
Operating Temperature (TC02) ............. – 20°C to +125°C
Operating Temperature (TC03) ............. – 20°C to +100°C
Storage Temperature ............................ – 55°C to +150°C
Lead Temperature (Soldering, 10 sec)  
SOT-23B-3 ..................................................... +260°C
TO-92-3 .......................................................... +300°C

* Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

**ABSOLUTE MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V CC</td>
<td>Supply Voltage (TC02)</td>
<td></td>
<td>3.0</td>
<td>—</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>V CC</td>
<td>Supply Voltage (TC03)</td>
<td></td>
<td>2.2</td>
<td>—</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>I S</td>
<td>Supply Current Note 1</td>
<td></td>
<td>—</td>
<td>40</td>
<td>60</td>
<td>µA</td>
</tr>
<tr>
<td>I SRC</td>
<td>V OUT Output Source Current</td>
<td></td>
<td>—</td>
<td>—</td>
<td>1.0</td>
<td>mA</td>
</tr>
<tr>
<td>Accuracy at Room Temperature T A = 25°C (Note 2)</td>
<td></td>
<td>– 2</td>
<td>± 0.5</td>
<td>2</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Accuracy at Minimum Temperature T A = – 20°C (Note 2)</td>
<td></td>
<td>—</td>
<td>± 3</td>
<td>—</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

**ELECTRICAL CHARACTERISTICS :** T A = – 20°C to +125°C, V CC = 5V ±5%, unless otherwise specified.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V OUTMAX</td>
<td>Maximum Output Voltage TC02: 3.0V ≤ V CC ≤ 12V</td>
<td></td>
<td>—</td>
<td>—</td>
<td>VCC – 1.2</td>
<td>V</td>
</tr>
<tr>
<td>V OUTMAX</td>
<td>Maximum Output Voltage TC03: 2.2V ≤ V CC ≤ 12V</td>
<td></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Notes:** 1. V OUT outputs open circuited.
2. Accuracy = Difference between calculated output voltage (10mV/°C x Device case temperature at specified temperature and power supply) and measured output voltage expressed in °C.
3. Nonlinearity = deviation of output voltage versus temperature from the best-fit straight line over the device rated temperature range.
4. Guaranteed by design.

**DETAILED DESCRIPTION**

A plot of output voltage versus temperature for both the TC02 and TC03 appears in Figure 1. The TC03 can be used with single power supply to measure temperatures from 0°C to 100°C. A pull-down resistor (R1 in Figure 2) must be added from V OUT to the negative power supply for measuring temperatures less than 0°C. The value of the resistor must be chosen to limit the maximum current pulled from the output to the negative supply to — 50µA (i.e. R1 = V SS/50µA).

**OUTPUT STAGE**

Both the TC02 and TC03 have Class A output stages capable of sourcing 1mA. These devices have a limited ability to drive heavy capacitive loads. Loads of 50pF (to ground) can be driven directly. For heavier loads, a 2kΩ (or greater) resistor should be placed in series with the output for decoupling. If the TC02/03 is used in a noisy electrical environment, a 0.1µF bypass capacitor from V CC to GND is recommended.
Figure 1. Output Voltage vs Temperature

Figure 2. TC02/03 Power Supply Connections for Full Scale Measurements

TC02: $V_{\text{OUT}} = \left(10 \text{mV/°C}\right) (\text{Temperature °C}) + 500 \text{mV}$

TC03: $V_{\text{OUT}} = \left(10 \text{mV/°C}\right) (\text{Temperature °C})$

$V_{\text{CC}} = 2.2 \text{V to 12.0V MIN.}$

$R1 = \frac{V_{\text{SS}}}{50 \mu\text{A}}$

TC03 (−20°C to +100°C)

$V_{\text{CC}} = 3.0 \text{V to 12.0V}$

TC02 (−20°C to +125°C)
TYPICAL CHARACTERISTICS

**Supply Current vs. Temperature**

- Supply Current (µA) vs. Temperature (°C)
- V_{CC} = +5V

**Thermal Time Constant (Sec) vs. Air Velocity**

- Thermal Time (Sec) vs. Air Velocity (FPM)

**Thermal Response in Still Air vs. Time**

- Percent of Final Value (%) vs. Time (Sec.)

**V_{OUT} (From Power Initially Applied) vs. Time (Turn-on Response)**

- V_{OUT} (From Power Initially Applied) vs. Time (Turn-on Response)
- 2V/DIV
- 500mV/DIV
- 0V
- 20µsec/DIV
MARKING

SOT-23B-3

1 & 2 = part number code and temperature range
TC02VNB = AA – 20°C to 125°C
TC03VNB = AB – 20°C to 100°C

ex: 02 = A A A A
ex: 03 = A B A A

3 = year and quarter
4 = lot ID

TO-92-3

1 & 2 = TC (fixed)
3, 4 & 5 = blank
6, 7, 8 & 9 = part number
10 = temperature range
C = –20°C to +125°C
D = –20°C to +100°C
11, 12, 13, 14 & 15 = traceability code

TAPPING FORMS

SOT-23B-3

Standard Reel Component Orientation
for 713 or TR Suffix Device
(Mark Right Side Up)

Reverse Reel Component Orientation
for 723 or RT Suffix Device
(Mark Upside Down)

Tape & Reel Specifications Table

<table>
<thead>
<tr>
<th>Package</th>
<th>Carrier Width (W)</th>
<th>Pitch (P)</th>
<th>Part Per Full Reel</th>
<th>Reel Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3L SOT-23B</td>
<td>8 mm</td>
<td>4 mm</td>
<td>3000</td>
<td>7</td>
</tr>
</tbody>
</table>
Component Taping Orientation for TO-92

User Direction of Feed

Standard Reel Component Orientation
for 713 or TR Suffix Device

Reverse Reel Component Orientation
for 723 or RT Suffix Device

Tape & Reel Specifications Table

<table>
<thead>
<tr>
<th>Package</th>
<th>Carrier Width (W)</th>
<th>Pitch (P)</th>
<th>Part Per Full Reel</th>
<th>Reel Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO-92-3</td>
<td>18 mm</td>
<td>12.7 mm</td>
<td>2000</td>
<td>13</td>
</tr>
</tbody>
</table>
PACKAGE DIMENSIONS

*SOT-23B-3

*NOTE: SOT-23B-3 is equivalent to JEDEC (TO-236)

TO-92-3

Dimensions: inches (mm)
5V, DUAL TRIP POINT TEMPERATURE SENSORS

FEATURES
- User-Programmable Hysteresis and Temperature Set Point
- Easily Programs with 2 External Resistors
- Wide Temperature Detection Range ................. – 40°C to +125°C (TC620/621CVx)
- External Thermistor for Remote Sensing Applications (TC621x)

APPLICATIONS
- Power Supply Overtemperature Detection
- Consumer Equipment
- Temperature Regulators
- CPU Thermal Protection

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Package</th>
<th>Ambient Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC620xC</td>
<td>8-Pin SOIC</td>
<td>0°C to +70°C</td>
</tr>
<tr>
<td>TC620xC</td>
<td>8-Pin Plastic DIP</td>
<td>0°C to +70°C</td>
</tr>
<tr>
<td>TC620xE</td>
<td>8-Pin SOIC</td>
<td>– 40°C to +85°C</td>
</tr>
<tr>
<td>TC620xE</td>
<td>8-Pin Plastic DIP</td>
<td>– 40°C to +85°C</td>
</tr>
<tr>
<td>TC621xC</td>
<td>8-Pin SOIC</td>
<td>0°C to +70°C</td>
</tr>
<tr>
<td>TC621xC</td>
<td>8-Pin Plastic DIP</td>
<td>0°C to +70°C</td>
</tr>
</tbody>
</table>

GENERAL DESCRIPTION

The TC620 and TC621 are programmable logic output temperature detectors designed for use in thermal management applications. The TC620 features an on-board temperature sensor, while the TC621 connects to an external NTC thermistor for remote sensing applications.

Both devices feature dual thermal interrupt outputs (HIGH LIMIT and LOW LIMIT), each of which program with a single external resistor. On the TC620, these outputs are driven active (high) when measured temperature equals the user-programmed limits. The CONTROL (hysteresis) output is driven high when temperature equals the high limit setting, and returns low when temperature falls below the low limit setting. This output can be used to provide simple ON/OFF control to a cooling fan or heater. The TC621 provides the same output functions except that the logical states are inverted.

The TC620/621 are usable over a maximum temperature range of – 40°C to +125°C.

FUNCTIONAL BLOCK DIAGRAM

*Suffix code "C" denotes cooling option (high true CONTROL output);
suffix code "H" denotes heating option (low true CONTROL output).
**TC620**

**TC621**

**ABSOLUTE MAXIMUM RATINGS**

Package Power Dissipation (T_A ≤ 70°C)
- PDIP ...............................................................730mW
- SOIC ..............................................................470mW

Derating Factors
- Plastic ..............................................................8mW/°C
- Supply Voltage ............................................-20V
- Input Voltage Any Input ...... (GND – 0.3V) to (V_DD +0.3V)

Operating Temperature
- M Version ....................................................−55°C to +125°C
- V Version ....................................................−40°C to +125°C
- E Version ....................................................−40°C to +85°C
- C Version ....................................................0°C to +70°C

Maximum Chip Temperature ...........................................+150°C

Storage Temperature ............................................−65°C to +150°C

Lead Temperature (Soldering, 10 sec) ...........................................+300°C

*Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**ELECTRICAL CHARACTERISTICS:** T_A = 25°C, unless otherwise specified.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage Range</td>
<td>4.5 ≤ V_DD ≤ 18V</td>
<td></td>
<td>—</td>
<td>18</td>
<td>V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>5V ≤ V_DD ≤ 18V</td>
<td>—</td>
<td>270</td>
<td>400</td>
<td>μA</td>
</tr>
<tr>
<td>Output Resistance</td>
<td>Output High or Low, 5V ≤ V_DD ≤ 18V</td>
<td>—</td>
<td>400</td>
<td>1000</td>
<td>Ω</td>
</tr>
<tr>
<td>Output Current</td>
<td>Temp Sensed Source/Sink</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>mA</td>
</tr>
<tr>
<td>Output Current</td>
<td>Cool/Heat Source/Sink</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>mA</td>
</tr>
<tr>
<td>Absolute Accuracy</td>
<td>T = Programmed Temperature</td>
<td>T − 3</td>
<td>T</td>
<td>T + 3</td>
<td>°C</td>
</tr>
</tbody>
</table>

**PIN CONFIGURATIONS** (DIP and SOIC)
5V, DUAL TRIP POINT TEMPERATURE SENSORS

DETAILED DESCRIPTION

The TC620/621 consists of a positive temperature coefficient (PTC) temperature sensor, and a dual threshold detector. Temperature setpoint programming is easily accomplished with external programming resistors from the HIGH SET and LOW SET inputs to VDD. The HIGH LIMIT and LOW LIMIT outputs remain low as long as measured temperature is below setpoint values. As measured temperature increases, the LOW LIMIT output is driven high when temperature equals the LOW SET setpoint (±3°C max). If temperature continues to climb, the HIGH LIMIT output is driven high when temperature equals the HIGH SET setpoint (Figure 1). The CONTROL (hysteresis) output is latched in its active state at the temperature specified by the HIGH SET resistor. CONTROL is maintained active until temperature falls to the value specified by the LOW SET resistor.

Programming The TC620

The resistor values to achieve the desired trip-point temperatures on HIGH SET and LOW SET are calculated using EQUATION 1 below:

$$R_{TRIP} = 0.5997 \times T^{2.1312}$$

Where: $R_{trip}$ = Programming resistor in Ohms

$T$ = The desired trip point temperature in degrees Kelvin

Equation 1.

For example, a 50°C setting on either the HIGH SET or LOW SET input is calculated using Equation 1 as follows:

$$R_{set} = 0.5997 \times ((50 + 273.15)^{2.1312}) = 133.6k \Omega$$

Care must be taken to ensure the LOW SET programming resistor is a smaller value than the HIGH SET programming resistor. Failure to do this will result in erroneous operation of the CONTROL output.

Care must also be taken to ensure the LOW SET temperature setting is at least 5°C lower than the HIGH SET temperature setting. That is:

$$\text{LOW SET} \leq \text{HIGH SET} - 5°C$$

The nomograph of Figure 2 can help the user obtain an estimate of the external resistor values required for the desired LOW SET and HIGH SET trip points.

Built-in Hysteresis

To prevent output “chattering” when measured temperature is at (or near) the programmed trip point values, the LOW SET and HIGH SET inputs each have built-in hysteresis of −2°C below the programmed settings (Figure 3).
Using The TC621

The TC621 operation is identical to that of the TC620, but requires an external NTC thermistor. Use the resistance versus temperature curve of the thermistor to determine the values of the programming resistors. Note that the pin numbers for the HIGH SET and LOW SET programming resistors for the TC621 are reversed versus that of the TC620 (i.e. the resistor value on HIGH SET [pin 2] should always be lower than the one connected to LOW SET [pin 3]). Also note that the outputs of the TC621 are LOW TRUE when used with an NTC thermistor.

TC621 Thermistor Selection

The TC621 uses an external thermistor to monitor the controlling temperature. A thermistor with a resistance value of approximately 100kΩ at 25°C is recommended.

A temperature setpoint is selected by picking a resistor whose value is equal to the resistance of the thermistor at the desired temperature. For example, a 30kΩ resistor between HIGH TEMP (pin 2) and V_DD (pin 8) sets the high temperature trip point at +51°C and a 49kΩ resistor on LOW TEMP (pin 3) sets the low temperature trip point to +41°C.

TC620/621 Outputs

Both devices have complimentary output stages. They are rated at a source or sink current of 1mA maximum.

APPLICATIONS

Dual Speed Temperature Control

The Dual Speed Temperature Control uses a TC620 and a TC4469 quad driver. Two of the drivers are configured in a simple oscillator. When the temperature is below the LOW TEMP set point, the output of the driver is OFF. When the temperature exceeds the LOW TEMP set point, the TC4469 gates the oscillator signal to the outputs of the driver. This square wave signal modulates the remaining outputs and drives the motor at a low speed. If this speed cannot keep the temperature below the HIGH TEMP set point, then the driver turns on continuously which increases the fan speed to high. The TC620 will monitor the temperature and only allow the fan to operate when needed, and at the required speed to maintain the desired temperature. A higher power option can be designed by adding a resistor and a power MOSFET.

Temperature Controlled Fan

In this application, a high and a low temperature is selected by two ‘set’ resistors. The TC620 monitors the ambient temperature and turns the FET switch on when the temperature exceeds the HIGH TEMP set point. The fan remains on until the temperature decreases to the LOW TEMP set point. This provides the hysteresis. In this application, the fan turns on only when required.

The TC621 uses an external thermistor to monitor the ambient temperature. This adds one part, but allows more flexibility in location of the sensor.

TYPICAL NTC THERMISTOR

![Graph of Typical Thermistor Resistance vs. Temperature](image)
5V, DUAL TRIP POINT
TEMPERATURE SENSORS

Figure 5.

Figure 6.

Figure 7. TC620 Heating/Cooling Application
5V, DUAL TRIP POINT TEMPERATURE SENSORS

TC620
TC621

Figure 8. TC620 Heating/Cooling Application

PACKAGE DIMENSIONS

8-Pin Plastic DIP

Dimensions: inches (mm)
5V, DUAL TRIP POINT
TEMPERATURE SENSORS

PACKAGE DIMENSIONS (Cont.)

8-Pin SOIC

Dimensions: inches (mm)
**FEATURES**

- Requires no external components
- Measures temperatures from –55°C to +125°C in 1°C increments. Fahrenheit equivalent is –67°F to +257°F in 1.8°F increments
- Converts temperature to digital word in 1 second (max.)
- Thermostatic settings are user definable and nonvolatile
- Available in 3-pin PR35, TO–220, and 8-pin SOIC packages
- Applications include thermostatic controls, industrial systems, consumer products, thermometers, or any thermally sensitive system

**PIN ASSIGNMENT**

**PIN DESCRIPTION**

- GND – Ground
- DQ – Data In/Out
- VDD – Power Supply Voltage +5V
- NC – No Connect
- DNC – Do Not Connect

**DESCRIPTION**

The DS1821 Programmable Digital Thermostat provides a thermal alarm logic output when the temperature of the device exceeds a user–defined temperature TH. The output remains active until the temperature drops below user defined temperature TL, allowing for any hysteresis necessary.

User–defined temperature settings are stored in nonvolatile memory, so parts can be programmed prior to insertion in a system. Communication to/from the DS1821 is accomplished through the DQ pin in a programming mode; this same pin is used in operation as the thermostat output.
**OVERVIEW**

The block diagram of Figure 1 shows the major components of the DS1821. The DS1821 has two operating modes: 1–Wire™ and thermostat.

The part arrives from the factory in 1–Wire mode. In this mode, the DQ pin of the DS1821 is configured as a 1–Wire communication port which would be connected to a microprocessor. The microprocessor will write data into the high and low temperature trigger registers, TH and TL, respectively, to set up the temperature limits for thermostat operation. In this mode, the result of the last temperature measurement made by the DS1821 may also be read directly by the microprocessor.

Once temperature limits have been set and thermostat operation has been verified, the user may convert the DS1821 from a temperature sensor into a thermostat by writing to a bit in the status register. The part will then be configured for thermostat operation; this will also become the default power-up state for the device on the subsequent power up.

In thermostat mode, the DQ line becomes the thermostat output. This open drain output will go to its active state (programmable on/off) when the temperature of the DS1821 goes above the limit set in the TH register, and will remain active until the temperature goes below the limit programmed into the TL register.

If the user wishes to establish communications with the DS1821 once it has been placed in thermostat mode (for example, to change temperature trip point limits), this may be done by dropping VDD while holding the DQ line high, then clocking the DQ line 16 times. The part will then be placed into 1–Wire mode, and will allow the I/O functions of the device to operate, and reads from or writes to the memory are possible. This does not change the power up state of the device, unless the user writes the configuration bit to do so.

**DS1821 BLOCK DIAGRAM**

![DS1821 Block Diagram](image)
**OPERATION**

**Temperature Measurement**
The DS1821 measures temperatures through the use of an on-board proprietary temperature measurement technique. The temperature reading is provided in an 8-bit, two's complement reading. Table 1 describes the exact relationship of output data to measured temperature. The data is transmitted serially over the 1-Wire interface. The DS1821 can measure temperature over the range of –55°C to +125°C in 1°C increments. For Fahrenheit usage, a lookup table or conversion factor must be used. Please refer to Application Note 105 for the method to increase the resolution of the DS1821.

<table>
<thead>
<tr>
<th>TEMPERATURE</th>
<th>DIGITAL OUTPUT (Binary)</th>
<th>DIGITAL OUTPUT (Hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+125°C</td>
<td>01111101</td>
<td>7Ah</td>
</tr>
<tr>
<td>+25°C</td>
<td>00011001</td>
<td>19h</td>
</tr>
<tr>
<td>0°C</td>
<td>00000000</td>
<td>00h</td>
</tr>
<tr>
<td>–1°C</td>
<td>11111111</td>
<td>FFh</td>
</tr>
<tr>
<td>–25°C</td>
<td>11100111</td>
<td>E7h</td>
</tr>
<tr>
<td>–55°C</td>
<td>11001001</td>
<td>C9h</td>
</tr>
</tbody>
</table>

**Thermostat Controls**
In its thermostat mode, the DS1821 functions as a thermostat with programmable hysteresis, as shown in Figure 2. Temperature conversions begin as soon as VDD is applied to the device, and are continually made, so that the thermostat output updates as soon as a temperature conversion is complete. This is approximately once every second.

When the DS1821’s temperature meets or exceeds the value stored in the high temperature trip register (TH), the output becomes active, and will stay active until the temperature falls below the temperature stored in the low temperature trigger register (TL). In this way, any amount of hysteresis may be obtained.

The active state for the output is programmable by the user, so that an active state may either be a logic 1 (+5V, output transistor off) or a logic 0 (0V, output transistor on).

**THERMOSTAT OUTPUT OPERATION**

**PROGRAMMING THE DS1821**
To program the DS1821, it must be placed in 1-Wire mode. This mode is active when the device arrives from the factory. Once the part has been programmed, and if the user has set the power-up state to thermostat mode, 1-Wire mode may only be achieved by bringing the VDD pin low while holding the DQ line high, then clocking the DQ line 16 times.

The DS1821 has four internal registers that may be accessed through the DQ pin when the device is in 1-Wire mode. These registers are the high temperature trigger (TH), low temperature trigger (TL), the actual measured temperature result, and the status register. The TH, TL, and status registers are all nonvolatile.

The DS1821 must have temperature settings resident in the TH and TL registers for thermostatic operation. The temperature result register and the thermostat limit registers (TH and TL) hold an eight bit number in the two's complement format described in Table 1.

A status register is also present, indicating the status of the thermostatic control, and allowing configuration of the output polarity as either active high or active low, and establishes the power-up state of the device.

The status register is defined as follows:

<table>
<thead>
<tr>
<th>DONE</th>
<th>NVB</th>
<th>THF</th>
<th>TLF</th>
<th>T/R</th>
<th>POL</th>
<th>ISHOT</th>
</tr>
</thead>
</table>

**THERMOSTAT OUTPUT OPERATION**

Figure 2

DQ (Thermostat output, Active=High) VDD=5 volts
until reset by writing 0 into this location. This feature provides a method of determining if the DS1821 has ever been subjected to temperatures above TH. This bit is nonvolatile, and is stored in E² memory.

TLF = Temperature Low Flag. This bit will normally be “0”, but will be set to “1” when the temperature is lower than the value of TL. It will remain “1” until reset by writing 0 into this location. This feature provides a method of determining if the DS1821 has ever been subjected to temperatures below TL. This bit is nonvolatile, and is stored in E² memory.

NVB= Nonvolatile memory busy flag. “1” = Write to an E² memory cell in progress, “0” = nonvolatile memory is not busy. A write to E² may take up to 10 ms.

T/R* = Power–up mode bit. If set to a “1”, the DS1821 will power up in a thermostat mode. If set to a “0”, the device will power up in 1–Wire “read” mode. This bit is nonvolatile.

POL = Output Polarity Bit. “1” = active high, “0” = active low. This bit is nonvolatile.

1SHOT= One Shot Mode. If 1SHOT is “1”, the DS1821 will perform one temperature conversion upon reception of the Start Convert T protocol. If 1SHOT is “0”, the DS1821 will continuously perform temperature conversions. Note that the One Shot mode is available only when the device is in 1–Wire mode. In thermostat mode, the device continuously performs temperature conversions. This bit is nonvolatile.

PROGRAMMING COMMAND FUNCTIONS

The command set for the DS1821 as shown in Table 2 is as follows:

**Read Temperature [AAh]**

This command reads the contents of the register which contains the last temperature conversion result.

**Write TH [01h]**

This command writes to the TH (HIGH TEMPERATURE) register. After issuing this command, the user writes eight bits of data to the TH register.

**Write TL [02h]**

This command writes to the TL (LOW TEMPERATURE) register. After issuing this command, the user writes eight bits of data to the TL register.

**Read TH [A1h]**

This command reads the value of the TH (HIGH TEMPERATURE) register. After issuing this command, the user reads the eight bits of data present in the TH register.

**Read TL [A2h]**

This command reads the value of the TL (LOW TEMPERATURE) register. After issuing this command, the user reads the eight bits of data present in the TL register.

**Write Status [0Ch]**

This command writes to the status register. This would be used for clearing the values of the THF and TLF flags, and setting the T/R, POL and 1SHOT bits. After issuing this command, the user writes the eight bit data into the register.

**Read Status [ACh]**

This command reads the value in the status register. After issuing this command, the user reads the eight bits present in the status register.

**Start Convert T [EEh]**

This command begins a temperature conversion. No further data is required. In One Shot mode, the temperature conversion will be performed and then the DS1821 will remain idle. In continuous mode, this command will initiate continuous conversions.

**Stop Convert T [22h]**

This command stops temperature conversion. No further data is required. This command may be used to halt a DS1821 in continuous conversion mode. After issuing this command, the current temperature measurement will be completed, and then the DS1821 will remain idle until a Start Convert T is issued to resume continuous operation.
RETURNING TO 1–WIRE MODE FROM THERMOSTAT MODE

The operating mode of the DS1821 is determined at power–up, depending upon the setting of the T/R bit. If the T/R bit is set to a “1”, the DS1821 will power up in thermostat mode. In this mode, the device cannot be written to or read from over the DQ line. However, it is possible to return to the 1–Wire “read” mode temporarily, in cases where thermostat limits may need to be changed after insertion and use in a system.

To return to the 1–Wire “read” mode, the V DD pin of the DS1821 is brought to 0V while the DQ line is held high. The DQ line must then be clocked low 16 times. After this is accomplished, the V DD line may be brought high again, and the DS1821 will then be in 1–Wire “read” mode.

To toggle between modes, V DD is brought low while DQ is held high and then clocked 16 times. When V DD is brought high again, the part will then be in thermostat mode again. This technique may be used to toggle between the two operating modes of the DS1821 as often as required.

When both V DD and DQ are low for more than approximately 10 seconds, the part is powered down. When powered up again, the part will begin operating in the mode set by T/R* bit (1=thermostat mode, 0=”read” mode).

DS1821 COMMAND SET  Table 2

<table>
<thead>
<tr>
<th>INSTRUCTION</th>
<th>DESCRIPTION</th>
<th>PROTOCOL</th>
<th>1–WIRE BUS DATA AFTER ISSUING PROTOCOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Convert T</td>
<td>Initiates temperature conversion.</td>
<td>EEh</td>
<td>idle</td>
</tr>
<tr>
<td>Stop Convert T</td>
<td>Halts temperature conversion.</td>
<td>22h</td>
<td>idle</td>
</tr>
<tr>
<td>Read Temperature</td>
<td>Reads last converted temperature value from temperature register.</td>
<td>AAh</td>
<td>&lt;read data&gt;</td>
</tr>
<tr>
<td>Write TH</td>
<td>Writes high temperature limit value into TH register.</td>
<td>01h</td>
<td>&lt;write data&gt;</td>
</tr>
<tr>
<td>Write TL</td>
<td>Writes low temperature limit value into TL register.</td>
<td>02h</td>
<td>&lt;write data&gt;</td>
</tr>
<tr>
<td>Read TH</td>
<td>Reads stored value of high temperature limit from TH register.</td>
<td>A1h</td>
<td>&lt;read data&gt;</td>
</tr>
<tr>
<td>Read TL</td>
<td>Reads stored value of low temperature limit from TL register.</td>
<td>A2h</td>
<td>&lt;read data&gt;</td>
</tr>
<tr>
<td>Write Status</td>
<td>Writes configuration data to configuration register.</td>
<td>0Ch</td>
<td>&lt;write data&gt;</td>
</tr>
<tr>
<td>Read Status</td>
<td>Reads configuration data from configuration register.</td>
<td>ACh</td>
<td>&lt;read data&gt;</td>
</tr>
</tbody>
</table>
Example: CPU sets up DS1821 for low temp limit of +10°C and high temp limit of +40°C, output active high (i.e., DQ pin is off), then instructs the DS1821 to become a thermostat.

<table>
<thead>
<tr>
<th>DQ PORT PIN</th>
<th>DATA (LSB FIRST)</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>Reset</td>
<td>Reset pulse (480–960 μs).</td>
</tr>
<tr>
<td>RX</td>
<td>Presence</td>
<td>Presence pulse.</td>
</tr>
<tr>
<td>TX</td>
<td>01h</td>
<td>CPU issues Write TH command.</td>
</tr>
<tr>
<td>TX</td>
<td>28h</td>
<td>CPU sends data for TH limit of +40°C.</td>
</tr>
<tr>
<td>TX</td>
<td>Reset</td>
<td>Reset pulse (480–960 μs).</td>
</tr>
<tr>
<td>RX</td>
<td>Presence</td>
<td>Presence pulse.</td>
</tr>
<tr>
<td>TX</td>
<td>02h</td>
<td>CPU issues Write TL command.</td>
</tr>
<tr>
<td>TX</td>
<td>0Ah</td>
<td>CPU sends data for TL limit of +10°C.</td>
</tr>
<tr>
<td>TX</td>
<td>Reset</td>
<td>Reset pulse (480–960 μs).</td>
</tr>
<tr>
<td>RX</td>
<td>Presence</td>
<td>Presence pulse.</td>
</tr>
<tr>
<td>TX</td>
<td>A1h</td>
<td>CPU issues Read TH command.</td>
</tr>
<tr>
<td>RX</td>
<td>28h</td>
<td>DS1821 sends back stored value of TH for CPU to verify.</td>
</tr>
<tr>
<td>TX</td>
<td>Reset</td>
<td>Reset pulse (480–960 μs).</td>
</tr>
<tr>
<td>RX</td>
<td>Presence</td>
<td>Presence pulse.</td>
</tr>
<tr>
<td>TX</td>
<td>A2h</td>
<td>CPU issues Read TL command.</td>
</tr>
<tr>
<td>RX</td>
<td>0Ah</td>
<td>DS1821 sends back stored value of TL for CPU to verify.</td>
</tr>
<tr>
<td>TX</td>
<td>Reset</td>
<td>Reset pulse (480–960 μs).</td>
</tr>
<tr>
<td>RX</td>
<td>Presence</td>
<td>Presence pulse.</td>
</tr>
<tr>
<td>TX</td>
<td>0Ch</td>
<td>CPU issues Write Config command.</td>
</tr>
<tr>
<td>TX</td>
<td>06h</td>
<td>CPU sets DS1821 up for active high output, sets T/R bit to instruct device to become thermostat.</td>
</tr>
<tr>
<td>&lt;high impedance&gt;</td>
<td>Power cycles; DS1821 now comes up in thermostat mode.</td>
<td></td>
</tr>
</tbody>
</table>
1–WIRE BUS SYSTEM
The DS1821 1–Wire bus is a system which has a single bus master and one slave. The DS1821 behaves as a slave. The DS1821 is not able to be multidropped, unlike other 1–Wire devices from Dallas Semiconductor.

The discussion of this bus system is broken down into three topics: hardware configuration, transaction sequence, and 1–Wire signaling (signal types and timing).

HARDWARE CONFIGURATION
The 1–Wire bus has only a single line by definition; it is important that each device on the bus be able to drive it at the appropriate time. To facilitate this, each device attached to the 1–Wire bus must have open drain or 3–state outputs. The 1–Wire port of the DS1821 (DQ pin) is open drain with an internal circuit equivalent to that shown in Figure 4. The 1–Wire bus requires a pull–up resistor of approximately 5K.

HARDWARE CONFIGURATION Figure 4

The idle state for the 1–Wire bus is high. If for any reason a transaction needs to be suspended, the bus MUST be left in the idle state if the transaction is to resume. Infinite recovery time can occur between bits so long as the 1–Wire bus is in the inactive (high) state during the recovery period. If this does not occur and the bus is left low for more than 480 µs, all components on the bus will be reset.

TRANSACTION SEQUENCE
The protocol for accessing the DS1821 via the 1–Wire port is as follows:

• Initialization
• Function Command
• Transaction/Data

INITIALIZATION
All transactions on the 1–Wire bus begin with an initialization sequence. The initialization sequence consists of a reset pulse transmitted by the bus master followed by presence pulse(s) transmitted by the slave(s).

The presence pulse lets the bus master know that the DS1821 is on the bus and is ready to operate. For more details, see the “1–Wire Signaling” section.

1–WIRE SIGNALING
The DS1821 requires strict protocols to insure data integrity. The protocol consists of several types of signaling on one line: reset pulse, presence pulse, write 0, write 1, read 0, and read 1. All of these signals, with the exception of the presence pulse, are initiated by the bus master.

The initialization sequence required to begin any communication with the DS1821 is shown in Figure 5. A reset pulse followed by a presence pulse indicates the DS1821 is ready to send or receive data given the correct function command.
The bus master transmits (TX) a reset pulse (a low signal for a minimum of 480 µs). The bus master then releases the line and goes into a receive mode (RX). The 1-Wire bus is pulled to a high state via the 5K pull-up resistor. After detecting the rising edge on the DQ pin, the DS1821 waits 15–60 µs and then transmits the presence pulse (a low signal for 60–240 µs).

READ/WRITE TIME SLOTS
DS1821 data is read and written through the use of time slots to manipulate bits and a command word to specify the transaction.

Write Time Slots
A write time slot is initiated when the host pulls the data line from a high logic level to a low logic level. There are two types of write time slots: Write One time slots and Write Zero time slots. All write time slots must be a minimum of 60 µs in duration with a minimum of a one µs recovery time between individual write cycles.

The DS1821 samples the DQ line in a window of 15 µs to 60 µs after the DQ line falls. If the line is high, a Write One occurs. If the line is low, a Write Zero occurs (see Figure 6).

For the host to generate a Write One time slot, the data line must be pulled to a logic low level and then released, allowing the data line to pull up to a high level within 15 microseconds after the start of the write time slot.

For the host to generate a Write Zero time slot, the data line must be pulled to a logic low level and remain low for the duration of the write time slot.

Read Time Slots
The host generates read time slots when data is to be read from the DS1821. A read time slot is initiated when the host pulls the data line from a logic high level to logic low level. The data line must remain at a low logic level for a minimum of one µsmicrosecond; output data from the DS1821 is then valid for the next 14 µs maximum. The host therefore must stop driving the DQ pin low in order to read its state 15 µs from the start of the read slot (see Figure 6). By the end of the read time slot, the DQ pin will pull back high via the external pull-up resistor. All read time slots must be a minimum of 60 µs in duration with a minimum of a one µs recovery time between individual read slots.

Figure 7 shows that the sum of \( T_{\text{INIT}} \), \( T_{\text{RC}} \), and \( T_{\text{SAMPLE}} \) must be less than 15 µs. Figure 8 shows that system timing margin is maximized by keeping \( T_{\text{INIT}} \) and \( T_{\text{RC}} \) as small as possible and by locating the master sample time towards the end of the 15 µs period.
**READ/WRITE TIMING DIAGRAM** Figure 6

**MASTER WRITE “0” SLOT**
- $60 \mu s < T_x \cdot 0 \leq 120 \mu s$
- $1 \mu s < t_{REC} < \infty$

**MASTER WRITE “1” SLOT**
- $1 \mu s < t_{REC} < \infty$

**DS1821 SAMPLES**
- MIN
- TYP
- MAX

**MASTER READ “0” SLOT**
- $60 \mu s < T_x \cdot 0 \leq 120 \mu s$
- $>1 \mu s$

**MASTER READ “1” SLOT**
- $1 \mu s < t_{REC} < \infty$

**MASTER SAMPLES**
- MIN
- TYP
- MAX

**LINE TYPE LEGEND:**
- **BUS MASTER ACTIVE LOW**
- **DS1821 ACTIVE LOW**
- **BOTH BUS MASTER AND DS1821 ACTIVE LOW**
- **RESISTOR PULL-UP**
**DETAILED MASTER READ “1” TIMING** Figure 7

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**RECOMMENDED MASTER READ “1” TIMING** Figure 8

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**Related Application Notes**

The following Application Notes can be applied to the DS1821. These notes can be obtained from the Dallas Semiconductor “Application Note Book”, via our website at http://www.dalsemi.com/, or through our faxback service at (214) 450–0441.

- Application Note 67: “Applying and Using the DS1620 in Temperature Control Applications”
- Application Note 74: “Reading and Writing Touch Memories via Serial Interfaces”
- Sample 1–Wire subroutines that can be used in conjunction with AN74 can be downloaded from the website or our Anonymous FTP Site.
ABSOLUTE MAXIMUM RATINGS*
Voltage on Any Pin Relative to Ground –0.5V to +7.0V
Operating Temperature –55°C to +125°C
Storage Temperature –55°C to +125°C
Soldering Temperature 260°C for 10 seconds

* This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

RECOMMENDED DC OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITION</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>VDD</td>
<td>Operation</td>
<td>2.7V</td>
<td>5.5</td>
<td>5.5</td>
<td>V</td>
<td>1</td>
</tr>
<tr>
<td>Data Pin</td>
<td>DQ</td>
<td>–0.5</td>
<td>5.5</td>
<td>V</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic 1</td>
<td>VIH</td>
<td>2.0</td>
<td>VCC+0.3</td>
<td>V</td>
<td>1, 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic 0</td>
<td>VIL</td>
<td>–0.3</td>
<td>+0.8</td>
<td>V</td>
<td>1, 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DC ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITION</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermometer Error</td>
<td>tERR</td>
<td>0°C to +85°C, –55°C to –40°C and 85°C to +125°C</td>
<td>±1°C</td>
<td>±1°C</td>
<td>See Typical Curve</td>
<td>7, 8</td>
<td></td>
</tr>
<tr>
<td>Open Drain Output Logic Low (DQ pin)</td>
<td>VIL</td>
<td>–0.3</td>
<td>+0.8</td>
<td>V</td>
<td>1, 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sink Current</td>
<td>IS</td>
<td>VDD=0.4V</td>
<td>–4.0</td>
<td>mA</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standby Current</td>
<td>IQ</td>
<td></td>
<td>1.0</td>
<td>3.0</td>
<td>μA</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Active Current</td>
<td>IDD</td>
<td>Temperature Conversions, Programming</td>
<td>500</td>
<td>1000</td>
<td>μA</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Input Resistance</td>
<td>RI</td>
<td></td>
<td>500</td>
<td>KΩ</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### AC ELECTRICAL CHARACTERISTICS:

(-55°C to +125°C; V<sub>DD</sub>=3.6V to 5.5V)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Conversion Time</td>
<td>t&lt;sub&gt;CONV&lt;/sub&gt;</td>
<td>0.4</td>
<td>1.0</td>
<td></td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Time Slot</td>
<td>t&lt;sub&gt;SLOT&lt;/sub&gt;</td>
<td>60</td>
<td></td>
<td>120</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Recovery Time</td>
<td>t&lt;sub&gt;REC&lt;/sub&gt;</td>
<td>1</td>
<td></td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Write 0 Low Time</td>
<td>t&lt;sub&gt;LOW0&lt;/sub&gt;</td>
<td>60</td>
<td></td>
<td>120</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Write 1 Low Time</td>
<td>t&lt;sub&gt;LOW1&lt;/sub&gt;</td>
<td>1</td>
<td></td>
<td>15</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Read Data Valid</td>
<td>t&lt;sub&gt;RDV&lt;/sub&gt;</td>
<td></td>
<td></td>
<td>15</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Reset Time High</td>
<td>t&lt;sub&gt;RSTH&lt;/sub&gt;</td>
<td>480</td>
<td></td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Reset Time Low</td>
<td>t&lt;sub&gt;RSTL&lt;/sub&gt;</td>
<td>480</td>
<td></td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Presence Detect High</td>
<td>t&lt;sub&gt;PDHIGH&lt;/sub&gt;</td>
<td>15</td>
<td></td>
<td>60</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Presence Detect Low</td>
<td>t&lt;sub&gt;PDLOW&lt;/sub&gt;</td>
<td>60</td>
<td></td>
<td>240</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>EEPROM Write Time</td>
<td>t&lt;sub&gt;WR&lt;/sub&gt;</td>
<td>10</td>
<td></td>
<td>50</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;DD&lt;/sub&gt; Low to Mode Toggle Clock</td>
<td>t&lt;sub&gt;P&lt;/sub&gt;</td>
<td>100</td>
<td></td>
<td></td>
<td>ns</td>
<td>6</td>
</tr>
<tr>
<td>Low</td>
<td>t&lt;sub&gt;PC&lt;/sub&gt;</td>
<td>100</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Mode Toggle Clock 16 High to V&lt;sub&gt;DD&lt;/sub&gt; High</td>
<td>t&lt;sub&gt;C&lt;/sub&gt;</td>
<td>100</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Mode Toggle Clock Pulse Low Time</td>
<td>t&lt;sub&gt;CL&lt;/sub&gt;</td>
<td>0.1</td>
<td></td>
<td>10</td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Mode Toggle Clock Pulse High Time</td>
<td>t&lt;sub&gt;CH&lt;/sub&gt;</td>
<td>0.1</td>
<td></td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Mode Toggle Clock High–to–Low or Low–to–High Transition Time</td>
<td>t&lt;sub&gt;T&lt;/sub&gt;</td>
<td>100</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Capacitance</td>
<td>C&lt;sub&gt;IN/OUT&lt;/sub&gt;</td>
<td>25</td>
<td></td>
<td></td>
<td>pF</td>
<td></td>
</tr>
</tbody>
</table>

### NOTES:

1. All voltages are referenced to ground.
2. Logic one voltages are specified at a source current of 1 mA.
3. Logic zero voltages are specified at a sink current of 4 mA.
4. I<sub>DD</sub> specified with V<sub>CC</sub> at 5.0V.
5. DQ line in "hi–Z" state and Idq=0.
6. Time for part to disable thermostat output.
7. For T<0°C, accuracy degrades by 0.5°C/V for V<sub>CC</sub> < 4.3V.
8. See typical curve for specification limits outside the 0°C to +85°C range. Thermometer error reflects sensor accuracy as tested during calibration.
9. Standby current is specified up to 85°C. Standby current is typically 5 uA at 125°C.
TIMING DIAGRAMS

1–WIRE WRITE ONE TIME SLOT

1–WIRE WRITE ZERO TIME SLOT

1–WIRE READ ZERO TIME SLOT

1–WIRE RESET PULSE

1–WIRE PRESENCE DETECT
MODE TOGGLE TIMING (Return to 1–Wire mode after setting T/R bit)
DS1821 PROGRAMMABLE DIGITAL THERMOSTAT TEMPERATURE READING ERROR

![Graph showing temperature vs. error with upper and lower limit specifications.]

Error (°C)

Temperature (°C)

Upper Limit Specification

Lower Limit Specification