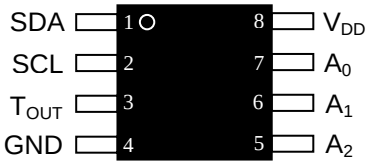
DS1631/DS1631A/DS1731

High-Precision Digital Thermometer and Thermostat

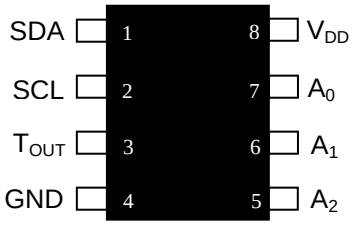
FEATURES

- DS1631 and DS1631A Provide ±0.5°C Accuracy over a 0°C to +70°C Range
- DS1731 Provides ±1°C Accuracy over a -10°C to +85°C Range
- DS1631A Automatically Begins Taking Temperature Measurements at Power-Up
- Operating Temperature Range: -55°C to +125°C (-67°F to +257°F)
- Temperature Measurements Require No External Components
- Output Resolution is User-Selectable to 9, 10, 11, or 12 Bits
- Wide Power-Supply Range (+2.7V to +5.5V)
- Converts Temperature-to-Digital Word in 750ms (max)
- Multidrop Capability Simplifies Distributed Temperature-Sensing Applications
- Thermostatic Settings are User-Definable and Nonvolatile (NV)
- Data is Read/Written Through 2-Wire Serial Interface (SDA and SCL Pins)
- All Three Devices are Available in 8-Pin µSOP Packages and the DS1631 is Also Available in a 150mil SO package—see Table 1 for Ordering Information

PIN CONFIGURATIONS



µSOP
(DS1631U+, DS1631AU+, DS1731U+)



SO (150mil and 208mil)
(DS1631Z+, DS1631S+)

See Table 2 for Pin Descriptions

APPLICATIONS

- Network Routers and Switches
- Cellular Base Stations
- Portable Products
- Any Space-Constrained Thermally Sensitive Product

DESCRIPTION

The DS1631, DS1631A, and DS1731 digital thermometers provide 9, 10, 11, or 12-bit temperature readings over a -55°C to +125°C range. The DS1631 and DS1631A thermometer accuracy is ±0.5°C from 0°C to +70°C with $3.0V \le V_{DD} \le 5.5V$, and the DS1731 accuracy is ±1°C from -10°C to +85°C with $3.0V \le V_{DD} \le 5.5V$. The thermostat on all three devices provides custom hysteresis with user-defined trip points (T_H and T_L). The T_H and T_L registers and thermometer configuration settings are stored in NV EEPROM so they can be programmed prior to installation. In addition, the DS1631A automatically begins taking temperature measurements at power-up, which allows it to function as a stand-alone thermostat. Communication with the DS1631/DS1631A/DS1731 is achieved through a 2-wire serial interface, and three address pins allow up to eight devices to be multidropped on the same 2-wire bus.

Pin descriptions for the DS1631/DS1631A/DS1731 are provided in Table 2 and user-accessible registers are summarized in Table 3. A functional diagram is shown in Figure 1.

Table 1. ORDERING INFORMATION

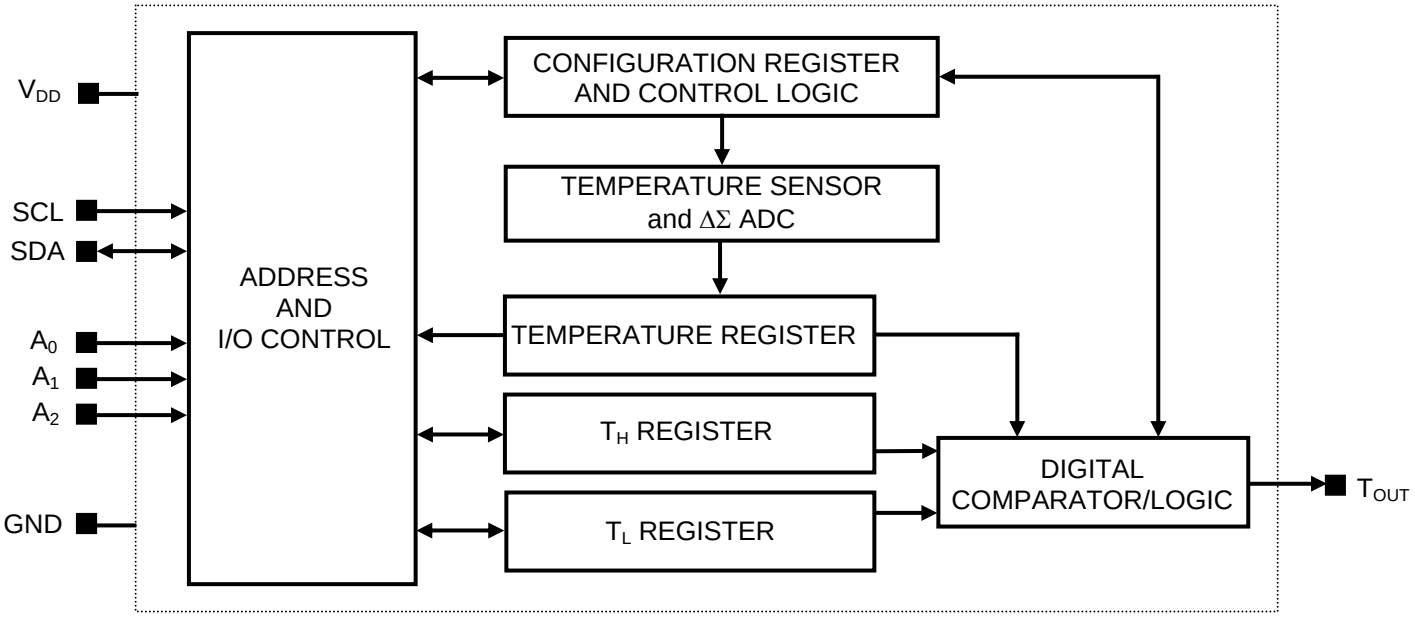
ORDERING NUMBER	PACKAGE MARKING	DESCRIPTION
DS1631U+	D1631 (See Note)	DS1631 in Lead-Free 8-Pin µSOP
DS1631U+T&R	D1631 (See Note)	DS1631 in Lead-Free 8-Pin µSOP, 3000 Piece Tape-and-Reel
DS1631Z+	DS1631Z (See Note)	DS1631 in Lead-Free 150 mil 8-Pin SO
DS1631Z+T&R	DS1631Z (See Note)	DS1631 in Lead-Free 150 mil 8-Pin SO, 2500 Piece Tape-and-Reel
DS1631AU+	1631A (See Note)	DS1631A in Lead-Free 8-Pin µSOP
DS1631AU+T&R	1631A (See Note)	DS1631A in Lead-Free 8-Pin µSOP, 3000 Piece Tape-and-Reel
DS1631S+	DS1631S (See Note)	DS1631 in Lead-Free 208 mil 8-Pin SO
DS1631S+T&R	DS1631S (See Note)	DS1631 in Lead-Free 208 mil 8-Pin SO, 2000 Piece Tape-and-Reel
DS1631+	DS1631 (See Note)	DS1631 in Lead-Free 300 mil 8-Pin DIP
DS1731U+	D1731 (See Note)	DS1731 in Lead-Free 8-Pin µSOP
DS1731U+T&R	D1731 (See Note)	DS1731 in Lead-Free 8-Pin µSOP, 3000 Piece Tape-and-Reel
DS1631U	D1631	DS1631 in 8-Pin µSOP
DS1631U/T&R	D1631	DS1631 in 8-Pin µSOP, 3000-Piece Tape-and-Reel
DS1631Z	DS1631Z	DS1631 in 150mil 8-Pin SO
DS1631Z/T&R	DS1631Z	DS1631 in 150mil 8-Pin SO, 2500-Piece Tape-and-Reel
DS1631AU	1631A	DS1631A in 8-Pin µSOP
DS1631AU/T&R	1631A	DS1631A in 8-Pin µSOP, 3000-Piece Tape-and-Reel
DS1631S	DS1631S	DS1631 in 208 mil 8-Pin SO
DS1631S/T&R	DS1631S	DS1631 in Lead-Free 208 mil 8-Pin SO, 2000 Piece Tape-and-Reel
DS1631	DS1631	DS1631 in 300 mil 8-Pin DIP
DS1731U	D1731	DS1731 in 8-Pin µSOP
DS1731U/T&R	D1731	DS1731 in 8-Pin µSOP, 3000-Piece Tape-and-Reel

Note: A "+" symbol will also be marked on the package near the Pin 1 indicator

Table 2. DETAILED PIN DESCRIPTION

PIN	SYMBOL	DESCRIPTION
1	SDA	Data Input/Output Pin for 2-Wire Serial Communication Port. Open-Drain.
2	SCL	Clock Input Pin for 2-Wire Serial Communication Port.
3	T_{OUT}	Thermostat Output Pin. Push-Pull.
4	GND	Ground Pin
5	A_2	Address Input Pin
6	A_1	Address Input Pin
7	A_0	Address Input Pin
8	V_{DD}	Supply Voltage Pin. +2.7V to +5.5V Power-Supply Pin.

Figure 1. FUNCTIONAL DIAGRAM



ABSOLUTE MAXIMUM RATINGS*

Voltage on any Pin Relative to Ground	-0.5V to +6.0V
Operating Temperature Range	-55°C to +125°C
Storage Temperature Range	-55°C to +125°C
Solder Dip Temperature (10s)	See IPC/JEDEC J-STD-020A Specification
Reflow Oven Temperature	+220°C

* *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 this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.*

DC ELECTRICAL CHARACTERISTICS

(V_{DD} = 2.7V to 5.5V; T_A = -55°C to +125°C.)

PARAMETER	SYMBOL	CONDITION	MIN	MAX	UNITS	NOTES
Supply Voltage	V_{DD}		2.7	5.5	V	1
DS1631, DS1631A Thermometer Error	T_{ERR}	0°C to +70°C, 3.0V ≤ V_{DD} ≤ 5.5V		±0.5	°C	2
		0°C to +70°C, 2.7V ≤ V_{DD} < 3.0V		±1		
		-55°C to +125°C		±2		
DS1731 Thermometer Error	T_{ERR}	-10°C to +85°C, 3.0V ≤ V_{DD} ≤ 5.5V		±1	°C	2
		-10°C to +85°C, 2.7V ≤ V_{DD} < 3.0V		±1.5		
		-55°C to +125°C		±2		
Low-Level Input Voltage	V_{IL}		-0.5	0.3 x V_{DD}	V	
High-Level Input Voltage	V_{IH}		0.7 x V_{DD}	V_{DD} + 0.3	V	
SDA Low-Level Output Voltage	V_{OL1}	3mA sink current	0	0.4	V	
	V_{OL2}	6mA sink current	0	0.6		
Input Current Each I/O Pin		0.4 < $V_{I/O}$ < 0.9V_{DD}	-10	+10	µA	
Active Supply Current	I_{DD}	Temperature conversion -55°C to +85°C		1	mA	3
		Temperature conversion +85°C to +125°C		1.25		
		E^2 write		400	µA	
		Communication only		110		
Standby Supply Current	I_{STBY}	0°C to +70°C		800	nA	4
T_{OUT} Output Logic Voltage	V_{OH}	1mA source current	2.4		V	1
	V_{OL}	4mA sink current		0.4	V	1

AC ELECTRICAL CHARACTERISTICS

(V_{DD} = 2.7V to 5.5V; T_A = -55°C to +125°C.)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
Temperature Conversion Time	t_{TC}	9-bit resolution			93.75	ms	
		10-bit resolution			187.5		
		11-bit resolution			375		
		12-bit resolution			750		
SCL Frequency	f_{SCL}		0		400	kHz	
Bus Free Time Between a STOP and START Condition	t_{BUF}		1.3			µs	5
START and Repeated START Hold Time from Falling SCL	$t_{HD:STA}$		0.6			µs	5, 6
Low Period of SCL	t_{LOW}		1.3			µs	5
High Period of SCL	t_{HIGH}		0.6			µs	5
Repeated START Condition Setup Time to Rising SCL	$t_{SU:STA}$		0.6			µs	5
Data-Out Hold Time from Falling SCL	$t_{HD:DAT}$		0		0.9	µs	5
Data-In Setup Time to Rising SCL	$t_{SU:DAT}$		100			ns	5
Rise Time of SDA and SCL	t_R		$20 + 0.1C_B$		1000	ns	5, 7
Fall Time of SDA and SCL	t_F		$20 + 0.1C_B$		300	ns	5, 7
STOP Setup Time to Rising SCL	$t_{SU:STO}$		0.6			µs	5
Capacitive Load for Each Bus Line	C_B				400	pF	
I/O Capacitance	$C_{I/O}$			10		pF	
Input Capacitance	C_I			5		pF	
Spike Pulse Width that can be Suppressed by Input Filter	t_{SP}		0		50	ns	

NOTES:

1) All voltages are referenced to GND.
2) See Figure 2 for Typical Operating Curves.
3) Specified with T_{OUT} pin open; A_0, A_1, A_2 = 0V or V_{DD}; and $f_{SCL} \geq 2$Hz.
4) Specified with temperature conversions stopped; T_{OUT} pin open; SDA = V_{DD}; SCL = V_{DD}; and A_0, A_1, A_2 = 0V or V_{DD}.
5) See Timing Diagram in Figure 3. All timing is referenced to 0.9 x V_{DD} and 0.1 x V_{DD}.
6) After this period the first clock pulse is generated.
7) For example, if C_B = 300pF, then t_R[min] = t_F[min] = 50ns.

EEPROM AC ELECTRICAL CHARACTERISTICS

(V_{DD} = 2.7V to 5.5V; T_A = -55°C to +125°C.)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS
EEPROM Write Cycle Time	t_{wr}			4	10	ms
EEPROM Writes	N_{EEWR}	-55°C to +55°C	50k			Writes
EEPROM Data Retention	t_{EEDR}	-55°C to +55°C	10			Years

Figure 2. TYPICAL OPERATING CURVES

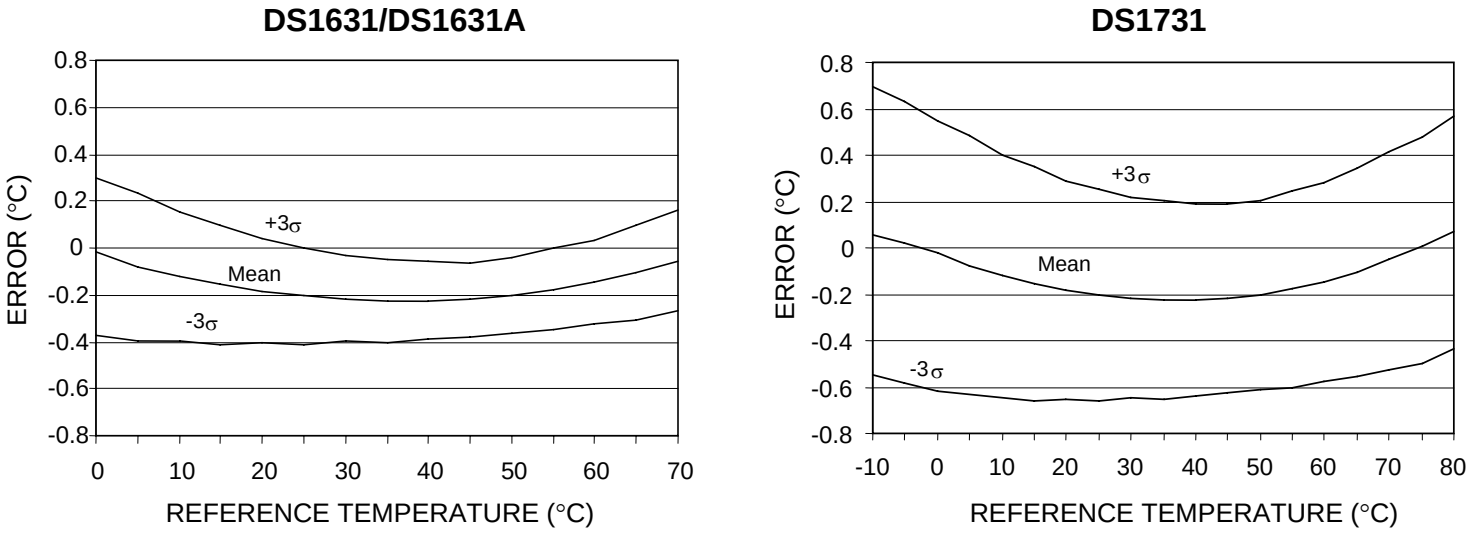


Figure 3. TIMING DIAGRAM

All timing is referenced to 0.9 x V_{DD} and 0.1 x V_{DD}.