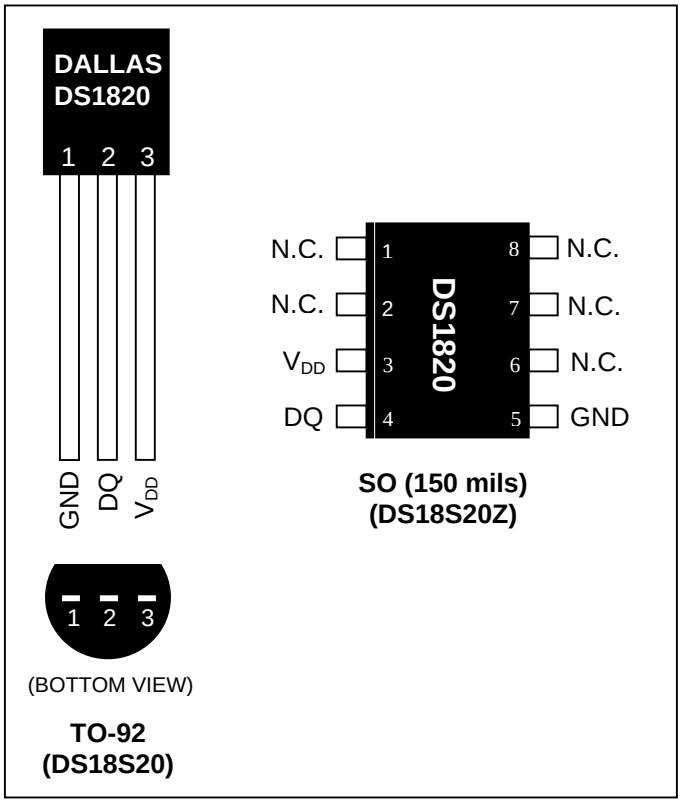
DS18S20
High-Precision 1-Wire Digital Thermometer

FEATURES

- Unique 1-Wire® Interface Requires Only One Port Pin for Communication
- Each Device has a Unique 64-Bit Serial Code Stored in an On-Board ROM
- Multidrop Capability Simplifies Distributed Temperature Sensing Applications
- Requires No External Components
- Can Be Powered From Data Line. Power Supply Range is 3.0V to 5.5V
- Measures Temperatures from -55°C to +125°C (-67°F to +257°F)
- ±0.5°C Accuracy from -10°C to +85°C
- 9-Bit Thermometer Resolution
- Converts Temperature in 750ms (max)
- User-Definable Nonvolatile (NV) Alarm Settings
- Alarm Search Command Identifies and Addresses Devices Whose Temperature is Outside Programmed Limits (Temperature Alarm Condition)
- Applications Include Thermostatic Controls, Industrial Systems, Consumer Products, Thermometers, or Any Thermally Sensitive System

PIN CONFIGURATIONS



DESCRIPTION

The DS18S20 digital thermometer provides 9-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18S20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of –55°C to +125°C and is accurate to ±0.5°C over the range of –10°C to +85°C. In addition, the DS18S20 can derive power directly from the data line (“parasite power”), eliminating the need for an external power supply.

Each DS18S20 has a unique 64-bit serial code, which allows multiple DS18S20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18S20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

ORDERING INFORMATION

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
DS18S20	–55°C to +125°C	3 TO-92	DS1820
DS18S20+	–55°C to +125°C	3 TO-92	DS1820
DS18S20/T&R	–55°C to +125°C	3 TO-92 (2000 Piece)	DS1820
DS18S20+T&R	–55°C to +125°C	3 TO-92 (2000 Piece)	DS1820
DS18S20-SL/T&R	–55°C to +125°C	3 TO-92 (2000 Piece)*	DS1820
DS18S20-SL+T&R	–55°C to +125°C	3 TO-92 (2000 Piece)*	DS1820
DS18S20Z	–55°C to +125°C	8 SO	DS18S20
DS18S20Z+	–55°C to +125°C	8 SO	DS18S20
DS18S20Z/T&R	–55°C to +125°C	8 SO (2500 Piece)	DS18S20
DS18S20Z+T&R	–55°C to +125°C	8 SO (2500 Piece)	DS18S20

+Denotes a lead-free package. A "+" will appear on the top mark of lead-free packages.
T&R = Tape and reel.
** TO-92 packages in tape and reel can be ordered with straight or formed leads. Choose "SL" for straight leads. Bulk TO-92 orders are straight leads only.*

PIN DESCRIPTION

PIN		NAME	FUNCTION
TO-92	SO		
1	5	GND	Ground
2	4	DQ	Data Input/Output. Open-drain 1-Wire interface pin. Also provides power to the device when used in parasite power mode (see the *Powering the DS18S20* section.)
3	3	V_{DD}	Optional V_{DD}. V_{DD} must be grounded for operation in parasite power mode.
—	1, 2, 6, 7, 8	N.C.	No Connection

OVERVIEW

Figure 1 shows a block diagram of the DS18S20, and pin descriptions are given in the *Pin Description* table. The 64-bit ROM stores the device's unique serial code. The scratchpad memory contains the 2-byte temperature register that stores the digital output from the temperature sensor. In addition, the scratchpad provides access to the 1-byte upper and lower alarm trigger registers (T_H and T_L). The T_H and T_L registers are nonvolatile (EEPROM), so they will retain data when the device is powered down.

The DS18S20 uses Maxim's exclusive 1-Wire bus protocol that implements bus communication using one control signal. The control line requires a weak pullup resistor since all devices are linked to the bus via a 3-state or open-drain port (the DQ pin in the case of the DS18S20). In this bus system, the microprocessor (the master device) identifies and addresses devices on the bus using each device's unique 64-bit code. Because each device has a unique code, the number of devices that can be addressed on one bus is virtually unlimited. The 1-Wire bus protocol, including detailed explanations of the commands and "time slots," is covered in the *1-Wire Bus System* section.

Another feature of the DS18S20 is the ability to operate without an external power supply. Power is instead supplied through the 1-Wire pullup resistor via the DQ pin when the bus is high. The high bus signal also charges an internal capacitor (C_{PP}), which then supplies power to the device when the bus is low. This method of deriving power from the 1-Wire bus is referred to as "parasite power." As an alternative, the DS18S20 may also be powered by an external supply on V_{DD}.

ABSOLUTE MAXIMUM RATINGS

Voltage Range 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 Temperature .....Refer to the IPC/JEDEC J-STD-020 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 (-55°C to +125°C; V_{DD} = 3.0V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Supply Voltage	V_{DD}	Local Power	+3.0		+5.5	V	1
Pullup Supply Voltage	V_{PU}	Parasite Power	+3.0		+5.5	V	1, 2
		Local Power	+3.0		V_{DD}		
Thermometer Error	t_{ERR}	-10°C to +85°C			±0.5	°C	3
		-55°C to +125°C			±2		
Input Logic-Low	V_{IL}		-0.3		+0.8	V	1, 4, 5
Input Logic-High	V_{IH}	Local Power	+2.2		The lower of 5.5 or V_{DD} + 0.3	V	1, 6
		Parasite Power	+3.0				
Sink Current	I_L	$V_{I/O}$ = 0.4V	4.0			mA	1
Standby Current	I_{DDS}			750	1000	nA	7, 8
Active Current	I_{DD}	V_{DD} = 5V		1	1.5	mA	9
DQ Input Current	I_{DQ}			5		µA	10
Drift				±0.2		°C	11

AC ELECTRICAL CHARACTERISTICS—NV MEMORY

(-55°C to +100°C; V_{DD} = 3.0V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NV Write Cycle Time	t_{WR}			2	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

AC ELECTRICAL CHARACTERISTICS (-55°C to +125°C; V_{DD} = 3.0V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Temperature Conversion Time	t_{CONV}				750	ms	1
Time to Strong Pullup On	t_{SPON}	Start Convert T Command Issued			10	µs	
Time Slot	t_{SLOT}		60		120	µs	1
Recovery Time	t_{REC}		1			µs	1
Write 0 Low Time	t_{LOW0}		60		120	µs	1
Write 1 Low Time	t_{LOW1}		1		15	µs	1
Read Data Valid	t_{RDV}				15	µs	1
Reset Time High	t_{RSTH}		480			µs	1
Reset Time Low	t_{RSTL}		480			µs	1, 2
Presence-Detect High	t_{PDHIGH}		15		60	µs	1
Presence-Detect Low	t_{PDLOW}		60		240	µs	1
Capacitance	$C_{IN/OUT}$				25	pF	

Figure 16. Typical Performance Curve