AN176

Using the DS1631 Temperature Sensor in DS1621 Applications

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INTRODUCTION

The DS1631 was designed to be software compatible with the DS1621 in most applications, which makes it a simple matter to switch from the DS1621 to the DS1631. This application note describes the differences and similarities between the two parts including DS1631 functions that allow compatibility with the DS1621 but which are not documented in the DS1631 data sheet. All subjects not covered in this application note (e.g., 2-wire communication) are the same for both devices.

This application note is aimed at users interested in transitioning from the DS1621 to the DS1631. For new designs incorporating the DS1631, please refer to the DS1631 data sheet for usage instructions, as information in this application note will not be pertinent. Users switching from the DS1621 to the DS1631 will also need to reference the DS1631 data sheet for device specifications and other information not covered in this application note.

DS1631 TEMPERATURE SENSING ARCHITECTURE

The DS1631 uses a bandgap temperature sensing architecture in conjunction with a sigma-delta analog to digital converter to provide digital temperature measurements. The bandgap circuit produces a voltage that varies linearly with temperature. This voltage is converted to a digital value by the analog-to-digital converter (ADC). This architecture allows the user to select 9, 10, 11, or 12-bit temperature readings by setting the R1 and R0 bits in the configuration register.

DS1621 TEMPERATURE SENSING ARCHITECTURE

The DS1621 measures temperature using a dual-oscillator architecture that provides 9-bit temperature readings. If desired, the user can calculate higher resolution temperatures using data from the DS1621's COUNT_REMAIN and COUNT_PER_C registers. This data is a direct result of the dual-oscillator architecture. This architecture is described in detail in Application Note 105 *High Resolution Temperature Measurement with Dallas Direct-to-Digital Temperature Sensors*, and the method for performing high-resolution temperature calculations with the DS1621 is explained in the DS1621 data sheet.

COUNT_REMAIN AND COUNT_PER_C REGISTERS

To maintain software compatibility with DS1621 applications that perform high-resolution temperature calculations, the DS1631 provides user-accessible COUNT_REMAIN and COUNT_PER_C registers. Since the data for these registers can't be generated directly from the bandgap architecture, the COUNT_REMAIN register is loaded with a value derived from the measured temperature, and the COUNT_PER_C register is hardwired to 16 (decimal). For reverse compatibility, the command protocols for accessing the DS1631 COUNT_REMAIN and COUNT_PER_C registers are the same as for the DS1621 (see Table 1). These commands are not documented in the DS1631 data sheet. Note that the value in the DS1631 COUNT_REMAIN register is only valid for high-resolution temperature calculations if temperature conversions are initiated using the DS1621 Start Convert T command as explained in the next section.

Table 1. UNDOCUMENTED DS1631 COMMANDS

COMMAND	DESCRIPTION	PROTOCOL	COMMENTS
Start Convert T	Initiates temperature conversion(s).	EEh	DS1621 Start Convert T command causes the DS1631 to operate in DS1621 mode.
Read Counter	Reads 1-byte COUNT_REMAIN register.	A8h	The DS1621 Start Convert T command must be used for the data in the COUNT_REMAIN register to be valid for high-resolution calculations.
Read Slope	Reads 1-byte COUNT_PER_C register.	A9h	The COUNT_PER_C register is hard-wired to 16 (decimal) in the DS1631.

INITIATING TEMPERATURE MEASUREMENTS

Temperature conversions in the DS1631 can be initiated using either the DS1631 Start Convert T command (protocol = 51h) or the DS1621 Start Convert T command (protocol = EEh). When the 51h Start Convert T command is used, the output temperature resolution in determined by the R1 and R0 bits in the configuration register (as described in the DS1631 data sheet), and data in the COUNT_REMAIN register is not valid for high-resolution temperature calculations. When the EEh Start Convert T command is used, the R1 and R0 bits in the configuration register are ignored by the DS1631 regardless of what values have been written to them, and the output temperature resolution is set to 9 bits, exactly like in the DS1621. In addition, when the EEh command is used, the data in the COUNT_REMAIN register is valid for high-resolution calculations.

PACKAGE INFORMATION

The DS1631 is available in 150mil 8-pin SO and 8-pin µSOP packages. The DS1621 is available in 150mil 8-pin SO, 208mil 8-pin SO, and 300mil 8-pin PDIP packages. In the 150mil 8-pin SO package, both devices have the same pinout. Table 2 summarizes the part numbers for each package type for the DS1621 and DS1631.

Table 2. PACKAGE CROSS-REFERENCE

	DS1621 PART NUMBER	DS1631 PART NUMBER
8-pin µSOP	—	DS1631U
150mil 8-pin SO	DS1621S	DS1631Z
208mil 8-pin SO	DS1621V	—
300mil 8-pin PDIP	DS1621	—

SPECIFICATION DIFFERENCES

Most electrical specifications are the same for both the DS1631 and the DS1621. However, there are a few specification differences, which are summarized in Table 3. Please note that Table 3 is for reference only and does not contain all the information needed for design purposes. Consult the DS1621 and DS1631 data sheets for complete specification information.

Table 3. SPECIFICATION DIFFERENCES

(-55°C ≤ Temp ≤ +125°C and 2.7V ≤ V_{DD} ≤ 5.5V unless otherwise noted).

PARAMETER	CONDITIONS	DS1631 MAX	DS1621 MAX	UNITS
Thermometer Error	0°C to 70°C 3.0V ≤ V_{DD} ≤ 5.5V	±½	±½	°C
	0°C to 70°C 2.7V ≤ V_{DD} < 3.0V	±1	±½	
	-55°C to +125°C	±2	See curve in DS1621 data sheet	
High Level Input Voltage		V_{DD} + 0.3	V_{DD} + 0.5	V
Active Supply Current	Temperature Conversion -55°C to +85°C	1	1	mA
	Temperature Conversion +85°C to +125°C	1.25	1	
	E^2 Write	400	400	µA
	Communication Only	110	100	
Standby Supply Current		800	1000	nA
Thermometer resolution		12	Unspecified	bits
Temperature Conversion Time	9-Bit Resolution	93.75	1000 (9-bit output with ability to calculate higher resolution results)	ms
	10-Bit Resolution	187.5		
	11-Bit Resolution	375		
	12-Bit Resolution	750		
Absolute Maximum Voltage on any Pin, Relative to GND		+6.0	+7.0	V

SUMMARY

For most applications the DS1631 is reverse compatible with the DS1621 since the DS1631 was designed to respond to all DS1621 commands and can provide all the data needed for DS1621-style high-resolution temperature calculations. Thus, architectural differences between the parts are outwardly invisible to the user, making it a simple matter to switch from the DS1621 to the DS1631.

If you require further information about transitioning your application from the DS1621 to the DS1631, please contact our technical support team. The DS1631 and DS1621 data sheets can be downloaded from the Maxim website at www.maximintegrated.com.