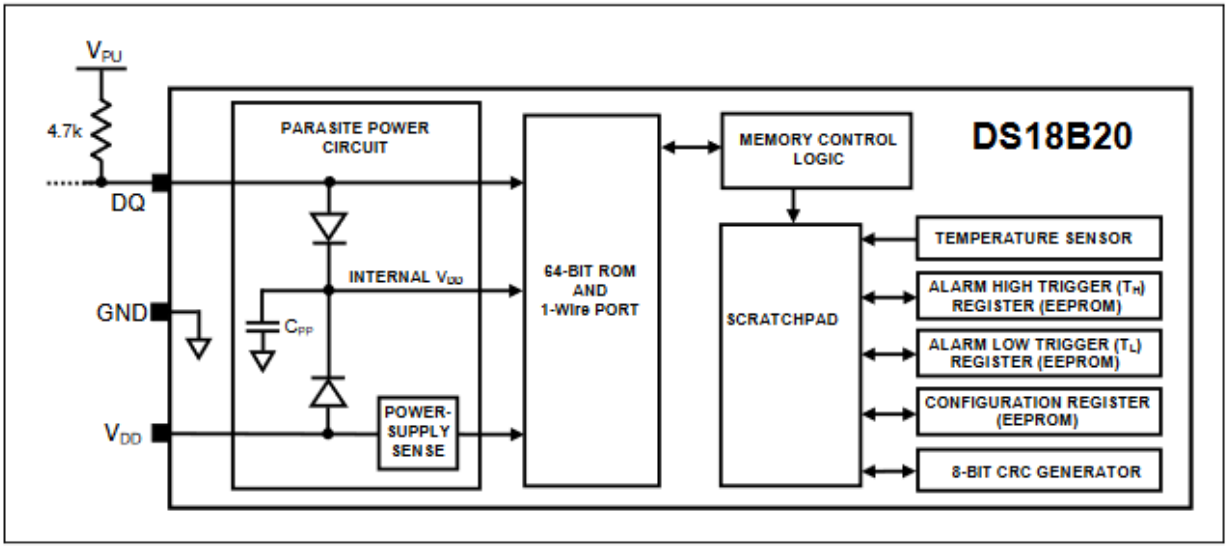
Overview - DS18B20 1-Wire Digital Thermometer

Key Features

- Accuracy is ±0.5 °C over the range -10°C to +85°C.
- Has an alarm function with programmable upper and lower trigger points (in non-volatile EEPROM).
- Communication over 1-Wire bus (i.e. can connect several DS18B20 on the same bus)
- Can derive power directly from the data line ("parasite power")
- Unique 64-bit Serial Code Stored in an On-Board ROM
- Converts temperature to 12-bit Digital Word in 750ms (max)
- Several DS18B20 can be connected on the same Bus
- User-configurable resolution to 0.5, 0.25, 0.125 or 0.0625°C (9, 10, 11 or 12 bits)
- Output in Celsius

Block Diagram

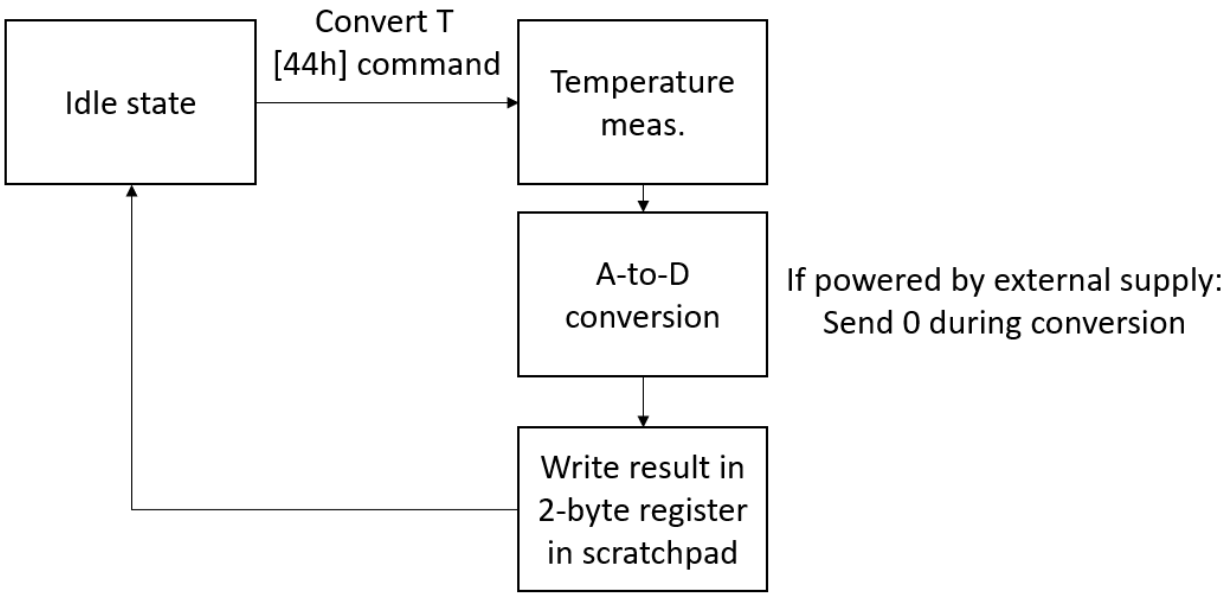
Figure 1. DS18B20 Block Diagram



Notes

- 4.7k pull-up is required because all devices are linked to the bus via a 3-state or open-drain port.
- In "parasite power" mode, the high bus charges an internal capacitor (Cpp).

Operation



Note:

- If using “parasite power”, cannot notify sending 0 because it needs to be pulled high by a strong pullup during the entire temperature conversion
- Least significant bit is sent first.

Data Storage

Using 16-bit sign-extended two’s complement number.

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
LS BYTE	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}
	BIT 15	**BIT 14**	**BIT 13**	**BIT 12**	**BIT 11**	**BIT 10**	**BIT 9**	**BIT 8**
MS BYTE	S	S	S	S	S	2^6	2^5	2^4

S = SIGN

TEMPERATURE (°C)	DIGITAL OUTPUT (BINARY)	DIGITAL OUTPUT (HEX)
+125	0000 0111 1101 0000	07D0h
+85*	0000 0101 0101 0000	0550h
+25.0625	0000 0001 1001 0001	0191h
+10.125	0000 0000 1010 0010	00A2h
+0.5	0000 0000 0000 1000	0008h
0	0000 0000 0000 0000	0000h
-0.5	1111 1111 1111 1000	FFF8h
-10.125	1111 1111 0101 1110	FF5Eh
-25.0625	1111 1110 0110 1111	FE6Fh
-55	1111 1100 1001 0000	FC90h

Notes:

- If resolution is reduced, the LSB are filled will be undefined. For instance, if the resolution is 9 bit, bit 0, 1 and 2 are undefined.
- The power-on reset value of the temperature register is +85°C.

Powering the DS18B20

1- Parasite power:

- Steals the power from the bus data.
- VDD must be connected to the ground.
- Necessary to apply a strong pullup for the duration of the conversation or data transfer.
- No other activity can take place on the 1-Wire bus while the pullup is enabled.
- Not recommended for temperature higher than 100°C.
- Within 10us, there must be a strong pullup during the conversion

2- Regular VDD

- No strong pullup required.
- 1-Wire Bus is free to carry other traffic during the temperature conversion time.

To know which power mode is in use: master can issue a Skip ROM [CCh] command, followed by a Read Power Supply [B4h] command followed by a “read time slot”. If the bus is pulled low, the master knows that it must supply the strong pullup on the 1-Wire bus during temperature conversions.

Figure 4. Supplying the Parasite-Powered DS18B20 During Temperature Conversions

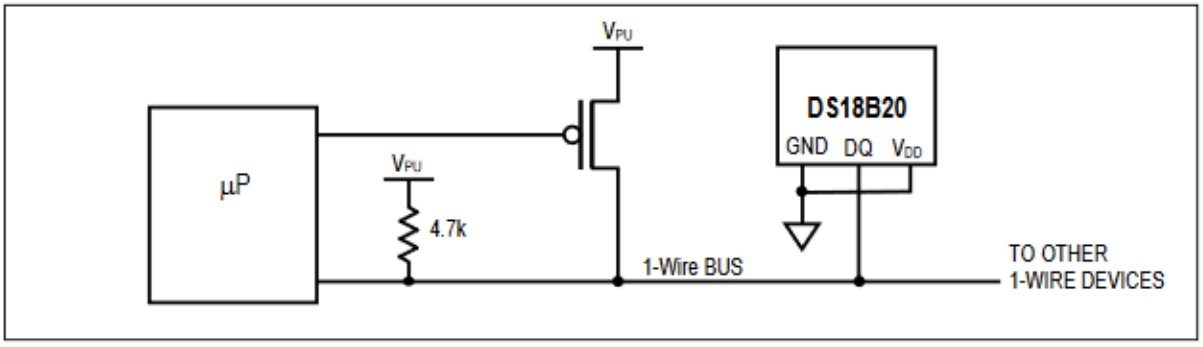
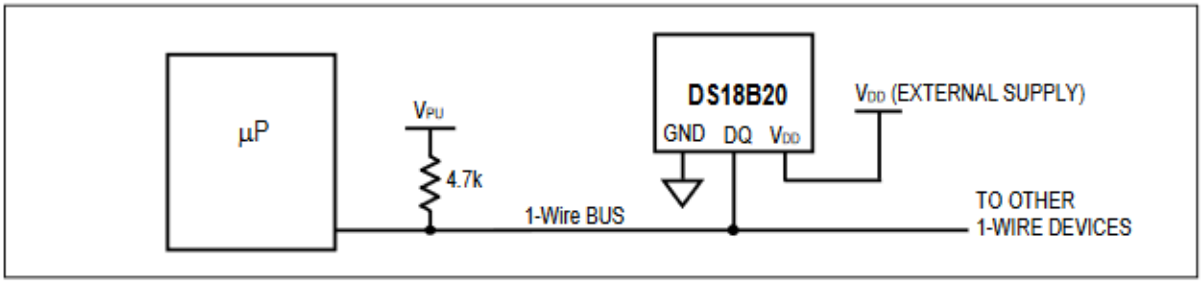


Figure 5. Powering the DS18B20 with an External Supply



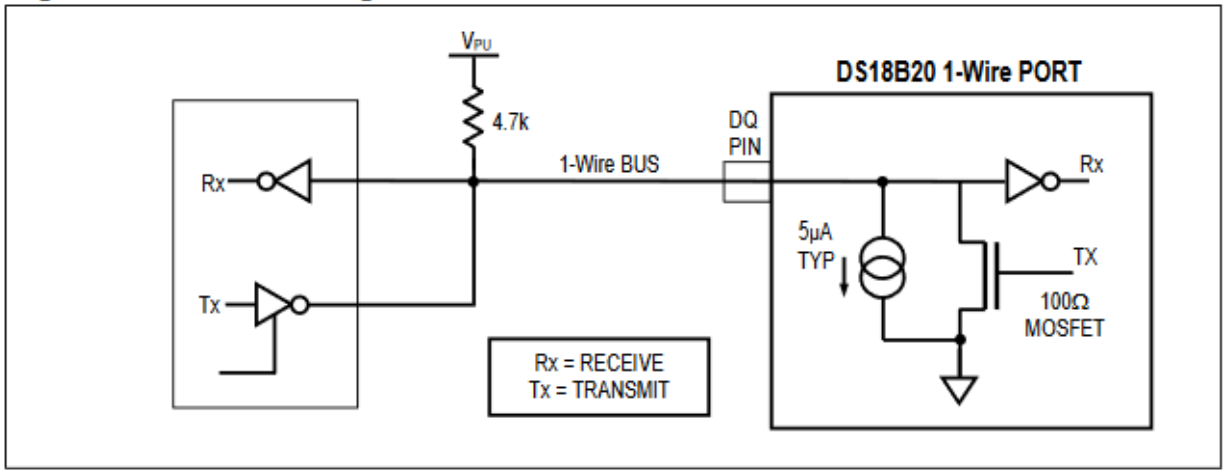
Trade-Off between conversion time and resolution:

Table 2. Thermometer Resolution Configuration

R1	R0	RESOLUTION (BITS)	MAX CONVERSION TIME	
0	0	9	93.75ms	(t_{CONV}/8)
0	1	10	187.5ms	(t_{CONV}/4)
1	0	11	375ms	(t_{CONV}/2)
1	1	12	750ms	(t_{CONV})

1-Wire bus system

Figure 10. Hardware Configuration



Notes:

- Each device interfaces to the data line via an open-drain or 3-state port.
- Idle state is high for the bus.
- The bus must be held low for more than 480us for all components on the bus to be reset.
- Not the same command if there is only one slave or several.

TRANSACTION SEQUENCE

The transaction sequence for accessing the DS18B20 is as follows:

Step 1. Initialization

Step 2. ROM Command (followed by any required data exchange)

Step 3. DS18B20 Function Command (followed by any required data exchange)

AC Electrical Characteristics:

Capacitance (in/out) is max 25pF.

Figure 15. Detailed Master Read 1 Timing

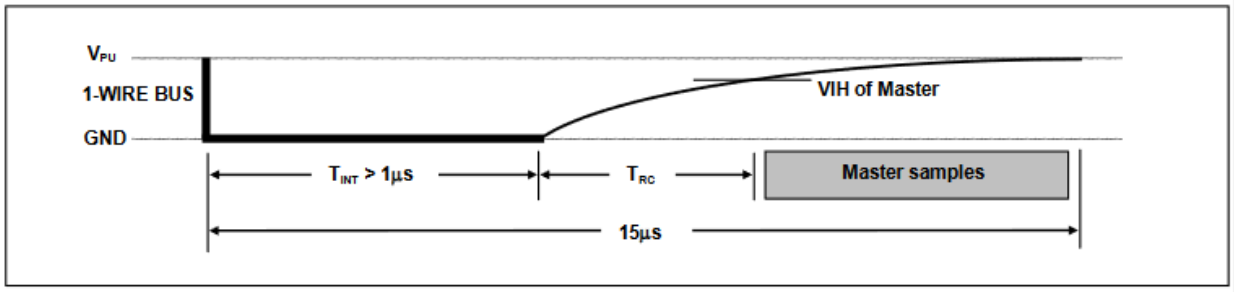
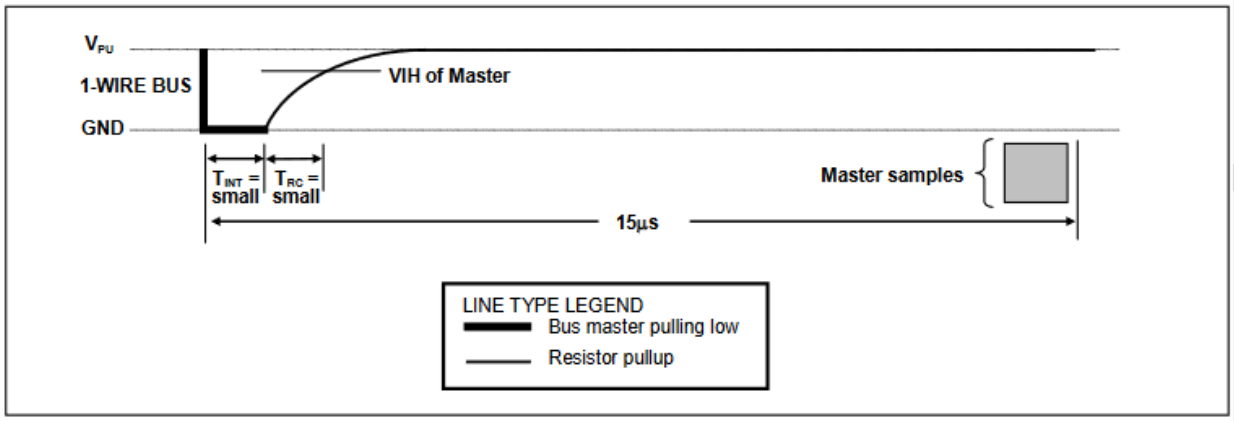


Figure 16. Recommended Master Read 1 Timing



16.3 kbps

Might need to increase the pullup

To send a “1”, the bus master sends a very brief (1-15us) low pulse. To send a “0”, the master sends a 60us low pulse.

https://en.wikipedia.org/wiki/1-Wire

To receive data, the master sends a 1-15us 0-volt pulse to start ech bit. If the transmitting slave unit wants to send a “1”, it does nothing. And the bus goes to the pulled-up voltage. If the transmitting salve wants to send a “0”, it pulls the data line to ground for 60 us.

Can find 75 devices per second.

For maximum cable length:

Two things to check:

Voltage is respected? (i.e. the voltage drop along the line)

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			

Work-around: change the Rpullup.

Timings must be respected: It will depend on the cable capacitance and the R. Need to check at both side of the cable.

https://www.maximintegrated.com/en/design/technical-documents/app-notes/7/74.html

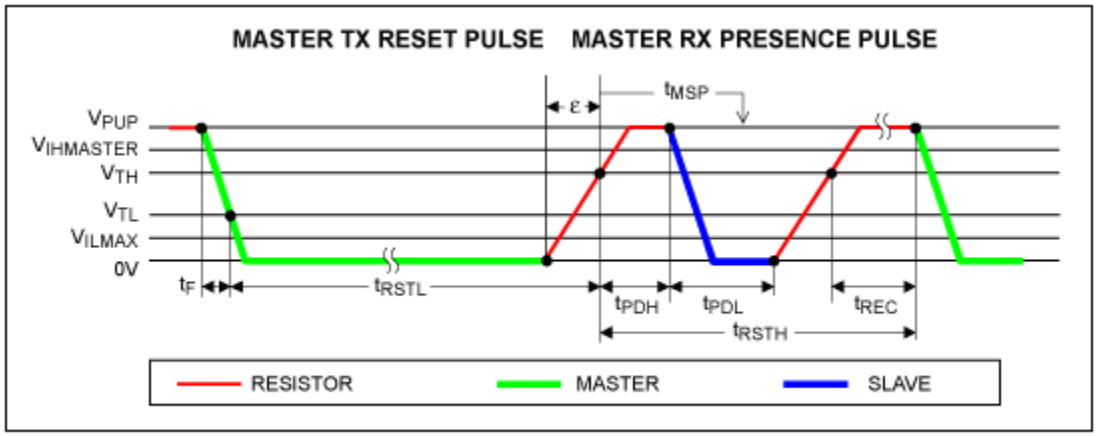


Figure 1. Reset and presence pulse.

Need to make sure there is no glitch in the rising and falling edges!

Epsilon depends on Rpullup and the capacitance of the bus.

Need to watch out for reflection.

https://www.maximintegrated.com/en/design/technical-documents/app-notes/1/126.html

1. The communication port must be bidirectional, its output is open-drain, and there is a weak pullup on the line. This is a requirement of any 1-Wire application note 4206, "Choosing the Right 1-Wire® Master for Embedded Application" for a simple example of a 1-Wire master microprocessor
2. The system must be capable of generating an accurate and repeatable 1µs delay for standard speed and 0.25µs delay for overdrive speed.
3. The communication operations must not be interrupted while being generated.