NTC thermistors versus voltage output IC temp sensors

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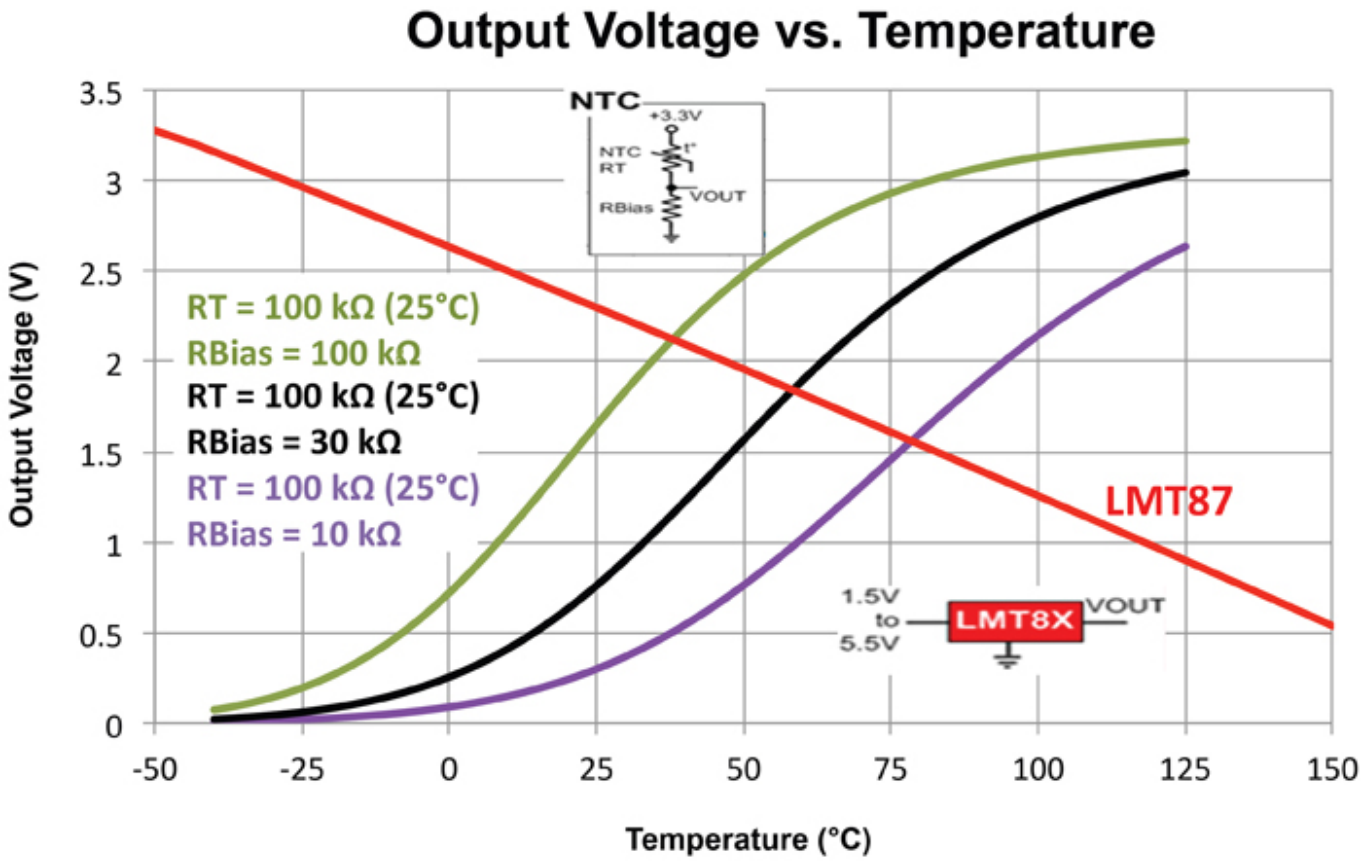
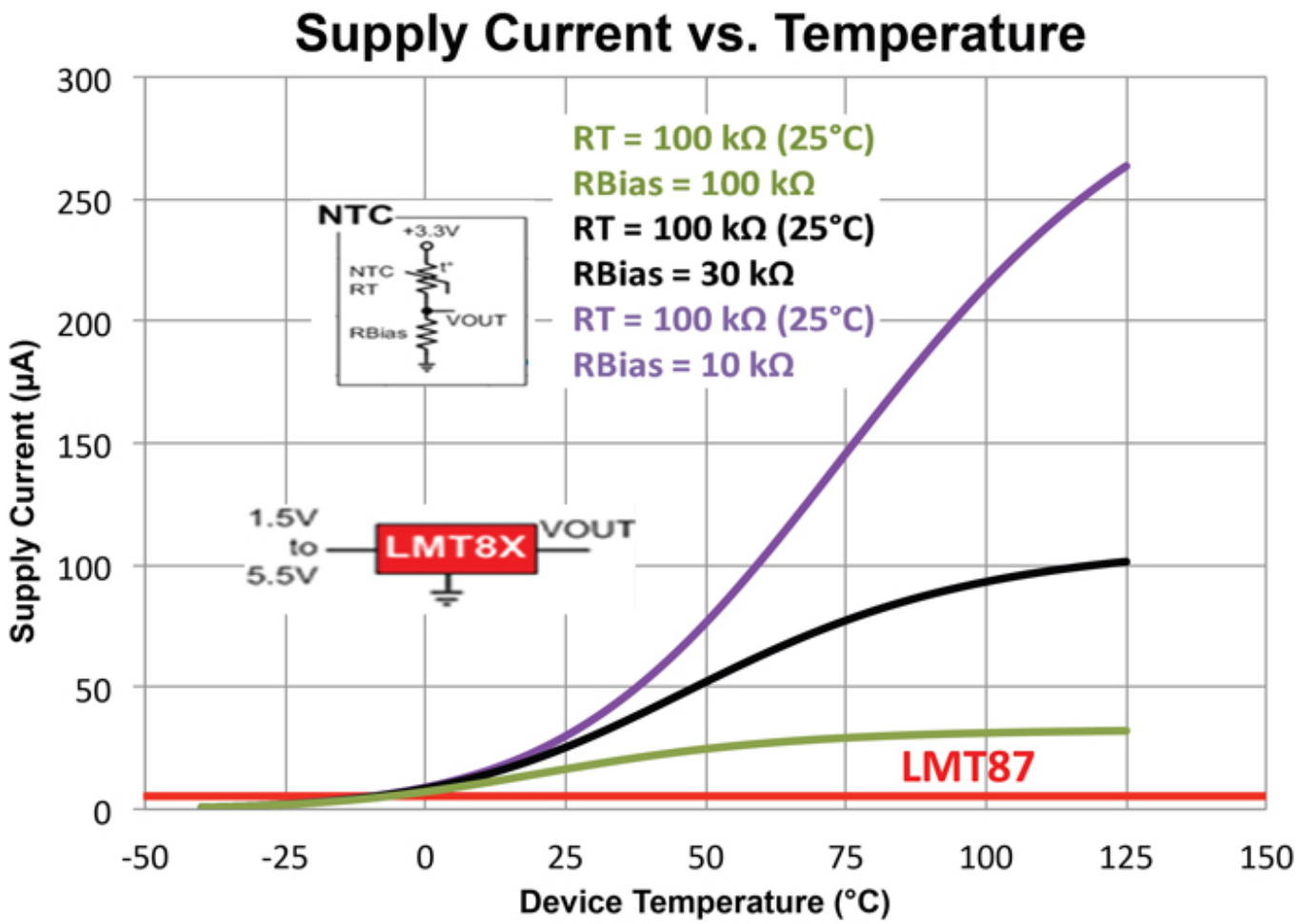
Electronic engineers are finding that thermometry is becoming increasingly more popular in modern applications. Two types of commonly used temperature sensing solutions are negative temperature coefficient (NTC) thermistors and voltage output integrated circuit (IC) temp sensors. A thermistor is a resistor whose resistance varies with temperature. In particular, NTC thermistor's resistance decreases as temperature increases. Voltage output IC temp sensors are silicon temperature sensors that output an analog voltage that is proportional to temperature.

There are a few advantages for using an NTC thermistor over a voltage output IC temp sensor. A key advantage is that there are many more package options available. This includes packages smaller than those available for voltage output IC temp sensors. Oftentimes, this translates to faster response times as response time is highly dependent on the package size. An advantage when interfacing an NTC thermistor with an analog-to-digital converter (ADC) is ratiometric configuration, resulting in the canceling of the ADC reference error. Additionally, NTC thermistors appear to be cheaper than voltage output IC temp sensors. However, additional components often are necessary when using NTC thermistors and must be considered in the cost of the overall temperature sensing solution. For a higher price, engineers can get NTC thermistors with a wider temperature range than voltage output IC temp sensors.

Alternatively, there are advantages for using a voltage output IC temp sensor over an NTC thermistor. One advantage is that voltage output IC temp sensors tend to be easier to use as they have a user friendly virtual linear output. Alternatively, NTC thermistor's resistance vs. temperature characteristic is exponential. Figure 1 shows the output voltage vs. temperature of three voltage divider NTC thermistor networks and Texas Instrument's LMT87 voltage output IC temp sensor. The NTC thermistor's change in voltage per °C is not constant across the temperature range, while the voltage output IC temp sensor's change in voltage per °C is virtually constant. When interfaced with an ADC, voltage output IC temp sensors tend to be more accurate across the device's entire temperature range. This is because the resolution of the ADC is enough to detect a change in voltage for the voltage output IC temp sensor, but not always for the NTC thermistor. However, thermistors can be combined with complex resistive networks to help linearize the curve over a limited temperature range. Note that the resistive networks used with NTC thermistors increase the complexity, cost, and footprint of the overall temperature sensing solution.



Another advantage for using a voltage output IC temp sensor is that they dissipate much less power due to having a fairly constant low supply current. NTC thermistors, on the other hand, have a supply current that varies greatly over temperature. Figure 2 illustrates this advantage by showing the typical supply current versus the device temperature of three voltage divider thermistor networks and Texas Instrument’s LMT8X series of voltage output IC temp sensors. As temperature increases, the NTC thermistor’s resistance decreases. As seen in Figure 2, this causes the current through the voltage divider network to increase. When the current is high, NTC thermistors can self-heat above the ambient temperature of the environment resulting in temperature errors.



One last thing to consider when deciding to use an NTC thermistor or voltage output IC temp sensor is output impedance. Voltage output IC temp sensors have fairly constantly low output impedance, while NTC thermistors output impedance is generally higher and varies over temperature. When using an ADC with an NTC thermistor, care must be taken to ensure that the ADC can handle the NTC thermistor's source impedance. In some cases, a buffer may be required.

Summary
Technology is constantly evolving and engineers are finding that the need for temperature sensing is becoming more common. NTC thermistors and voltage output IC temp sensors are both useful temperature sensing solutions. But in the end, the suitable temperature sensing solution is dependent on the output metrics and requirements of individual applications.

References
Download the LMT87 datasheet: www.ti.com/lmt87-ca [1].
For more information, visit: www.ti.com/tempsensors-ca [2].

About the author
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