System telemetry: What, why and how?

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Introduction

There has been a recent increase in demand for telemetry in many end-equipment applications using FPGAs or ASICs. The primary market segments with the largest increase in this demand have been in the computing, communications, defense, avionics and industrial markets. This article describes what telemetry is and examines several options for implementation.

First off, what is telemetry? As referred to in this article, telemetry is the measurement, control and automatic transmission of data through a digital interface such as PMBus, I²C or SPI. Why is telemetry needed in a power supply? Many end applications require voltage, current, temperature, power and several other device parameters to be monitored, and even controlled dynamically. For example, in a FPGA application with a multi-phase supply, telemetry could be used to add or shed one phase to adjust the solution for optimal performance. Other typical applications include servers, base stations, routers, defense applications, and test and measurement equipment.

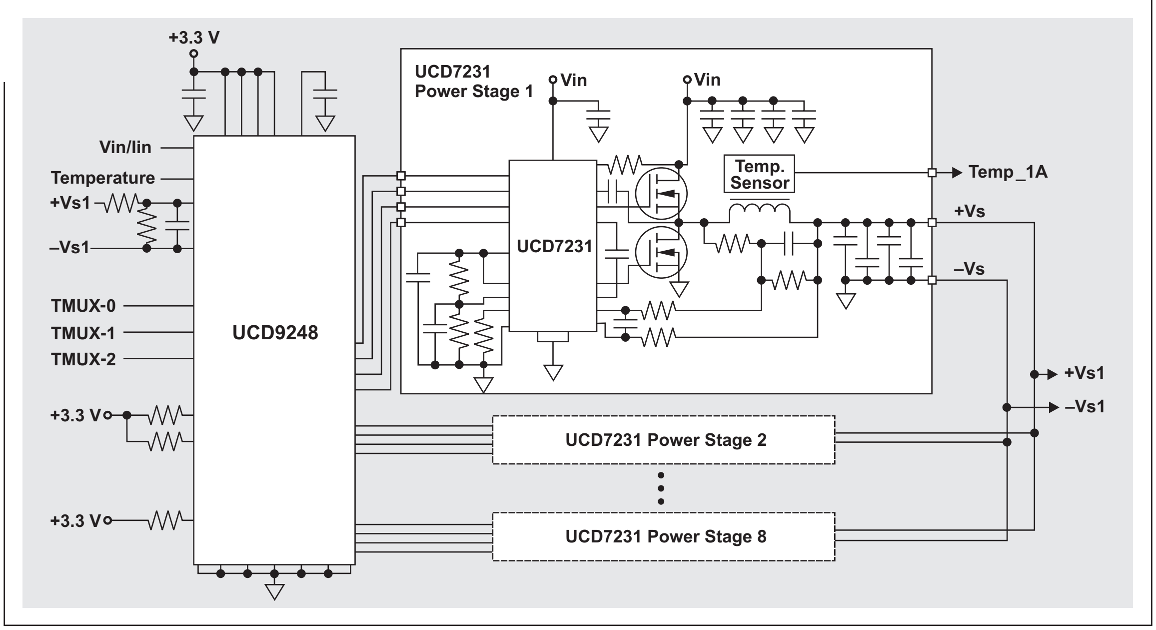
How can telemetry be applied to your applications? There are several ways to incorporate telemetry into a system that gives the designer options for maximum control, flexibility and simplicity. For a maximum level of control, a digital power controller offers the advantage of integrated data converters with a microcontroller (MCU) in addition to an extensive register set that can be used to capture and process the sensed data to manipulate the solution. If simplicity is desired for controlling the basic features, a controller with integrated PMBus (or I²C, SPI, and others) telemetry functions can be a good fit for your application. An alternative to power controllers with a digital interface would be a digital sequencer or system health monitor that can be used in combination with discrete analog controllers and converters.

Option 1: Maximum level of control

Digital power controller

Digital power solutions with an built-in precision analog-to-digital converter (ADC) help measure the input and output voltage and current to capture the telemetric data. This data can be used to set the fault conditions for protection and can be logged into non-volatile memory to help understand the cause of the fault. Additional features that can be incorporated in a digital power solution includes voltage tracking, margining, sequencing, soft-start timing, current balancing and phase adding/shedding, among others. Typically, digital power solutions come with a graphical user interface (GUI) that makes it easier for the end user to configure and track real-time data measurements. An example of a digital power solution is shown in Figure 1.

Figure 1: Digital Controller used with a Fusion GUI to control the power stages



Digital power solutions provide the utmost control and flexibility in terms of scalability, monitoring real-time data, and setting up consequences to certain fault conditions. However, the solution comes with a level of complexity and higher cost. While this makes it the right solution for certain applications, it is in excess for others.

Option 2: Simplicity

PMBus converters with integrated telemetry

If the objective is to simplify the solution compared to a digital power controller, an analog power IC with an integrated digital interface is another option. This option offers the key parameters and control of telemetry, but it lacks the extensive list of controls offered by a digital power controller. Here are a few PMBus registers that are commonly found in this type of solution to store data for measurement and system control.

- Output voltage margining and adjustment
- Soft-start time
- V_{DD} undervoltage lockout (UVLO) level
- Overcurrent protection/current limit setting
- Switching frequency

This solution can be more cost-effective and less complex than a purely digital power solution. The drawback, however, is that the solution is not as flexible due to a limited register set.

Option 3: Flexibility

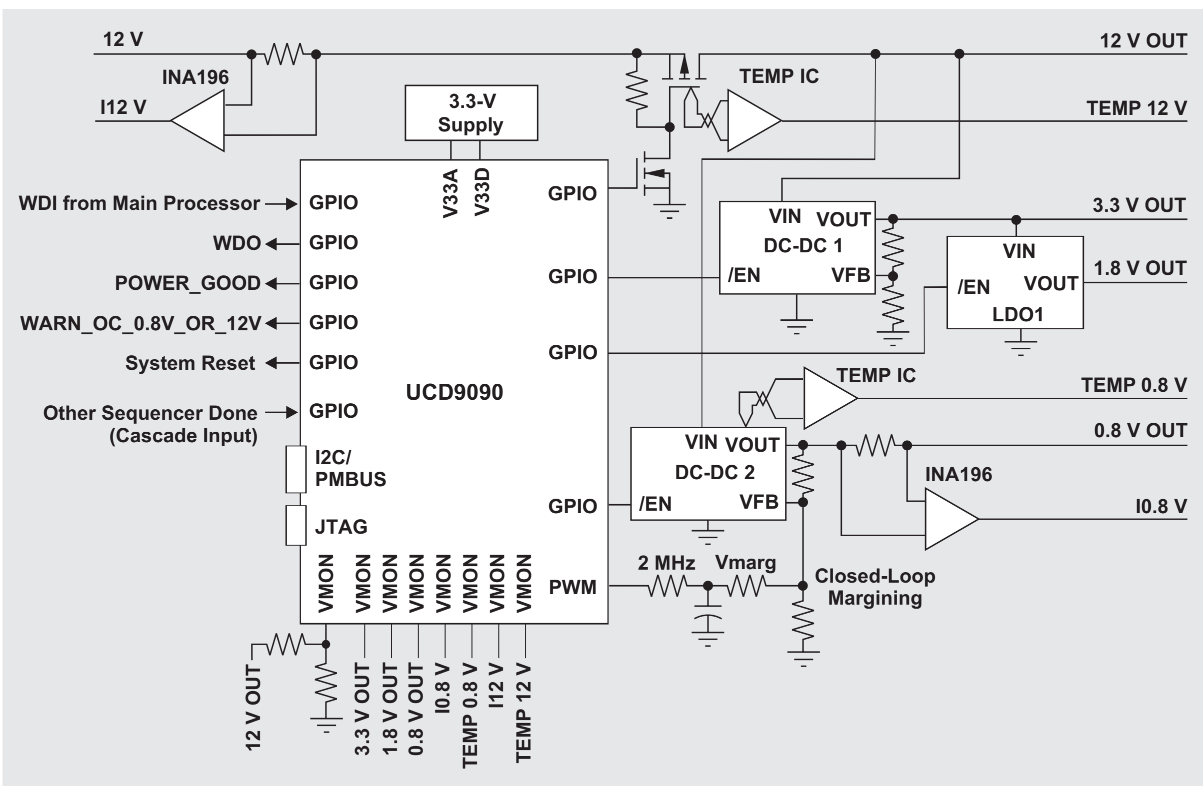
External digital-system health monitor + current sensor + temperature sensor

Another option for adding telemetry to a system is the addion of external ICs, such as a digital-system health monitor with high-precision current sensors and temperature sensors. This option provides the flexibility to use any power management IC in the industry (with or without digital interface). It also can be paired with these external ICs to provide telemetry.

A digital-system health monitor is an IC that includes rail sequencing, margining, UVLO, overvoltage protection (OVP), and a digital-communication interface. It captures and logs data that can be utilized for controlling the fault conditions and other system controls. If current and temperature also need to be monitored, the system health monitor can be used in conjunction with a current-sense amplifier and temperature sensor as shown in the Figure 2.

To accurately sense current, the current first must be converted to a voltage by placing a small-value, low-tolerance sense resistor in the current path. The voltage across the resistor can then be amplified through a current shunt monitor IC such as the INA196. This IC provides the necessary gain to provide an output voltage that can be sent to an ADC input of the digital health monitor and then to the FPGA.

Figure 2: System health monitor with current-sense amplifier and temperature sensor



There are some applications that require such high precision in measurements that an external high-resolution ADC is required, which comes with added cost. To save the cost of an independent ADC, power monitoring ICs (INA226) are available with an integrated precision ADC that can monitor voltage and current, calculate power and provide I^2C telemetry (Figure 3).

Temperature monitoring is another common telemetry application that is similar to current monitoring. Some ICs, such as digital sequencers, are equipped with internal temperature sensors on the die to provide temperature monitoring. However, this limits temperature reading to only one point in the system; at the die. To monitor the temperatures at several points in a system, such as local to each power supply, remote temperature-monitoring ICs are available to convert temperature to voltage and provide telemetry interface.

Conclusion

There are many methods for measuring and controlling a system via telemetry. As a starting point, this article presented three options for integrating telemetry into your system. Digital power provides the utmost level of control, while an analog power solution with digital interface provides simplicity. The external system monitor provides the most flexibility in picking the right parts for the solution.

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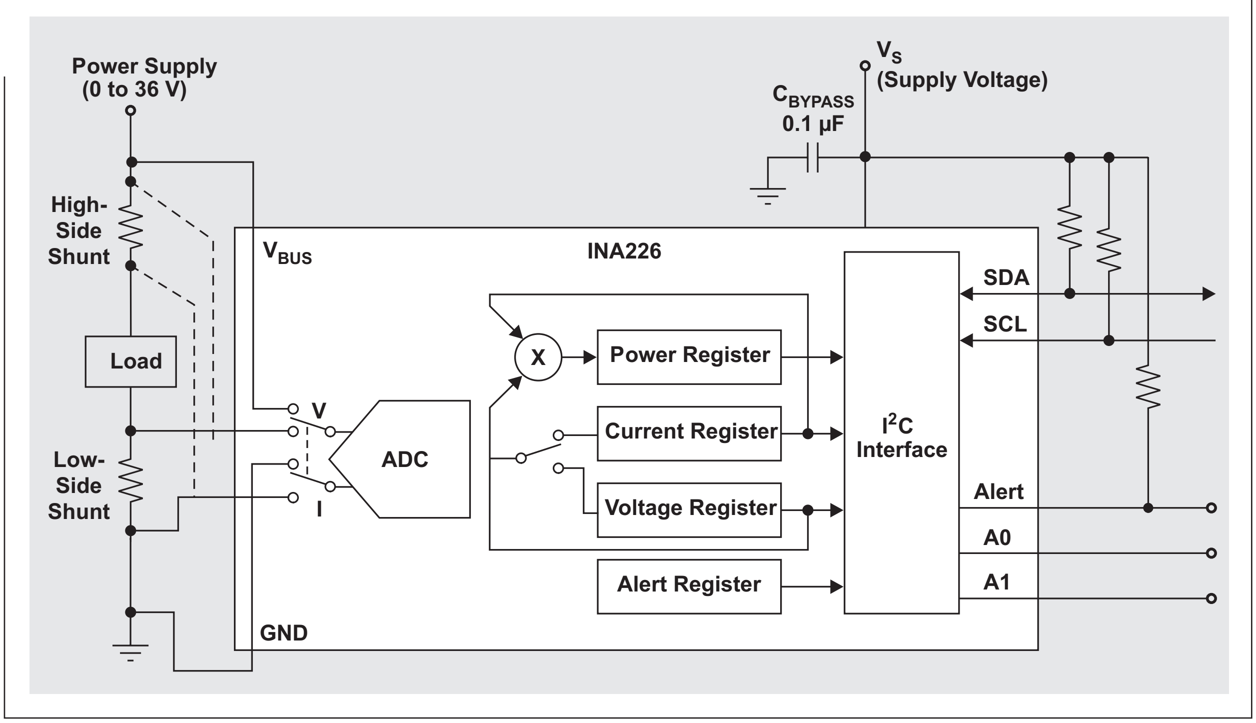
Figure 3: Power monitor with integrated ADC and telemetry



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