A Reinforced-Isolated Analog Input Chain for Space-Constrained Applications

Lars Lotzenburger

The need for higher performance and higher channel density for PLC I/O modules is still unbroken. Higher density means less space per channel in all three dimensions. Requirements in application height are important, as more modules can be installed to a cap rail with given length. This is contrary to the need of isolation of power and data in such a module. While data isolation is under control with digital multichannel isolators like the ISO7741, the isolation of power requires a bulky transformer massively limiting the module height. Power isolation can be removed by supplying the isolated (field) side from the 24-V field power supply, but at the cost of additional screw terminals on the front-side, more installation effort (cabling), and a high input voltage power stage, including protection. In the past, thin, isolated solutions have been developed using a PCB transformer at the cost of board space. See TIDA-00688 for an example. This application note shows how both requirements (isolation and thinness) can be easily combined using the UCC12050, an integrated, reinforced-isolated DC/DC converter in a SOIC16 package.

The UCC12050 accepts an input voltage of 5 V. The output voltage is 3.3 V or 5 V. Two additional outputs of 3.7 V and 5.4 V can be used to feed an LDO, which outputs 3.3 V or 5 V (the 400 mV are used for the LDO dropout voltage). See Figure 1 for an example schematic targeting a 3.3 V output voltage either with or without the LDO LP2985-33. The total output power of 500 mW enables applications with a reinforced-isolation of up to 5 kV RMS. The integrated thermal shutdown and tolerance to short-circuit at the output enables very robust applications.

In the following, the performance of the UCC12050 in a PLC analog input module is investigated. See TIDA-01434 for schematics of the analog front end used for the test.

The ISO7741 in SOIC-16 package is selected to have at least the same isolation rating as the UCC12050. If a basic isolation is sufficient, and power consumption is important, the ISO7041 is a good option.

The UCC12050 output drives an ADS124S08, a precision, 24-bit delta-sigma converter. The ADS124S08 has separate power pins for the analog (AVDD) and digital (DVDD) section. Both portions are 3.3-V compatible, and driven from the UCC12050 output. A rudimentary analog front end connected to the ADS124S08 mimics a 20-mV input, a 2.435-V input, and a radiometric 3-wire Resistance Temperature Device (RTD) input. It is suitable for a operating temperature range of -40°C to +125°C. Figure 2 shows the test setup.

The test setup is compared against the ADS124S08 data sheet performance numbers. The measurement results in Figure 3 follow the ADS124S08 setup in Table 6 of the data sheet, and presents the influence of the data rate to the effective resolution in bits. Both analog input pins are shorted for the measurement. The gain is 1 V/V to use the PGA. The digital filter is set to SINC3 for the best noise performance. Chopping mode is enabled to remove input DC offset, and 512 samples are taken for every data point (data rate). To investigate the need for a successive LDO, the measurement was performed with LDO and LDO bypassed.

Figure 1. UCC12050 Schematic

Figure 2. Test Setup

Figure 3. Measurement Results
As Figure 3 shows, there is no noticeable difference between the data sheet and whether the setup uses an LDO. The UCC12050 internally works with a DC/DC converter clock of 8 MHz. The LDO cannot reject ripple at the frequency anyway, explaining the alike curves. For good EMI performance, it is good practice to place a high-voltage cap between the two isolated grounds of the UCC12050. If space permits, the cap can be designed with the PCB layers obeying the targeted isolation ratings.

The ADS124S08 has a power supply good rejection ratio (AVDD > 90 dB and DVDD > 100 dB), which helps suppress remaining switching noise from the UCC12050.

This application note has shown that with the UCC12050, an integrated, low-height isolation power device, the performance of the analog signal chain is not influenced, and space-constrained applications can be served with this new technology. The 500 mW output power of the UCC12050 can support channel-to-channel and group-isolated analog input modules. Visit the analog input modules page to learn more about this application.
IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated