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

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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 peak efficiency of the UCC12050 is 60%. The integrated thermal shutdown and tolerance to short-circuit at the output enables very robust applications.

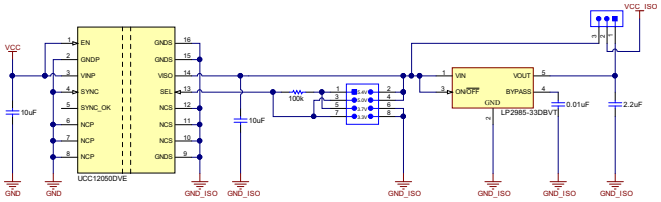

Figure 1. UCC12050 Schematic

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.

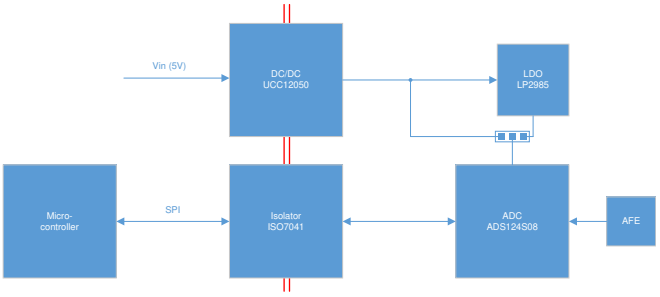

Figure 2. Test Setup

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.

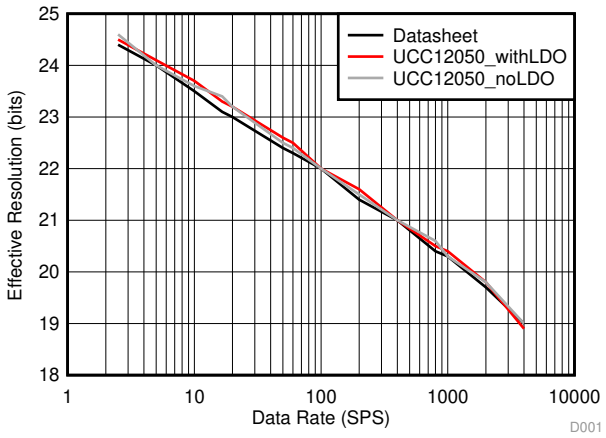

Figure 3. Test Results

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.

PARAMETER	UCC12050	ISOW7841	PCB TRANSFORMER	STANDARD TRANSFORMER
Application height	+++	+++	++	-
Board space	++	+++	-	+
Efficiency	++	+	++	+++
Electromagnetic emissions	+++	++	+/++/+++	+/++/+++
Temperature range	+++	+++	+++	+++
Isolation rating	+++	+++	+/++/+++	+/++/+++

Table 1. Alternative Device Recommendations

DEVICE	OPTIMIZED PARAMETERS	PERFORMANCE TRADE-OFF
ISOW7841	Power and data isolation	Efficiency
SN6501	Efficiency	Height
ISO7741	Cost	Basic isolation
ISO7041	Power consumption	Speed, basic isolation

Table 2. Adjacent Documentation

LINK	TITLE
TIDA-00688	1-W Isolated Power Supply With Planar Transformer Reference Design
TIDA-01434	Isolated, Transformerless, Bipolar Supply for 24-Bit ADCs Reference Design
SBAS660	ADS124S0x Low-Power, Low-Noise, Highly Integrated, 6- and 12-Channel, 4-kSPS, 24-Bit, Delta-Sigma ADC with PGA and Voltage Reference
SNVSB38	UCC12050 500 mW, High-Efficiency, 5 kVRMS Isolated DC-DC Converter

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