

Analog/Linear ICs: Filling Important Roles

By Sam Davis, Editor, *Power Electronics Technology*

The increasing importance of more accurate energy measurement data and real-time access to that data is accelerating the acceptance of digital metering technology. Today, mixed signal ICs combine analog and digital circuits to meter electrical energy and measure run time, while employing a precise RC time base. Keeping up with this technology, Analog Devices Inc. (ADI) has a new high-accuracy electrical energy metering IC, the ADE7757, with an on-chip oscillator that requires no external crystal or resonator—reducing the overall cost of building a watt-hour meter. It achieves less than 0.1% linearity error over a dynamic range of 500:1, and surpasses the accuracy requirements of the IEC1036 standard. It operates from a single 5V power supply with proprietary analog and digital circuitry to measure electrical energy usage over wide variations of environmental conditions and long periods of time (Fig. 1).

In operation, the chip directly interfaces with a shunt resistor (current sensor) and ac voltage sensing input. Pins V1P and V1N accept the current sensing input obtained from the current sense resistor. Pins V2P and V2N obtain

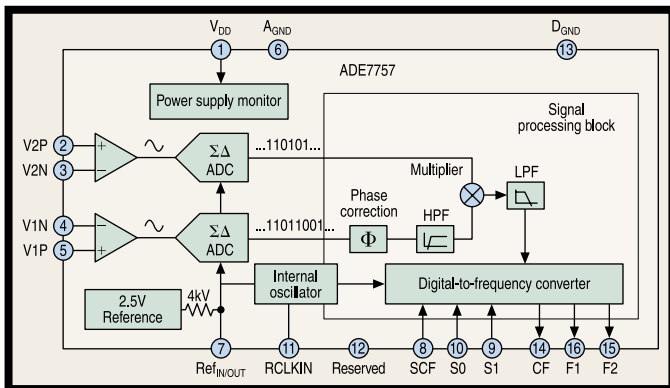


Fig. 1. ADE7757 energy metering IC.

inputs via a resistor divider that provides a signal proportional to the ac line voltage.

The small, full-scale analog input range allows the chip to interface to low-value shunt resistances without sacrificing dynamic range. Low-frequency pulse outputs supply average real power information and can directly interface to a stepper motor counter display. In addition, synchronized high-frequency pulse outputs are available for

calibration and test purposes. The high-frequency pulse outputs can also be used with a microcontroller or an automatic meter reading (AMR) module.

All other signal processing (e.g., multiplication and filtering) is carried out in the digital domain. This approach provides superior stability and accuracy over time and extreme environmental conditions.

The chip supplies average real power information on the low-frequency outputs F1 and F2 and instantaneous real power information on the high-frequency output CF. You can use F1 and F2 to drive an electromechanical counter or interface with an MCU. The CF logic output, ideal for calibration and test purposes, can directly interface with an MCU or AMR module.

A power supply monitoring circuit connects to the V_{DD} supply pin. The ADE7757 will remain inactive until the supply voltage on V_{DD} reaches about 4V. If the supply falls below 4V, it will remain inactive and the F1, F2, and CF will move to their nonactive modes.

Internal phase matching circuitry ensures that the voltage and current channels are phase matched while the high-pass filter in the current channel eliminates dc offsets. An internal no-load threshold guarantees that the ADE7757 doesn't exhibit creep when no load is present.

Two A/D converters digitize the voltage signals from the current and voltage sensors. These converters are 16-bit sigma-delta with an oversampling rate of 466 kHz. This analog input structure greatly simplifies sensor interfacing by providing a wide dynamic range for direct connection to the sensor and also simplifies the anti-aliasing filter design. A high-pass filter in the current channel removes any dc component from the current signal. This eliminates any inaccuracies in the real power calculation due to offsets in the voltage or current signals. Because the high pass filter is always enabled, the IC only operates with ac input.

The chip derives the real power calculation from the instantaneous power signal generated by a direct multiplication of the current and voltage signals. A low-pass filter extracts the real power component (i.e., the dc component) from the instantaneous power signal. This scheme correctly calculates real power for sinusoidal current and voltage waveforms at all power factors.

It generates the low-frequency outputs (F1, F2) by accumulating real power information. This low frequency inherently means a long accumulation time between

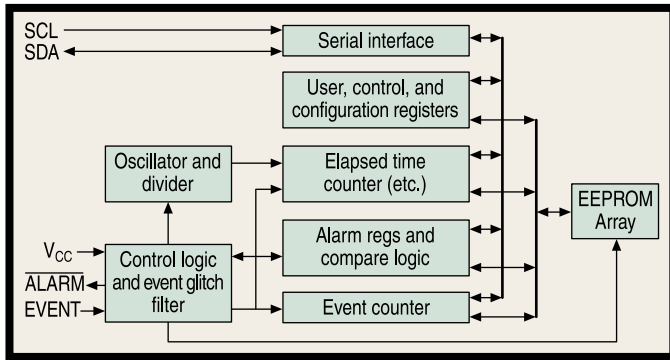


Fig. 2. Functional blocks of the DS1682.

output pulses. Consequently, the resulting output frequency is proportional to the average real power. This average real power information is then accumulated (e.g., by a counter) to generate real energy information. The CF output frequency is proportional to the instantaneous real power due to its high-output frequency and hence, shorter integration time. This CF output is useful for system calibration, which can be done faster under steady load conditions.

Elapsed Time Recorder

The DS1682 from Dallas Semiconductor is an integrated elapsed time recorder containing a factory-calibrated, temperature-compensated RC time base that eliminates the need for an external crystal. Using EEPROM technology to maintain data in the absence of power, DS1682 requires no backup power source. It detects and records the num-

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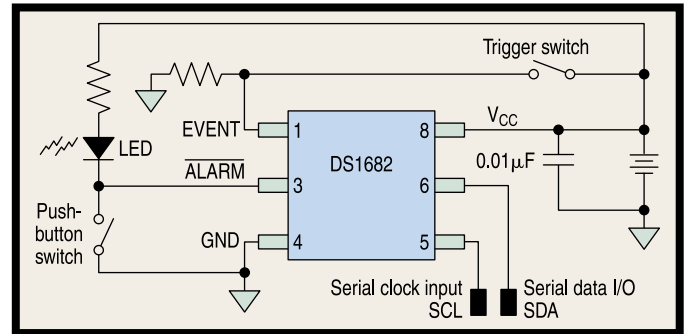


Fig. 3. DS1682 circuit measuring total run time.

ber of events on the EVENT pin and the total cumulative event time since it was last reset to zero. The $\overline{\text{ALARM}}$ pin alerts the user when the total accumulated time equals the

user-programmed alarm value. You can program the polarity of the open-drain $\overline{\text{ALARM}}$ pin to either drive low or to become a high impedance upon an alarm condition. The DS1682 is ideal for applications that monitor the total amount of time that a device has been in operation and/or the number of uses since inception of service, repair, or last calibration.

Upon power-up, the DS1682 transfers the contents of the EEPROM into the counters and memory registers that read or write data through the serial interface. When the EVENT pin transitions from a logic high to a logic low, the counters and memory registers transfer their contents into EEPROM memory. Fig. 2 shows the relationship between the functional blocks, serial interface, and EEPROM memory section of the DS1682.

The DS1682 uses a calibrated, temperature-compensated RC time base to increment an elapsed time counter (ETC) while an event is active. When the event becomes active, the IC transfers the contents of the nonvolatile EEPROM to the ETC and event counter and the oscillator starts. As the event continues, the IC increments the ETC in quarter-second increments. When the event becomes inactive, the DS1682 increments the counter and writes the contents of the ETC and event counter into the nonvolatile EEPROM.

Use the $\overline{\text{ALARM}}$ output to indicate when the ETC matches the value in the alarm register, or configure the DS1682 to prevent clearing the alarm, elapsed time, and event counters. User memory can be separately write-protected.

Fig. 3 shows the DS1682 measuring total run time and operating from a battery with the alarm tied to an LED and push-button switch to trigger the alarm output. **PETech**

Moving Toward Digital Utility Meters

Digital metering technology provides companies with the ability to offer highly accurate energy management services for process plants, factories, and other commercial and residential applications. With this new technology comes a new end-to-end energy measurement system for gas, water, and electricity. Built with ADI's ADE7759 IC, the Invensys iCon Meter allows utility companies to monitor and manage electricity use via data networks. It provides solid energy measurement technology that optimizes the meter's capabilities to include "smart" functions in demand by utilities, including integrated electric/gas/water meter reading and remote data collection. With easy connectivity to facilitate automatic meter reading and access to networked utility data, it features end-point device monitoring, network connectivity, Internet access, and energy consumption data. The meter is redefining the future of energy management.