

Preliminary Technical Data

AD7754

FEATURES

High Accuracy, supports 50/60 Hz IEC 521/1036

Less than 0.2% error over a dynamic range of 500 to 1 (per phase)

Three phase voltage and current inputs

Watt-hour accumulation register

Internal calibration of phase and gain.

Internal temperature register.

Mean square values of current and voltage.

A SPI compatible Serial Interface.

A pulse output with programmable frequency.

An Interrupt Request line and STATUS register

provide early warning of register overflow

Proprietary ADCs and DSP provide high accuracy over variations in time and environment.

Reference 2.5V±8% (50 ppm/°C maximum) with external overdrive capability

Single 5V Supply with ground referenced input

Low power consumption (15mW typical)

GENERAL DESCRIPTION

The AD7754 is a high accuracy electrical power measurement IC with a serial interface and a pulse output. Its transducer

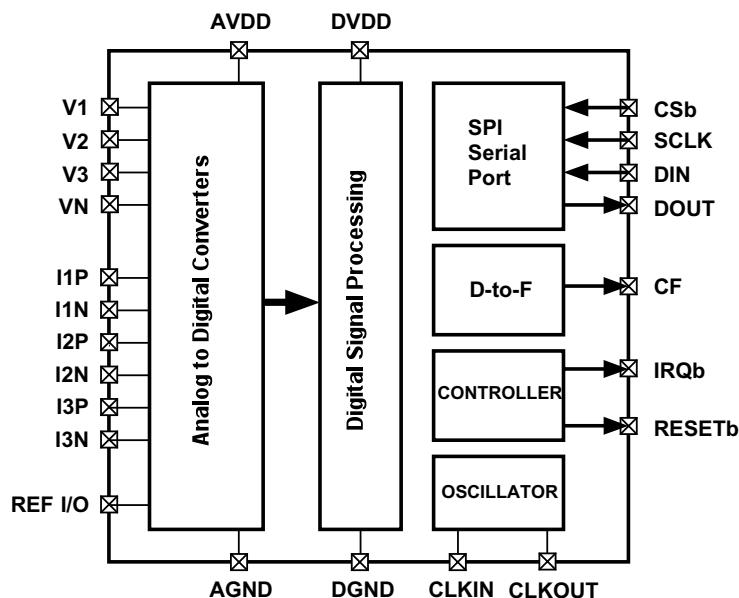
interface uses three fully differential current inputs and three single-ended voltage inputs. These inputs are immediately fed into an over-sampling analog-to-digital conversion block so that all calculations are performed in the digital domain.

The AD7754 also incorporates reference circuitry and all the signal processing required to perform continuous calculations of real power, active energy, and mean square values of voltage and current. Registers are capable of holding at least 20 seconds of accumulated power at full load. Data is read from the AD7754 via the serial interface. A warning of register overflow is issued through the interrupt pin $\overline{\text{IRQ}}$.

The interrupt request output is an open drain, active low logic output. A status register will indicate the nature of the interrupt. The $\overline{\text{IRQ}}$ output will also become active when the accumulated real power register is half full or when it overflows.

The AD7754 provides system calibration features, i.e., channel offset correction, phase calibration and power calibration to reduce bandwidth requirements of a microprocessor. The AD7754 also provides a pulse output with a frequency which is proportional to the instantaneous real power. It is available in a 24 lead SSOP package.

FUNCTIONAL BLOCK DIAGRAM



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AD7754 - SPECIFICATIONS^{1,4}

(AVDD = DVDD = 5V ± 5%, AGND = DGND = 0V, On-Chip Reference,
CLKIN = 10MHz, TMIN to TMAX = -40°C to +85°C)

Parameters	A Version	B Version	Test Conditions/Comments
ACCURACY			
Measurement Error (per phase)	0.1% typ	0.2% max	Over a dynamic range 500 to 1
Phase Error ¹ Between Channels (PF = 0.8 Capacitive)	±0.05° max	±0.05° max	Line Frequency = 45Hz to 65Hz
(PF = 0.5 Inductive)	±0.05° max	±0.05° max	Phase Lead 37°
ac Power Supply Rejection ¹			V1 Phase Lag 60°
Output Frequency Variation (CF)	0.01% typ	0.01% typ	Ripple on AV _{DD} of 250mV rms / 50Hz
dc Power Supply Rejection ¹			V1P = V2P = V3P = ±100mV rms
Output Frequency Variation (CF)	0.01% typ	0.01% typ	V1P = V2P = V3P = ±100mV rms
ANALOG INPUTS			<i>See Analog Inputs Section</i>
Maximum Signal Levels	±1V max	±1V max	Wide selection of lower ranges
Input Impedance (dc)	400kΩ min	400kΩ min	CLKIN = 10 MHz
Bandwidth	3.5kHz typ	3.5kHz typ	
ADC Offset Error ¹	±10mV max	±10mV max	See Terminology (uncalibrated)
Gain Error ¹	±4% typ	±4% typ	External 2.5V reference
Gain Error Match ¹	±0.3% typ	±0.3% typ	External 2.5V reference
REFERENCE INPUT			
REF _{IN/OUT} Input Voltage Range	2.7V max 2.3V min	2.7V max 2.3V min	2.5 V +8% 2.5V -8%
Input Impedance	4kΩ min	4kΩ min	
Input Capacitance	10pF max	10pF max	
ON-CHIP REFERENCE			Nominal 2.5V
Reference Error	±200mV max	±200mV max	
Temperature Coefficient	30ppm/°C typ	50ppm/°C max	
TEMPERATURE SENSOR	±2°C	±2°C	Calibrated dc offset
CLKIN			Note all specifications for CLKIN of 10 MHz
Input Clock Frequency	15 MHz max 5 MHz min	15 MHz max 5 MHz min	
LOGIC INPUTS			
RESET, DIN, SCLK and CS			
Input High Voltage, V _{INH}	2.4V min	2.4V min	DV _{DD} = 5 V ± 5%
Input Low Voltage, V _{INL}	0.8V max	0.8V max	DV _{DD} = 5 V ± 5%
Input Current, I _{IN}	±3μA max	±3μA max	Typically 10nA, V _{IN} = 0V to DV _{DD}
Input Capacitance, C _{IN}	10pF max	10pF max	
LOGIC OUTPUTS³			
CF, IRQ, DOUT			
Output High Voltage, V _{OH}	4V min	4V min	I _{SOURCE} = 10mA DV _{DD} = 5V ± 5%
Output Low Voltage, V _{OL}	1V max	1V max	I _{SINK} = 10mA DV _{DD} = 5V ± 5%
POWER SUPPLY			For specified Performance
AV _{DD}	4.75V min 5.25V max	4.75V min 5.25V max	5V - 5% 5V +5%
DV _{DD}	4.75V min 5.25V max	4.75V min 5.25V max	5V - 5% 5V +5%
AI _{DD}	3mA max	3mA max	Typically 1.5 mA
DI _{DD}	2mA max	2mA max	Typically 1.5 mA

NOTES:

¹See Terminology Section for explanation of Specifications

²Fault Detection Section of data sheet for explanation of fault detection functionality

³ See Plots in Typical Performance Graphs

⁴ Specifications subject to change without notice

PIN FUNCTION DESCRIPTION

Pin No.	MNEMONIC	DESCRIPTION
x	$\overline{\text{RESET}}$	Reset pin for the AD7754. A logic low on this pin will hold the ADCs and digital circuitry (including the Serial Interface) in a reset condition.
x	DV _{DD}	Digital power supply. This pin provides the supply voltage for the digital circuitry in the AD7754. The supply voltage should be maintained at $5V \pm 5\%$ for specified operation.
x	AV _{DD}	Analog power supply. This pin provides the supply voltage for the analog circuitry in the AD7754. The supply should be maintained at $5V \pm 5\%$ for specified operation.
x	I1P, I1N I2P, I2N I3P, I3N	Analog inputs for Current Channel. These inputs are fully differential voltage inputs with a maximum signal level of $\pm 1V$ for specified operation. This current channel has a PGA programmable through a register. Inputs have internal ESD protection circuitry and in addition an over-voltage of $\pm 6V$ can be sustained on these inputs without risk of permanent damage.
x	V1, V2, V3, VN	Analog inputs for Voltage Channel. These inputs are single ended voltage inputs with a maximum signal level of $\pm 1V$ with respect to pin VN. This voltage channel has a PGA programmable through a register. Inputs have internal ESD protection circuitry and in addition an over-voltage of $\pm 6V$ can be sustained on these inputs without risk of permanent damage.
x	REF _{IN/OUT}	This pin provides access to the on-chip voltage reference. The on-chip reference has a nominal value of $2.5V \pm 8\%$ and a typical temperature coefficient of $30\text{ppm}/^\circ\text{C}$. An external reference source may also be connected at this pin.
x	AGND	This pin provides the ground reference for the analog circuitry in the AD7754, i.e. ADCs and reference. This pin should be tied to the analog ground plane of the PCB. The analog ground plane is the ground reference for all analog circuitry, e.g. anti aliasing filters, current and voltage transducers etc. For good noise suppression the analog ground plane should only be connected to the digital ground plane at the DGND pin.
x	DGND	This provides the ground reference for the digital circuitry in the AD7754, i.e. multiplier, filters and digital-to-frequency converter. This pin should be tied to the digital ground plane of the PCB. The digital ground plane is the ground reference for all digital circuitry, e.g. MCUs and indicator LEDs.
x	CF	Calibration Frequency logic output. The CF logic output gives instantaneous real power information. This output is intended to be used for calibration purposes. The full scale output frequency can be adjusted by writing to the CFDIV Register
x	$\overline{\text{IRQ}}$	Interrupt Request Output. These mask interrupts include: Active Energy Register rollover, Active Energy Register at half level, zero crossing for each phase, and calibration complete flag.
x	CLKIN	An external clock can be provided at this logic input. Alternatively a crystal can be connected across CLKIN and CLKOUT to provide a clock source for the AD7754. The clock frequency for specified operation is 10MHz. Crystal load capacitors 33pF ceramic should be used with gate oscillator circuit.
x	CLKOUT	A crystal can be connected across this pin and CLKIN as described above to provide a clock source for the AD7754. The CLKOUT pin can drive one CMOS load when an external clock is supplied at CLKIN.
x	$\overline{\text{CS}}$	Chip Select. Part of the four wire Serial Interface. This logic input allows the AD7754 to share the serial bus with several other devices. See AD7754 Serial Interface.
x	SCLK	Serial Clock Input for the synchronous serial interface. All Serial data transfers are synchronized to this clock – See AD7754 Serial Interface. The SCLK has a schmitt-trigger Input for used with a clock source which has a slow edge transition time, e.g., opto-isolator outputs etc.
x	DOUT	Data Output for the Serial Interface. Data is shifted out at this pin on the rising edge of SCLK.
x	DIN	Data Input for the Serial Interface. Data is shifted in at this pin on the falling edge of SCLK.

FUNCTIONAL DESCRIPTION - AD7754

General Operation

The AD7754 is a high accuracy electrical power measurement IC with a serial interface and a pulse output. Its transducer interface uses three fully differential voltage inputs applicable for the current channels and three single-ended voltage inputs for the voltage channels. These signals are immediately converted to the digital domain for further processing. The AD7754 incorporates reference circuitry and all the signal processing required to perform continuous calculations of real power, active energy, and mean square current and voltage for each phase. An internal temperature measurement accurate to within $\pm 2^{\circ}\text{C}$ after offset calibration is also available.

Reference

A CMOS reference with a maximum of 50ppm/C drift is offered for the high grade (B Grade) parts and a low grade (A Grade) part is offered with a typical 30ppm/C drift as a low cost option for people using an external reference.

Calculations (stored in registers)

The following calculations are stored in double buffered registers. The values can either be read from a continuously updated register or from a register that is updated on a programmable time period. The user has the option to update the double buffered register at a zero crossing of the first, second, or third phase or an arbitrary time period. Calculated register contents includes instantaneous real power and active energy for the sum of three phases as well as uncalibrated mean square values for the current and voltage of each phase. Energy in each phase is calibrated based on the calibration frequency output (CF).

Microprocessor Communication

Two control pins and a 4 pin SPI compatible serial interface are used to communicate to a microprocessor. The two control pins are Interrupt (zero crossing for each phase, calibration complete, register overflow flag) and dedicated reset ($\overline{\text{RESET}}$).

Internal Calibration

The AD7754 has offsets that can also be manually adjusted to reduce bandwidth requirements of the system microprocessor. Calibration adjustments include gain offset, voltage to current phase mismatch, channel offset, and temperature offset.

Frequency Output

The high frequency output (CF pin) represents the sum of real power on three phases. The AD7754 offers start-up current programmability by allowing the microprocessor to switch off the frequency output. The microprocessor can dictate the minimum acceptable watts measurement.

DEVELOPMENT UPDATES

Visit our energy metering web site periodically at <http://www.analog.com/energymeter>. Updates to this data sheet will appear in the AD7754 product center as soon as it is available. Questions about any of our energy measurement products can be submitted directly to our development team through the "Contact the Energy Measurement Group" option available on every page of our web site.