Gambar 1. Hasil Pengukuran Arus Pada Multimeter

Gambar 2. Hasil Pengukuran Tegangan pada Multimeter

Gambar 3. Cara mengukur Tegangan atau arus pada SCC MPPT

Gambar 4. Cara mengukur Tegangan atau arus pada SCC PWM

Gambar 5. Hasil Pengukuran pada Lux Meter

PWM Solar Charge Controller

- 12VDC or 24VDC available
- Multi-stage charging method
- Lightweight design

PWM Solar Charge Controller Selection Guide

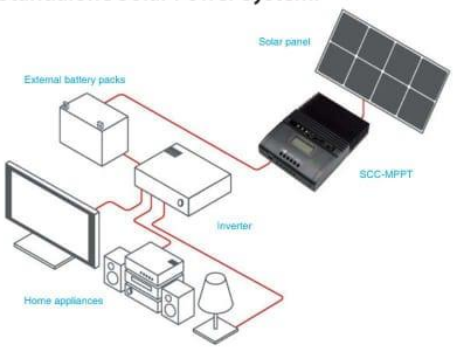
MODEL	SCC-PWM-120W	SCC-PWM-240W	SCC-PWM-360W	SCC-PWM-600W	SCC-PWM-720W	SCC-PWM-1200W
INPUT						
Maximum PV Array Open Circuit Voltage	25 VDC	50 VDC	75 VDC	75 VDC	75 VDC	75 VDC
Maximum PV Array Power	120 W	240 W	360 W	600 W	720 W	1200 W
Maximum Current	10 A		30 A	50 A	30 A	50 A
OUTPUT						
Nominal Battery Voltage	12 VDC	24 VDC	12 VDC	12 VDC	24 VDC	24 VDC
Connected Battery Type	Sealed lead acid battery					
Maximum Charging Current	10 A		30 A	50 A	30 A	50 A
Ripple Voltage	< ± 1 V					
Charging Method	Two stages: bulk and floating 1 / floating 2		Three stages: bulk, abs cv, floating			
INDICATORS						
LED Display	Green LED indicating charging status					
PHYSICAL						
Dimension, D X W X H (mm)	92.6 x 60.7 x 30.8		107.6 x 75 x 30.8	131 x 85 x 40.5	107.6 x 75 x 30.8	131 x 85 x 40.5
Net Weight	210 g		340 g	490 g	340 g	490 g
Connector	PV/Battery terminal block		PV/Battery/Load terminal block			
IP Protection	IP 31					
ENVIRONMENT						
Operating Temperature	-20°C to 55°C					
Storage Temperature	-40°C to 75°C					
Altitude	0 ~ 3000 m					

Product specifications are subject to change without further notice.

MPPT Solar Charge Controller

- Intelligent Maximum Power Point Tracking technology
- Built-in DSP controller with high performance
- Automatic battery voltage detection
- Three-stage charging optimizes battery performance
- Auto load-detection
- Multifunction LCD displays detailed information
- Reverse polarity protection for solar panel and battery
- Overcharge and overload protection
- IP 43 protection for outdoor and harsh environment
- Suitable for battery types: sealed lead acid, vented, Gel, and NiCd

Standalone Solar Power System:



Combined MPPT technology and DSP controller, SCC-MPPT will convert best voltage to charge battery based on varied temperature. Compared to traditional solar charge controller, it allows your solar panels to operate at their optimum power output voltage, providing higher efficiency up to 98% with lower power loss.

Integrated SCC-MPPT with inverter, solar panel, and external battery packs, it will become a standalone solar power system to generate green power for your home appliances. SCC-MPPT will convert solar power to charge external batteries, and then provide power to home appliances via inverter.

MPPT Solar Charge Controller Selection Guide

MODEL	SCC-MPPT 300W	SCC-MPPT 600W
INPUT		
MPPT Range @ Operating Voltage	15 V ~ 33 V @ 12 V	30 V ~ 66 V @ 24 V
Maximum PV Array Open Circuit Voltage	50 V	75 V
Maximum PV Array Power	300 W	600 W
Maxium Current	18 A	
OUTPUT		
Nominal Battery Voltage	12 V	24 V
Connected Battery Type	Sealed lead acid, vented, Gel, NiCd battery	
Maximum Charging Current	25 A	
Maximum Efficiency	98%	
Standby Power Consumption	1 W	2 W
Charging Method	Three stages: bulk, absorption, and floating	
PROTECTION		
Overload Protection	> 110% : audible alarm	
Overcharge Protection	Yes	
Polarity Reversal Protection @ Solar Cell & Battery	Yes	
INDICATORS		
LCD Panel	LCD panel indicating solar power, load level, battery voltage/capacity, charging current, and fault conditions	
LED Display	Three indicators for solar, charging, and load status	
PHYSICAL		
Dimension, D x W x H (mm)	135 x 170 x 57.5	220 x 170 x 57.5
Net Weight (Kgs)	0.92	1.85
Connector	Input/Output terminal block	
Type of Mechanical Protection	IP 43	
ENVIRONMENT		
Humidity	0 ~ 100% RH (No condensing)	
Operating Temperature	-20°C to 55°C	
Storage Temperature	-40°C to 75°C	
Altitude	0 ~ 3000 m	

Product specifications are subject to change without further notice

MPPT Solar Charge Controller

- Intelligent Maximum Power Point Tracking technology increases efficiency 25%~30%
- Compatible for PV systems in 12V, 24V or 48V
- Three-stage charging optimizes battery performance
- Maximum charging current up to 60A
- Maximum efficiency up to 98%
- Battery temperature sensor (BTS) automatically provides temperature compensation
- Support wide range of lead-acid batteries including wet, AGM, and gel batteries
- Multifunction LCD displays detailed information

PWM Solar Charge Controller

- 12VDC or 24VDC available
- Two-stage charging method
- Lightweight design

SCC-MPPT 3KW Specification

MODEL	SCC-MPPT 3KW		
PV INPUT			
MPPT Range	60 VDC ~ 115 VDC		
Maximum PV Array Open Circuit Voltage	145VDC		
Maximum PV Array Power	800W	1600W	3200W
Maximum Input Current	50 A		
BATTERY			
Nominal Battery Voltage	12 V	24 V	48 V
Connected Battery Type	Sealed lead acid, AGM or Gel		
Maximum Charging Current	60 A		
Maximum Efficiency	98%		
Charging Method	Three stages: bulk, absorption and floating		
PHYSICAL			
Dimension, D X W X H (mm)	315 x 165 x 128		
Net Weight (kgs)	4.5		
Type of Mechanical Protection	IP 31		
COMMUNICATION			
Standard	RS-232 and Dry contact		
Optional	USB, Modbus and SNMP		
ENVIRONMENT			
Humidity	5 ~ 95% RH (No condensing)		
Operating Temperature	0°C to 55°C		
Storage Temperature	-15°C to 60°C		

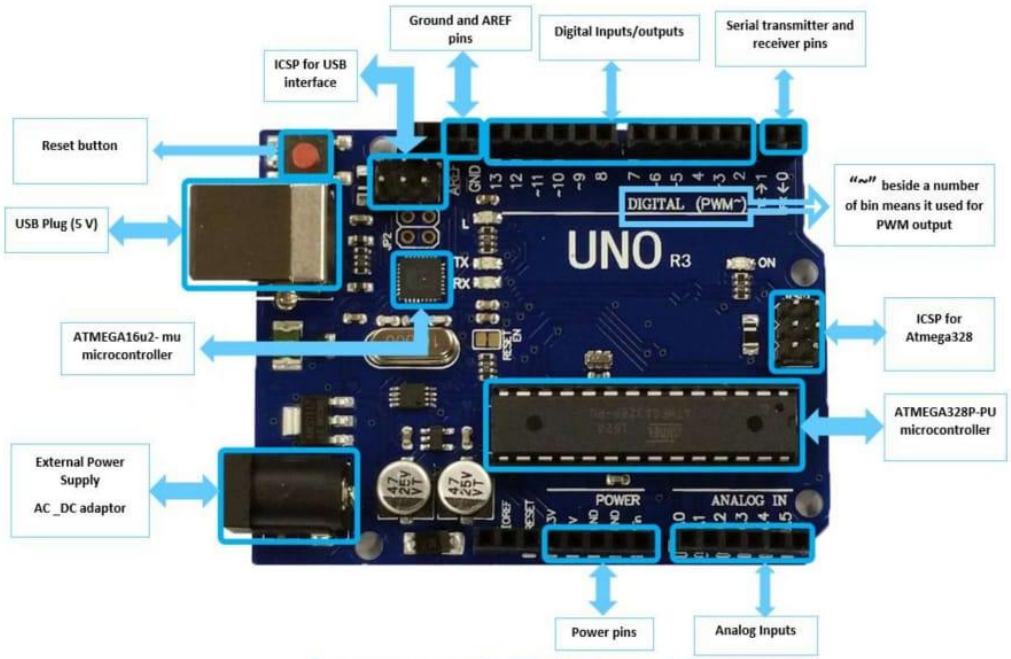
Product specifications are subject to change without further notice

PWM Solar Charge Controller Selection Guide

MODEL	SCC-PWM-120W	SCC-PWM-240W
INPUT		
Maximum PV Array Open Circuit Voltage	25 V	50 V
Maximum PV Array Power	120 W	240 W
Maxium Current	10 A	
OUTPUT		
Nominal Battery Voltage	12 V	24 V
Connected Battery Type	Sealed lead acid battery	
Maximum Charging Current	10 A	
Ripple Voltage	< ± 1 V	
Maximum Efficiency	99.0 %	
Charging Method	Two stage: bulk and floating 1 / floating 2	
INDICATORS		
LED Display	Green LED indicating charging status	
PHYSICAL		
Dimension, D X W X H (mm)	93 x 60 x 29	
Net Weight	160 g	
Connector	Input/Output terminal block	
Type of Mechanical Protection	IP 31	
ENVIRONMENT		
Operating Temperature	-20°C to 55°C	
Storage Temperature	-40°C to 75°C	
Altitude	0 ~ 3000 m	

Product specifications are subject to change without further notice

Arduino Uno R3



INTRODUCTION

Arduino is used for building different types of electronic circuits easily using of both a physical programmable circuit board usually microcontroller and piece of code running on computer with USB connection between the computer and Arduino.

Programming language used in Arduino is just a simplified version of C++ that can easily replace thousands of wires with words.

ARDUINO UNO-R3 PHYSICAL COMPONENTS

ATMEGA328P-PU microcontroller

The most important element in Arduino Uno R3 is ATMEGA328P-PU is an 8-bit Microcontroller with flash memory reach to 32k bytes. It's features as follow:

- High Performance, Low Power AVR
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Up to 20 MIPS Throughput at 20 MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory
  - 256/512/512/1K Bytes EEPROM
  - 512/1K/1K/2K Bytes Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C
  - Optional Boot Code Section with Independent Lock Bits
  - In-System Programming by On-chip Boot Program
  - True Read-While-Write Operation
  - Programming Lock for Software Security

- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
  - Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
  - Temperature Measurement
  - Programmable Serial USART

- Master/Slave SPI Serial Interface
- Byte-oriented 2-wire Serial Interface (Philips I2 C compatible)
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator
- Interrupt and Wake-up on Pin Change

• Special Microcontroller Features

- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated Oscillator
- External and Internal Interrupt Sources
- Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby

• I/O and Packages

- 23 Programmable I/O Lines
- 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF

• Operating Voltage:

- 1.8 - 5.5V

• Temperature Range:

- -40°C to 85°C

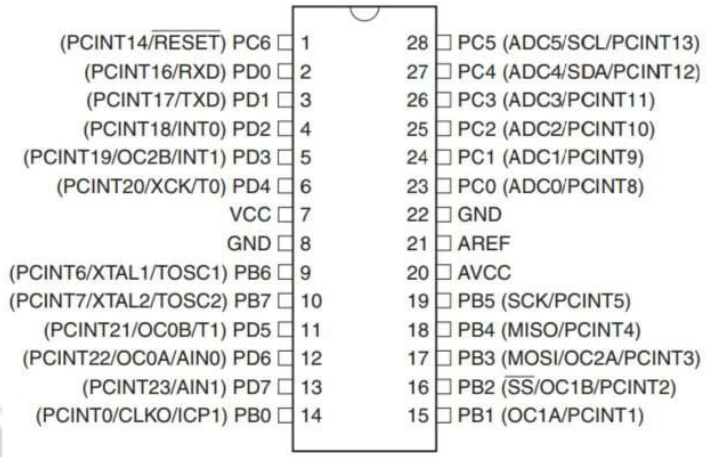
• Speed Grade:

- 0 - 4 MHz@1.8 - 5.5V, 0 - 10 MHz@2.7 - 5.5.V, 0 - 20 MHz @ 4.5 - 5.5V

• Power Consumption at 1 MHz, 1.8V, 25°C

- Active Mode: 0.2 mA
- Power-down Mode: 0.1 µA
- Power-save Mode: 0.75 µA (Including 32 kHz RTC)

- Pin configuration



ATMEGA16u2- mu microcontroller

Is a 8-bit microcontroller used as USB driver in Arduino uno R3 it's features as follow:

- High Performance, Low Power AVR

• Advanced RISC Architecture

- 125 Powerful Instructions – Most Single Clock Cycle Execution
- 32 x 8 General Purpose Working Registers
- Fully Static Operation
- Up to 16 MIPS Throughput at 16 MHz

• Non-volatile Program and Data Memories

- 8K/16K/32K Bytes of In-System Self-Programmable Flash
- 512/512/1024 EEPROM
- 512/512/1024 Internal SRAM
- Write/Erase Cycles: 10,000 Flash/ 100,000 EEPROM
- Data retention: 20 years at 85˚C/ 100 years at 25˚C

- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by on-chip Boot Program hardware-activated after reset
- Programming Lock for Software Security

• USB 2.0 Full-speed Device Module with Interrupt on Transfer Completion

- Complies fully with Universal Serial Bus Specification REV 2.0
- 48 MHz PLL for Full-speed Bus Operation: data transfer rates at 12 Mbit/s
- Fully independent 176 bytes USB DPRAM for endpoint memory allocation
- Endpoint 0 for Control Transfers: from 8 up to 64-bytes
- 4 Programmable Endpoints:
  - IN or Out Directions
  - Bulk, Interrupt and Isochronous Transfers
  - Programmable maximum packet size from 8 to 64 bytes
  - Programmable single or double buffer
- Suspend/Resume Interrupts
- Microcontroller reset on USB Bus Reset without detach
- USB Bus Disconnection on Microcontroller Request

• Peripheral Features

- One 8-bit Timer/Counters with Separate Prescaler and Compare Mode (two 8-bit PWM channels)
- One 16-bit Timer/Counter with Separate Prescaler, Compare and Capture Mode(three 8-bit PWM channels)
- USART with SPI master only mode and hardware flow control (RTS/CTS)
- Master/Slave SPI Serial Interface
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator
- Interrupt and Wake-up on Pin Change

• On Chip Debug Interface (debug WIRE)

• Special Microcontroller Features

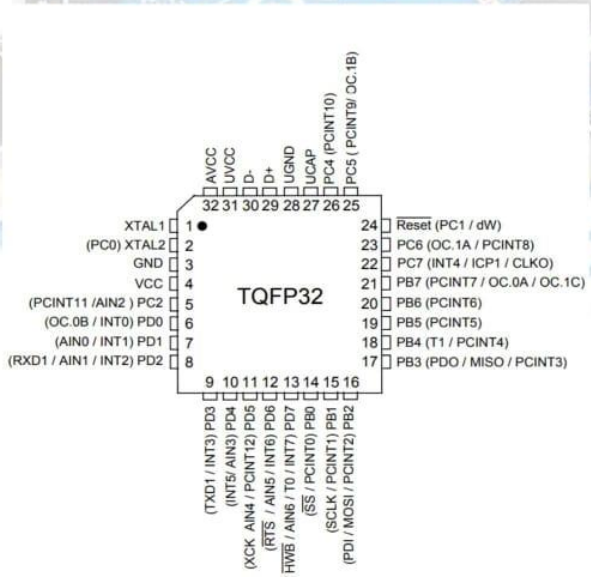
- Power-On Reset and Programmable Brown-out Detection
- Internal Calibrated Oscillator
- External and Internal Interrupt Sources
- Five Sleep Modes: Idle, Power-save, Power-down, Standby, and Extended Standby

• I/O and Packages

- 22 Programmable I/O Lines
- QFN32 (5x5mm) / TQFP32 packages

- Operating Voltages
  - 2.7 - 5.5V
- Operating temperature
  - Industrial (-40°C to +85°C)
- Maximum Frequency
  - 8 MHz at 2.7V - Industrial range
  - 16 MHz at 4.5V - Industrial range

- Pin configuration



OTHER ARDUINO UNO R3 PARTS

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode (), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 k Ohms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

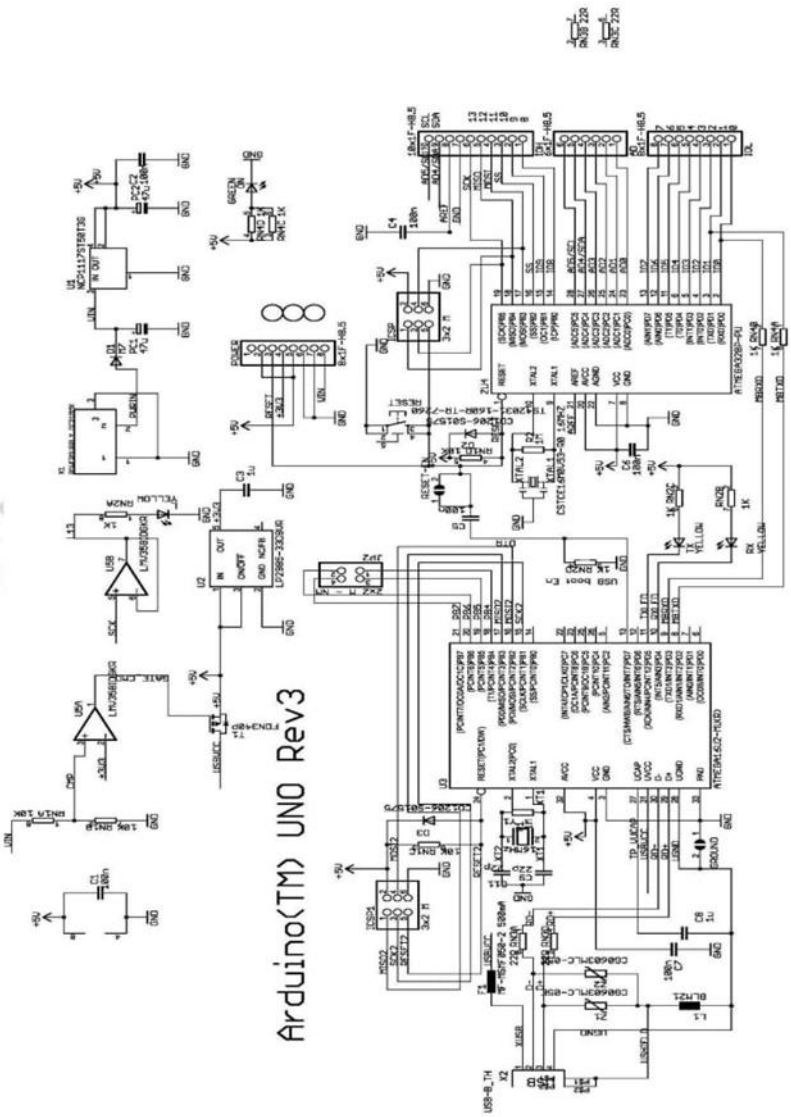
The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e.1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

There are a couple of other pins on the board:

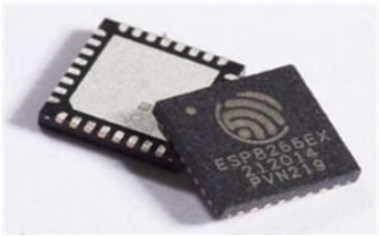
- AREF: Reference voltage for the analog inputs. Used with analogReference().
- Reset: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

ARDUINO UNO R3 SCHEMATIC DIAGRAM



ESP8266 NodeMCU Basics: Datasheet, Pinout [FAQ]

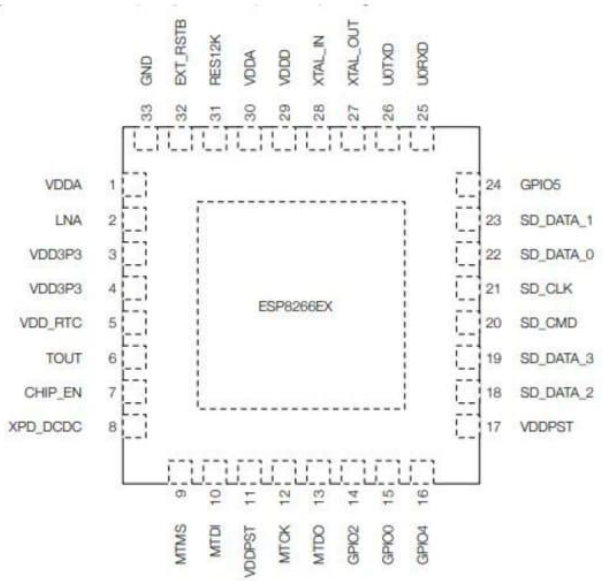
Author: Mia **Date:** 30 Dec 2020 167



Most people call **ESP8266** as a **WIFI module**, but it is actually a **microcontroller**. ESP8266 is the name of the microcontroller developed by Espressif Systems which is a company based out of shanghai. This microcontroller has the ability to perform WIFI related activities hence it is widely used as a WIFI module.

Catalog

ESP8266 Pin Configuration and Functions



ESP8266 NodeMCU pin functions:

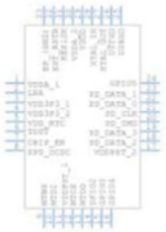
Pin	Name	Type	Function
1	VDDA	P	Analog Power 2.5 V ~ 3.6 V
2	LNA	I/O	RF antenna interface Chip output impedance = 39 + j6 Ω. It is suggested to retain the π-type matching network to match the antenna.
3	VDD3P3	P	Amplifier Power 2.5 V ~ 3.6 V

4	VDD3P3	P	Amplifier Power 2.5 V ~ 3.6 V
5	VDD_RTC	P	NC (1.1 V)
6	TOUT	I	ADC pin. It can be used to test the power-supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin 6). However, these two functions cannot be used simultaneously.
7	CHIP_EN	I	Chip Enable High: On, chip works properly Low: Off, small current consumed
8	XPD_DCDC	I/O	Deep-sleep wakeup (need to be connected to EXT_RSTB); GPIO16
9	MTMS	I/O	GPIO 14; HSPI_CLK
10	MTDI	I/O	GPIO 12; HSPI_MISO
11	VDDPST	P	Digital/IO Power Supply (1.8 V ~ 3.6 V)
12	MTCK	I/O	GPIO 13; HSPI_MOSI; UART0_CTS
13	MTDO	I/O	GPIO 15; HSPI_CS; UART0_RTS
14	GPIO2	I/O	UART TX during flash programming; GPIO2
15	GPIO0	I/O	GPIO0; SPI_CS2
16	GPIO4	I/O	GPIO4
17	VDDPST	P	Digital/IO Power Supply (1.8 V ~ 3.6 V)
18	SDIO_DATA_2	I/O	Connect to SD_D2 (Series R: 20 Ω); SPIHD; HSPIHD; GPIO9
19	SDIO_DATA_3	I/O	Connect to SD_D3 (Series R: 200 Ω); SPIWP; HSPIWP; GPIO10
20	SDIO_CMD	I/O	Connect to SD_CMD (Series R: 200 Ω); SPI_CS0; GPIO11
21	SDIO_CLK	I/O	Connect to SD_CLK (Series R: 200 Ω); SPI_CLK; GPIO6
22	SDIO_DATA_0	I/O	Connect to SD_D0 (Series R: 200 Ω); SPI_MISO; GPIO7
23	SDIO_DATA_1	I/O	Connect to SD_D1 (Series R: 200 Ω); SPI_MOSI; GPIO8
24	GPIO5	I/O	GPIO5
25	U0RXD	I/O	UART Rx during flash programming; GPIO3
26	U0TXD	I/O	UART TX during flash programming; GPIO1; SPI_CS1
27	XTAL_OUT	I/O	Connect to crystal oscillator output, can be used to provide BT clock input
28	XTAL_IN	I/O	Connect to crystal oscillator input

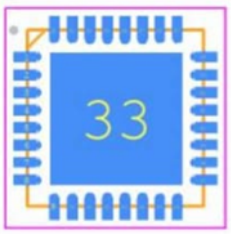
29	VDDD	P	Analog Power 2.5 V ~ 3.6 V
30	VDDA	P	Analog Power 2.5 V ~ 3.6 V
31	RES12K	I	Serial connection with a 12 kΩ resistor and connect to the ground
32	EXT_RSTB	I	External reset signal (Low voltage level: active)

ESP8266 CAD Models

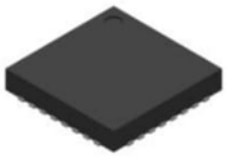
- Part Symbol



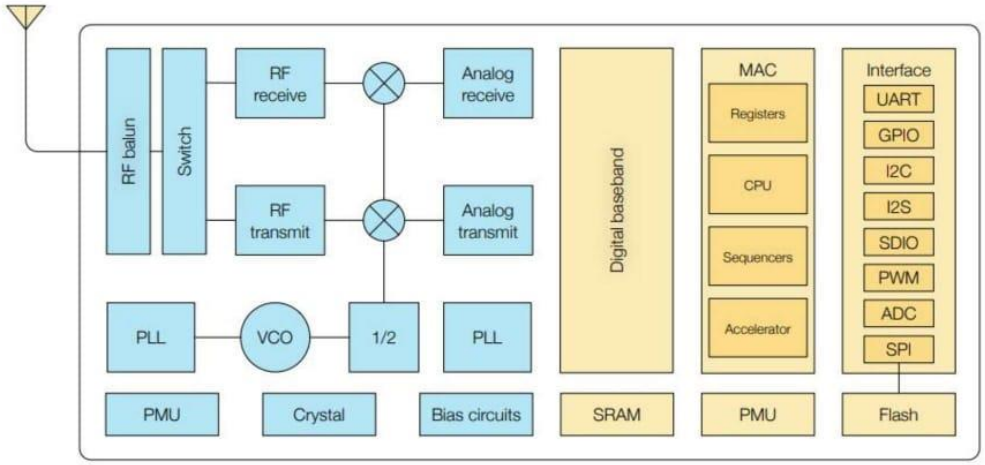
- Footprint



- 3D Model



ESP8266 Functional Block Diagram



ESP8266 Functional Block Diagram

ESP8266 Features

- 802.11 b/g/n support
- 802.11 n support (2.4 GHz), up to 72.2 Mbps
- Defragmentation
- 2 x virtual Wi-Fi interface
- Automatic beacon monitoring (hardware TSF)
- Support Infrastructure BSS Station mode/SoftAP mode/Promiscuous mode

ESP8266 Specifications

Categories	Items	Parameters
Wi-Fi	Certification	Wi-Fi Alliance
	Protocols	802.11 b/g/n (HT20)
	Frequency Range	2.4 GHz ~ 2.5 GHz (2400 MHz ~ 2483.5 MHz)
	TX Power	802.11 b: +20 dBm
		802.11 g: +17 dBm
		802.11 n: +14 dBm
	Rx Sensitivity	802.11 b: –91 dbm (11 Mbps)
		802.11 g: –75 dbm (54 Mbps)
		802.11 n: –72 dbm (MCS7)
	Antenna	PCB Trace, External, IPEX Connector, Ceramic Chip
Hardware	CPU	Tensilica L106 32-bit processor
	Peripheral Interface	UART/SDIO/SPI/I2C/I2S/IR Remote Control
		GPIO/ADC/PWM/LED Light & Button
	Operating Voltage	2.5 V ~ 3.6 V
	Operating Current	Average value: 80 mA
	Operating Temperature Range	–40 °C ~ 125 °C
	Package Size	QFN32-pin (5 mm x 5 mm)
	External Interface	-
Software	Wi-Fi Mode	Station/SoftAP/SoftAP+Station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network)
	Software Development	Supports Cloud Server Development / Firmware and SDK for fast on-chip programming
	Network Protocols	IPv4, TCP/UDP/HTTP
	User Configuration	AT Instruction Set, Cloud Server, Android/iOS App

ESP8266 Applications

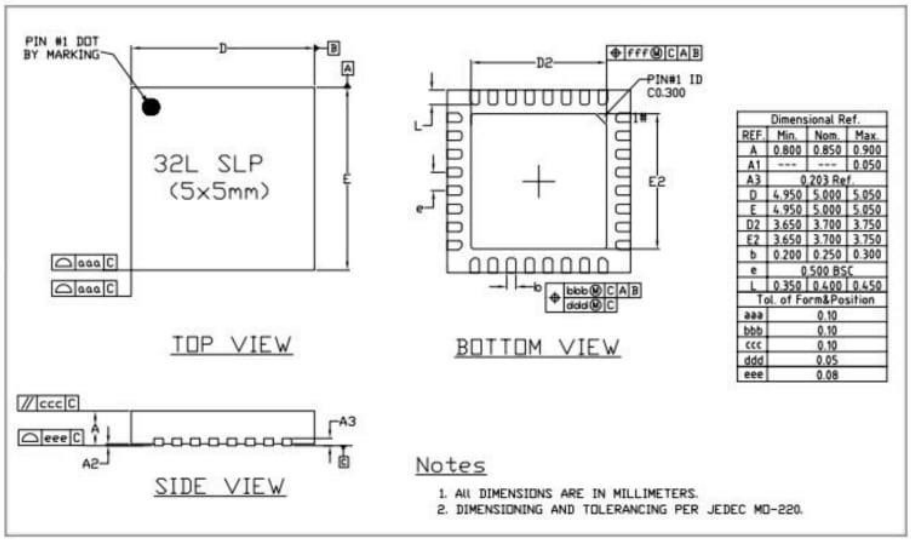
- Home appliances
- Home automation
- Smart plugs and lights
- Industrial wireless control
- Baby monitors
- IP cameras

- Sensor networks
- Wearable electronics
- Wi-Fi location-aware devices
- Security ID tags
- Wi-Fi position system beacons

Other Development Boards

Arduino, Raspberry Pi, PIC Development Board, AVR Development Board, MSP430 Launchpad, Intel Edison, Beagle Bone

ESP8266 Package



Dimensional Ref.			
REF.	Min.	Nom.	Max.
A	0.800	0.850	0.900
A1	---	---	0.050
A3	0.203 Ref.		
D	4.950	5.000	5.050
E	4.950	5.000	5.050
D2	3.650	3.700	3.750
E2	3.650	3.700	3.750
b	0.200	0.250	0.300
e	0.500 BSC		
L	0.350	0.400	0.450
Tol. of Form&Position			
aaa	0.10		
bbb	0.10		
ccc	0.10		
ddd	0.05		
eee	0.08		

How to Program NodeMCU ESP8266

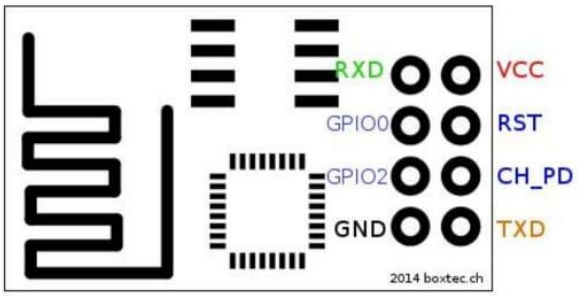
- **Requirements**

1. An ESP8266 module.
2. Arduino UNO, UARTbee or any UART to the USB device.
3. Jumper wires.

4. Arduino IDE version 1.6.6 or higher.

- **Get Started**

  First, we'll need to identify the pinout of ESP8266.



ESP8266-01

To set the ESP8266 in programming mode you need to connect its wires like this:

ESP8266	UARTbee	Arduino UNO
RXD	TXD	RX
GPIO0	GND	GND
GPIO2	———	———
GND	GND	GND
VCC	3.3	3.3V
RST	———	———
CH_PD	3.3V	3.3V
TXD	RXD	TX

NOTE: If you are using an Arduino UNO you will need to set Arduino RST to GND. Please be careful with the VCC of the ESP8266, it works only with a 3.3V supply.

- **Setup the Arduino IDE**

1. Download Arduino IDE.
2. Open your IDE and click on **File -> Preferences".**
3. In "Aditional Boards Manager URLs" add this line and click on "OK":

Zerø-Drift, Bi-Directional CURRENT/POWER MONITOR with I²C™ Interface

FEATURES

- SENSES BUS VOLTAGES FROM 0V TO +26V
- REPORTS CURRENT, VOLTAGE, AND POWER
- 16 PROGRAMMABLE ADDRESSES
- HIGH ACCURACY: 1% (Max) OVER TEMPERATURE
- FILTERING OPTIONS
- CALIBRATION REGISTERS
- SOT23-8 AND SO-8 PACKAGES

APPLICATIONS

- SERVERS
- TELECOM EQUIPMENT
- NOTEBOOK COMPUTERS
- POWER MANAGEMENT
- BATTERY CHARGERS
- WELDING EQUIPMENT
- POWER SUPPLIES
- TEST EQUIPMENT

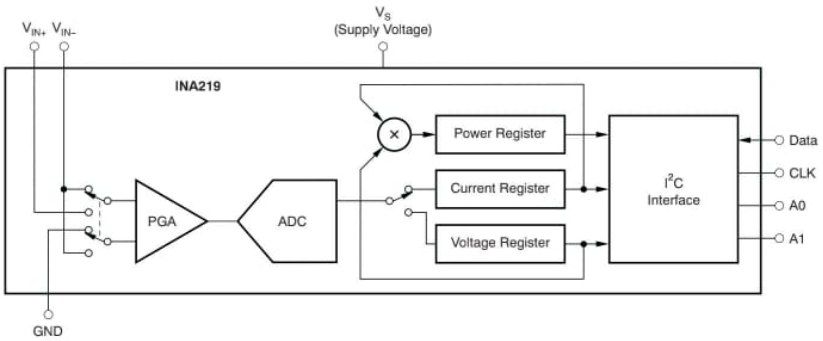
DESCRIPTION

The INA219 is a high-side current shunt and power monitor with an I²C interface. The INA219 monitors both shunt drop and supply voltage, with programmable conversion times and filtering. A programmable calibration value, combined with an internal multiplier, enables direct readouts in amperes. An additional multiplying register calculates power in watts. The I²C interface features 16 programmable addresses.

The INA219 senses across shunts on buses that can vary from 0V to 26V. The device uses a single +3V to +5.5V supply, drawing a maximum of 1mA of supply current. The INA219 operates from –40°C to +125°C.

RELATED PRODUCTS

DESCRIPTION	DEVICE
Current/Power Monitor with Watchdog, Peak-Hold, and Fast Comparator Functions	INA209
Zerø-Drift, Low-Cost, Analog Current Shunt Monitor Series in Small Package	INA210-INA214



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ORDERING INFORMATION(1)

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	PACKAGE MARKING
INA219	SO-8	D	I219A
	SOT23-8	DCN	A219

(1) For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

ABSOLUTE MAXIMUM RATINGS(1)

Over operating free-air temperature range (unless otherwise noted).

		INA219	UNIT
Supply Voltage, V_S		6	V
Analog Inputs, V_{IN+}, V_{IN-}	Differential (V_{IN+}) – (V_{IN-})(2)	–26 to +26	V
	Common-Mode	-0.3 to +26	V
SDA		GND – 0.3 to +6	V
SCL		GND – 0.3 to V_S + 0.3	V
Input Current Into Any Pin		5	mA
Open-Drain Digital Output Current		10	mA
Operating Temperature		–40 to +125	°C
Storage Temperature		–40 to +150	°C
Junction Temperature		+150	°C
ESD Ratings	Human Body Model	4000	V
	Charged-Device Model	750	V
	Machine Model (MM)	200	V

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(2) V_{IN+} and V_{IN-} may have a differential voltage of –26V to +26V; however, the voltage at these pins must not exceed the range –0.3V to +26V.

ELECTRICAL CHARACTERISTICS: V_S = +3.3V

Boldface limits apply over the specified temperature range, **T_A = –25°C to +85°C.**
At T_A = +25°C, V_{IN+} = 12V, V_{SENSE} = (V_{IN+} – $V_{IN–}$) = 32mV, PGA = ÷ 1, and BRNG(1) = 1, unless otherwise noted.

PARAMETER		TEST CONDITIONS	INA219 MIN	INA219 TYP	INA219 MAX	UNIT
INPUT						
Full-Scale Current Sense (Input) Voltage Range		PGA = ÷ 1	0		±40	mV
		PGA = ÷ 2	0		±80	mV
		PGA = ÷ 4	0		±160	mV
		PGA = ÷ 8	0		±320	mV
Bus Voltage (Input Voltage) Range(2)		BRNG = 1	0		32	V
		BRNG = 0	0		16	V
Common-Mode Rejection	CMRR	V_{IN+} = 0V to 26V	100	120		dB
Offset Voltage, RTI(3)	V_{OS}	PGA = ÷ 1		±10	±100	µV
		PGA = ÷ 2		±20	±125	µV
		PGA = ÷ 4		±30	±150	µV
		PGA = ÷ 8		±40	±200	µV
vs Temperature				**0.1**		**µV/°C**
vs Power Supply	PSRR	V_S = 3V to 5.5V		10		µV/V
Current Sense Gain Error				±40		m%
vs Temperature				**10**		**ppm/°C**
Input Impedance		Active Mode				
V_{IN+} Pin				20		µA
V_{IN-} Pin				20 || 320		µA || kΩ
Input Leakage(4)		Power-Down Mode				
V_{IN+} Pin				0.1	±0.5	µA
V_{IN-} Pin				0.1	±0.5	µA
DC ACCURACY						
ADC Basic Resolution				12		Bits
1 LSB Step Size						
Shunt Voltage				10		µV
Bus Voltage				4		mV
Current Measurement Error				±0.2	±0.5	%
over Temperature					**±1**	**%**
Bus Voltage Measurement Error				±0.2	±0.5	%
over Temperature					**±1**	**%**
Differential Nonlinearity				±0.1		LSB
ADC TIMING						
ADC Conversion Time		12-Bit		532	586	µs
		11-Bit		276	304	µs
		10-Bit		148	163	µs
		9-Bit		84	93	µs
Minimum Convert Input Low Time			4			µs

(1) BRNG is bit 13 of the Configuration Register.
(2) This parameter only expresses the full-scale range of the ADC scaling. In no event should more than 26V be applied to this device.
(3) Referred-to-input (RTI).
(4) Input leakage is positive (current flowing into the pin) for the conditions shown at the top of the table. Negative leakage currents can occur under different input conditions.

ELECTRICAL CHARACTERISTICS: V_S = +3.3V (continued)

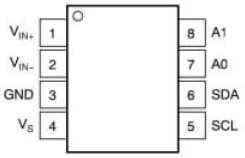
Boldface limits apply over the specified temperature range, **T_A = –25°C to +85°C.**
At T_A = +25°C, V_{IN+} = 12V, V_{SENSE} = (V_{IN+} – $V_{IN–}$) = 32mV, PGA = ÷ 1, and BRNG = 1, unless otherwise noted.

PARAMETER	TEST CONDITIONS	INA219 MIN	INA219 TYP	INA219 MAX	UNIT
SMBus					
SMBus Timeout[5]			28	35	ms
DIGITAL INPUTS (SDA as Input, SCL, A0, A1)					
Input Capacitance			3		pF
Leakage Input Current	$0 \le V_{IN} \le V_S$		0.1	1	µA
Input Logic Levels:					
V_{IH}		0.7 (V_S)		6	V
V_{IL}		–0.3		0.3 (V_S)	V
Hysteresis			500		mV
OPEN-DRAIN DIGITAL OUTPUTS (SDA)					
Logic '0' Output Level	I_{SINK} = 3mA		0.15	0.4	V
High-Level Output Leakage Current	$V_{OUT} = V_S$		0.1	1	µA
POWER SUPPLY					
Operating Supply Range		+3		+5.5	V
Quiescent Current			0.7	1	mA
Quiescent Current, Power-Down Mode			6	15	µA
Power-On Reset Threshold			2		V
TEMPERATURE RANGE					
Specified Temperature Range		–25		+85	°C
Operating Temperature Range		–40		+125	°C
Thermal Resistance[6] θ_{JA}					
SOT23-8			142		°C/W
SO-8			120		°C/W

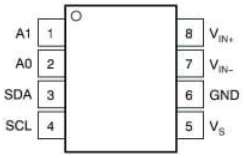
(5) SMBus timeout in the INA219 resets the interface any time SCL or SDA is low for over 28ms.
(6) θ_{JA} value is based on JEDEC low-K board.

PIN CONFIGURATIONS

DCN PACKAGE
SOT23-8
(Top View)



D PACKAGE
SO-8
(Top View)



PIN DESCRIPTIONS: SOT23-8

SOT23-8 (DCN)		
PIN NO	NAME	DESCRIPTION
1	V_{IN+}	Positive differential shunt voltage. Connect to positive side of shunt resistor.
2	V_{IN-}	Negative differential shunt voltage. Connect to negative side of shunt resistor. Bus voltage is measured from this pin to ground.
3	GND	Ground.
4	V_S	Power supply, 3V to 5.5V.
5	SCL	Serial bus clock line.
6	SDA	Serial bus data line.
7	A0	Address pin. Table 1 shows pin settings and corresponding addresses.
8	A1	Address pin. Table 1 shows pin settings and corresponding addresses.

PIN DESCRIPTIONS: SO-8

SO-8 (D)		
PIN NO	NAME	DESCRIPTION
1	A1	Address pin. Table 1 shows pin settings and corresponding addresses.
2	A0	Address pin. Table 1 shows pin settings and corresponding addresses.
3	SDA	Serial bus data line.
4	SCL	Serial bus clock line.
5	V_S	Power supply, 3V to 5.5V.
6	GND	Ground.
7	V_{IN-}	Negative differential shunt voltage. Connect to negative side of shunt resistor. Bus voltage is measured from this pin to ground.
8	V_{IN+}	Positive differential shunt voltage. Connect to positive side of shunt resistor.

ACS712

Fully Integrated, Hall Effect-Based Linear Current Sensor with 2.1 kVRMS Voltage Isolation and a Low-Resistance Current Conductor

Features and Benefits

- Low-noise analog signal path
- Device bandwidth is set via the new FILTER pin
- 5 µs output rise time in response to step input current
- 50 kHz bandwidth
- Total output error 1.5% at T_A = 25°C, and 4% at –40°C to 85°C
- Small footprint, low-profile SOIC8 package
- 1.2 mΩ internal conductor resistance
- 2.1 kV_{RMS} minimum isolation voltage from pins 1-4 to pins 5-8
- 5.0 V, single supply operation
- 66 to 185 mV/A output sensitivity
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage

Package: 8 pin SOIC (suffix LC)

Approximate Scale 1:1 

Description

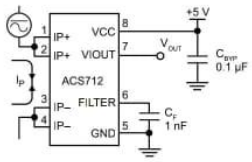
The Allegro® ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, automotive, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection.

The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging.

The output of the device has a positive slope (>$V_{IOUT(Q)}$) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power

Continued on the next page...

Typical Application



Application 1. The ACS712 outputs an analog signal, V_{OUT}, that varies linearly with the uni- or bi-directional AC or DC primary sensed current, I_P, within the range specified. C_F is recommended for noise management, with values that depend on the application.

Description (continued)

loss. The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 5 through 8). This allows the ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS712 is provided in a small, surface mount SOIC8 package. The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory.

Selection Guide

Part Number	Packing*	T_{OP} (°C)	Optimized Range, I_P (A)	Sensitivity, Sens (Typ) (mV/A)
ACS712ELCTR-05B-T	Tape and reel, 3000 pieces/reel	–40 to 85	±5	185
ACS712ELCTR-20A-T	Tape and reel, 3000 pieces/reel	–40 to 85	±20	100
ACS712ELCTR-30A-T	Tape and reel, 3000 pieces/reel	–40 to 85	±30	66

*Contact Allegro for additional packing options.

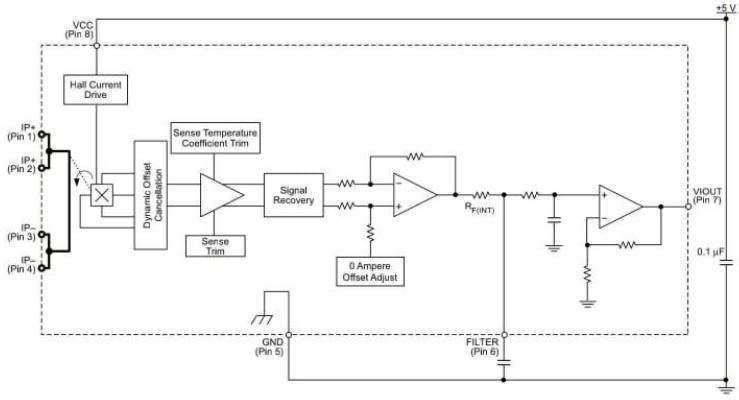
Absolute Maximum Ratings

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V_{CC}		8	V
Reverse Supply Voltage	V_{RCC}		–0.1	V
Output Voltage	V_{IOUT}		8	V
Reverse Output Voltage	V_{RIOUT}		–0.1	V
Output Current Source	$I_{IOUT(Source)}$		3	mA
Output Current Sink	$I_{IOUT(Sink)}$		10	mA
Overcurrent Transient Tolerance	I_P	100 total pulses, 250 ms duration each, applied at a rate of 1 pulse every 100 seconds.	60	A
Maximum Transient Sensed Current	I_R(max)	Junction Temperature, $T_J < T_J$(max)	60	A
Nominal Operating Ambient Temperature	T_A	Range E	–40 to 85	°C
Maximum Junction	T_J(max)		165	°C
Storage Temperature	T_{stg}		–65 to 170	°C

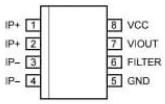
TÜV America
Certificate Number:
U8V 06 05 54214 010

Parameter	Specification
Fire and Electric Shock	CAN/CSA-C22.2 No. 60950-1-03 UL 60950-1:2003 EN 60950-1:2001

Functional Block Diagram



Pin-out Diagram



Terminal List Table

Number	Name	Description
1 and 2	IP+	Terminals for current being sensed; fused internally
3 and 4	IP–	Terminals for current being sensed; fused internally
5	GND	Signal ground terminal
6	FILTER	Terminal for external capacitor that sets bandwidth
7	VIOUT	Analog output signal
8	VCC	Device power supply terminal

COMMON OPERATING CHARACTERISTICS[1] over full range of T_{OP}, C_F = 1 nF, and V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
ELECTRICAL CHARACTERISTICS						
Supply Voltage	V_{CC}		4.5	5.0	5.5	V
Supply Current	I_{CC}	V_{CC} = 5.0 V, output open	6	8	11	mA
Output Zener Clamp Voltage	V_Z	I_{CC} = 11 mA, T_A = 25°C	6	8.3	–	V
Output Resistance	R_{IOUT}	I_{IOUT} = 1.2 mA, T_A=25°C	–	1	2	Ω
Output Capacitance Load	C_{LOAD}	VIOUT to GND	–	–	10	nF
Output Resistive Load	R_{LOAD}	VIOUT to GND	4.7	–	–	kΩ
Primary Conductor Resistance	$R_{PRIMARY}$	T_A = 25°C	–	1.2	–	mΩ
RMS Isolation Voltage	V_{ISORMS}	Pins 1-4 and 5-8; 60 Hz, 1 minute, T_A=25°C	2100	–	–	V
DC Isolation Voltage	V_{ISODC}	Pins 1-4 and 5-8; 1 minute, T_A=25°C	–	5000	–	V
Propagation Time	t_{PROP}	I_P = I_P(max), T_A = 25°C, C_{OUT} = open	–	3	–	µs
Response Time	$t_{RESPONSE}$	I_P = I_P(max), T_A = 25°C, C_{OUT} = open	–	7	–	µs
Rise Time	t_r	I_P = I_P(max), T_A = 25°C, C_{OUT} = open	–	5	–	µs
Frequency Bandwidth	f	–3 dB, T_A = 25°C; I_P is 10 A peak-to-peak	50	–	–	kHz
Nonlinearity	E_{LIN}	Over full range of I_P	–	±1	±1.5	%
Symmetry	E_{SYM}	Over full range of I_P	98	100	102	%
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirectional; I_P = 0 A, T_A = 25°C	–	V_{CC} × 0.5	–	V
Magnetic Offset Error	V_{ERROM}	I_P = 0 A, after excursion of 5 A	–	0	–	mV
Clamping Voltage	V_{CH}		Typ. –110	V_{CC} × 0.9375	Typ. +110	mV
	V_{CL}		Typ. –110	V_{CC} × 0.0625	Typ. +110	mV
Power-On Time	t_{PO}	Output reaches 90% of steady-state level, T_J = 25°C, 20 A present on leadframe	–	35	–	µs
Magnetic Coupling[2]			–	12	–	G/A
Internal Filter Resistance[3]	$R_{F(INT)}$			1.7		kΩ

[1]Device may be operated at higher primary current levels, I_P, and ambient, T_A, and internal leadframe temperatures, T_{OP}, provided that the Maximum Junction Temperature, T_J(max), is not exceeded.

[2]1G = 0.1 mT.

[3]$R_{F(INT)}$ forms an RC circuit via the FILTER pin.

COMMON THERMAL CHARACTERISTICS[1]

			Min.	Typ.	Max.	Units
Operating Internal Leadframe Temperature	T_{OP}	E range	–40	–	85	°C
					Value	Units
Junction-to-Lead Thermal Resistance[2]	$R_{\theta JL}$	Mounted on the Allegro ASEK 712 evaluation board			5	°C/W
Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	Mounted on the Allegro 85-0322 evaluation board, includes the power consumed by the board			23	°C/W

[1]Additional thermal information is available on the Allegro website.

[2]The Allegro evaluation board has 1500 mm² of 2 oz. copper on each side, connected to pins 1 and 2, and to pins 3 and 4, with thermal vias connecting the layers. Performance values include the power consumed by the PCB. Further details on the board are available from the Frequently Asked Questions document on our website. Further information about board design and thermal performance also can be found in the Applications Information section of this datasheet.