SC8902
Low-Voltage Quad H-Bridge Driver

1 Features

- H-Bridge Motor Driver
  - Drives Brush DC Motors or Other Loads
  - Low-MOSFET ON-Resistance: HS + LS 0.85Ω
- 1.0-A Maximum Drive Current
- 1.6-V to 6.0-V Operating Supply-Voltage
- Standard PWM Interface (IN1/IN2)
- Small Package and Footprint
  - 24 QFN 4.00 x 4.00 mm
- Protection Features
  - MVCCX Undervoltage Lockout (UVLO)
  - Overcurrent Protection (OCP)
  - Thermal Shutdown (TSD)

2 Applications

- IR-CUT
- Cameras
- DSLR Lenses
- Consumer Products
- Toys
- Robotics
- Medical Devices

3 Description

The SC8902 provides an integrated motor driver solution for cameras, consumer products, toys, and other low-voltage or battery-powered motion control applications. The device has quad H-bridge drivers, and drives brush DC motors, as well as other devices like solenoids. The output driver block consists of N-channel power MOSFETs configured as an H-bridge to drive the motor winding. An internal charge pump generates gate drive voltages.

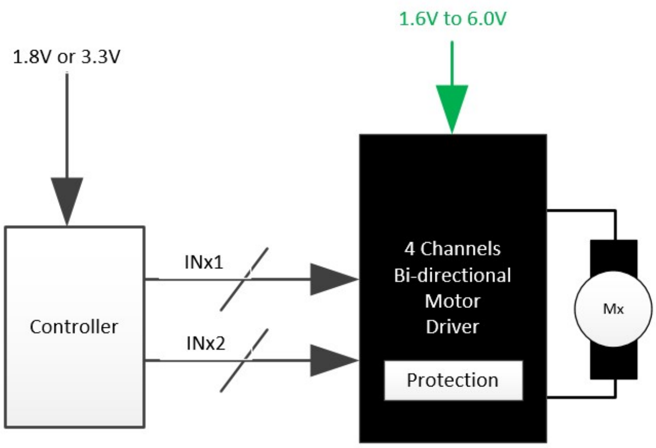
The SC8902 supplies up to 1.0-A of output current. The power supply voltage from 1.6 V to 6.0 V.

The SC8902 device has a PWM(IN/IN) input interface. Internal shutdown functions are provided for overcurrent protection, short circuit protection, undervoltage lockout, and overtemperature.
The SC8902 is packaged in a 24-pin QFN package.

Device Information

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SC8902	QFN (24)	4.00 mm × 4.00 mm

Simplified Schematic

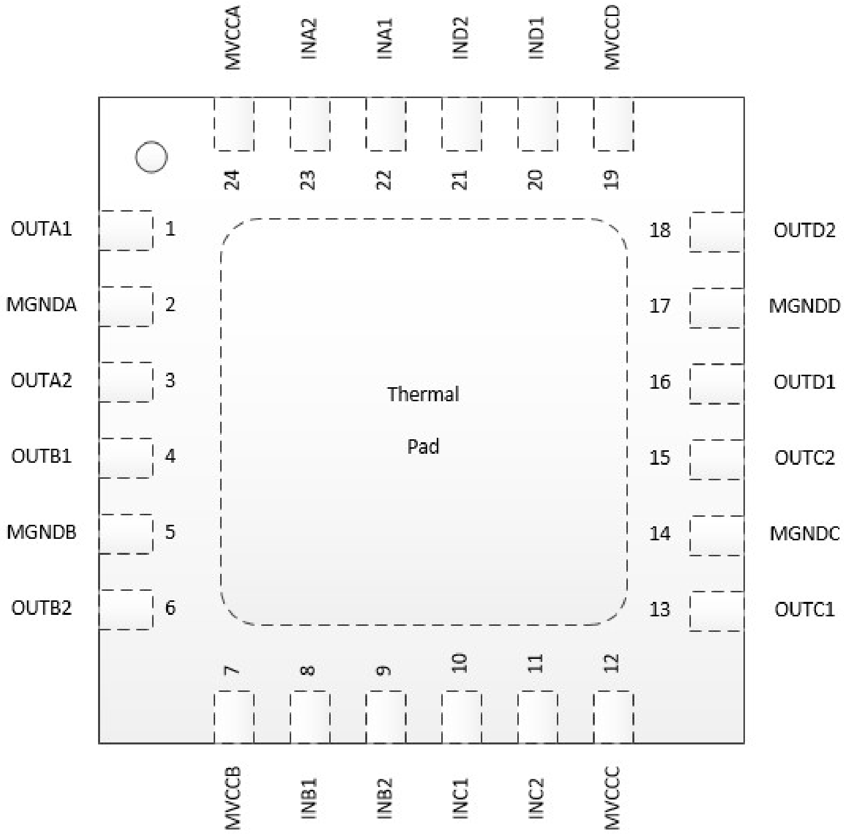


4 Pin Configuration and Functions

QFN24 Package

With Exposed Thermal Pad

Top View



Pin Functions

PIN		TYPE	DESCRIPTION	EXTERNAL COMPONENTS OR CONNECTIONS
NAME	NO.			
POWER AND GROUND				
MGNDA	2	PWR	Device ground	This pin must be connected to the PCB ground
MVCCA	24	PWR	Motor supply	Bypass to MGNDA with a 0.1uF(minimum) ceramic capacitor
MGNDB	5	PWR	Device ground	This pin must be connected to the PCB ground
MVCCB	7	PWR	Motor supply	Bypass to MGNDB with a 0.1uF(minimum) ceramic capacitor
MGNDC	14	PWR	Device ground	This pin must be connected to the PCB ground
MVCCC	12	PWR	Motor supply	Bypass to MGNDC with a 0.1uF(minimum) ceramic capacitor
MGNDD	17	PWR	Device ground	This pin must be connected to the PCB ground
MVCCD	19	PWR	Motor supply	Bypass to MGNDD with a 0.1uF(minimum) ceramic capacitor
CONTROL				
INA1	22	I	A Bridge input 1	Logic high sets OUTA1 high Internal pulldown resistor
INA2	23	I	A Bridge input 2	Logic high sets OUTA2 high Internal pulldown resistor
INB1	8	I	B Bridge input 1	Logic high sets OUTB1 high Internal pulldown resistor
INB2	9	I	B Bridge input 2	Logic high sets OUTB2 high Internal pulldown resistor
INC1	10	I	C Bridge input 1	Logic high sets OUTC1 high Internal pulldown resistor
INC2	11	I	C Bridge input 2	Logic high sets OUTC2 high Internal pulldown resistor
IND1	20	I	D Bridge input 1	Logic high sets OUTD1 high Internal pulldown resistor
IND2	21	I	D Bridge input 2	Logic high sets OUTD2 high Internal pulldown resistor
OUTPUT				
OUTA1	1	O	A Bridge output 1	Connect to motor winding
OUTA2	3	O	A Bridge output 2	
OUTB1	4	O	B Bridge output 1	Connect to motor winding
OUTB2	6	O	B Bridge output 2	
OUTC1	13	O	C Bridge output 1	Connect to motor winding
OUTC2	15	O	C Bridge output 2	
OUTD1	16	O	D Bridge output 1	Connect to motor winding
OUTD2	18	O	D Bridge output 2	

5 Specifications

5.1 Absolute Maximum Ratings

See[1][2]

		MIN	MAX	UNIT
	Power supply voltage, MVCCX	-0.3	6.0	V
	Outputs, OUTx1, OUTx2	-0.3	6.0	V
	Digital input pin voltage, INx1, INx2	-0.5	6.0	V
	Peak motor drive output current	Internally limited		A
T_J	Operating junction temperature	-40	150	℃
T_{stg}	Storage temperature	-65	150	℃
	Lead Temperature (Soldering, 10sec)		260	℃

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to network ground terminal.

5.2 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
MV_{CCX}	Motor power supply voltage	1.6		6.0	V
V_{IN}	Logic level input voltage	0		6.0	V
I_{OUT}	Continuous motor drive output current	0		1.0	A
f_{pwm}	Externally applied PWM frequency	0		50	kHz
T_A	Operating ambient temperature	-40		85	℃

5.4 Electrical Characteristics

T_A = 25°C, MV_{CCX} = 5.0 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
I_{MVCCX}	MVCCX quiescent supply current	V_{CC} =5.0V, no PWM		150	550	μA
I_{MVCCXQ}	MVCCX sleep mode supply current	V_{CC} =5.0V, INX1/INX2 low, no load		0.01	1	μA
V_{UVLO}	MVCCX undervoltage lockout voltage	MV_{CCX} rising			1.6	V
		MV_{CCX} falling			1.5	V
LOGIC-LEVEL INPUTS						
V_{IL}	Input low voltage				0.8	V
V_{IH}	Input high voltage		1.6			V
I_{IL}	Input low current	V_{IN}=0	-5		5	μA
I_{IH}	Input high current	V_{IN}=3.3V			50	μA
R_{PD}	Pulldown resistance			100		kΩ
H-BRIDGE FETS						
$R_{DS(ON)}$	HS+LS FET on resistance	MV_{CCX}=5.0V,I_O=500mA,T_J=25℃		850		mΩ
I_{OFF}	OFF-state leakage current	V_{OUTx}=0V	-200		200	nA
PROTECTION CIRCUITS						
I_{OCP}	Overcurrent protection trip level		1.2			A
t_{DEG}	Overcurrent de-glitch time			1		μs
t_{OCR}	Overcurrent protection retry time			1		ms
t_{TSD} (1)	Thermal shutdown temperature	Die temperature	150	160	180	℃

(1) Not tested in production; limits are based on characterization data

5.5 Timing Requirements

T_A = 25°C, MV_{CCX} = 5.0 V, R_L = 20 Ω

NO.			MIN	MAX	UNIT
1	t_1	Output enable time		10	µs
2	t_2	Output disable time		300	ns
3	t_3	Delay time, INx low to OUTx high		160	ns
4	t_4	Delay time, INx high to OUTx low		160	ns
5	t_5	Output rise time		188	ns
6	t_6	Output fall time		188	ns

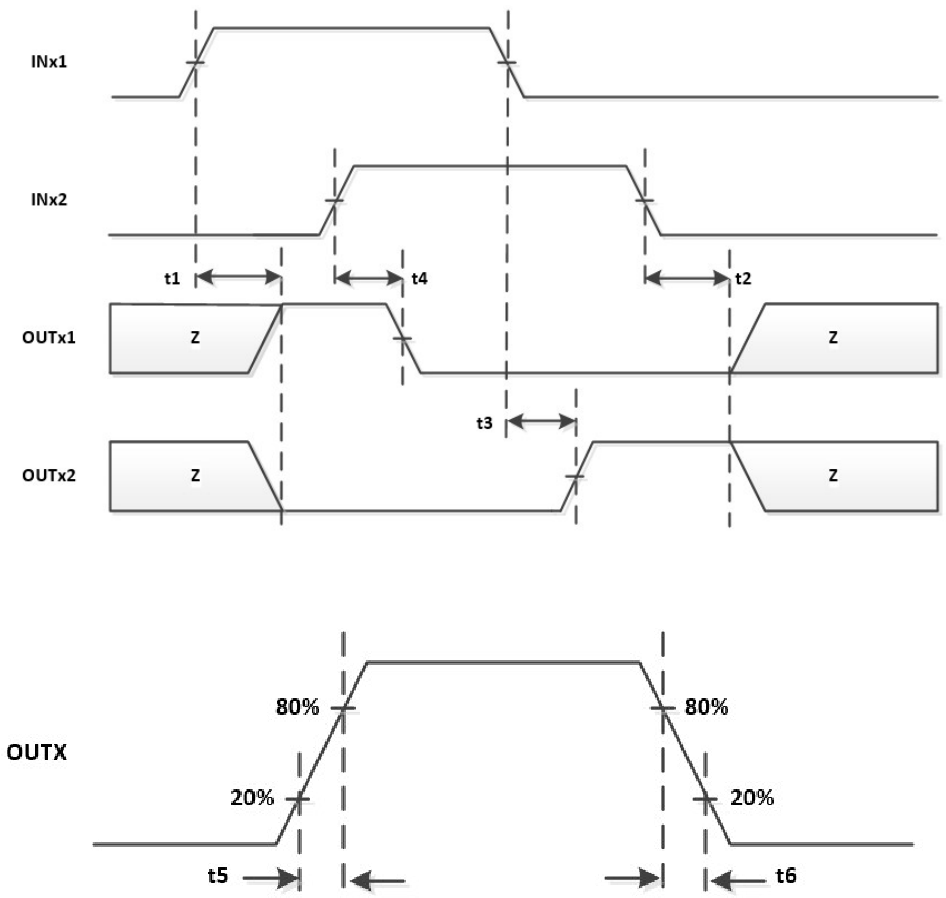


Figure 1. Input and Output Timing for SC8902

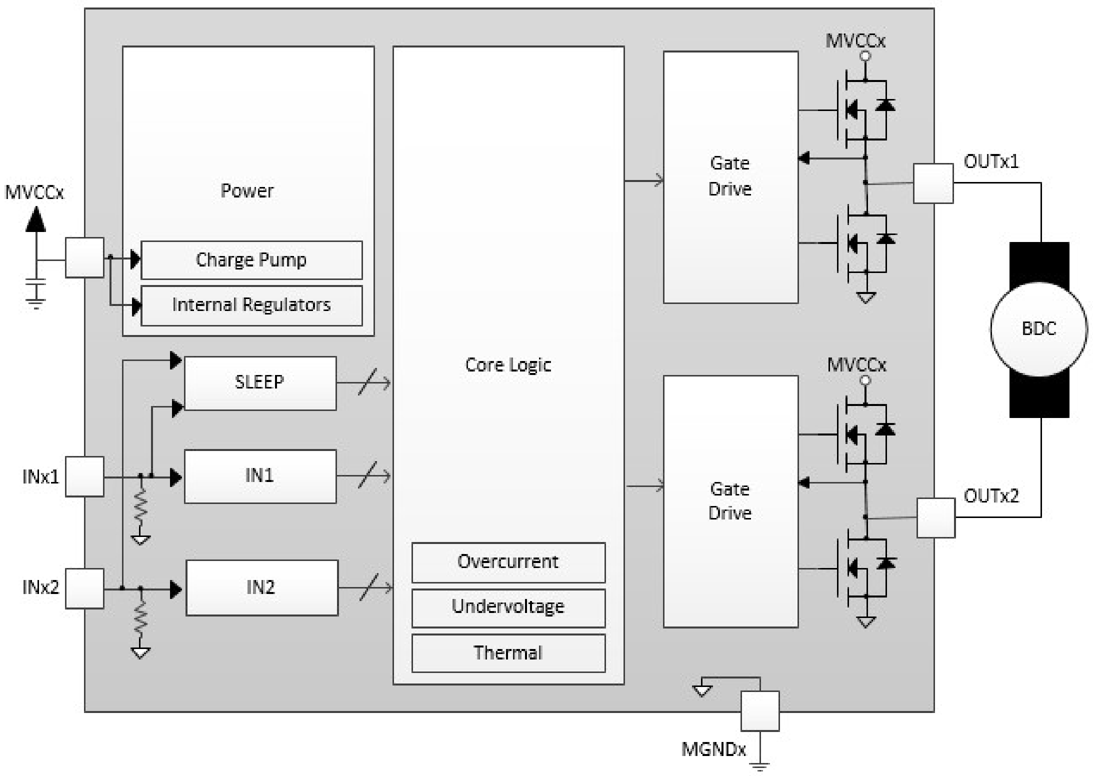
6 Detailed Description

6.1 Overview

The SC8902 device is an H-bridge driver that can drive brush DC motors or other devices like solenoids. The outputs are controlled using a PWM interface (INX1/INX2).

This device greatly reduces the component count of motor driver systems by integrating the necessary driver FETs and FET control circuitry into a single device. In addition, the SC8902 device adds protection features beyond traditional discrete implementations: undervoltage lockout, overcurrent protection, and thermal shutdown.

6.2 Functional Black Diagram(one H-Bridge Driver)



6.3 Feature Description

6.3.1 Bridge Control

The SC8902 device is controlled using a PWM input interface, also called an IN/IN interface. Each output is controlled by a corresponding input pin.

Table 1 shows the logic for the SC8902 device.

Table 1. SC8902 Device Logic

INx1	INx2	OUTx1	OUTx2	FUNCTION (DC MOTOR)
0	0	Z	Z	Sleep
0	1	L	H	Reverse
1	0	H	L	Forward
1	1	L	L	Brake

6.3.2 Sleep Mode

If the INX1 pin and INX2 pin both are brought to a logic-low state, the SC8902 device enters a low-power sleep mode. In this state, all unnecessary internal circuitry is powered down.

6.3.3 Power Supplies and Input Pins

The input pins can be driven within the recommended operating conditions with MVCCX. No leakage current path exists to the supply. Each input pin has a weak pulldown resistor (approximately 100 kΩ) to ground.

6.3.4 Protection Circuits

The SC8902 is fully protected against MVCCX undervoltage, overcurrent, and overtemperature events.

MVCCX undervoltage lockout If at any time the voltage on the MVCCX pin falls below the undervoltage lockout threshold voltage, all FETs in the H-bridge are disabled. Operation resumes when the MVCCX pin voltage rises above the UVLO threshold.

Overcurrent protection (OCP) An analog current-limit circuit on each FET limits the current through the FET by removing the gate drive. If this analog current limit persists for longer than t_{DEG}, all FETs in the H-bridge are disabled. Operation resumes automatically after t_{RETRY} has elapsed. Overcurrent conditions are detected on both the high-side and low-side devices. A short to the MVCCX pin, GND, or from the OUT1 pin to the OUT2 pin results in an overcurrent condition.

Thermal shutdown (TSD) If the die temperature exceeds safe limits, all FETs in the H-bridge are disabled. After the die temperature falls to a safe level, operation automatically resumes.

Table 2. Fault Behavior

FAULT	CONDITION	H-BRIDGE	INTERNAL CIRCUIT	RECOVERY
MVCCX undervoltage(UVLO)	V_{CC}<1.5V	Disabled	Disabled	V_{CC}>1.6V
Overcurrent(OCP)	I_{OUT}>1.2A(MIN)	Disabled	Operating	t_{OCR}
Thermal Shutdown(TSD)	T_J>150℃(MIN)	Disabled	Operating	T_J<150℃

7 Application and Implementation

NOTE

Information in the following applications sections is not part of the SteadiChips component specification, and SteadiChips does not warrant its accuracy or completeness. SteadiChips's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

7.1 Application Information

The SC8902 device is device is used to drive one DC motor or other devices like solenoids. The following design procedure can be used to configure the SC8902 device.

7.2 Typical Application

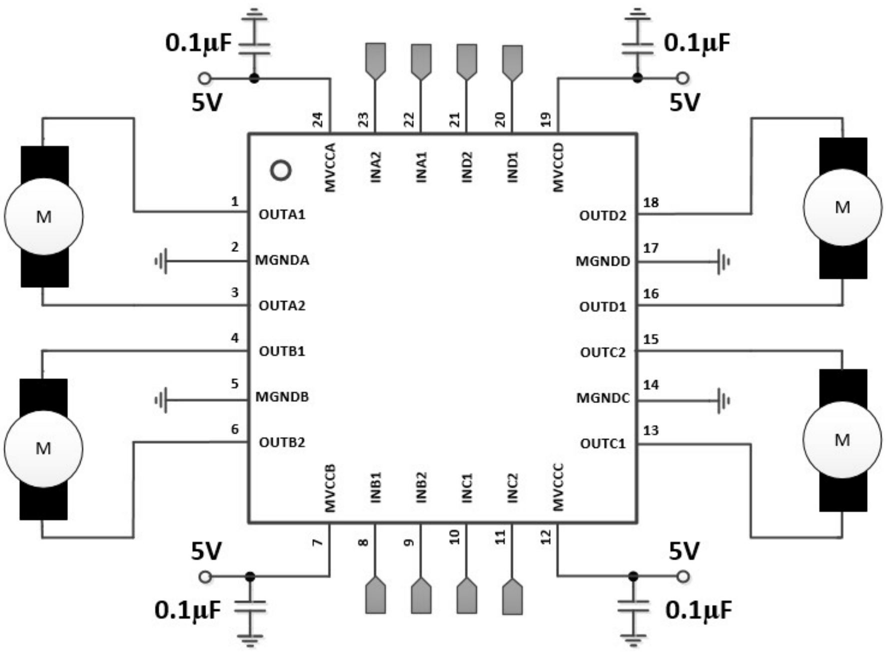


Figure 2. Schematic of SC8902 Application

8 Power Supply Recommendations

8.1 Bulk Capacitance

Having appropriate local bulk capacitance is an important factor in motor-drive system design. It is generally beneficial to have more bulk capacitance, while the disadvantages are increased cost and physical size.

The amount of local capacitance needed depends on a variety of factors, including:

- The highest current required by the motor system
- The power-supply capacitance and ability to source current
- The amount of parasitic inductance between the power supply and motor system
- The acceptable voltage ripple
- The type of motor used (brushed dc, brushless dc, stepper)
- The motor braking method

The inductance between the power supply and motor drive system limits the rate at which current can change from the power supply. If the local bulk capacitance is too small, the system responds to excessive current demands or dumps from the motor with a change in voltage. When adequate bulk capacitance is used, the motor voltage remains stable and high current can be quickly supplied.

The data sheet generally provides a recommended value, but system-level testing is required to determine the appropriate size of bulk capacitor.

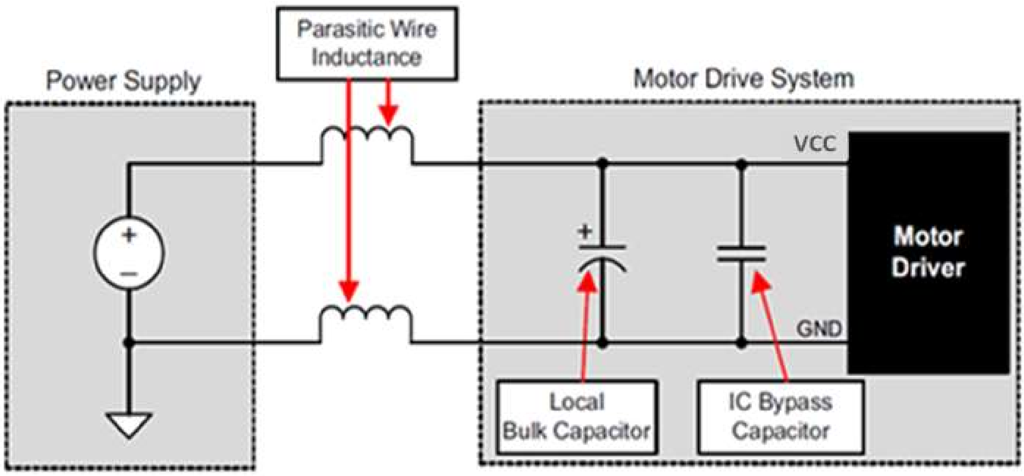


Figure 3. Example Setup of Motor Drive System With External Power Supply

The voltage rating for bulk capacitors should be higher than the operating voltage, to provide margin for cases when the motor transfers energy to the supply

9 Layout

9.1 Layout Guidelines

The MVCCX pins should be bypassed to GND using low-ESR ceramic bypass capacitors with a recommended value of 0.1 µF rated for the MVCCX supplies. These capacitors should be placed as close to the MVCCX pins as possible with a thick trace or ground plane connection to the device GND pin. In addition bulk capacitance is required on the MVCCX pin.

9.2 Layout Example

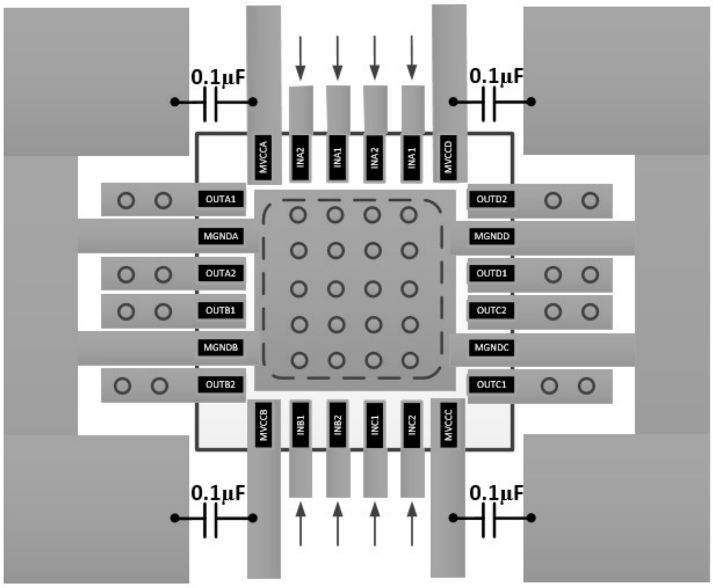


Figure 4. Simplified Layout Example

9.3 Power Dissipation

Power dissipation in the SC8902 is dominated by the power dissipated in the output FET resistance, or $R_{DS(on)}$. Average power dissipation when running both H-bridges can be roughly estimated by Equation 1:

$$P_{TOT} = R_{DS(ON)} \times (I_{OUT(RMS)})^2 \quad (1)$$

where

- P_{TOT} is the total power dissipation
- $R_{DS(ON)}$ is the resistance of the HS plus LS FETs
- $I_{OUT(RMS)}$ is the RMS or DC output current being supplied to the load

The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

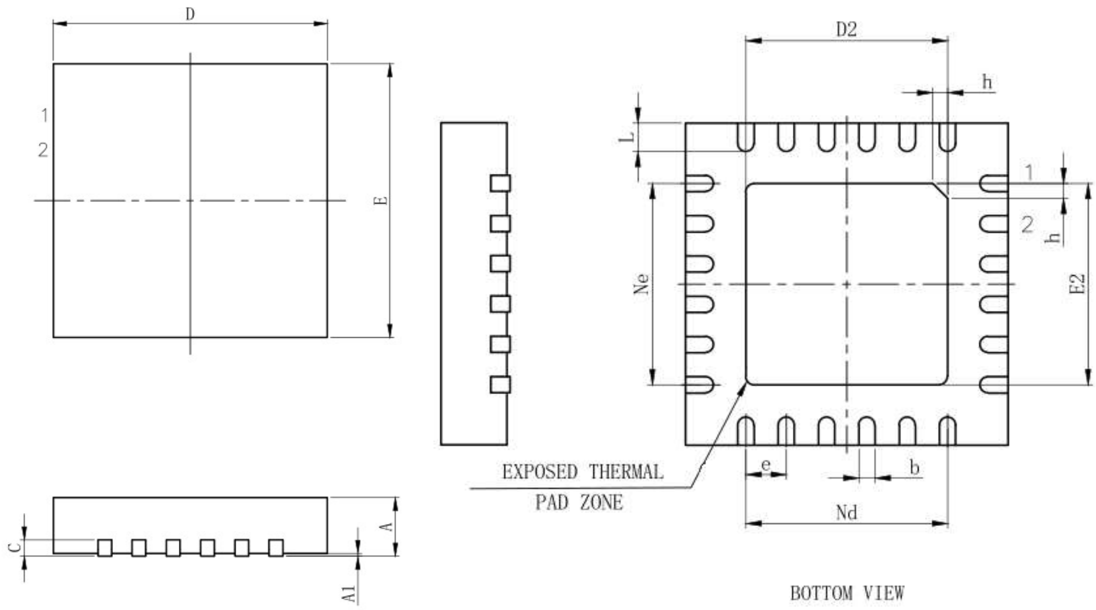
NOTE

The value of $R_{DS(ON)}$ increases with temperature, so as the device heats, the power dissipation increases.

The SC8902 device has thermal shutdown protection. If the die temperature exceeds approximately 150°C, the device is disabled until the temperature drops to a safe level.

Any tendency of the device to enter thermal shutdown is an indication of either excessive power dissipation, insufficient heatsinking, or too high an ambient temperature.

10 Package Outline



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0. 70	0.75	0. 80
	0.80	0.85	0. 90
	0.85	0.90	0. 95
A1	—	0.02	0. 05
b	0. 18	0.25	0. 30
c	0. 18	0.20	0. 25
D	3. 90	4. 00	4. 10
D2	2. 40	2. 50	2. 60
e	0. 50BSC		
Ne	2. 50BSC		
Nd	2. 50BSC		
E	3. 90	4. 00	4. 10
E2	2. 40	2. 50	2. 60
L	0. 35	0.40	0. 45
h	0. 30	0. 35	0. 40