

# 12 Bit ADC Module with +/-10V Range

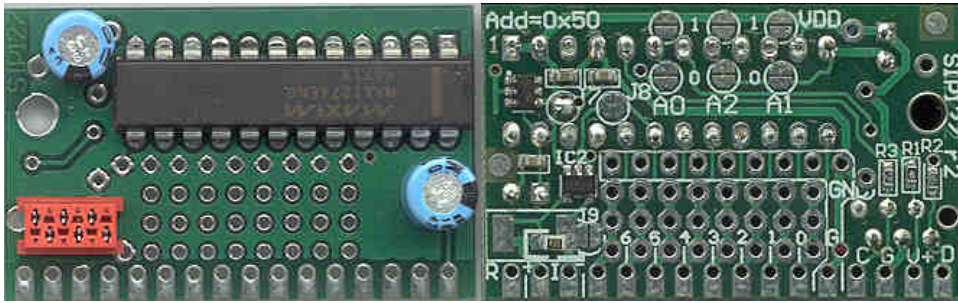
December 2, 2008

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## 1 Introduction

The SIP127 module is an 8 channel, 12 bit ADC module based on the [Maxim MAX127](#) or [MAX128](#) ADC chip.



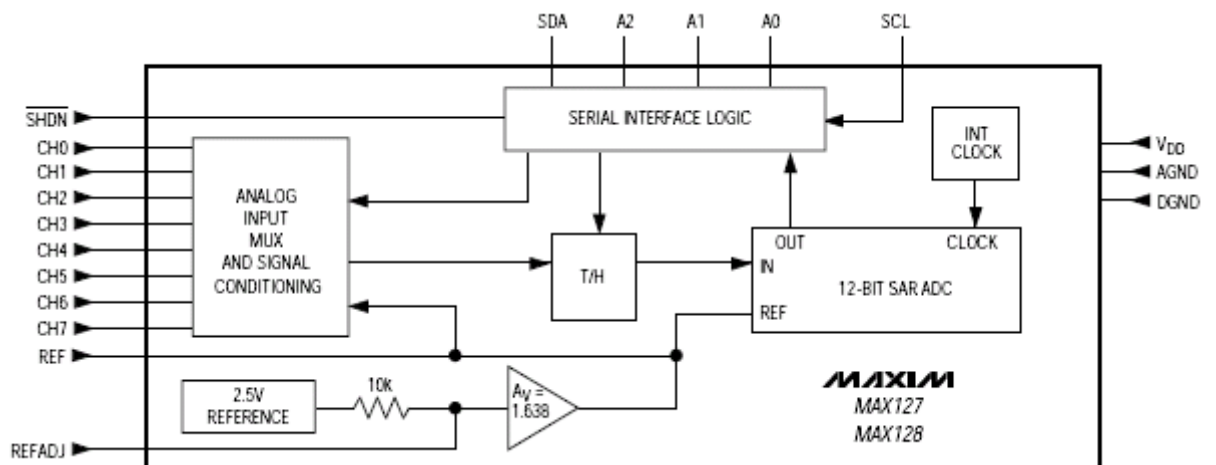
The MAX127/8 have several unique features that are not available in other ADC chips and make them ideal for instrumentation and test systems.

- 0-5V,  $\pm 5V$ , 0-10V,  $\pm 10V$  Input ranges from a 5V supply.
- $\pm 16.5V$  Overvoltage-Tolerant Input Multiplexer
- DIP package for easy field replacement
- precision internal reference, or external reference
- 8 ADC channels

The SIP127 module is a small easy to use module:

- MAX127 (standard) or MAX128 (optional) can be fitted
- Small Prototype area to fit resistor dividers, RC input filter etc
- High-side current sensor with on-board or external shunt for measuring power supply currents and voltages
- Optional high precision external reference chip
- Up to 8 boards per I2C bus

## 2 MAX127 vs Max128

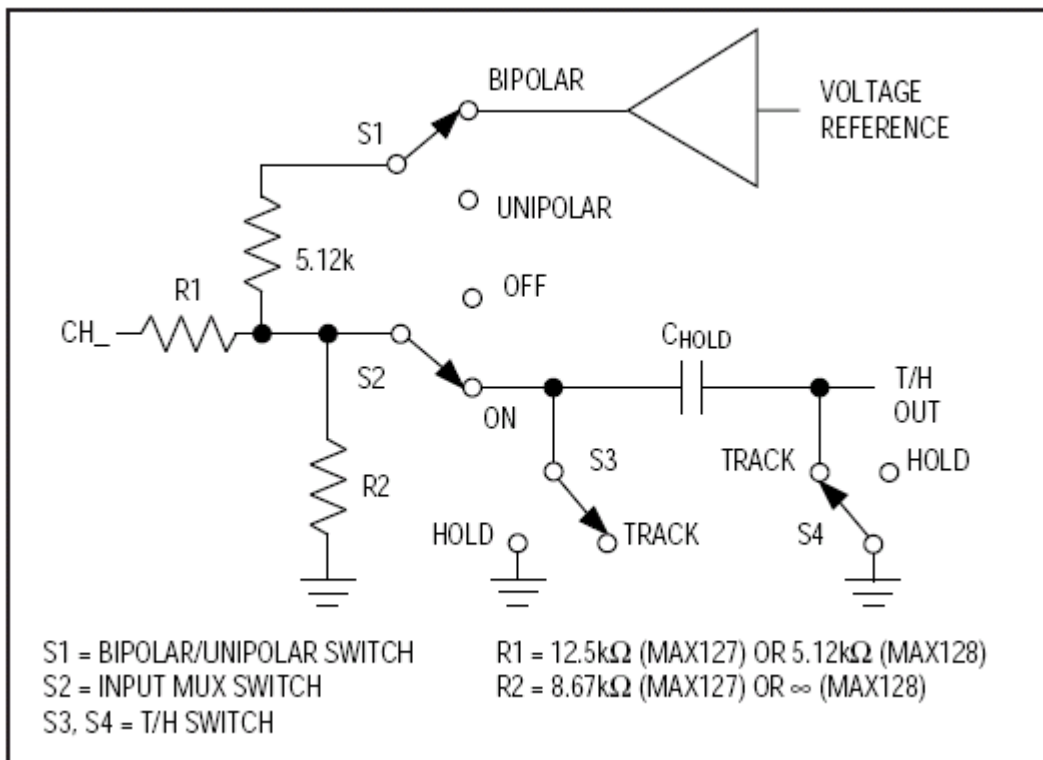


These two IC's are almost identical. They differ only in the input voltage range and divider arrangement. They both have the same effective  $V_{Ref}$  to the ADC of 4.096V.

The MAX127 has scaled input divide ratios at the input that gives exact 0-5,+/-5,0-10,+/-10V input ranges. When using an external reference, full scale is  $(5/4.096)*V_{Ref}$ , ie  $V_{REF} \times 1.2207$ . Note that the MAX127 will measure 0-5V, even when its supply voltage is 4.75V

The MAX128 is for low input voltages. has simple x1 input to give 0- $V_{Ref}/2$ , +/- $V_{Ref}/2$ , 0- $V_{Ref}$ , +/-  $V_{Ref}$  ranges. (Internal  $V_{Ref}$  is 4.096V). A consequence of this is that the 0-5V range has a high input impedance on the MAX128, but not on the MAX127.

## 2.1 Input Multiplexor



If you want to measure lower voltages with the external 2.5V reference, then the MAX128 is a better choice.

	VRef	RB=00	RB=10	RB=01	RB=11			
MAX127	Int	0-5	0-10	+/-5	+/-10			
MAX127	Ext 2.5V	0-3.052	0-6.104	+/-3.052	+/-6.104			
MAX128	Int	0-2.048	0-4.096	+/-2.048	+/-4.096			
MAX128	Ext 2.5V	0-1.25	0-2.5	+/-1.25	+/-2.5			

If you are using input dividers or high impedance sources then study the input circuit carefully. The input resistance is different in unipolar or bipolar mode

	Unipolar	Bipolar	
MAX127	21.17k	15.72k	
MAX128	open	10.24k	

In bipolar input mode, the input current is not flowing to ground, but to a +ve reference depending on range.

	VRef	Range=0	Range=1
MAX127	Int 4.096	1.25V	2.5V
MAX127	Ext	VRef/2.44	VRef/1.2207
MAX128	Int 4.096	2.048	4.096
MAX128	Ext	VRef/2	VRef

## 2.2 Unselected Channels

The multiplexor arrangement does not appear to be specified by Maxim.

Current continues to flow input unselected inputs, they appear to have similar input resistance to selected channels, connected to some +ve voltage.

## 3 I2C Communications

The base address is 0x50. 8 sub-addresses are available through J1-6. Note that the order of A0,A2,A1 is correct.



Realterm (V2.0.0.65+) has controls for reading the MAX127/8 on the I2C-2 tab.

The MAX127/8 is very easy to use. The control register is written to select the channel and initiate a read cycle, then the 2 byte result is read. To read Channel 0, 5V range:

```
S5080PR02P
```

Data is Big Endian. In unipolar input mode, the output is straight binary. For bipolar input mode, the output is two's complement.

## 4 Current Sensor Max4372

The **MAX4372T** high side current sensor is connected to *ADC6*. If you want to use this as an ADC input, then cut J8. *ADC6* is the current measurement channel

- 0-28V common mode range
- Maximum Vout = VSense-0.25V
- Standard is 0.1ohm shunt and MAX4372T

## 4.1 On-board Sense Resistor

From the factory the SIP127 comes with an 0805, 0.1ohm current sense resistor and the 20V/V MAX4372T.

This gives 2V/A sensitivity at the ADC, or 610uA per count resolution.

Max continuous current is 1A.

The small 0805 sense resistor can be replaced with a larger 3210 resistor on the PCB. For very high currents, the internal sense resistor can be removed, and an external shunt used instead.



## 4.2 Measuring the ISENSE Voltage

J9 connects ADC7 to ISENSE\_OUT. The sensed voltage must be within the 0-10V working range of the MAX127. J9 is normally open and must be connected. ADC7 is to measure the supply voltage to the device connected to ISenseOut. ADC6 is measuring the current drawn by that device.

If the sensed voltage is greater than 10V, then you can fit a resistor divider in the prototype area.

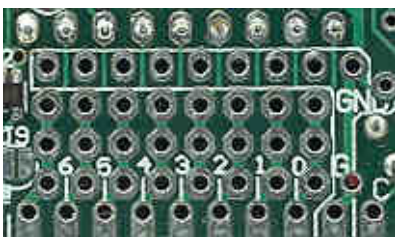
## 4.3 MAX4372 Versions

There are 3 gain variants of the MAX4372 available

Version	Gain	Marking	V@0.1ohm	
MAX4372T	20V/V	ADIU	2V/A	
MAX4372F	50V/V	ADIV	5V/A	
MAX4372H	100V/V	ADIW	10V/A	

## 5 Prototyping Area: Dividers and Filters

There is small prototyping area. You can use this for input dividers or RC or LC filters. The pads closest to IC1 are ground pads.



When using resistor dividers or series resistors on the input, pay careful attention to the input resistance of the MAX127/8. It is not a high impedance input (except MAX128 on 0-Vref range). The input resistance changes with the range selected.

As the internal resistors are precise, they can form part of a voltage divider, so only a series resistor is needed in many cases. The voltage at the input must remain within the +/-16.5V multiplexor limits on unselected channels, so see the input circuit notes above.

## Optional Zener

You can fit Z1 the optional 6.2V protection zener where there is a chance of reversed or over voltage supply to the I2C bus, or where destructive voltages might get applied to the ADC inputs. In some cases it will prevent or limit damage spreading through the system

## 6 MAX6033 Optional Precision Reference

The module has provision for an optional **MAX6033** precision reference. Compared to the built in reference it offers:

- Superior calibration accuracy of 0.04%
- better temperature stability of 7ppm/°C

With a 5V supply you can use the following variants:

	Suffix	Vout
	-25	2.5V
	-30	3.0V
	-41	4.096

### 6.1 Fitting the MAX6033

To use the external reference, fit IC4 (note the dot for pin 1), and link J7 to disable the internal reference of the MAX127/8



Note that J7 must be linked if IC4 is fitted. If you need to revert to the internal reference when IC4 is fitted, you will have to cut the pcb track connecting IC4,5 to IC1,2,3

## 6.2 Using External Reference Input

The reference connection can be an input to the MAX127/8 or an output from it.

To use it as an input, J7 is closed. By default it is an output of 4.096V

## 7 Jumpers

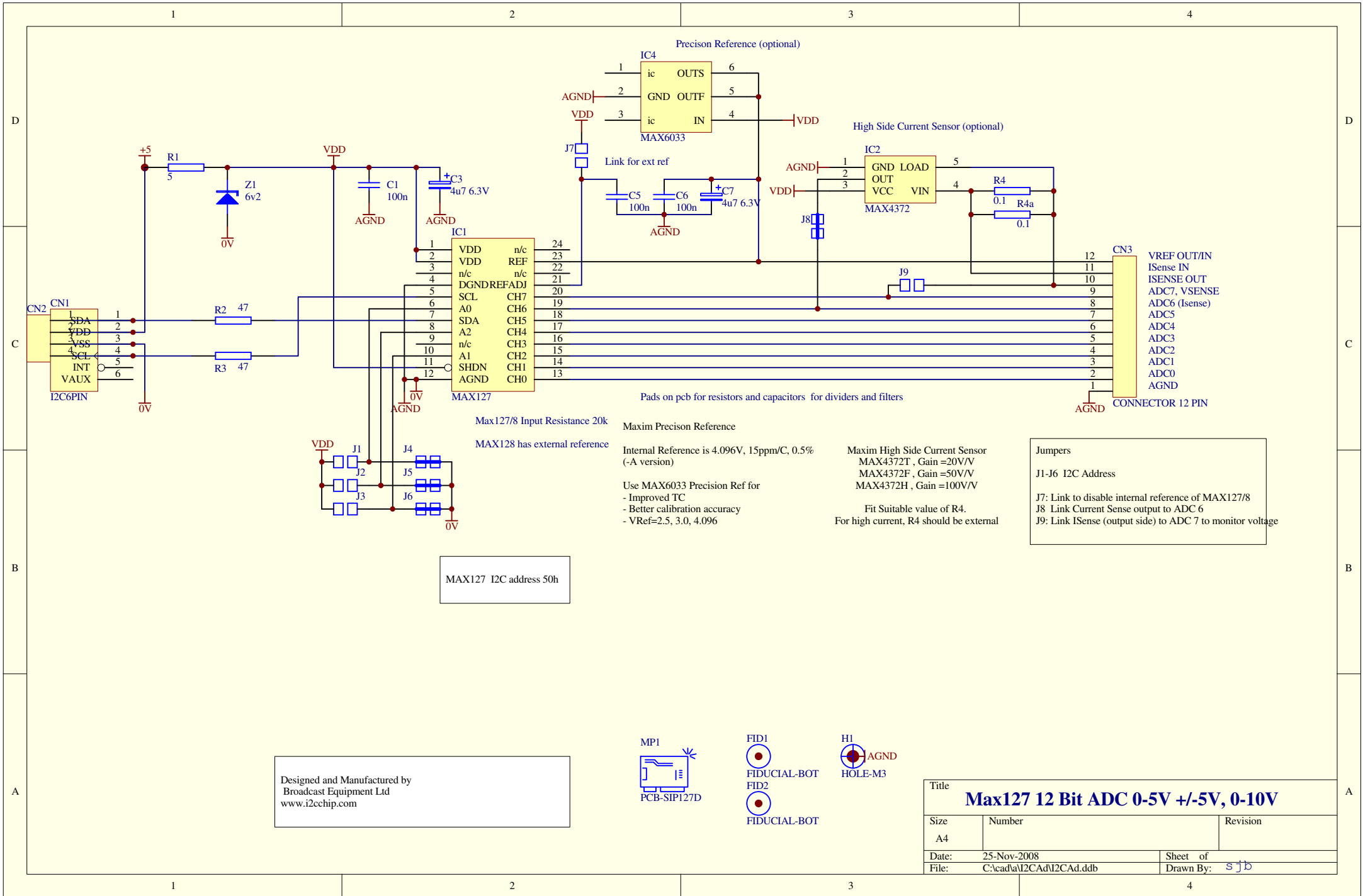
J#	Function	default	
J1-6	I2C Sub Address	joined to 0	
J7	Disable Internal Ref	open	
J8	Current sense to ADC6	closed	
J9	ISENSE_OUT to ADC7	open	

## 8 Edge Connector

Pin	Function	
1	SDA	
2	+5	
3	GND	
4	SCL	
5	AGND	
6	ADC0	
7	ADC1	
8	ADC2	
9	ADC3	
10	ADC4	
11	ADC5	
12	ADC6	Current Sense
13	ADC7	J9 links to 14
14	ISENSE_OUT	
15	ISENSE_IN	
16	VREF (in/out)	

## 9 Drawings

### 9.1 Circuit Diagram



Precision Reference (optional)

High Side Current Sensor (optional)

Pads on pcb for resistors and capacitors for dividers and filters

Max127/8 Input Resistance 20k

Maxim Precision Reference

Internal Reference is 4.096V, 15ppm/C, 0.5% (-A version)

- Use MAX6033 Precision Ref for
  - Improved TC
  - Better calibration accuracy
  - VRef=2.5, 3.0, 4.096

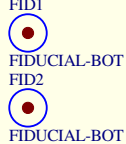
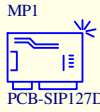
Maxim High Side Current Sensor  
 MAX4372T, Gain =20V/V  
 MAX4372F, Gain =50V/V  
 MAX4372H, Gain =100V/V

Fit Suitable value of R4.  
 For high current, R4 should be external

**Jumpers**  
 J1-J6 I2C Address  
 J7: Link to disable internal reference of MAX127/8  
 J8: Link Current Sense output to ADC 6  
 J9: Link ISENSE (output side) to ADC 7 to monitor voltage

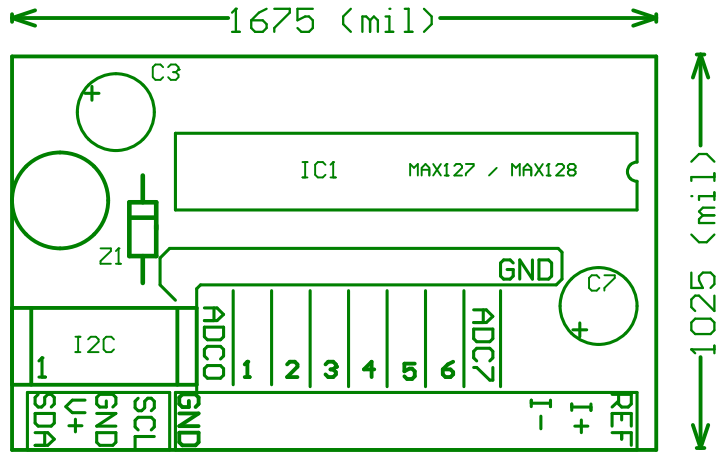
MAX127 I2C address 50h

Designed and Manufactured by  
 Broadcast Equipment Ltd  
 www.i2cchip.com

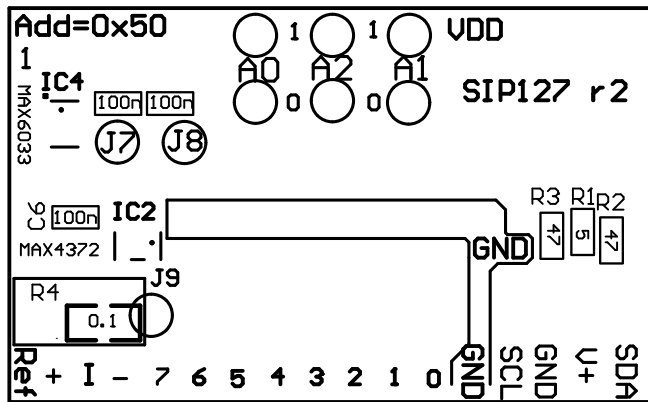


Title		
<b>Max127 12 Bit ADC 0-5V +/-5V, 0-10V</b>		
Size	Number	Revision
A4		
Date:	25-Nov-2008	Sheet of
File:	C:\cad\va\I2CA\I2CA.ddb	Drawn By: s j b

## 9.2 PCB Drawings



Bottom Side View



- J7: Link to disable internal reference of MAX127/8
- J8: Link Current Sense output to ADC 6
- J9: Link ISense (output side) to ADC 7 to monitor voltage

## Revision History

Date	Rev#	Changes
2 Dec 2008	2	Add detail to MAX127/8 of ranges and input resistance