OP5340-1/OP5340-2 USER GUIDE

Analog to Digital Converter Module

WWW.OPAL-RT.COM

Published by

OPAL-RT Technologies, Inc. 1751 Richardson, suite 2525 Montréal (Québec) Canada H3K 1G6

www.opal-rt.com

CONTENTS

OP5340-1/-2 ANALOG TO DIGITAL CONVERTER

GETTING STARTED

Before you begin, verify that your system meets t requirements of the OP5340 board:

Software Requirements

- RT-LAB 8.4.0 and higher
- MATLAB 32 bits 6.5 and higher
- Windows XP and higher

Hardware Requirements

- OPAL-RT simulator:
  - OP5000 series hardware-in-the-loop simulator
  - OPAL-RT I/O expansion box (only for use with OPAL-RT simulators)
  - OPAL-RT carrier boards: OP5130, OP5220, OP5222, OP5620, OP6228, OP7220

Features

- HYPERSIM compatible
- OP5340-1: 16 differential analog input channels
- OP5340-2: 8 analog input channels
- All inputs are sampled simultaneously for additional simulation accuracy. They can be sampled up to 500 kSPS
- 16 bit resolution
- ±24V input range up to 120V

INTRODUCTION

The OP5340 analog to digital converter is a part of the OP5000 series of optional modules for OPAL-RT's state of the art HIL (hardware-in-the-loop) systems, intended for use with OPAL-RT carrier boards. Designed for OPAL-RT's simulation systems, the OP5340 converts analog signals to digital, which ensures simultaneous signal capture from multiple channels, thus eliminating the skew errors associated with multiplexed channels.

Each ADC can sample up to 500 kS/s, giving a total throughput of 8 MS/s, all channels are simultaneously sampled. The on-board EEPROM provides offsets and gains data adjustment written during the calibration process The board also contains over-voltage protection.

DESCRIPTION

The OP5340-1 module provides 16 differential analog input channels and the OP5340-2 provides 8 differential analog input channels. Each channel uses a 16-bit resolution analog-to-digital converter. The OP5340 module also has input signal conditioning capabilities that allow the user to apply a signal range from ±20v up to ±120v on the inputs. By default, the maximum input signal is set to ±20 volts.

OFFSET AND GAIN CALIBRATION

OP5340 module contains a serial EEPROM to store the module identification, calibration information and any other important information. Each OP5340 module is calibrated after assembly; during calibration, gain and offset are adjusted to ensure accurate target output values at ±20 mV noise and offset.

During the load, RT-LAB, OPAL-RT's simulation software, reads the EEPROM contents of each OP5340 (ADC) module connected to the OP5220 board. For each module, the calibration parameters stored in the EEPROM are used to determine the gain and offset values for each channel.

CIRCUIT LAYOUT DIAGRAMS

When the OP5340 is installed on the carrier board, only the top of the circuit board is visible, as shown in Figure 1. Users may request resistors (at time of purchase) to change voltages for specific needs, according to the values provided in Table 1 (though factory customized orders are recommended).

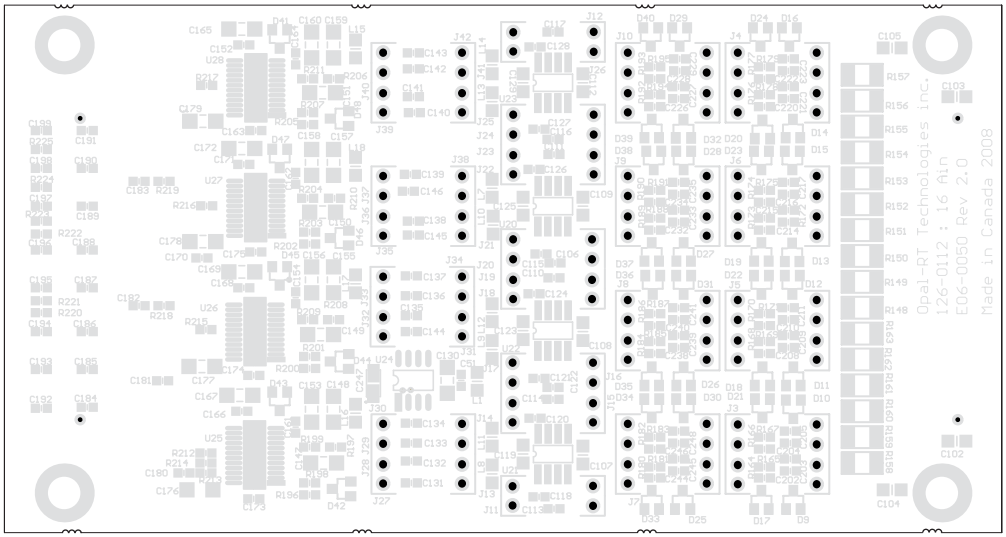


Figure 1: OP5340 analog to digital converter module (top view)

SCHEMATICS

Figure 2 represents a simplified schematic of one channel of the OP5340 modules. It is composed of three stages: the first stage consists of one operational amplifier that works in differential input mode and permits gain adjustment; the second stage, the level shifter, forms the signal for the A/D converter input; the third stage occurs after the conversion to the digital type, as the signal is sent to the carrier board.

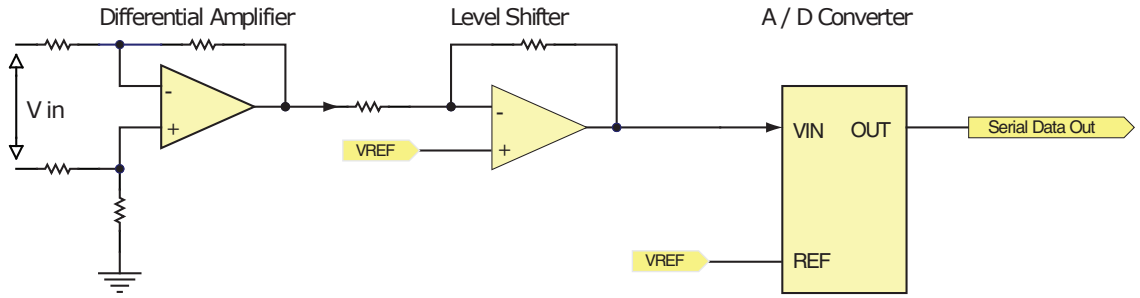
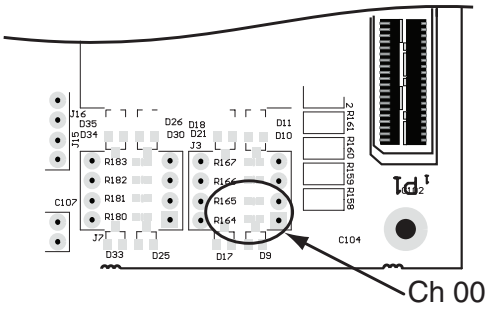


Figure 2: Differential input ADC circuit

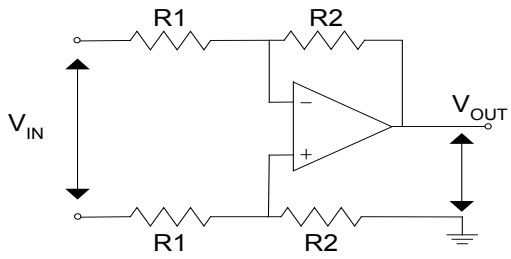
Input Gain Selection



The OP5340 module has user selectable input gain ability. By default, the maximum input voltage range is set to ±20 volts but each channel can be changed separately up to ±120 volts. The OP5340 module contains resistor sockets that allow insertion of additional precision resistors to change the input gain. The image on the right shows the placement for the additional resistors.

Please refer to the table at the end of this section for the exact relationship between channels and resistors.

The next diagram illustrates the input stage of one channel. The default values for resistors R1 and R2 were chosen to keep the maximum input voltage range of ±20 volts (40 volts) with no additional resistors.

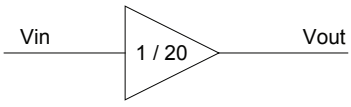


Vout full range = ±1 volt (2 volts)
Installed resistors: **R1** = 499 kΩ
R2 = 25 kΩ

Vout Formula

$$Vout = \left(\frac{R2}{R1}\right) Vin$$

The factory installed surface mount resistors on the OP5340 module give an attenuation of 20.



Input Gain Calculations

The figures below show the complete circuit with resistor Rx as the axial insertable resistor by the user.

Input Gain Schematic with Rx

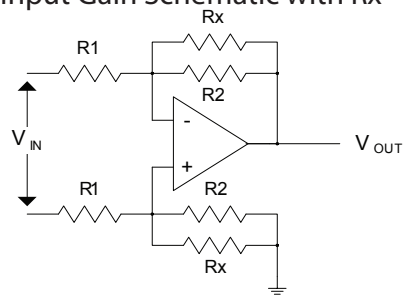


Figure 3: Input gain with Rx

Vout Formula with Rx

$$Vout = \left(\frac{R2}{R1}\right)\left(\frac{Rx}{R2 + Rx}\right)Vin$$

Vout Formula, with Default R Values and Rx
R1= 499K, R2= 25K

$$Vout = \frac{1}{20}\left(\frac{Rx}{25 + Rx}\right)Vin$$

Figure 4: Vout formulas

Users may define the input gain value and calculate the corresponding Rx resistor value.

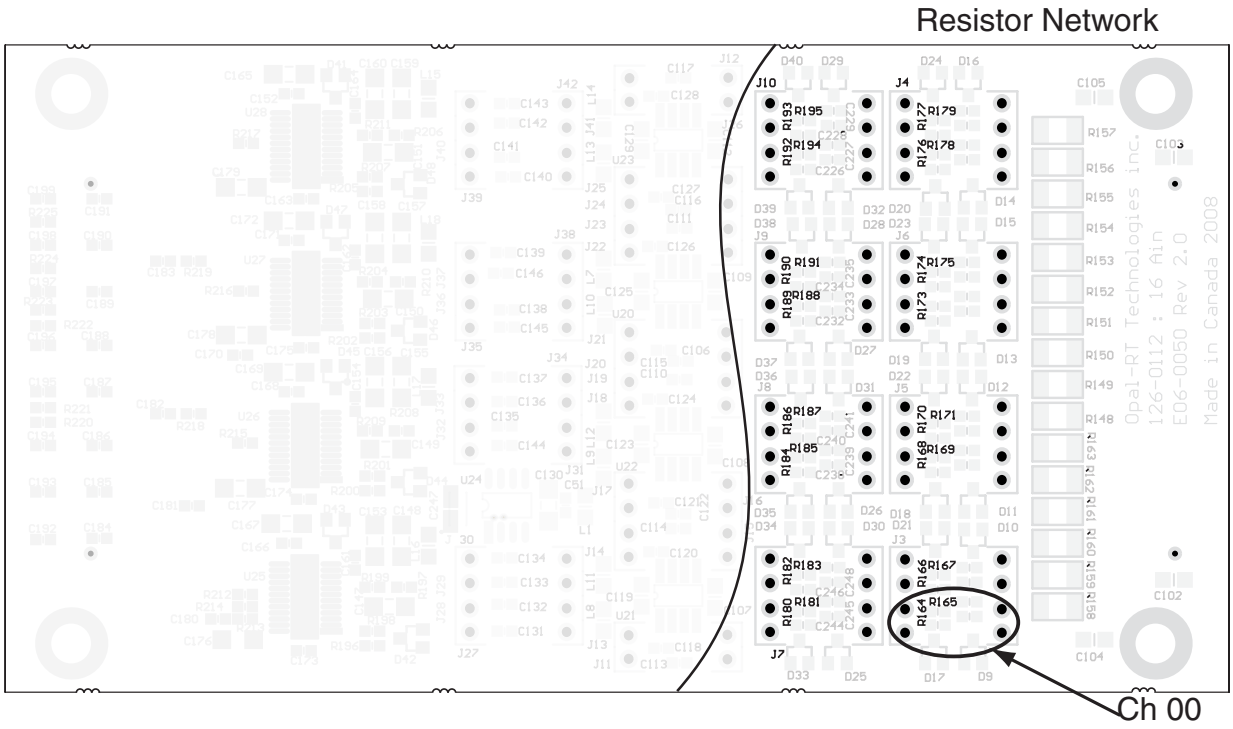
Table 1 provides maximum range values and associated Rx resistor values (chosen in 0.1% series range). To yield the same unit of measurement, the model must compensate for any new gain value different from the original gain of 1/20. The last column provides the gain to insert in the input signal of the simulation model.

Input Gain	Max Voltage Input	Rx value 0.1% series range	Gain to insert in the model
1/20	±20V (or 40V)	none	1
1/40	±40V (or 80V)	24.9 kΩ	2
1/60	±60V (or 120V)	12.4 kΩ	3
1/80	±80V (or 160V)	8.25 kΩ	4
1/100	±100V (or 200V)	6.20 kΩ	5
1/120	±120V (or 240V)	4.99 kΩ	6

Table 1: Maximum Range and Resistor Values

Added Rx resistor of 4.99 kΩ in parallel with R2 resistor gives an attenuation of approximately 120 so the input voltage can be increased to ±120 volts (or 240 volts).

Table 2 shows the relationship between channel and board resistors (as illustrated) used for the input gain changes.



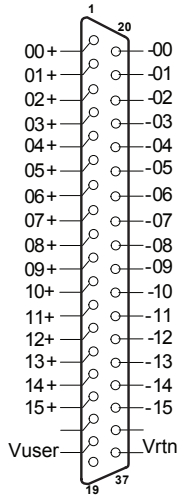
Channel #	Resistor Rx	Channel #	Resistor Rx
Channel 00	R164, R165	Channel 08	R172, R173
Channel 01	R180, R181	Channel 09	R188, R189
Channel 02	R166, R167	Channel 10	R174, R175
Channel 03	R182, R183	Channel 11	R190, R191
Channel 04	R168, R169	Channel 12	R176, R178
Channel 05	R184, R185	Channel 13	R192, R194
Channel 06	R170, R171	Channel 14	R177, R179
Channel 07	R186, R187	Channel 15	R193, R195

Table 2: Resistor Network Channel Identification*

* OP5340-2 uses only channels 0-7 while OP5340-1 uses all 16 channels

DB37 PIN ASSIGNMENTS

Connector A Ch. 0-15				Connector A Ch. 16-31			
DB37	**Module pin assignment**	**DB37**	**Module pin assignment**	**DB37**	**Module pin assignment**	**DB37**	**Module pin assignment**
1	+CH00	20	-CH00	1	+CH16	20	-CH16
2	+CH01	21	-CH01	2	+CH17	21	-CH17
3	+CH02	22	-CH02	3	+CH08	22	-CH18
4	+CH03	23	-CH03	4	+CH19	23	-CH19
5	+CH04	24	-CH04	5	+CH20	24	-CH20
6	+CH05	25	-CH05	6	+CH21	25	-CH21
7	+CH06	26	-CH06	7	+CH22	26	-CH22
7	+CH07	27	-CH07	7	+CH23	27	-CH23
9	+CH08	28	-CH08	9	+CH24	28	-CH24
10	+CH09	29	-CH09	10	+CH25	29	-CH25
11	+CH10	30	-CH10	11	+CH26	30	-CH26
12	+CH11	31	-CH11	12	+CH27	31	-CH27
13	+CH12	32	-CH12	13	+CH28	32	-CH28
14	+CH13	33	-CH13	14	+CH29	33	-CH29
15	+CH14	34	-CH14	15	+CH30	34	-CH30
16	+CH15	35	-CH15	16	+CH31	35	-CH31
17		36		17		36	
18	Vuser 1 A	37	Vrtn 1 A	18	Vuser 2 A	37	Vrtn 2 A
19				19			



SPECIFICATIONS

Product Name:	**OP5340-1, OP5340-2**	
Part Number:	126-0112, 126-0xxx	
Number of channels:	OP5340-1: 16 differential OP5340-2: 8 differential	
Resolution:	16 bits	
Max. Sampling Frequency:	500 kS/s	
Min Conversion / Acquisition Time:	2.5 µs per channel	
ADC Type:	8 x Dual ADC with 10 MBit/s Serial Output Transfer	
Nominal Input Ranges (V)		
	Positive Full Scale	**Negative Full Scale**
	+120.0	-120.0
	+100.0	-100.0
	+80.0	-80.0
	+60.0	-60.0
	+40.0	-40.0
	+20.0 (hardware default value)	-20.0
Calibration	Calibration factors are stored in on-board non-volatile memory (flash memory). This memory is not accessible for calibration.	
Recommended warm-up time:	5 min.	
Calibration interval:	as required	
Dimensions:	6.60 cm x 12.50 cm (2.6” x 4.92”)	
I/O connector:	80-pin high speed header to carrier	
Environmental		
Operating temperature:	10 to 40 °C	
Storage temperature:	-55 to 85 °C	
Relative humidity:	10 to 90%, non condensing	
Maximum altitude:	2,000 m	

CONTACT

OPAL-RT Corporate Headquarters

1751 Richardson, Suite 2525
Montréal, Québec, Canada
H3K 1G6
Tel.: 514-935-2323
Toll free: 1-877-935-2323

Technical Services
www.com/support

Note:

While every effort has been made to ensure accuracy in this publication, no responsibility can be accepted for errors or omissions. Data may change, as well as legislation, and you are strongly advised to obtain copies of the most recently issued regulations, standards, and guidelines.
This publication is not intended to form the basis of a contract.

UG13-21141-OP1
07/2016