

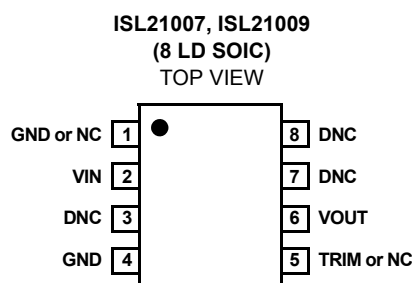
# Adjusting the ISL21007, ISL21009 V<sub>OUT</sub> Using the ISL95810

TB473  
Rev 1.00  
July 10, 2007

## Introduction

The ISL21007, ISL21009 voltage references are fabricated on Intersil's proprietary Floating Gate Analog (FGA) technology and are very low power, high precision, and low noise. The reference Trim pin enables the user to adjust the output voltage up or down by 2.5%, thereby giving the flexibility to use the part for a wide range of applications.

## Pinout



## Trim Pin Circuitry

As shown in Figure 1, the Trim input is internally biased by a resistor divider, such that when the Trim pin is floating, the voltage at the pin is  $V_{OUT}/2$ . It can be driven externally by using a Digitally Controlled Potentiometer (DCP), such as the ISL95810. As long as the DCP resistance is significantly lower than 625k $\Omega$ , the voltage reference part can be trimmed to obtain a  $V_{OUT}$  within  $\pm 2.5\%$  of the nominal value.

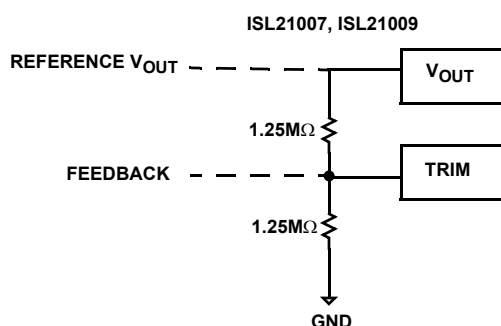


FIGURE 1. TRIM PIN CIRCUITRY

## Adjusting $V_{OUT}$ Using ISL95810

The ISL95810 DCP is low noise, and has a low power I<sup>2</sup>C bus with 256 taps and is implemented with a combination of resistor elements and CMOS switches. The position of the wiper is controlled by the user through the I<sup>2</sup>C bus interface. The potentiometer has an associated volatile Wiper Register (WR) and a non-volatile Initial Value Register (IVR) that can be directly written to and read by the user. The content of the WR controls the position of the wiper. At power-up, the device recalls the contents of the DCP's IVR to the WR. A block diagram of the ISL95810 is shown in Figure 2<sup>1</sup>.

The high terminal of the DCP (RH) is connected to the  $V_{OUT}$  pin of the ISL21007, ISL21009, and the Wiper terminal of the DCP part (RW) is connected to the Trim pin of the reference. The Low terminal of the DCP (RL) is connected to ground. The evaluation software available with the ISL95810 evaluation parts allows the user to write to the wiper register (WR) in order to adjust the output voltage of the ISL21007, ISL21009. Ideally, the DCP resistance is approximately 10x smaller than the resistance at the Trim pin. As a result, the DCP resistance will dominate the voltage reference part and it can be externally biased to achieve the desired output voltage adjustment.

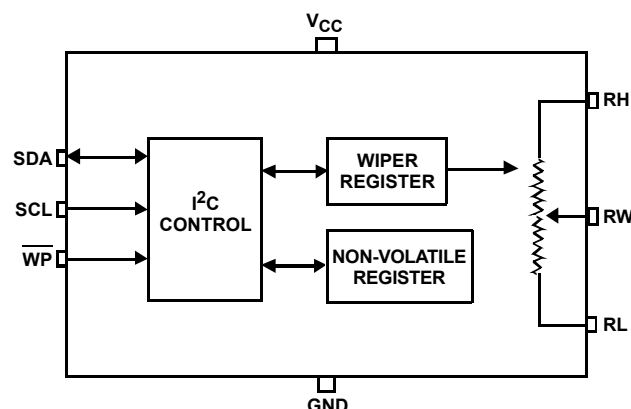


FIGURE 2. ISL95810 BLOCK DIAGRAM

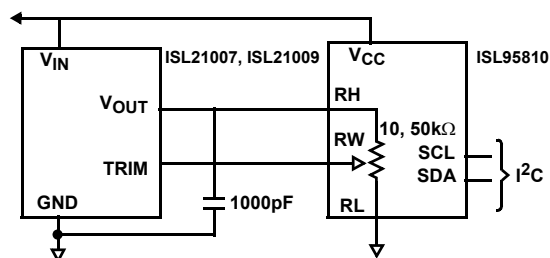


FIGURE 3. CONNECTING THE ISL21007, ISL21009 TO ISL95810

1. Intersil Corporation ISL95810 data sheet.

Figure 4 shows the variation in the output of the ISL21007-25 as the Trim pin is swept from 0 to  $V_{OUT}$  using ISL95810. The output voltage of the reference will vary up to nominal  $V_{OUT} \pm 2.5\%$ . The step size of the change in output voltage is  $488\mu V$  due to the fact that the DCP used to adjust  $V_{OUT}$  has 256 taps and the allowed Trim is  $\pm 2.5\% V_{OUT}$ .

When the Trim pin voltage is  $V_{OUT}/2$ , the output voltage of the part is the nominal output of the part, in this case 2.50V. Also, when the trim pin is floating at room temperature, the voltage at the trim pin is half the nominal  $V_{OUT}$  as a result of the voltage divider at the Trim pin shown in Figure 1.

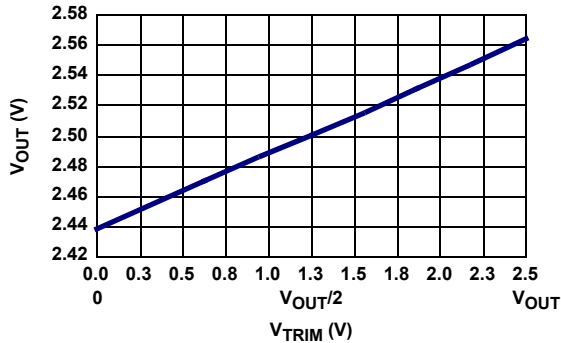


FIGURE 4.  $V_{OUT}$  (V) vs TRIM PIN VOLTAGE (V)

TABLE 1.  $V_{REF}$  (V) AS A FUNCTION OF TRIM PIN VOLTAGE (V)

TRIM PIN VOLTAGE (V)	$V_{REF}$ (V)
0	$V_{OUT} - 2.5\% V_{OUT} *$
$V_{OUT}/2$	$V_{OUT}$
$V_{OUT}$	$V_{OUT} + 2.5\% V_{OUT}$

\* $V_{OUT}$  indicates nominal output voltage of the voltage reference part

### Effects of Trimming on Voltage Reference Temperature Coefficient

Temperature Coefficient (TC) is a measure of the output voltage change with respect to changes in the operating temperature. The TC for ISL21007, ISL21009 is low and varies from  $3\text{ppm}/^\circ\text{C}$  to  $10\text{ppm}/^\circ\text{C}$  for B- and D-grades respectively.

Given the parabolic shape of the TC curve, the standard for specifying the TC of a reference is the Box Method<sup>2</sup>. In the box method, the reference voltage is measured throughout the temperature range from the minimum specified temperature to the maximum specified temperature as shown in Equation 1:

$$TC = \frac{(V_{REFmax} - V_{REFmin}) / (T_{max} - T_{min})}{V_{REFnominal}} \cdot 10^6 \text{ ppm}/^\circ\text{C} \quad (\text{EQ. 1})$$

The two plots in Figure 5 show the change in output voltage over temperature as the Trim pin is adjusted using the DCP. The TC for the case when the voltage reference part is connected to the DCP for  $V_{OUT}$  adjustment and when the trim pin is floating are approximately the same in value,  $1.7\text{ppm}/^\circ\text{C}$ . The trim pin should be left floating when no output voltage adjustment is desired.

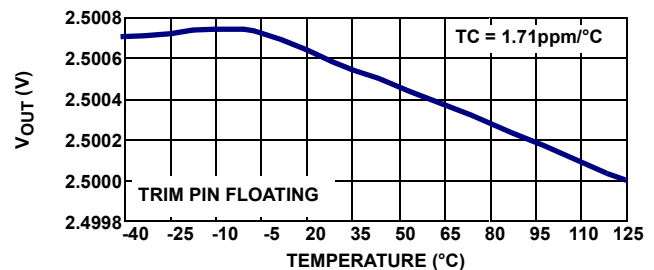
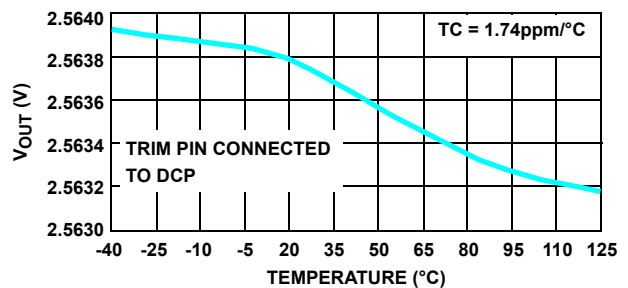


FIGURE 5. CHANGE IN OUTPUT VOLTAGE OVER TEMPERATURE AS A FUNCTION OF THE TRIM PIN CONNECTION

### Conclusion

The output voltage of the ISL21007 and ISL21009 can be adjusted using the DCP without any significant change in the TC. As seen in Figure 5, even after the adjusting the output voltage, the TC of the voltage reference parts is well within the guaranteed limits of the datasheet specifications.

## Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
  2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
  3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
  4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
  5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.

"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
  6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
  7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
  8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
  9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
  10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
  11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
  12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.
- (Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
- (Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)



### SALES OFFICES

### Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

**Renesas Electronics America Inc.**  
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.  
Tel: +1-408-432-8888, Fax: +1-408-434-5351

**Renesas Electronics Canada Limited**  
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3  
Tel: +1-905-237-2004

**Renesas Electronics Europe Limited**  
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K  
Tel: +44-1628-651-700, Fax: +44-1628-651-804

**Renesas Electronics Europe GmbH**  
Arcadiastrasse 10, 40472 Düsseldorf, Germany  
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

**Renesas Electronics (China) Co., Ltd.**  
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

**Renesas Electronics (Shanghai) Co., Ltd.**  
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China  
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

**Renesas Electronics Hong Kong Limited**  
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
Tel: +852-2265-6688, Fax: +852-2886-9022

**Renesas Electronics Taiwan Co., Ltd.**  
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan  
Tel: +886-2-8175-9600, Fax: +886-2-8175-9670

**Renesas Electronics Singapore Pte. Ltd.**  
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949  
Tel: +65-6213-0200, Fax: +65-6213-0300

**Renesas Electronics Malaysia Sdn.Bhd.**  
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

**Renesas Electronics India Pvt. Ltd.**  
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India  
Tel: +91-80-67208700, Fax: +91-80-67208777

**Renesas Electronics Korea Co., Ltd.**  
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5338