

Quad 12-/10-/8-Bit PWM to VOUT DACs with 10ppm/°C Reference

DESCRIPTION

Demonstration circuit 2197A features the [LTC®2645](#), Quad 12-/10-/8-Bit PWM to VOUT DACs with 10ppm/°C reference in a tiny 4.9mm × 4mm 16-lead MSOP package. DC2197A-A is populated with the 2.5V, 12-bit version of the LTC2645.

The LTC2645 measures the period and pulse width of the Pulse Width Modulation (PWM) input and updates the voltage output DAC at each rising edge. The PWM frequency can be any frequency between 30Hz and 100kHz. The input

level can be between 1.71V and 5.5V, set by a separate IOVCC pin. This device solves many of the problems associated with filtering a PWM signal to produce an analog voltage, producing a fast-settling, accurate analog voltage in response to a digital PWM input.

Design files for this circuit board are available at <http://www.linear.com/demo>

LT, LT, LTC, LTM, Linear Technology and the Linear logo are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

BOARD PHOTO

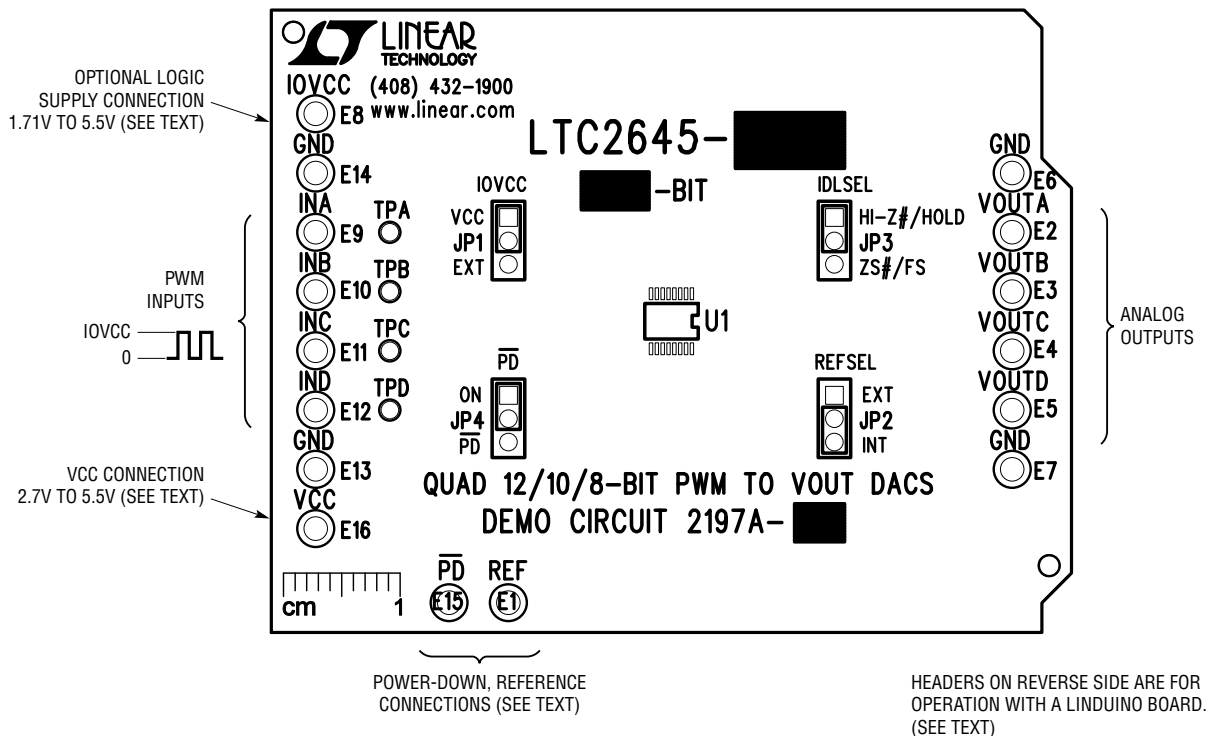


Figure 1. Basic Connections

QUICK START PROCEDURE

Standalone Operation

DC2197A makes evaluation of the LTC2645 very easy. Figure 1 shows the basic connections to operate the DC2197A as a standalone board. Connect a 2.7V to 5.5V supply to the VCC turret and a GND turret. IOVCC is connected to VCC by default such that the input logic level matches the VCC supply. If a different logic level is required, move the IOVCC jumper to the EXT position and connect a supply equal to the PWM signals' logic level to the IOVCC and GND turrets. There is no sequencing requirement between VCC and IOVCC.

Any convenient PWM source can be used. A pulse generator with a computer interface (GPIB, USB, Ethernet, etc.) can be used for characterization. In the end application, signals can originate from an FPGA, microcontroller, programmable logic controller (PLC), optocoupler, etc.

Linduino Operation

DC2197A is in an “Arduino Shield” form factor, compatible with Linear Technology’s DC2026 Linduino board and other Arduino Uno compatible boards. This provides a convenient way to evaluate the LTC2645 under computer control. The Linduino board has two PWM outputs with 16-bit resolution and four with 8-bit resolution. INA and INB are connected to 16-bit PWM capable outputs on digital pins 9 and 10, INC and IND are connected to 8-bit PWM capable outputs on digital pins 5 and 6; these can be remapped by removing R8 – R11 and making appropriate connections to TPA – TPD. The Linduino program (“sketch”) provides a simple terminal interface allowing voltages or codes to be entered manually. It can also be controlled by any programming language that can communicate with a USB virtual COM port (Matlab, Python, C++, C#, etc.) The program can be modified as desired to change or add functionality.

Install the DC2197A onto the DC2026 as shown in Figure 2. Ensure that the IOVCC jumper is set to VCC.

QUICK START PROCEDURE

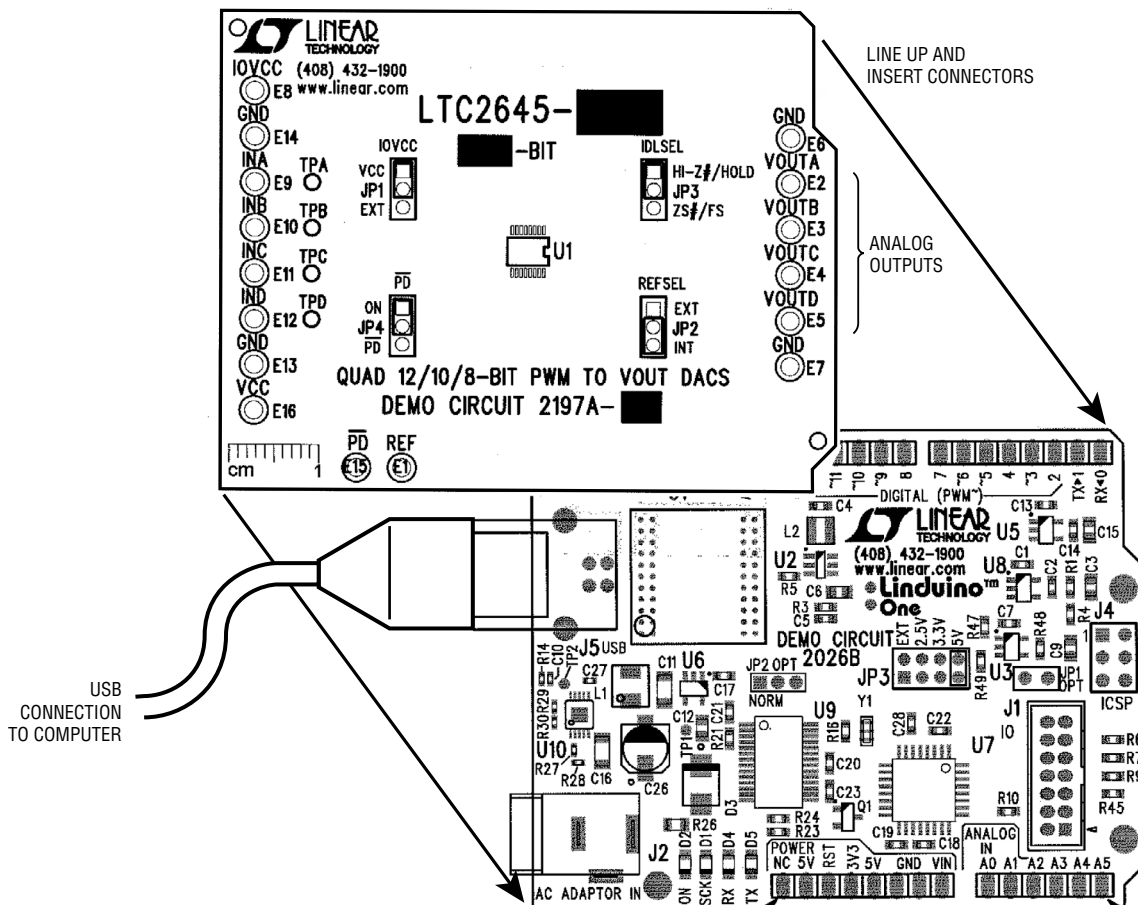


Figure 2. Linduino Connections

Follow the procedure for installing drivers and sketchbook in the DC2026 Demo Manual. Upload the DC2197 program (“sketch”). Select:

File → Sketchbook → Part Number → 2000 → 2600 → 2645 → DC2197

Then click the “Upload” button. Open the Serial Monitor to interact with the program.

QUICK START PROCEDURE

Altera C5G Board Operation

Altera's C5G evaluation board for the Cyclone 5 GX FPGA has an Arduino shield port that is compatible with the DC2197A. The C5G provides 5V to the LTC2645's VCC supply, so IOVCC must be changed to 3.3V to match the voltage of the digital signals coming from the FPGA. Remove the IOVCC jumper and solder a 100Ω resistor from the IOVCC turret post to the test point indicated in Figure 3. Make sure gaps between connectors in the upper and lower rows line up properly. The upper row (JP3 and JP4 on the C5G board) will match perfectly; JP10 will

have two empty holes on the left-hand side and JP11 will have two empty holes on the right-hand side.

A Quartus archive project and FPGA configuration binary file are included with the DC2197A design files. The program sends PWM signals to all four DACs. Two quadrature numerically controlled oscillators supply data to the PWM generator. While not normally intended for AC signal generation, this demonstration shows the cycle by cycle updating operation of the LTC2645. Figure 4 shows all four DAC outputs, and Figure 5 shows the details of the relationship between the PWM input and DAC output.

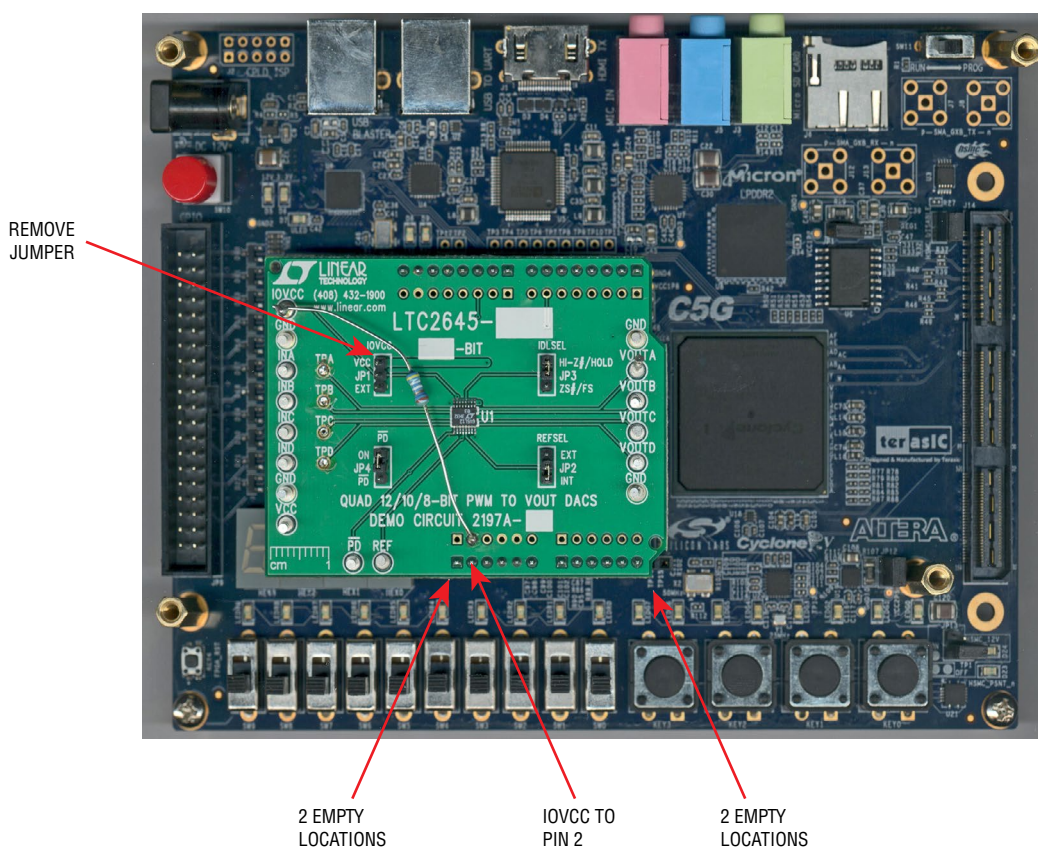


Figure 3. Altera C5G Connections

QUICK START PROCEDURE

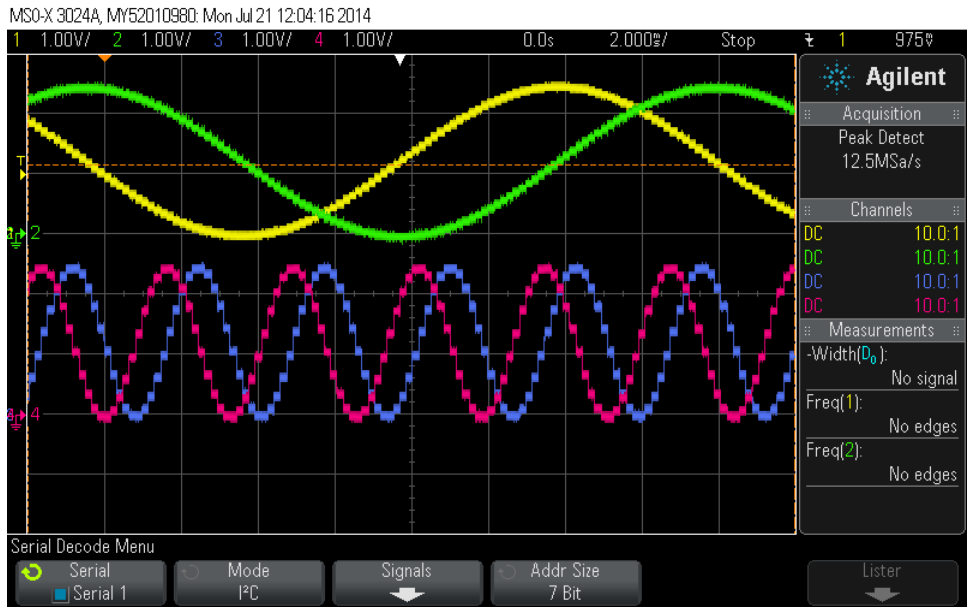


Figure 4. Altera Program Operation

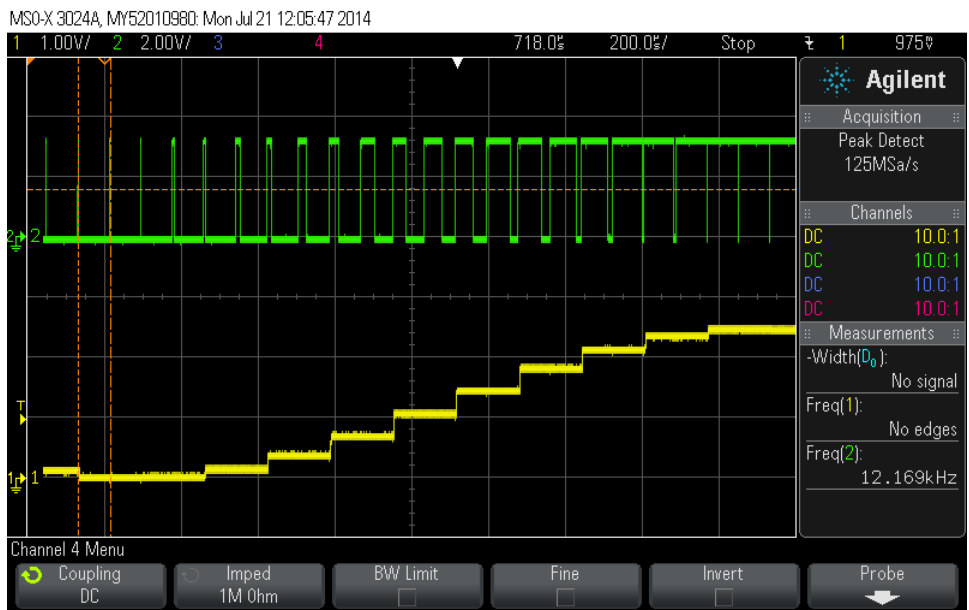


Figure 5. PWM Details

QUICK START PROCEDURE

EXTERNAL CONNECTIONS

GND: Four ground turrets are provided. These are connected directly to the ground plane and are the common connection for all supplies and signals.

IOVCC: I/O supply voltage that sets the high level of the PWM inputs. Connect to digital supply voltage between 1.71 and 5.5V. Often this can be connected to the same supply as the device that is providing the PWM signal (processor, FPGA, etc.).

INA, INB, INC, IND: PWM Inputs. Logic high level is determined by IOVCC.

VOUTA, VOUTB, VOUTC, VOUTD: DAC Voltage Outputs.

VCC: Analog Supply. Connect to low noise power supply between 2.7V and 5.5V.

$\overline{\text{PD}}$: Active Low Power-Down Input. This signal may be driven externally if the $\overline{\text{PD}}$ jumper is removed.

REF: Reference Output/Input. When the REFSEL jumper is set to INT, the LTC2645's internal reference can be measured at this point. Nominal impedance is 500 Ω . If it is used to drive external circuits it must be buffered appropriately. When REFSEL is set to EXT, an external reference between 1V and VCC may be connected to this point.

Arduino Shield Connections (IOL1, IOH1, ADO, POWER headers installed on back side of board) – These headers mate with the DC2026 Linduino and other Arduino Uno compatible microcontroller boards.

JUMPERS

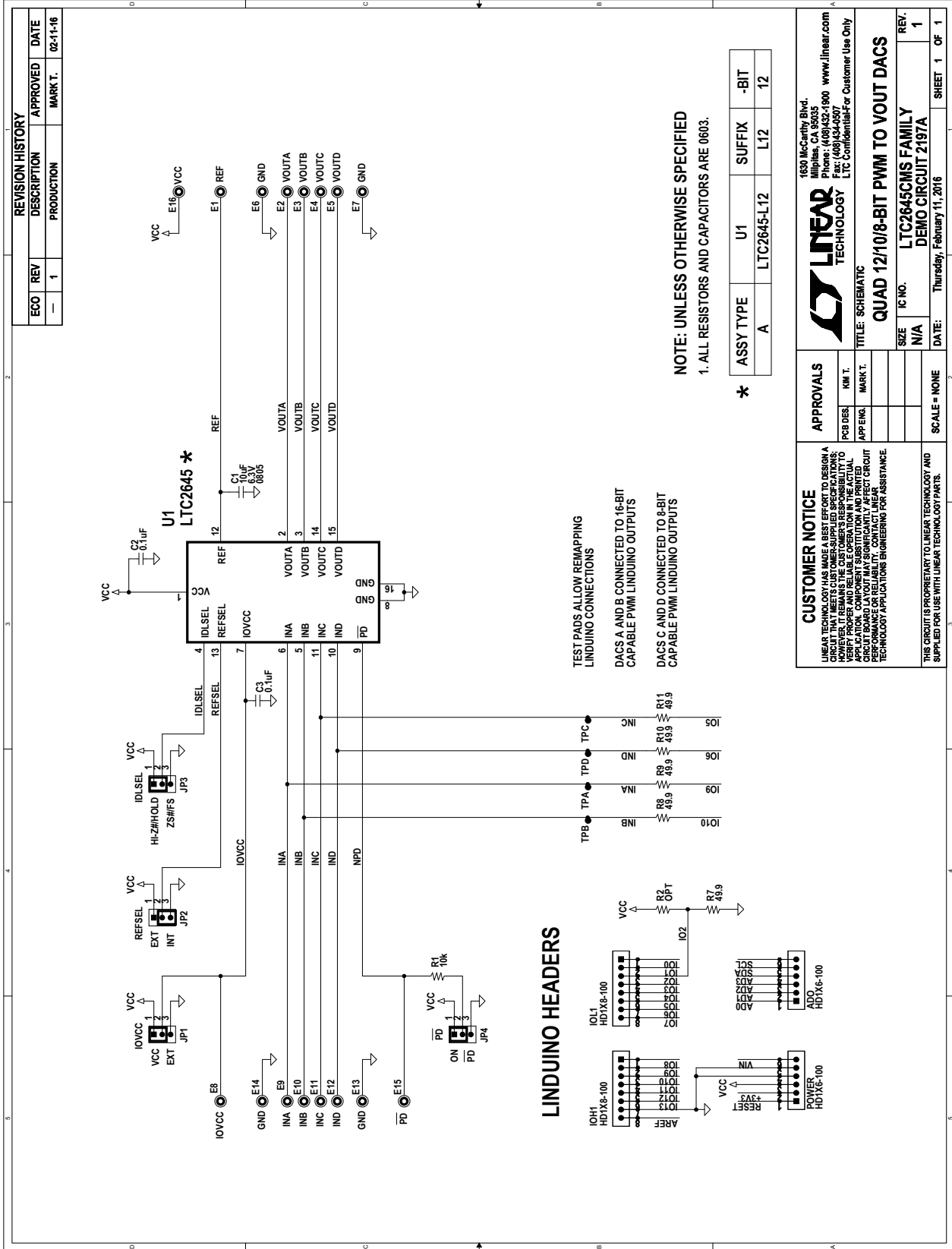
IOVCC: Set to VCC to connect IOVCC directly to VCC (default). No connection to the IOVCC turret is required in this case. Set to EXT if a separate supply is connected to the IOVCC turret.

$\overline{\text{PD}}$: Power Down – Set to ON to enable normal operation (default.) Set to $\overline{\text{PD}}$ to put the LTC2645 into shutdown mode.

IDLSEL: Idle Mode Select Input. Determines the DAC behavior when the PWM input remains high or low for more than the Idle Mode Timeout time (50ms minimum, 70ms maximum). When set to HI-Z#/HOLD (default), a low level on a PWM input will set the DAC output to a high-impedance state. A high level will cause the DAC output to hold its last value. When set to ZS#/FS, a low level on a PWM input will set the DAC output to zero-scale, and a high level will set the DAC output to full-scale.

REFSEL: Set to INT (default) to use the internal reference. Set to EXT to supply an external reference to the REF turret post.

SCHEMATIC DIAGRAM



DEMO MANUAL DC2197A

DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

Please read the DEMO BOARD manual prior to handling the product. Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged.**

This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

Copyright © 2004, Linear Technology Corporation