



DAC4813

QUAD 12-BIT DIGITAL-TO-ANALOG CONVERTER (12-bit port interface)

FEATURES

- COMPLETE WITH REFERENCE AND OUTPUT AMPLIFIERS
- 12-BIT PORT INTERFACE
- ANALOG OUTPUT RANGE: $\pm 10V$
- MONOTONICITY GUARANTEED OVER TEMPERATURE
- INTEGRAL LINEARITY ERROR: $\pm 1/2\text{LSB}$ max
- $\pm 12V$ to $\pm 15V$ SUPPLIES
- 28-PIN PLASTIC DIP PACKAGE

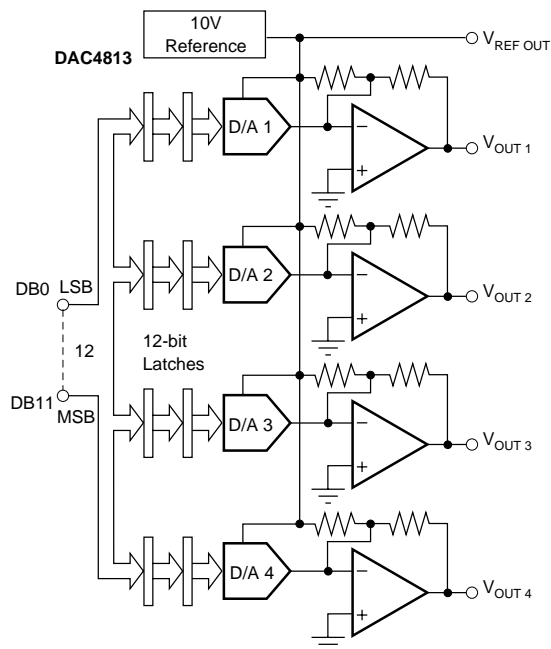
DESCRIPTION

DAC4813 is a complete quad 12-bit digital-to-analog converter with bus interface logic. Each package includes a precision +10V voltage reference, double-buffered bus interface including a RESET function and 12-bit D/A converters with voltage-output operational amplifiers.

The double-buffered interface consists of a 12-bit input latch and a D/A latch for each D/A converter. A RESET control allows the D/A outputs to be asynchronously reset to bipolar zero, a feature useful for power-up reset, system initialization and recalibration.

DAC4813 D/A converters are committed to the $\pm 10V$ output range only. Gain and offset are not externally adjustable.

DAC4813 is available with an integral linearity error of $1/2\text{LSB}$ and 12-bit monotonicity guaranteed over temperature. It is packaged in a 28-pin 0.6in. wide plastic DIP package and specified over -40°C to $+85^{\circ}\text{C}$ and 0°C to $+70^{\circ}\text{C}$.



International Airport Industrial Park • Mailing Address: PO Box 11400, Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd., Tucson, AZ 85706 • Tel: (520) 746-1111 • Twx: 910-952-1111
Internet: <http://www.burr-brown.com/> • FAXLine: (800) 548-6133 (US/Canada Only) • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

SPECIFICATIONS

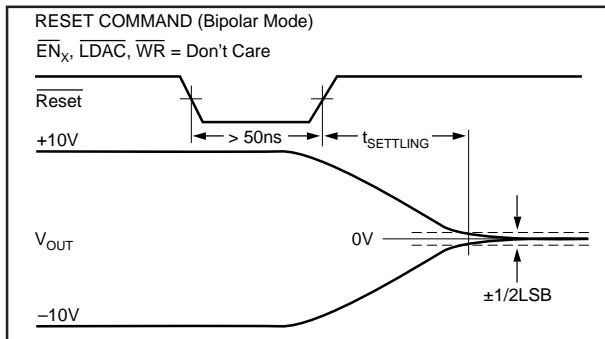
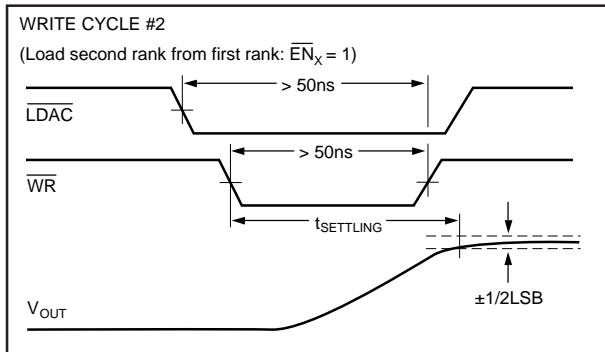
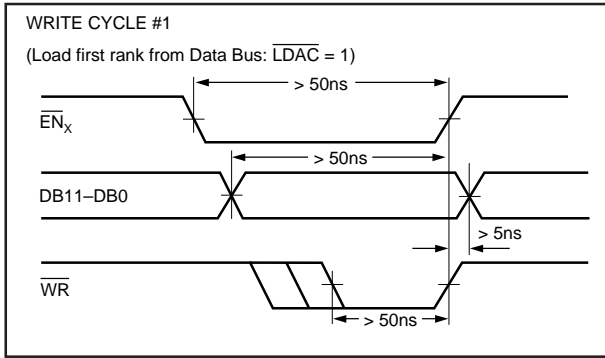
ELECTRICAL

T_A = +25°C, +V_{CC} = +12V or +15V, -V_{CC} = -12V or -15V, unless otherwise noted.

PARAMETER	CONDITIONS	DAC4813AP, JP			UNITS
		MIN	TYP	MAX	
INPUTS					
DIGITAL INPUTS	Over Temperature				
Input Code ⁽¹⁾	Range		Bipolar Offset Binary		
Logic Levels ⁽²⁾					
V _{IH} ⁽³⁾		+2		+5.5	V
V _{IL}		0		+0.8	V
Logic Input Currents DB0-DB11, WR, LDAC, RESET, EN _x					
I _{IH}	V _I = +2.7V			±40	µA
I _{IL}	V _I = +0.4V			±40	µA
TRANSFER CHARACTERISTICS					
ACCURACY					
Linearity Error			±1/4	±1/2	LSB
Differential Linearity Error			±1/2	±1	LSB
Gain Error			±0.05	±0.2	%
Bipolar Zero Error ⁽⁵⁾			±0.05	±0.2	%FSR ⁽⁴⁾
Power Supply Sensitivity Of Full Scale +V _{CC} -V _{CC}			±5 ±1	±20 ±10	ppmFSR/%+V _{CC} ppmFSR/%-V _{CC}
DRIFT					
Gain	Over Specification Temperature Range				
Bipolar Zero Drift			±5	±30	ppm/°C
Linearity Error over Temperature			±5	±15	ppmFSR/°C
Monotonicity			±1/2 Guaranteed	±3/4	LSB
DYNAMIC CHARACTERISTICS					
SETTLING TIME ⁽⁶⁾					
Full Scale Range Change	To within ±0.012%FSR of Final Value				
1LSB Output Step ⁽⁷⁾ At Major Carry	5kΩ 500pF Load				
Slew Rate	20V Range	2	4.5	6	µs
Crosstalk ⁽⁸⁾	5kΩ Loads				µs V/µs LSB
OUTPUT					
Output Voltage Range	±V _{CC} ≥ ±11.4V			±10	V
Output Current		±5			mA
Output Impedance			0.2		Ω
Short Circuit to ACOM Duration	at DC		Indefinite		
REFERENCE VOLTAGE					
Voltage		+9.95	+10.00	+10.05	V
Source Current Available for External Loads		2			mA
Impedance			0.2		Ω
Temperature Coefficient			±5	±25	ppm/°C
Short Circuit to Common Duration	at DC		Indefinite		
POWER SUPPLY REQUIREMENTS					
Voltage: +V _{CC} -V _{CC}		+11.4 -11.4	+15 -15	+16.5 -16.5	V V
Current:	No Load ±V _{CC} = ±15V				
+V _{CC}			48	60	mA
-V _{CC}			24	28	mA
Power Dissipation			1080	1320	mW
Potential at DCOM with Respect to ACOM ⁽⁹⁾		-3		+3	V
TEMPERATURE RANGES					
Specification: AP		-40		+85	°C
JP		0		+70	°C
Storage		-60		+100	°C
Thermal Resistance, θ _{JA} , Plastic DIP				30	°C/W

NOTES: (1) For Two's Complement Input Coding invert the MSB with an external logic inverter. (2) Digital inputs are TTL and +5V CMOS compatible over the specification temperature range. (3) Open DATA input lines will be pulled above +5.5V. See discussion under LOGIC INPUT COMPATIBILITY in the OPERATION section. (4) FSR means Full Scale Range. For example, for ±10V output, FSR = 20V. (5) Error at input code 800_{HEX}. (6) Maximum represents the 3σ limit. Not 100% tested for this parameter. (7) For the worst-case code change: 7FF_{HEX} to 800_{HEX} and 800_{HEX} to 7FF_{HEX}. (8) Crosstalk is defined as the change in any output as a result of any other output being driven from -10V to +10V at rated output current. (9) The maximum voltage at which ACOM and DCOM may be separated without affecting accuracy specifications.

TIMING DIAGRAMS



TRUTH TABLE

$\overline{\text{WR}}$	$\overline{\text{EN}}_1$	$\overline{\text{EN}}_2$	$\overline{\text{EN}}_3$	$\overline{\text{EN}}_4$	$\overline{\text{LDAC}}$	$\overline{\text{RESET}}$	OPERATION
X	X	X	X	X	X	0	Reset all D/A Latches
1	X	X	X	X	X	1	No Operation
X	1	1	1	1	1	1	No Operation
0	1	1	1	0	1	1	Load Data into First Rank for D/A 4
0	1	1	0	1	1	1	Load Data into First Rank for D/A 3
0	1	0	1	1	1	1	Load Data into First Rank for D/A 2
0	0	1	1	1	1	1	Load Data into First Rank for D/A 1
0	1	1	1	1	0	1	Load Second Rank from First Rank, All D/As
0	0	0	0	0	0	1	All Latches Transparent

"X" = Don't Care

ABSOLUTE MAXIMUM RATINGS

+V _{CC} to ACOM	0 to +18V
-V _{CC} to ACOM	0 to -18V
+V _{CC} to -V _{CC}	0 to +36V
ACOM to DCOM	±4V
Digital Inputs to DCOM	-1V to +V _{CC}
External Voltage applied to BPO Resistor	±18V
V _{REF OUT}	Indefinite short to ACOM
V _{OUT}	Momentary to ±18V
Lead Temperature, soldering 10s	+300°C
Max Junction Temperature	165°C

NOTE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum conditions for extended periods may affect device reliability.

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER ⁽¹⁾	TEMPERATURE RANGE
DAC4813AP	28-Pin Plastic DBL Wide DIP	215	-40°C to +85°C
DAC4813JP	28-Pin Plastic DBL Wide DIP	215	0°C to +70°C

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book.



ELECTROSTATIC DISCHARGE SENSITIVITY

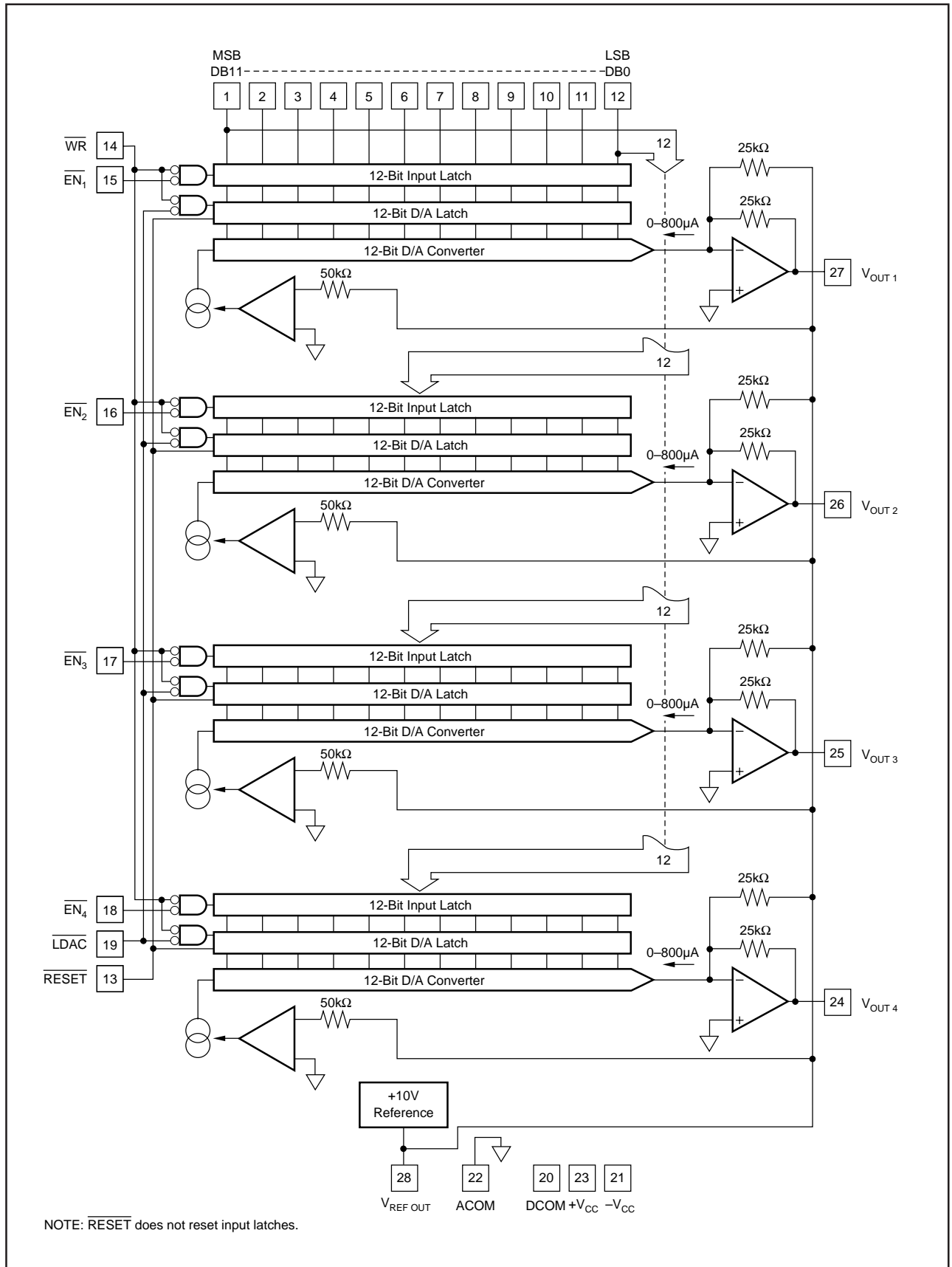
Electrostatic discharge can cause damage ranging from performance degradation to complete device failure. Burr-Brown Corporation recommends that all integrated circuits be handled and stored using appropriate ESD protection methods.

PIN DESCRIPTIONS

PIN	NAME	FUNCTION
1	DB11	DATA, MSB, positive true.
2	DB10	DATA
3	DB9	DATA
4	DB8	DATA
5	DB7	DATA
6	DB6	DATA
7	DB5	DATA
8	DB4	DATA
9	DB3	DATA
10	DB2	DATA
11	DB1	DATA
12	DB0	DATA, LSB.
13	RESET	Resets output of all D/As to bipolar-zero. The D/A remains in this state until overwritten by a LDAC- \overline{WR} command. RESET does not reset the input latch. After power-up and reset, input latches will be in an indeterminate state.
14	\overline{WR}	Write strobe. Must be low for data transfer to any latch (except RESET).
15	$\overline{EN1}$	Enable for 12-bit input data latch of D/A1. NOTE: This logic path is slower than the \overline{WR} / path.
16	$\overline{EN2}$	Enable for 12-bit input data latch of D/A2. NOTE: This logic path is slower than the \overline{WR} / path.
17	$\overline{EN3}$	Enable for 12-bit input data latch of D/A3. NOTE: This logic path is slower than the \overline{WR} / path.
18	$\overline{EN4}$	Enable for 12-bit input data latch of D/A4. NOTE: This logic path is slower than the \overline{WR} / path.
19	LDAC	Load DAC enable. Must be low with \overline{WR} for data transfer to the D/A latch and simultaneous update of all D/A converters.
20	DCOM	Digital common, logic currents return.
21	$-V_{CC}$	Analog supply input, nominally $-12V$ or $-15V$ referred to ACOM.
22	ACOM	Analog common, $+V_{CC}$, $-V_{CC}$ supply return.
23	$+V_{CC}$	Analog supply input, nominally $+12V$ or $+15V$ referred to ACOM.
24	$V_{OUT 4}$	D/A 4 analog output.
25	$V_{OUT 3}$	D/A 3 analog output.
26	$V_{OUT 2}$	D/A 2 analog output.
27	$V_{OUT 1}$	D/A 1 analog output.
28	$V_{REF OUT}$	$+10V$ reference output.

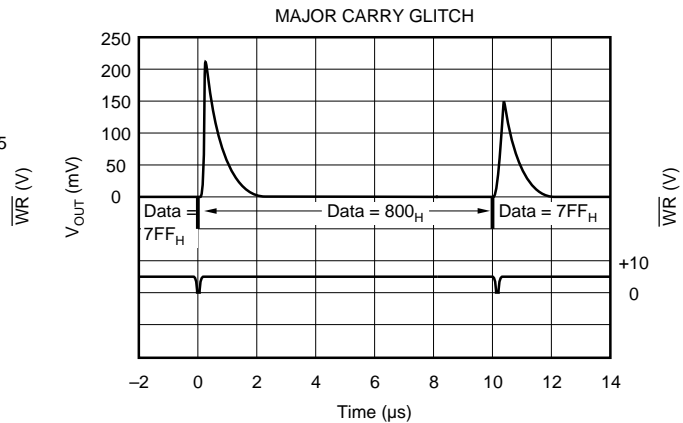
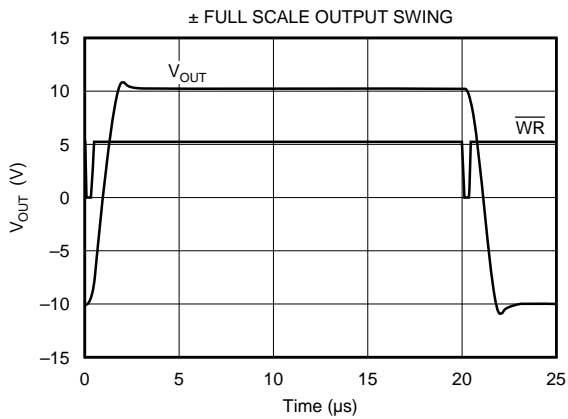
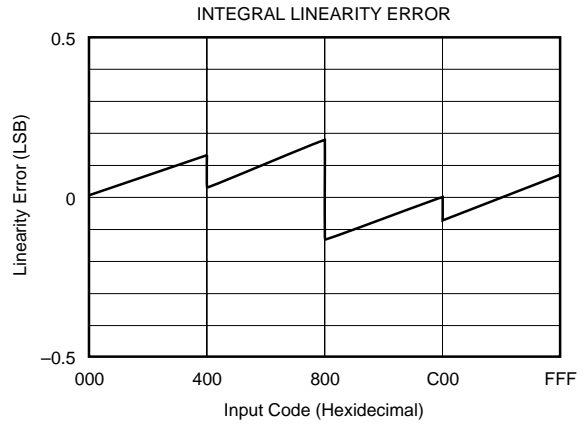
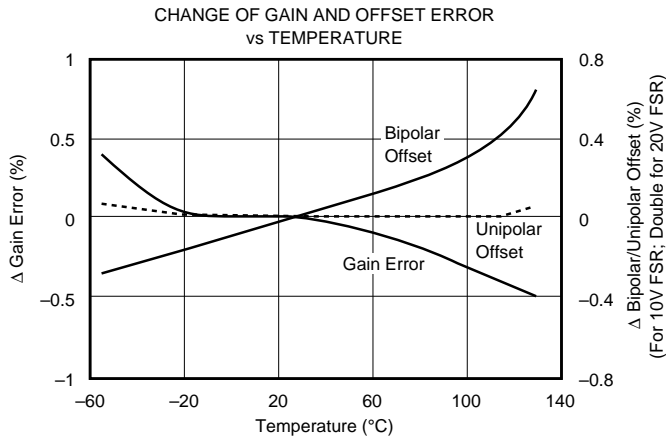
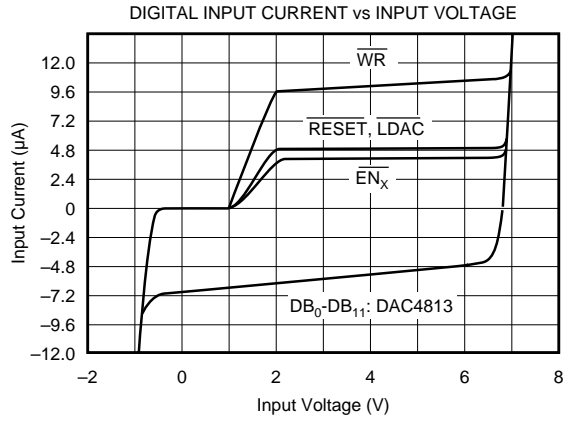
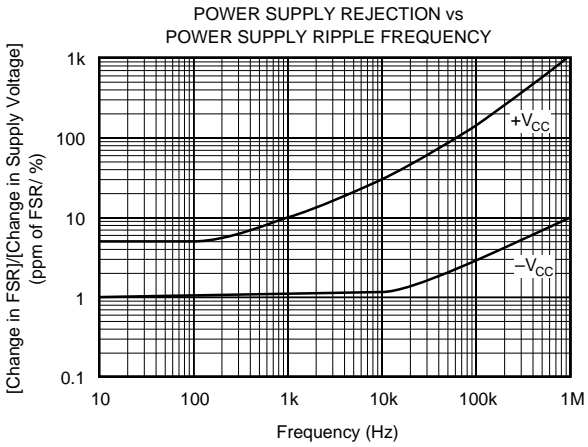
The information provided herein is believed to be reliable; however, BURR-BROWN assumes no responsibility for inaccuracies or omissions. BURR-BROWN assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party. BURR-BROWN does not authorize or warrant any BURR-BROWN product for use in life support devices and/or systems.

BLOCK DIAGRAM



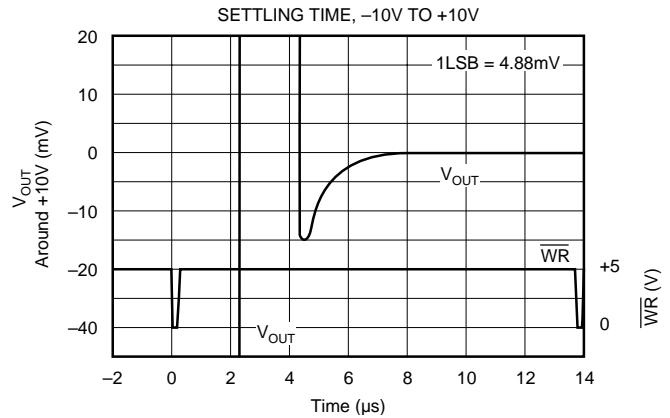
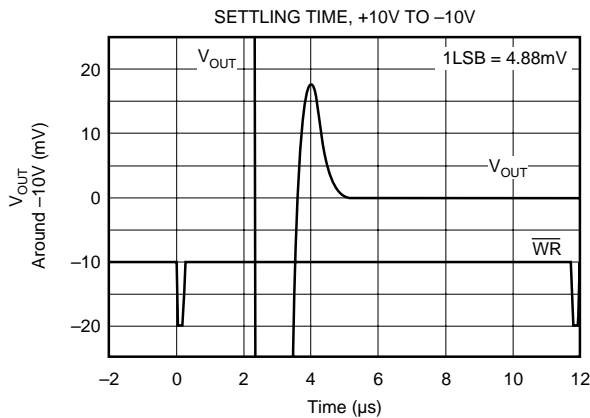
TYPICAL PERFORMANCE CURVES

$T_A = +25^\circ\text{C}$, $V_{CC} = \pm 15\text{V}$ unless otherwise noted.



TYPICAL PERFORMANCE CURVES (CONT)

$T_A = +25^\circ\text{C}$, $V_{CC} = \pm 15\text{V}$ unless otherwise noted.



DISCUSSION OF SPECIFICATIONS

LINEARITY ERROR

Linearity error is defined as the deviation of the analog output from a straight line drawn between the end points (digital inputs all “1s” and all “0s”). DAC4813 linearity error is $\pm 1/2\text{LSB}$ max at $+25^\circ\text{C}$.

DIFFERENTIAL LINEARITY ERROR

Differential Linearity Error (DLE) is the deviation from a 1LSB output change from one adjacent state to the next. A DLE specification of $1/2\text{LSB}$ means that the output step size can range from $1/2\text{LSB}$ to $3/2\text{LSB}$ when the digital input code changes from one code word to the adjacent code word. If the DLE is more positive than -1LSB , the D/A is said to be monotonic.

MONOTONICITY

A D/A converter is monotonic if the output either increases or remains the same for increasing digital input values. DAC4813 is monotonic over their specification temperature range -40°C to $+85^\circ\text{C}$.

DRIFT

Gain Drift is a measure of the change in the Full Scale Range (FSR) output over the specification temperature range. Gain Drift is expressed in parts per million per degree Celsius ($\text{ppm}/^\circ\text{C}$).

Bipolar Zero Drift is measured with a data input of 800_{HEX} . The D/A is configured for bipolar output. Bipolar Zero Drift is expressed in parts per million of Full Scale Range per degree Celsius (ppm of $\text{FSR}/^\circ\text{C}$).

SETTLING TIME

Settling Time is the total time (including slew time) for the output to settle to within an error band around its final value after a change in input. Settling times are specified to $\pm 0.01\%$ of Full Scale Range (FSR) for two conditions: one for a FSR output change of 20V ($25\text{k}\Omega$ feedback) and one for a 1LSB change. The 1LSB change is measured at the Major Carry (7FF_{HEX} to 800_{HEX} and 800_{HEX} to 7FF_{HEX}), the input code transition at which worst-case settling time occurs.

OPERATION

INTERFACE LOGIC

The bus interface logic of the DAC4813 consists of two independently addressable latches in two ranks for each D/A converter. The first rank consists of one 12-bit input latch which can be loaded directly from a 12- or 16-bit microprocessor/microcontroller bus. The input latch holds data temporarily before it is loaded into the second latch, the D/A latch. This double buffered organization permits simultaneous update of all D/As.

All latches are level-triggered. Data present when the control signals are logic “0” will enter the latch. When the control signals return to logic “1”, the data is latched.

CAUTION: DAC4813 was designed to use $\overline{\text{WR}}$ as the fast strobe. $\overline{\text{WR}}$ has a much faster logic path than $\overline{\text{EN}}_x$ (or $\overline{\text{LDAC}}$). Therefore, if one permanently wires $\overline{\text{WR}}$ to DCOM and uses only $\overline{\text{EN}}_x$ to strobe data into the latches, the DATA HOLD time will be long, approximately 20ns to 30ns, and this time will vary considerably in this range from unit to unit. DATA HOLD time using $\overline{\text{WR}}$ is 5ns max.

RESET FUNCTION

The Reset function resets only the D/A latch. Therefore, after a RESET, good data must be written to **all** the input latches before an $\overline{\text{LDAC}} - \overline{\text{WR}}$ command is issued. Otherwise, old data or unknown data is present in the input latches and will be transferred to the D/A latch producing an analog output value that may be unwanted.

LOGIC INPUT COMPATIBILITY

DAC4813 digital inputs are TTL compatible (1.4V switching level) over the operating range of $+V_{CC}$. Each input has low leakage and high input impedance. Thus the inputs are suitable for being driven by any type of 5V logic. An equivalent circuit of a digital input is shown in Figure 1.

Open DATA input lines will float to 7V or more. Although this will not harm the DAC4813, current spikes will occur in the input lines when a logic 0 is asserted and, in addition, the speed of the interface will be slower. A digital output driving a DATA input line of the DAC4813 must not drive, **or let the DATA input float**, above +5.5V. Unused DATA inputs should be connected to DCOM.

Unused control inputs should be connected to a voltage greater than +2V but not greater than +5.5V. If this voltage is not available, the control inputs can be connected to $+V_{CC}$ through a 100k Ω resistor to limit the input current.

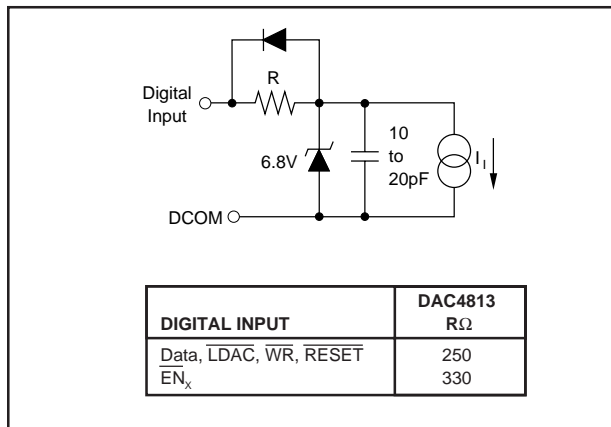


FIGURE 1. Equivalent Digital Input Circuit.

INPUT CODING

DAC4813 accepts positive-true binary input codes.

Input coding for bipolar analog outputs is Bipolar Offset Binary (BOB), where an input code of 000_{HEX} gives a minus full-scale output, an input of FFF_{HEX} gives an output 1LSB below positive full scale, and zero occurs for an input code of 800_{HEX} .

DAC4813 can be used with two's complement coding if a logic inverter is used ahead of the MSB input (DB11).

INTERNAL/EXTERNAL REFERENCE USE

DAC4813 contains a +10V $\pm 50\text{mV}$ voltage reference, $V_{\text{REF OUT}}$. $V_{\text{REF OUT}}$ is available to drive external loads sourcing up to 2mA. The load current should be constant, otherwise the gain (and bipolar offset, if connected) of the D/A converters will vary.

Because of the lack of additional pins required for external reference inputs, $V_{\text{REF OUT}}$ is connected internally to all 4 D/A converters. $V_{\text{REF OUT}}$ is available for external use on pin 28.

GAIN AND OFFSET ADJUSTMENTS

DAC4813 has no Gain and Offset Adjustment option.

INSTALLATION

POWER SUPPLY CONNECTIONS

Power supply decoupling capacitors should be added. Best settling time performance occurs using a 1 to 10 μF tantalum capacitor at $-V_{CC}$. Applications with less critical settling time may be able to use 0.01 μF at $-V_{CC}$ as well as at $+V_{CC}$. The capacitors should be located close to the package.

DAC4813 features separate digital and analog power supply returns to permit optimum connections for low noise and high speed performance. It is recommended that both DIGITAL COMMON (DCOM) and ANALOG COMMON (ACOM) be connected directly to a ground plane under the package. If a ground plane is not used, connect the ACOM and DCOM pins together close to the package. Since the reference point for V_{OUT} and $V_{\text{REF OUT}}$ is the ACOM pin, it is also important to connect the load directly to the ACOM pin. The change in current in the ACOM pin due to an input data word change from 000_{HEX} to FFF_{HEX} is only 1mA for each D/A converter.

OUTPUT VOLTAGE SWING AND RANGE CONNECTIONS

DAC4813 output amplifiers provide a $\pm 10\text{V}$ output swing while operating on supplies as low as $\pm 12\text{V} \pm 5\%$.

DAC4813 is fully committed to $\pm 10\text{V}$ output ranges. Optional ranges are not pin programmable.

12- AND 16-BIT BUS INTERFACES

DAC4813 data is latched into the input latches of each D/A by asserting low each $\overline{\text{EN}}_x$ individually and transferring the data from the bus to each input latch by asserting $\overline{\text{WR}}$ low. All D/A outputs in each package are then updated simultaneously by asserting $\overline{\text{LDAC}}$ and $\overline{\text{WR}}$ low.

Be sure to read the CAUTION statement in the LOGIC INPUT COMPATIBILITY section.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
DAC4813AP	OBSOLETE	PDIP	NTD	28		TBD	Call TI	Call TI

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265