T-51-09-12

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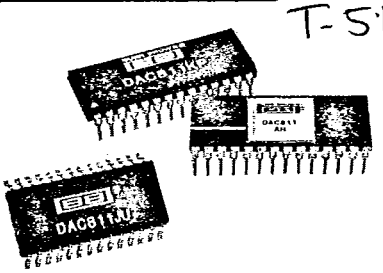


DAC811

AVAILABLE IN DIE FORM

Microprocessor-Compatible 12-BIT DIGITAL-TO-ANALOG CONVERTER

FEATURES

- SINGLE INTEGRATED CIRCUIT CHIP
- MICROCOMPUTER INTERFACE: DOUBLE-BUFFERED LATCH
- VOLTAGE OUTPUT: ±10V, ±5V, +10V
- MONOTONICITY GUARANTEED OVER TEMPERATURE
- ±1/2LSB MAXIMUM NONLINEARITY OVER TEMPERATURE
- GUARANTEED SPECIFICATIONS AT ±12V AND ±15V SUPPLIES
- TTL/5V CMOS-COMPATIBLE LOGIC INPUTS

DESCRIPTION

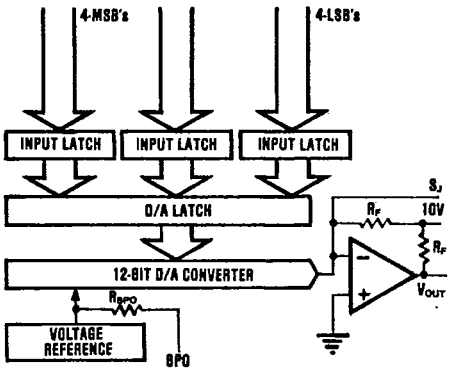
The DAC811 is a complete single-chip integrated circuit microcomputer-compatible 12-bit digital-to-analog converter. The chip includes a precision voltage reference, microcomputer interface logic, double-buffered latch, and a 12-bit D/A converter with a voltage output amplifier. Fast current switches and a laser-trimmed thin-film resistor network provide a highly accurate and fast D/A converter.

Microcomputer interfacing is facilitated by a double-buffered latch. The input latch is divided into three 4-bit nybbles to permit interfacing to 4-, 8-, 12- or 16-bit buses and to handle right- or left-justified data. The 12-bit data in the input latches is transferred to the D/A latch to hold the output value.

Input gating logic is designed so that loading the last nybble or byte of data can be accomplished simultaneously with the transfer of data (previously stored in adjacent latches) from adjacent input latches to the D/A latch. This feature avoids spurious analog output values while using an interface technique that saves computer instructions.

The DAC811 is laser trimmed at the wafer level and is specified to ±1/4LSB maximum linearity error (B, K, and S grades) at 25°C and ±1/2LSB maximum over the temperature range. All grades are guaranteed monotonic over the specification temperature range.

The DAC811 is available in six performance grades and three package types, as well as offering environmentally screened versions for enhanced reliability. DAC811J and K are specified over the temperature range of 0°C to +70°C; DAC811A and B are specified over −25°C to +85°C; DAC811R and S are specified over −55°C to +125°C. DAC811J and K are packaged in a reliable 28-pin plastic DIP or plastic SOIC package, while DAC811A, B, R, and S are available in a 28-pin 0.6-inch wide dual-in-line hermetically-sealed ceramic side-brazed package (H package).



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PDS-503E

SPECIFICATIONS

ELECTRICAL

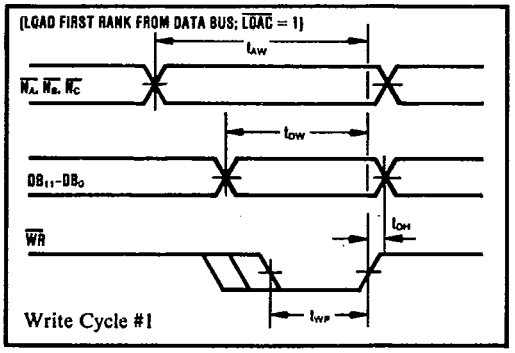
T_A = +25°C. $\pm V_{CC}$ = 12V or 15V unless otherwise noted.

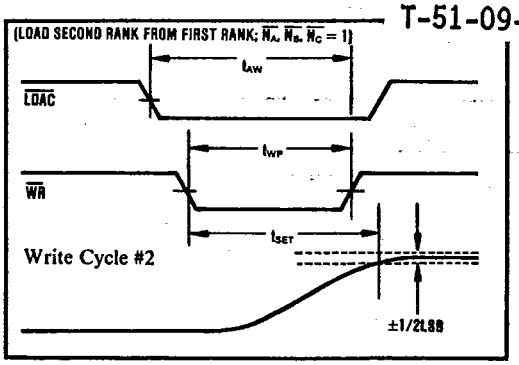
MODEL	DAC811AH, JP, JU			DAC811BH, KP, KU			DAC811RH			DAC811SH			UNITS
PARAMETER	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
INPUT													
DIGITAL INPUT													
Resolution			12										Bits
Codes[1]		USB, BOB											
Digital Inputs Over Temperature Range[2]													
V_{IH}	+2.0		+15										VDC
V_{IL}	0.0		+0.8										VDC
I_{IH}, V_I = +2.7V			+10										µA
I_{IL}, V_I = +0.4V			±20										µA
Digital Interface Timing Over Temperature Range													
t_{WR}, $\overline{WR}$ pulse width	50												nsec
t_{AW1}, $\overline{N_2}$ and $\overline{LDAC}$ valid to end of $\overline{WR}$	50												nsec
t_{DW}, data valid to end of $\overline{WR}$	80												nsec
t_{DH}, data valid hold time	0						+10						nsec
TRANSFER CHARACTERISTICS													
ACCURACY													
Linearity Error		±1/4	±1/2		±1/8	±1/4		±1/4	±1/2		±1/8	±1/4	LSB
Differential Linearity Error		±1/2	±3/4		±1/4	±1/2		±1/2	±3/4		±1/4	±1/2	LSB
Gain Error[3]		±0.1	±0.2		*	*		*	*		*	*	%
Offset Error[3,4]		±0.05	±0.15		*	*		*	*		*	*	% of FSR[5]
Monotonicity		Guaranteed			*	*		*	*		*	*	
Power Supply Sensitivity, +V_{CC}		±0.001	±0.003		*	*		*	*		*	*	% of FSR/%V_{CC}
−V_{CC}		±0.002	±0.006		*	*		*	*		*	*	% of FSR/%V_{CC}
V_{DD}		±0.0005	±0.0015		*	*		*	*		*	*	% of FSR/%V_{DD}
DRIFT (over specification temperature range)[10]													
Gain		±10	±30		±10	±20		±15	±30		±15	±30	ppm/°C
Unipolar Offset		±5	±10		±5	±7		±5	±10		±5	±7	ppm of FSR/°C
Bipolar Zero		±5	±10		±5	±7		±5	±10		±5	±7	ppm of FSR/°C
Linearity Error Over Temperature Range		±1/2	±3/4		±1/4	±1/2		±1/2	±3/4		±1/4	±1/2	LSB
Monotonicity Over Temperature Range		Guaranteed			*			*			*		
CONVERSION SPEED													
SETTLING TIME[6] (to within ±0.01% of FSR of final value; 2kΩ load)													
For Full Scale Range Change, 20V Range		3	4		*	*		*	*		*	*	µsec
10V Range		3	4		*			*			*		µsec
For 1LSB Change at Major Carry[7]		1			*			*			*		µsec
Slew Rate[8]	8	12		*	*		*	*		*	*		V/µsec
OUTPUT													
ANALOG OUTPUT													
Voltage Range ($\pm V_{CC}$ = 15V)[9], Unipolar		0 to +10			*			*			*		V
Bipolar		±5, ±10			*			*			*		V
Output Current	±5			*			*			*			mA
Output Impedance (at DC)		0.2			*			*			*		Ω
Short Circuit to Common Duration		Indefinite			*			*			*		
REFERENCE VOLTAGE													
Voltage	+6.2	+6.3	+6.4	*	*	*	*	*	*	*	*	*	V
Source Current Available for External Loads	+2.0			*			*			*			mA
Temperature Coefficient		±10	±30		±10	±20		±10	±30		±10	±20	ppm/°C
Short Circuit to Common Duration		Indefinite			*			*			*		
POWER SUPPLY REQUIREMENTS													
Voltage, +V_{CC}	+11.4	+15	+16.5	*	*	*	*	*	*	*	*	*	VDC
−V_{CC}	−11.4	−15	−16.5	*	*	*	*	*	*	*	*	*	VDC
V_{DD}	+4.5	+5	+5.5	*	*	*	*	*	*	*	*	*	VDC
Current (no load), +V_{CC}		+16	+25		*	*	*	*	*	*	*	*	mA
−V_{CC}		−23	−35		*	*	*	*	*	*	*	*	mA
V_{DD}		+8	+15		*	*	*	*	*	*	*	*	mA
Potential at DCOM with Respect to ACOM[9]			±0.5			*			*			*	V
Power Dissipation		625	800		*			*			*		mW
TEMPERATURE RANGE													
Specification: J, K	0		+70	*		*							°C
A, B	−25		+85	*		*							°C
R, S							−55		+125	*		*	°C
Storage: J, K	−60		+100	*		*							°C
A, B, R, S	−65		+150	*		*	*		*	*		*	°C

*Same as specification to immediate left.

NOTES: (1) USB = Unipolar Straight Binary; BOB = Bipolar Offset Binary. (2) Refer to Logic Input Compatibility section. (3) Adjustable to zero with external trim potentionmeter. (4) Error at input code 000_{16} for both unipolar and bipolar ranges. (5) FSR means Full Scale Range and is 20V for the ±10V range. (6) Maximum represents the 3σ limit. Not 100% tested for this parameter. (7)At the major carry, $7FF_{16}$ to 800_{16} and 800_{16} to $7FF_{16}$. (8) Minimum supply voltage required for ±10V output swing is ±13.5V. Output swing for ±11.4V supplies is at least −8V to +8V. (9) The maximum voltage at which ACOM and DCOM may be separated without affecting accuracy specifications. (10) Drift for the DAC811KU is identical to the JU grade on SOIC only, guaranteed.

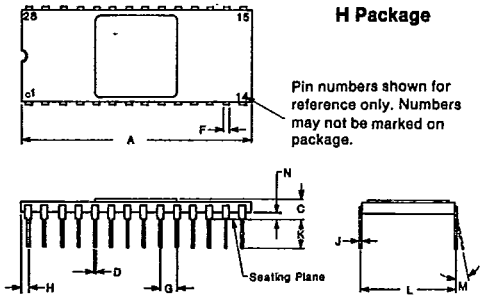
TIMING DIAGRAMS





MECHANICAL

H Package

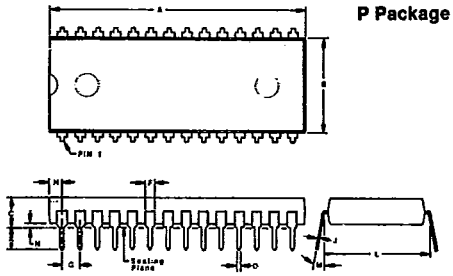


DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.386	1.414	35.20	35.92
C	.108	.166	2.74	4.22
D	.015	.021	0.38	0.53
F	.035	.060	0.89	1.52
G	.100 BASIC		2.54 BASIC	
H	.036	.064	0.91	1.63
J	.008	.012	0.20	0.30
K	.120	.240	3.05	6.10
L	.600 BASIC		15.24 BASIC	
M	—	10°	—	10°
N	.025	.060	0.64	1.52

NOTE: Leads in true position within 0.010" (0.25mm) R at MMC at seating plane.

CASE: Ceramic, hermetic
MATING CONNECTOR: 2803MC
WEIGHT: 4.8gm (0.17oz)

P Package

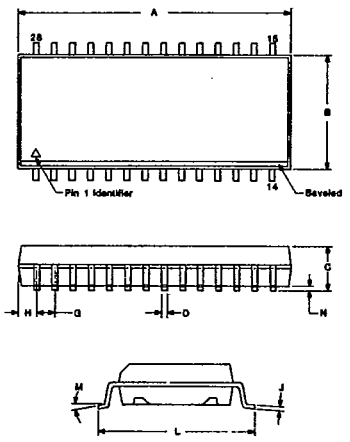


DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.400	1.460	35.56	37.08
B	0.530	0.575	13.46	14.61
C	0.169	0.224	4.29	5.69
D	0.015	0.023	0.38	0.58
F	0.043	0.065	1.09	1.65
G	0.100 BASIC		2.54 BASIC	
H	0.030	0.090	0.76	2.29
J	0.008	0.015	0.20	0.38
K	0.100	0.136	2.54	3.45
L	0.600 BASIC		15.24 BASIC	
M	0°C	15°C	0°C	15°C
N	0.018	0.022	0.46	0.56

NOTE:
Leads in true position within .010" (.25mm) R at MMC at seating plane.

CASE: Ceramic, hermetic
MATING CONNECTOR: 2803MC
WEIGHT: 4.3gm (0.15oz)

U Package



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.700	.716	17.78	18.19
B	.286	.302	7.26	7.67
C	.093	.109	2.36	2.77
D	.016 BASIC		0.41 BASIC	
G	.050 BASIC		1.27 BASIC	
H	.022	.038	0.56	0.97
J	.008	.012	0.20	0.30
L	.398	.414	10.11	10.52
M	5° TYP.		5° TYP.	
N	.000	.012	0.00	0.30

NOTE: Leads in true position within .010" (.25mm) R at MMC at seating plane.

Pin numbers shown for reference only. Numbers may not be marked on package.

ABSOLUTE MAXIMUM RATINGS

+Vcc	0 to +18V
-Vcc to ACOM	0 to -18V
VDD to DCOM	0 to +7V
VDD to ACOM	±7V
ACOM to DCOM	±7V
Digital Inputs (pins 2-14, 16-19) to DCOM	-0.4V to +18V
External Voltage Applied to 10V Range Resistor	±12V
REF OUT	Indefinite short to ACOM
External Voltage Applied to DAC Output	-5 to +5V
Power Dissipation	1000mW
Lead Temperature, Soldering	+300°C, 10s
Max Junction Temperature	165°C
Thermal Resistance, θ_{JA}: Plastic DIP & SOIC	100°C/W
Ceramic DIP	65°C/W

PIN NOMENCLATURE

PIN	NAME	FUNCTION	PIN	NAME	FUNCTION
1	V_{DD}	Logic Supply, +5V	14	D_4	DATA, Bit 5
2	$\overline{WR}$	WRITE, command signal to load latches. Logic low loads latches.	15	DCOM	DIGITAL COMMON, V_{DD} supply return
3	$\overline{LDAC}$	LOAD D/A CONVERTER, enables $\overline{WR}$ to load the D/A latch. Logic low enables.	16	D_0	DATA, Bit 1, LSB
4	$\overline{N_A}$	NYBBLE A, enables $\overline{WR}$ to load input latch A (the most significant nybble. Logic low enables.	17	D_1	DATA, Bit 2
5	$\overline{N_B}$	NYBBLE B, enables $\overline{WR}$ to load input latch B. Logic low enables.	18	D_2	DATA, Bit 3
6	$\overline{N_C}$	NYBBLE C, enables $\overline{WR}$ to load input latch C (the least significant nybble). Logic low enables.	19	D_3	DATA, Bit 4
7	D_{11}	DATA, Bit 12, MSB, positive true.	20	$+V_{CC}$	Analog Supply Input, +15V or +12V
8	D_{10}	DATA, Bit 11	21	$-V_{CC}$	Analog Supply Input, −15V or −12V
9	D_9	DATA, Bit 10	22	GAIN ADJ	To externally adjust gain
10	D_8	DATA, Bit 9	23	ACOM	ANALOG COMMON, $\pm V_{CC}$ supply return
11	D_7	DATA, Bit 8	24	V_{out}	D/A converter voltage output
12	D_6	DATA, Bit 7	25	10V RANGE	Connect to pin 24 for 10V Range
13	D_5	DATA, Bit 6	26	SJ	SUMMING JUNCTION of output amplifier
			27	BPO	BIPOLAR OFFSET. Connect to pin 26 for Bipolar Operation
			28	REF OUT	6.3V reference output

ORDERING INFORMATION

Model	Package	Temperature Range	Linearity Error, max (+25°C)	Gain Drift (ppm/°C)
DAC811JP	Plastic DIP	0°C to +70°C	±1/2LSB	30
DAC811JU	Plastic SOIC	0°C to +70°C	±1/2LSB	30
DAC811KP	Plastic DIP	0°C to +70°C	±1/4LSB	20
DAC811KU	Plastic SOIC	0°C to +70°C	±1/4LSB	20
DAC811AH	Ceramic DIP	−25°C to +85°C	±1/2LSB	30
DAC811AH/QM	Ceramic DIP	−25°C to +85°C	±1/2LSB	30
DAC811BH	Ceramic DIP	−25°C to +85°C	±1/4LSB	20
DAC811BH/QM	Ceramic DIP	−25°C to +85°C	±1/4LSB	20
DAC811RH	Ceramic DIP	−55°C to +125°C	±1/2LSB	30
DAC811RH/QM	Ceramic DIP	−55°C to +125°C	±1/2LSB	30
DAC811SH	Ceramic DIP	−55°C to +125°C	±1/4LSB	20
DAC811SH/QM	Ceramic DIP	−55°C to +125°C	±1/4LSB	±1

BURN-IN SCREENING OPTION
See text for details.

Model	Package	Temperature Range	Linearity Error, max (+25°C)	Gain Drift, (ppm/°C)
DAC811JP-BI	Plastic DIP	0°C to +70°C	±1/2LSB	30
DAC811JU-BI	Plastic SOIC	0°C to +70°C	±1/2LSB	30
DAC811KP-BI	Plastic DIP	0°C to +70°C	±1/4LSB	20
DAC811KU-BI	Plastic SOIC	0°C to +70°C	±1/4LSB	20

NOTE: (1) Or equivalent combination of time and temperature.

DISCUSSION OF SPECIFICATIONS

INPUT CODES

The DAC811 accepts positive true binary input codes. DAC811 may be connected by the user for any one of the following codes: USB (unipolar straight binary), BOB (bipolar offset binary) or, using an external inverter on the MSB line, BTC (binary two's complement). See Table I.

DIGITAL INPUT MSB ↓ LSB ↓	ANALOG OUTPUT USB Unipolar Straight Binary	BOB Bipolar Offset Binary	BTC* Binary Two's Complement
111111111111	+Full Scale	+Full Scale	−1 LSB
100000000000	+1/2 Full Scale	Zero	−Full Scale
011111111111	1/2 Full Scale −1 LSB	−1 LSB	+Full Scale
000000000000	Zero	−Full Scale	Zero

*Invert the MSB of the BOB code with external inverter to obtain BTC code.

TABLE I. Digital Input Codes.

LINEARITY ERROR

Linearity Error as used in D/A converter specifications by Burr-Brown is the deviation of the analog output from a straight line drawn between the end points (inputs all "1's" and all "0's"). The DAC811 linearity error is specified at ±1/4LSB (max) at +25°C for B, K, and S grades and ±1/2LSB (max) for A, J, and R grades.

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 1/2LSB means that the output step size can range from 1/2LSB to 3/2LSB when the input changes from one state to the next. Monotoni-

city requires that DLE be less than 1LSB over the temperature range of interest.

MONOTONICITY

A D/A converter is monotonic if the output either increases or remains the same for increasing digital inputs. All grades of DAC811 are monotonic over their specification temperature range.

DRIFT

Gain drift is a measure of the change in the full scale range output over the specification temperature range. Drift is expressed in parts per million per degree centigrade (ppm/°C). Gain drift is established by testing the full scale range value (e.g., +FS minus −FS) at high temperature, +25°C, and low temperature; calculating the error with respect to the +25°C value and dividing by the temperature change.

Unipolar offset drift is a measure of the change in output with all 0's on the input over the specification temperature range. Offset is measured at high temperature, +25°C, and low temperature. The maximum change in offset referred to the +25°C value divided by the temperature change is the offset drift. It is expressed in parts per million of full scale range per degree centigrade (ppm of FSR/°C).

Bipolar zero drift is measured at a digital input of 800_{16}, the code that gives zero volts output for bipolar operation.

SETTLING TIME

Settling Time is the total time (including slew time) for the output to settle within an error band around its final value after a change in input. Three settling times are specified to ±0.01% of Full Scale Range (FSR): two for maximum full scale range changes of 20V and 10V, and one for a 1LSB change. The 1LSB change is measured at the major carry ($7FF_{16}$ to 800_{16} and 800_{16} to $7FF_{16}$), the input transition at which worst-case settling time occurs.

REFERENCE SUPPLY

DAC811 contains an on-chip 6.3V reference. This voltage (pin 28) has a tolerance of ±0.1V. The reference output may be used to drive external loads, sourcing at least 2.0mA. This current should be constant for best performance of the D/A converter.

POWER SUPPLY SENSITIVITY

Power Supply Sensitivity is a measure of the effect of a power supply change on the D/A converter output. It is defined as a percent of FSR output change per percent of change in either the positive, negative, or logic supply voltages about the nominal voltages. Figure 1 shows typical power supply rejection versus power supply ripple frequency.

BURN-IN SCREENING

Burn-in screening is an option available for the plastic-DIP and plastic-SOIC package versions of the DAC811. Burn-in duration is 160 hours at 85°C (or equivalent combination of time and temperature). All units are tested after burn-in to ensure that grade specifications are met. To order burn-in, add "-BI" to the base model number.

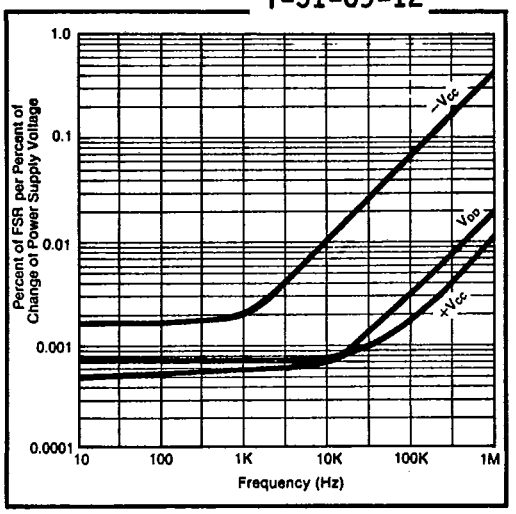


FIGURE 1. Power Supply Rejection versus Power Supply Ripple Frequency.

/QM SCREENING

Burr-Brown /QM models are environmentally screened versions of our ceramic-package versions of Model DAC811, designed to provide enhanced reliability. The screening, tabulated below, is performed to selected methods of MIL-STD-883. Reference to these methods provides a convenient method of communicating the screening levels and basic procedures employed; it does not imply conformance to any other military standards or to any methods of MIL-STD-883 other than those specified below. Burr-Brown's detailed procedures may very slightly, model-to-model from those in MIL-STD-883.

SCREENING FLOW FOR DAC811/QM

Screen	MIL-STD-883 Method	Condition
Internal Visual	2010	B
High Temperature Storage (Stabilization Bake)	1008	C (150°C, 24Hr)
Temperature Cycling	1010	C
Burn-in	1015	B (160h at 125°C)
Constant Acceleration	2001	E
Hermeticity: Fine Leak Gross Leak	1014 1014	A1 or A2 C
External Visual	2009	

OPERATION

DAC811 is a complete single IC chip 12-bit D/A converter. The chip contains a 12-bit D/A converter, voltage reference, output amplifier, and microcomputer-compatible input logic as shown in Figure 2.

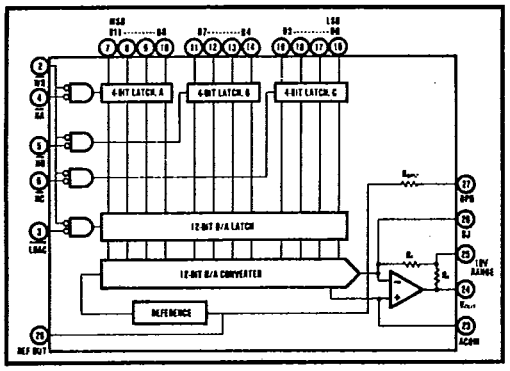


FIGURE 2. DAC811 Block Diagram.

INTERFACE LOGIC

Input latches A, B, and C hold data temporarily while a complete 12-bit word is assembled before loading into the D/A register. This double-buffered organization prevents the generation of spurious analog output values. Each register is independently addressable.

These input latches are controlled by $\overline{N_A}$, $\overline{N_B}$, $\overline{N_C}$ and $\overline{WR}$. $\overline{N_A}$, $\overline{N_B}$, and $\overline{N_C}$ are internally NORed with $\overline{WR}$ so that the input latches transmit data when both $\overline{N_A}$ (or $\overline{N_B}$, $\overline{N_C}$) and $\overline{WR}$ are at logic "0". When either $\overline{N_A}$ (or $\overline{N_B}$, $\overline{N_C}$) or $\overline{WR}$ go to logic "1", the input data is latched into the input registers and held until both $\overline{N_A}$ (or $\overline{N_B}$, $\overline{N_C}$) and $\overline{WR}$ go to logic "0".

The D/A latch is controlled by $\overline{LDAC}$ and $\overline{WR}$. $\overline{LDAC}$ and $\overline{WR}$ are internally NORed so that the latches transmit data to the D/A switches when both $\overline{LDAC}$ and $\overline{WR}$ are at logic "0". When either $\overline{LDAC}$ or $\overline{WR}$ are at logic "1", the data is latched in the D/A latch and held until $\overline{LDAC}$ and $\overline{WR}$ go to logic "0".

All latches are level-triggered. Data present when the control signals are logic "0" will enter the latch. When any one of the control signals returns to logic "1", the data is latched. A truth table for all latches is given in Table II.

TABLE II. DAC811 Interface Logic Truth Table.

$\overline{WR}$	$\overline{N_A}$	$\overline{N_B}$	$\overline{N_C}$	$\overline{LDAC}$	OPERATION
1	X	X	X	X	No Operation
0	0	1	1	1	Enables Input Latch 4MSB's
0	1	0	1	1	Enables Input Latch 4 Middle Bits
0	1	1	0	1	Enables Input Latch 4 LSB's
0	1	1	1	0	Loads D/A Latch From Input Latches
0	0	0	0	0	All Latches Transparent

"X" = Don't Care.

GAIN AND OFFSET ADJUSTMENTS

Figures 3 and 4 illustrate the relationship of Offset and Gain adjustments to unipolar and bipolar D/A converter output.

OFFSET ADJUSTMENT

For unipolar (USB) configurations, apply the digital input code that should produce zero voltage output and adjust the Offset potentiometer for zero output. For bipolar (BOB, BTC) configurations, apply the digital input code that should produce the maximum negative output voltage and adjust the Offset potentiometer for minus full scale voltage. Example: If the Full Scale Range is connected for 20V, the maximum negative output voltage is −10V. See Table III for corresponding codes.

GAIN ADJUSTMENT

For either unipolar or bipolar configurations, apply the digital input that should give the maximum positive voltage output. Adjust the Gain potentiometer for this positive full scale voltage. See Table III for positive full scale voltages.

±12V OPERATION

The DAC811 is fully specified for operation on ±12V power supplies. However, in order for the output to swing to ±10V, the power supplies must be ±13.5V or greater. When operating with ±12V supplies, the output

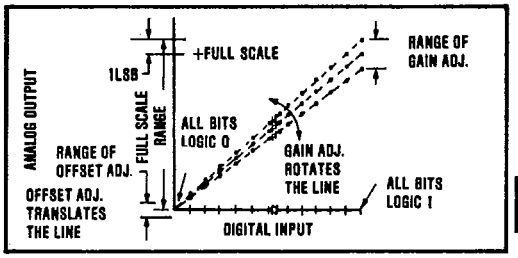


FIGURE 3. Relationship of Offset and Gain Adjustments for a Unipolar D/A Converter

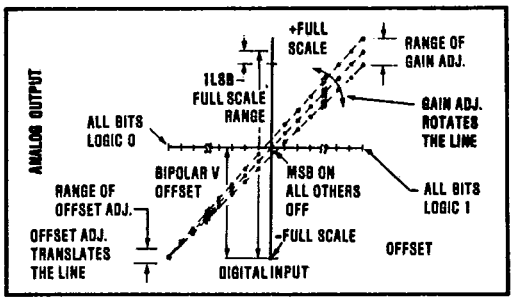


FIGURE 4. Relationship of Offset and Gain Adjustments for a Bipolar D/A Converter.

TABLE III. Digital Input/Analog Output, $\pm V_{CC} = \pm 15V$.

DIGITAL INPUT	ANALOG OUTPUT VOLTAGE		
	0 to +10V	±5V	±10V
12-Bit Resolution MSB ↓ LSB ↓			
111111111111	+9.9976V	+4.9976V	+9.9951V
100000000000	+5.0000V	0.0000V	0.0000V
011111111111	+4.9976V	−0.0024V	−0.0049V
000000000000	0.0000V	−5.0000V	−10.0000V
1LSB	2.44mV	2.44mV	4.88mV

swing should be restricted to ±8V in order to meet specifications.

LOGIC INPUT COMPATIBILITY

The DAC811 digital inputs are TTL, LSTTL, and 54/74HC CMOS-compatible over the operating range of V_{DD}. The input switching threshold remains at the TTL threshold over the supply range.

The logic input current over temperature is low enough to permit driving the DAC811 directly from the outputs of 4000B and 54/74C CMOS devices.

INSTALLATION

POWER SUPPLY CONNECTIONS

Decoupling: For optimum performance and noise rejection, power supply decoupling capacitors should be added as shown in the Connection Diagram, Figure 5.

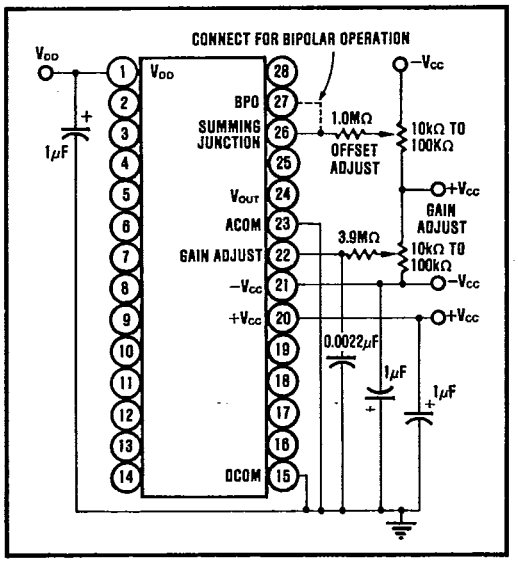


FIGURE 5. Power Supply, Gain, and Offset Potentiometer Connections.

These capacitors (1μF tantalum recommended) should be located close to the DAC811.

The DAC811 features separate digital and analog power supply returns to permit optimum connections for low noise and high speed performance. The Analog Common (pin 23) and Digital Common (pin 15) should be connected together at one point. Separate returns minimize current flow in low level signal paths if properly connected. Logic return currents are not added into the analog signal return path. A ±0.5V difference between ACOM and DCOM is permitted for specified operation. High frequency noise on DCOM with respect to ACOM may permit noise to be coupled through to the analog output, therefore, some caution is required in applying these common connections.

The Analog Common is the high quality return for the D/A converter and should be connected directly to the analog reference point of the system. The load driven by the output amplifier should be returned to the Analog Common.

EXTERNAL OFFSET AND GAIN ADJUSTMENT

Offset and Gain may be trimmed by installing external Offset and Gain potentiometers. Connect these potentiometers as shown in Figure 5. TCR of the potentiometers should be 100 ppm/°C or less. The 1.0MΩ and 3.9MΩ resistors (20% carbon or better) should be located close to the DAC811 to prevent noise pickup. If it is not convenient to use these high value resistors, an equivalent "T" network, as shown in Figure 6, may be substituted in each case. The Gain Adjust (pin 22) is a high impedance point and a 0.001μF to 0.01μF ceramic capacitor should be connected from this pin to Analog Common to reduce noise pickup in all applications, including those not employing external gain adjustment.

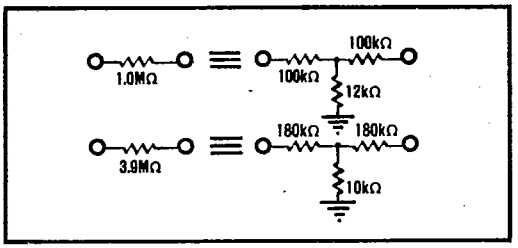


FIGURE 6. Equivalent Resistances.

OUTPUT RANGE CONNECTIONS

Internal scaling resistors provided in the DAC811 may be connected to produce bipolar output voltage ranges of ±10V and ±5V or unipolar output voltage range of 0 to +10V. The 20V range (±10V bipolar range) is internally connected. Refer to Figure 7. Connections for the output ranges are listed in Table IV.

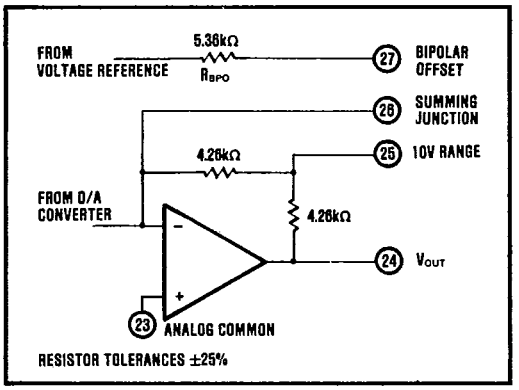


FIGURE 7. Output Amplifier Voltage Range Scaling Circuit.

Table IV. Output Range Connections.

Output Range	Digital Input Codes	Connect Pin 25 To	Connect Pin 27 To
0 to +10V	USB	24	23
±5V	BOB or BTC	24	26
±10V	BOB or BTC	NC	26

APPLICATIONS

MICROCOMPUTER BUS INTERFACING

The DAC811 interface logic allows easy interface microcomputer bus structures. The control signal $\overline{WR}$ is derived from external device select logic and the I/O Write or Memory Write (depending upon the system design) signals from the microcomputer.

The latch enable lines $\overline{N_A}$, $\overline{N_B}$, $\overline{N_C}$ and $\overline{LDAC}$ determine which of the latches are enabled. It is permissible to enable two or more latches simultaneously as shown in some of the following examples.

The double-buffered latch permits data to be loaded into the input latches of several DAC811's and later strobed into the D/A latch of all D/A's simultaneously updating all analog outputs. All the interface schemes shown below use a base address decoder. If blocks of memory are unused, the base address decoder can be simplified or eliminated altogether. For instance if half the memory space is unused, address line A_{15} of the microcomputer can be used as the chip select control.

4-BIT INTERFACE

An interface to a 4-bit microcomputer is shown in Figure 8. Each DAC811 occupies four address locations. A 74LS139 provides the two to four decoder and selects these with the base address. Memory Write ($\overline{WR}$) of the microcomputer is connected directly to the $\overline{WR}$ pin of the DAC811. A 8205 decoder is an alternative device to use instead of the 74LS139.

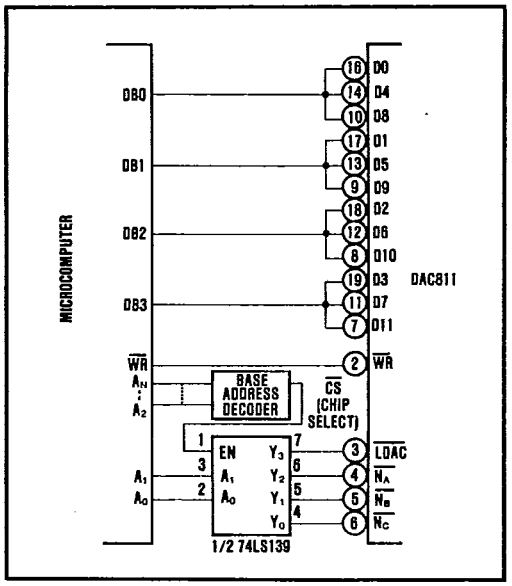


FIGURE 8. Addressing and Control for 4-Bit Microcomputer Interface.

8-BIT INTERFACE

The control logic of DAC811 permits interfacing to right- or left-justified data formats illustrated in Figure 9. When a 12-bit D/A converter is loaded from an 8-bit bus, two bytes of data are required. Figures 10 and 11 show an addressing scheme for right-justified and left-justified data respectively. The base address is decoded from the high-order address bits. A_0 and A_1 address the appropriate latches. Note that adjacent addresses are used. For the right-justified case $X10_{16}$ loads the 8 LSB's and $X01_{16}$ loads the 4MSB's and simultaneously transfers input latch data to the D/A latch. Addresses $X00_{16}$ and $X11_{16}$ are not used.

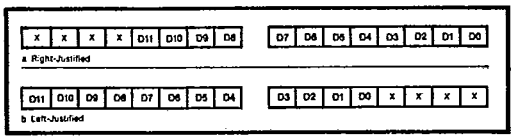


FIGURE 9. 12-Bit Data Formats for 8-Bit Systems.

Left-justified data is handled in a similar manner, shown in Figure 11. The DAC811 still occupies two adjacent locations in the microcomputer's memory map.

INTERFACING MULTIPLE DAC811's IN 8-BIT SYSTEMS

Many applications require that the outputs of several D/A converters be updated simultaneously such as

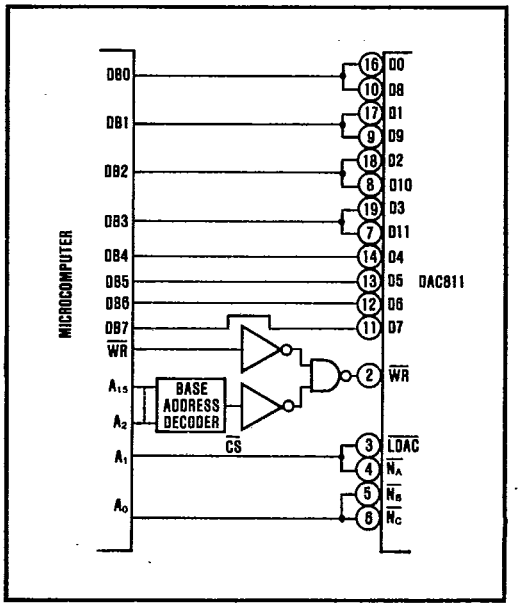


FIGURE 10. Right-Justified Data Bus Interface.

automatic test systems. The interface shown in Figure 12 uses a 74LS138 decoder to decode a set of eight adjacent addresses to load the input latches of four DAC811's. The example shows a right-justified data format.

A ninth address using A_3 causes all DAC811's to be updated simultaneously. If a particular DAC811 is always loaded last, for instance, D/A #4, A_3 is not needed, thus saving 8 address spaces for other uses. Incorporate A_3 into the Base Address Decoder, remove the inverter, connect the common $\overline{LDAC}$ line to $\overline{N_C}$ of D/A #4, and connect G1 of the 74LS138 to +5V.

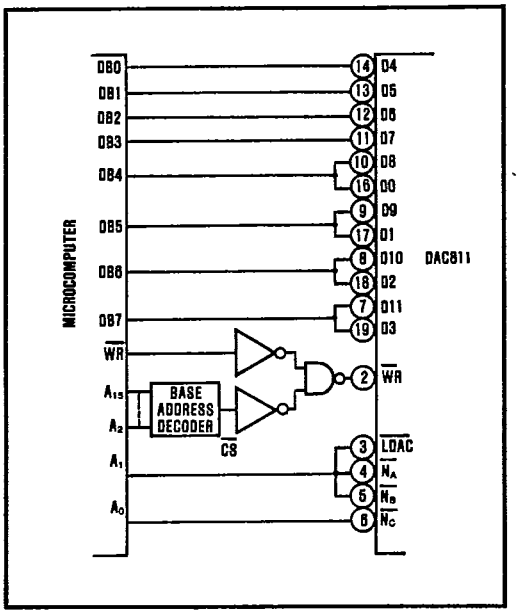


FIGURE 11. Left-Justified Data Bus Interface.

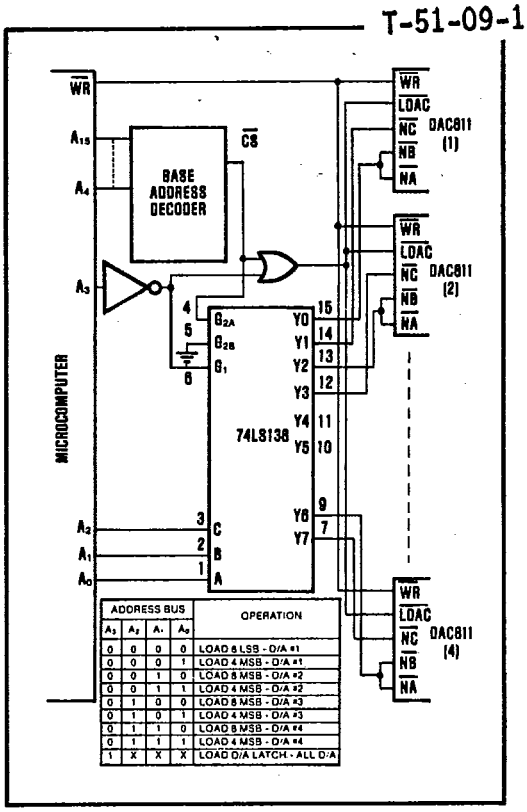


FIGURE 12. Interfacing Multiple DAC 811's to an 8-Bit Bus.

12- AND 16-BIT MICROCOMPUTER INTERFACE

For this application the input latch enable lines, $\overline{N_A}$, $\overline{N_B}$, $\overline{N_C}$ are tied low, causing the latches to be transparent. The D/A latch, and therefore DAC 811, is selected by the address decoder and strobed by $\overline{WR}$.