Negative 10V/10.24V Voltage Reference

REF-08

FEATURES

- Low Cost Negative Reference
- Pin Selectable To –10.24V Output For Binary Applications
- 10mA Minimum Output Current
- Wide Input Voltage Range, –11.4V to –36V
- Low 1.4V Drop Out Voltage
- Wide ±270mV Adjustment Range
- Available in Die Form

APPLICATIONS

- 8 & 10-Bit CMOS A/D and D/A Converters
- Voltage-to-Frequency Converters
- Strain Gauge Bridge Reference
- Precision Negative Ten Volt Regulator

ORDERING INFORMATION †

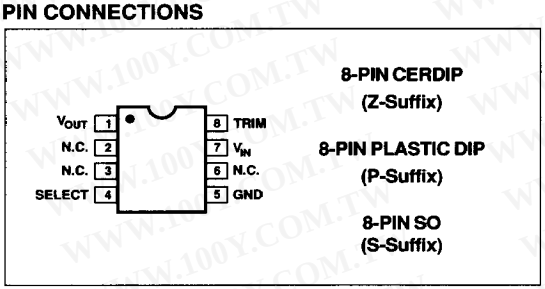
TCV_O ppm/°C	PACKAGE CERDIP 8-PIN	PACKAGE PLASTIC 8-PIN	PACKAGE SO 8-PIN	OPERATING TEMPERATURE RANGE
50	REF08BZ*	–	–	MIL
80	REF08GZ	–	–	XIND
100	–	REF08HP	REF08HS††	XIND

* For devices processed in total compliance to MIL-STD-883, add /883 after part number. Consult factory for 883 data sheet.

† Burn-in is available on commercial and industrial temperature range parts in cerDIP, plastic DIP, and TO-can packages.

†† For availability and burn-in information on SO and PLCC packages, contact your local sales office.

PIN CONNECTIONS



8-PIN CERDIP
(Z-Suffix)

8-PIN PLASTIC DIP
(P-Suffix)

8-PIN SO
(S-Suffix)

GENERAL DESCRIPTION

The REF-08 is a series regulation, buried Zener, negative voltage reference with pin selectable output voltage. Its low temperature coefficient, low noise, and selectable output make it an ideal reference for A/D converters such as the ADC-908 or the PM-7574. The REF-08 is also well suited for CMOS DAC applications where a positive output voltage is desired.

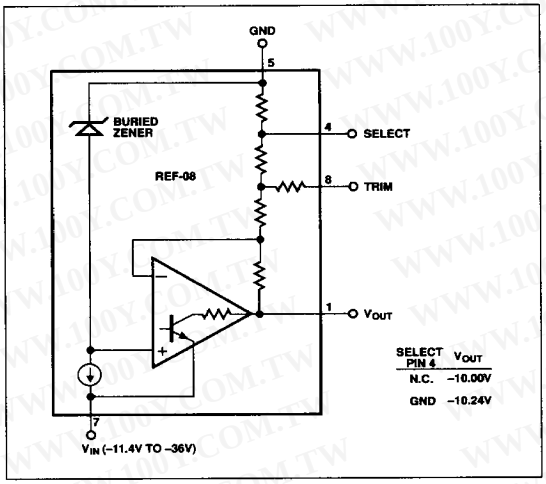
Applications with 8-bit accuracy will typically be able to use the REF-08 without trimming its output voltage. This is particularly true of CMOS DACs with low gain errors such as the DAC-8408 and PM-7528.

Leaving the SELECT pin open will result in a –10V output. Grounding SELECT will produce a –10.24V output (i.e. –10mV per 10-bit LSB) that is ideal for binary applications.

A ±270mV adjustment range is available with the REF-08 which exhibits a tight 0.04ppm/°C/mV of adjustment temperature coefficient. In many applications, the combined tempcos of an adjusted REF-08 will be superior to more expensive precision references with tighter initial tempcos but greater changes with adjustment.

The REF-08 has been designed to operate from a "worst case" –12V power supply (–11.4V). This low dropout voltage makes the best of the poor supply regulation in some digital systems. Its 10mA output current capability and unloaded supply current of only 2mA provide better power/performance than most traditional op amp inverter circuits.

FUNCTIONAL DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage (V_{IN}) ..... +0.3V to −36V
Output Voltage (V_{OUT}) ..... +0.3V to V_{IN}
TRIM Voltage (pin 8) ..... +0.3V to V_{IN}
SELECT Voltage (pin 4) ..... +0.3V to V_{OUT}
Output Short-Circuit Duration
(to Ground or V_{IN}) ..... 30 seconds
Operating Temperature Range
REF-08BZ ..... −55°C to +125°C
REF-08GZ, HP, HS ..... −40°C to 85°C
Storage Temperature Range
Z Package ..... −65°C to +150°C
S, P Packages ..... −65°C to +125°C
Junction Temperature Range ..... −65°C to +175°C
Lead Temperature (Soldering, 60 sec.) ..... 300°C

PACKAGE TYPE	Θ_{JA} (NOTE 2)	Θ_{JC}	UNITS
8-Pin Hermetic DIP (Z)	162	26	°C/W
8-Pin Plastic DIP (P)	110	50	°C/W
8-Pin SO (S)	160	44	°C/W

NOTES:
1. Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
2. Θ_{JA} is specified for worst case mounting conditions, i.e., Θ_{JA} is specified for device in socket for CerDIP and P-DIP packages; Θ_{JA} is specified for device soldered to printed circuit board for SO package.

ELECTRICAL CHARACTERISTICS at V_{IN} = −15V, NO LOAD, SELECT = open circuit; −55°C ≤ T_A ≤ +125°C for the REF08BZ, and −40°C ≤ T_A ≤ +85°C for the REF08GZ/HP/HS, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	REF-08B MIN	REF-08B MAX	REF-08G MIN	REF-08G MAX	REF-08H MIN	REF-08H MAX	UNITS
−10V Output Voltage	V_O	T_A = +25°C	−10.03	−9.97	−10.04	−9.96	−10.04	−9.96	V
		T_{MIN} to T_{MAX}	−10.05	−9.95	−10.06	−9.94	−10.08	−9.92	
−10V Output Voltage Tolerance	ΔV_O	T_A = +25°C	–	±30	–	±40	–	±40	mV
		T_{MIN} to T_{MAX}	–	±50	–	±60	–	±80	
−10.24 Output Voltage (Select=GND)	V_O	T_A = +25°C	−10.28	−10.20	−10.29	−10.19	−10.30	−10.18	V
		T_{MIN} to T_{MAX}	−10.30	−10.18	−10.32	−10.16	−10.36	−10.12	
−10.24V Output Voltage Tolerance (Select=GND)	ΔV_O	T_A = +25°C	–	±40	–	±50	–	±60	mV
		T_{MIN} to T_{MAX}	–	±60	–	±80	–	±120	
Output Voltage Temperature Coefficient	TCV_O	(Note 1)	–	50	–	80	–	100	ppm/°C

ELECTRICAL CHARACTERISTICS at V_{IN} = −15V, NO LOAD, SELECT = open circuit; −55°C ≤ T_A ≤ +125°C for the REF08BZ, and −40°C ≤ T_A ≤ +85°C for the REF08GZ/HP/HS, unless otherwise noted.

CHARACTERISTIC	SYMBOL	CONDITIONS	REF-08 MIN	REF-08 TYP	REF-08 MAX	UNITS
Output Voltage Adjustment Range	ΔV_{TRIM}	R_{TRIM} = 10kΩ	±270	±350	–	mV
Output Voltage Noise	$e_{n\,p\text{-}p}$	f = 2kHz to 10kHz, T_A = +25°C	–	75	–	$\mu V_{p\text{-}p}$
Line Regulation	LN_{reg}	V_{IN} = −11.4V to −36V	–	12	50	ppm/V
Load Regulation	LD_{reg}	I_{OUT} = 0 to 10mA, T_A = +25°C	–	10	25	ppm/mA
		T_{MIN} to T_{MAX}	–	15	50	

ELECTRICAL CHARACTERISTICS at V_{IN} = –15V, NO LOAD, SELECT = open circuit; –55°C ≤ T_A ≤ +125°C for the REF08BZ, and –40°C ≤ T_A ≤ +85°C for the REF08GZ/HP/HS, unless otherwise noted. *Continued*

CHARACTERISTIC	SYMBOL	CONDITIONS	REF-08 MIN	REF-08 TYP	REF-08 MAX	UNITS
Load Current (Into Pin 1)	I_{OUT}	(Note 2)	10	20	–	mA
Load Current (Out of Pin 1)	I_{OUT}	–10.04V ≤ V_O ≤ –9.96V	–0.1	–0.2	–	mA
Short-Circuit Output Current	I_{SC}		–	45	–	mA
Quiescent Supply Current	I_{SY}		–	1.1	2.0	mA

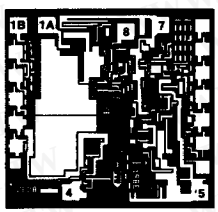
NOTES:

1. The REF-08BZ TCV_O is tested by measuring Output Voltage at –55°C and +125°C to guarantee the TCV_O limit. The REF-08GZ, HP, HS are tested by measuring Output Voltage at 25°C to guarantee the TCV_O limits. TCV_O is calculated by the end point method:

$$TCV_O = \frac{[V_O(T_{MAX}) - V_O(T_{MIN})]}{(10V)(10^{-6})(125°C)} \text{ in ppm/°C}$$

2. Guaranteed by Load Regulation Test.

DICE CHARACTERISTICS



DIE SIZE 0.066 x 0.065 inch, 4290 sq. mils (1.68 x 1.65mm, 2.77 sq. mm)

1A. V_{OUT}*
1B. V_{OUT}*
4. SELECT
5. GND
7. V_{IN}
8. TRIM

*** Pads 1A and 1B must be bonded together to V_{OUT}.**

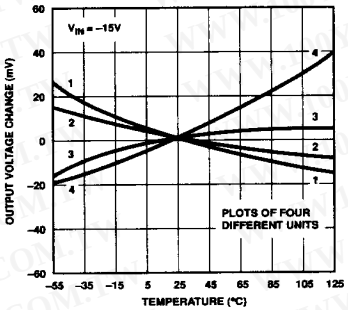
WAFER TEST LIMITS at V_{IN} = –15V, NO LOAD, SELECT = Open Circuit, T_A = 25°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	REF-08N LIMITS	UNITS
Output Voltage	V_O		–10.04 –9.96	V MIN V MAX
Output Voltage	V_O	SELECT = GND	–10.30 –10.18	V MIN V MAX
Line Regulation	LN_{reg}	V_{IN} = –11.4V to –16.5V	±50	ppm/V MAX
Load Regulation	LD_{reg}	Load Current = 0mA to 10mA	±25	ppm/mA MAX
Output Adjustment Voltage Range	V_{TRIM}	R_{TRIM} = 10kΩ	±270	mV MIN
Quiescent Supply Current	I_{SY}		2.0	mA MAX

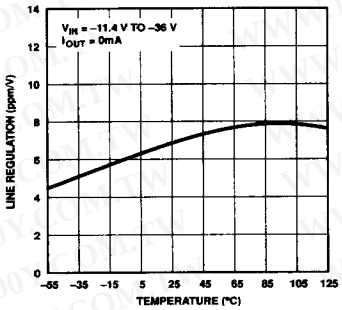
NOTE:
Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing.

TYPICAL ELECTRICAL CHARACTERISTICS

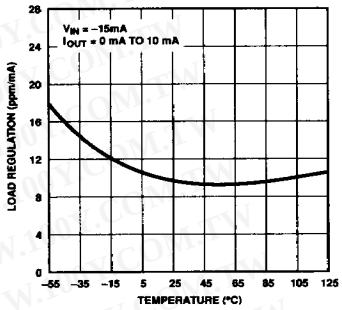
OUTPUT VOLTAGE CHANGE vs TEMPERATURE



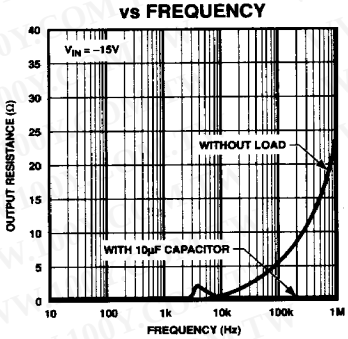
LINE REGULATION vs TEMPERATURE



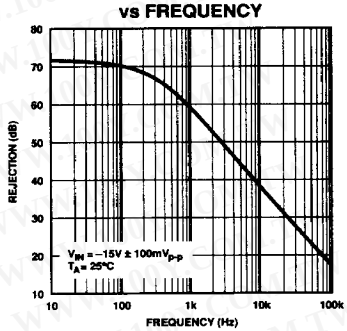
LOAD REGULATION vs TEMPERATURE



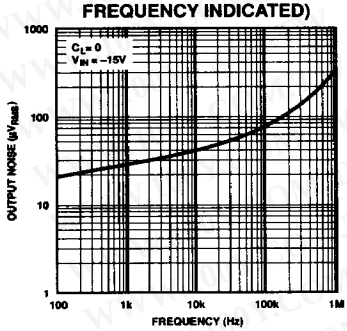
OUTPUT RESISTANCE vs FREQUENCY



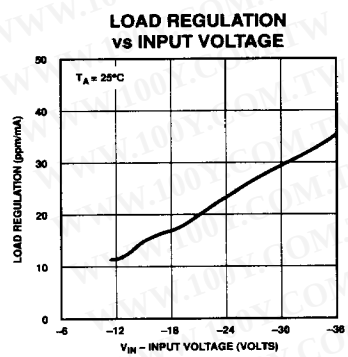
RIPPLE REJECTION vs FREQUENCY



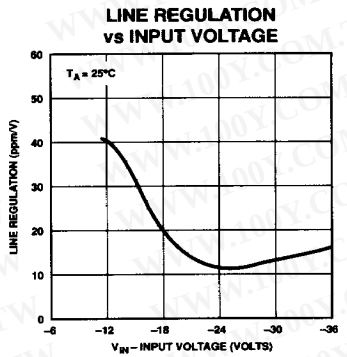
WIDEBAND NOISE vs FREQUENCY (10Hz TO FREQUENCY INDICATED)



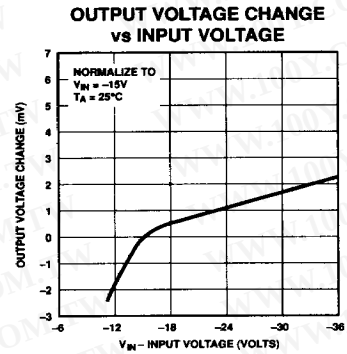
LOAD REGULATION vs INPUT VOLTAGE



LINE REGULATION vs INPUT VOLTAGE

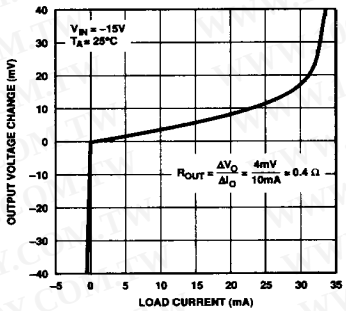


OUTPUT VOLTAGE CHANGE vs INPUT VOLTAGE

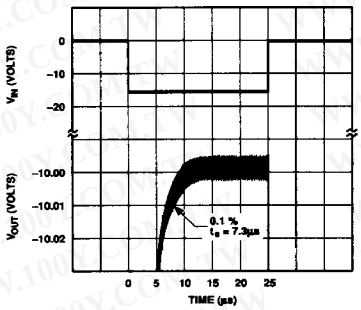


TYPICAL ELECTRICAL CHARACTERISTICS *Continued*

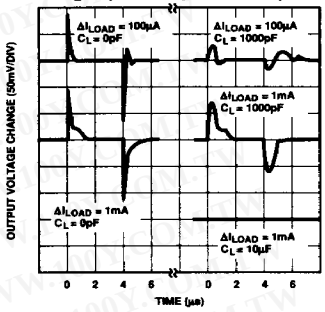
OUTPUT VOLTAGE CHANGE vs LOAD CURRENT



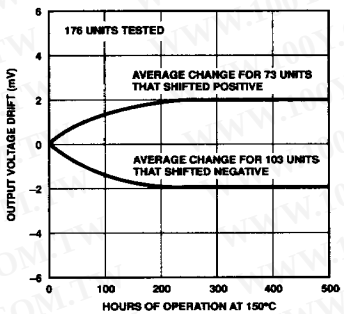
START-UP TIME



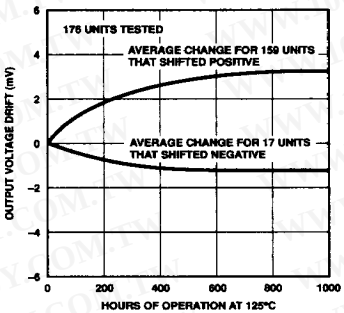
LOAD TRANSIENT RESPONSE C_L= 0pF, 1000pF, AND 10µF



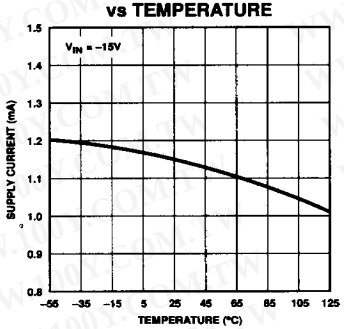
LONG TERM DRIFT ACCELERATED BY BURN-IN CERDIP PACKAGE



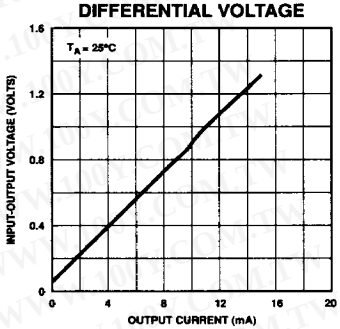
LONG TERM DRIFT ACCELERATED BY BURN-IN PLASTIC PACKAGES



SUPPLY CURRENT vs TEMPERATURE



MINIMUM INPUT-OUTPUT DIFFERENTIAL VOLTAGE



APPLICATIONS INFORMATION

The REF-08 provides a stable −10V output voltage with minimal dependence on load current, input voltage or temperature variations. This single package device works well as an absolute reference point in data conversion circuits, or in analog circuits such as logarithmic amplifiers, strain gauge bridge measurement systems, and power supply circuits. The REF-08 is especially applicable to CMOS data converter circuits that require −10V references.

BASIC CONNECTIONS

Figure 1 shows the connection diagram for the REF-08. For DC loads, no output capacitors are required. For high current load conditions Load Regulation needs consideration. The REF-08 load regulation of 25ppm/mA equates to 0.25Ω of output resistance. To maintain accurate distribution of the reference output voltage to the rest of the system, wiring resistances must be kept as small as is practical.

For dynamic loads the addition of C_O reduces high frequency output resistance which is shown in the R_{OUT} vs. frequency graphs in the typical performance characteristics. This is generally important with A/D converters that have a continuously changing load.

In the typical performance characteristics graph section, the Load Transient response plot shows a 1µs recovery time to a 1mA load current change which is representative of several typical CMOS A/D converters. Choosing the 0.01µF in parallel with a 10µF capacitor for C_O adequately reduces the reference output voltage transient amplitude.

One refinement to further reduce the reference voltage output transient is introduction of R_O in series with the output filter capacitors. R_O should be chosen equal to $1/2\pi C_O f_P$ where C_O is the total output filter capacitance and f_P is the frequency in the R_{OUT} vs. frequency plot at which the peak value of R_{OUT} occurs. This extra resistance, R_O, effectively damps the circuit resonance further reducing the voltage transient during output load changes.

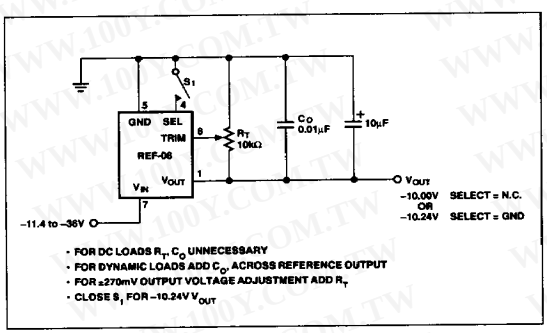


FIGURE 1: *Connection Diagram*

OUTPUT VOLTAGE ADJUSTMENT

Output voltages within ±270mV of nominal can easily be obtained by addition of the 10k Trimpot*. This range adequately addresses the full-scale adjustment ranges required by CMOS A/D and D/A converters. The effect on the REF-08 output voltage temperature coefficient is a low 0.04ppm/°C per mV of adjustment.

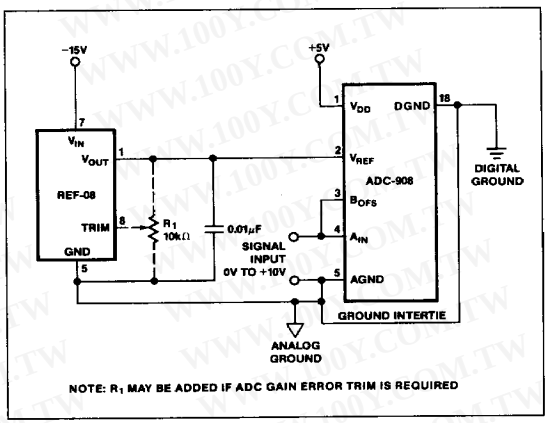


FIGURE 2: *−10V Reference for 8-Bit CMOS Analog-to-Digital Converter*

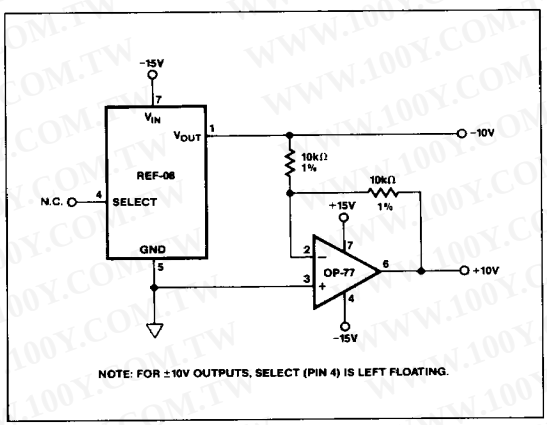


FIGURE 3: *±10V Reference*

*Trimpot is a registered trademark of Bourns, Inc.

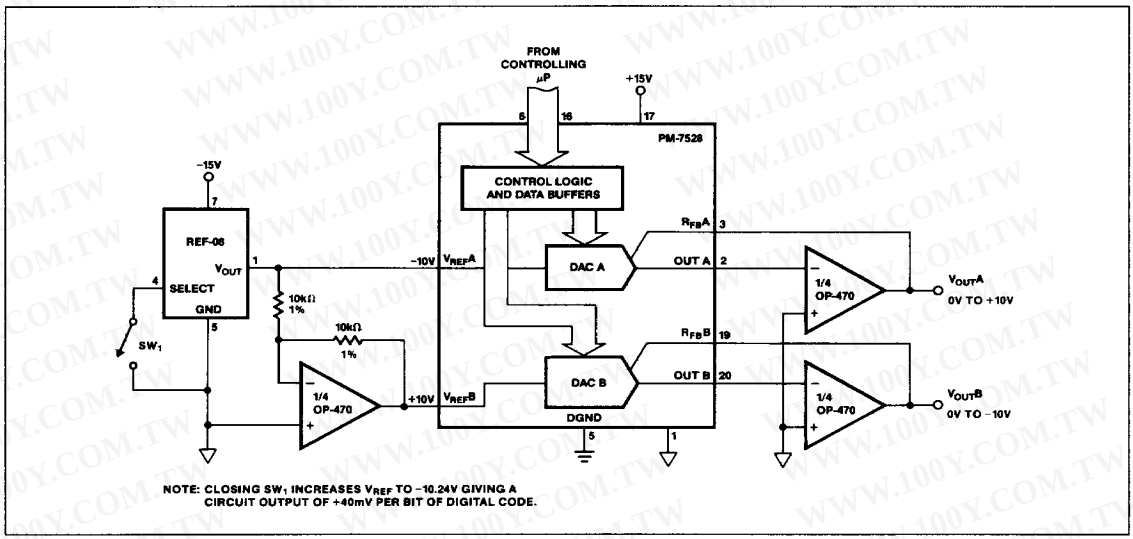


FIGURE 4: *8-Bit Resolution, Dual Output "No-Trim" DAC with 0V to +10V and 0V to −10V Outputs*

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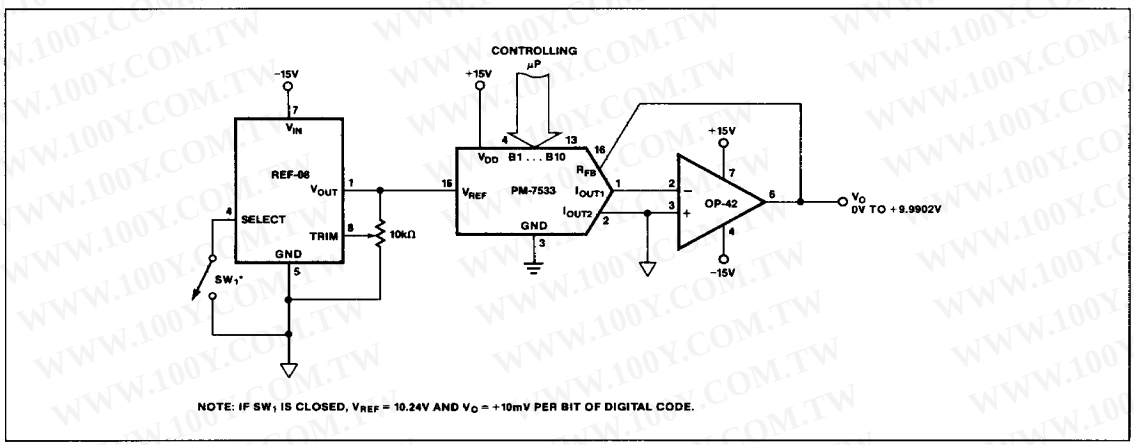

FIGURE 5: *10-Bit CMOS DAC with 0V to +10V Output*

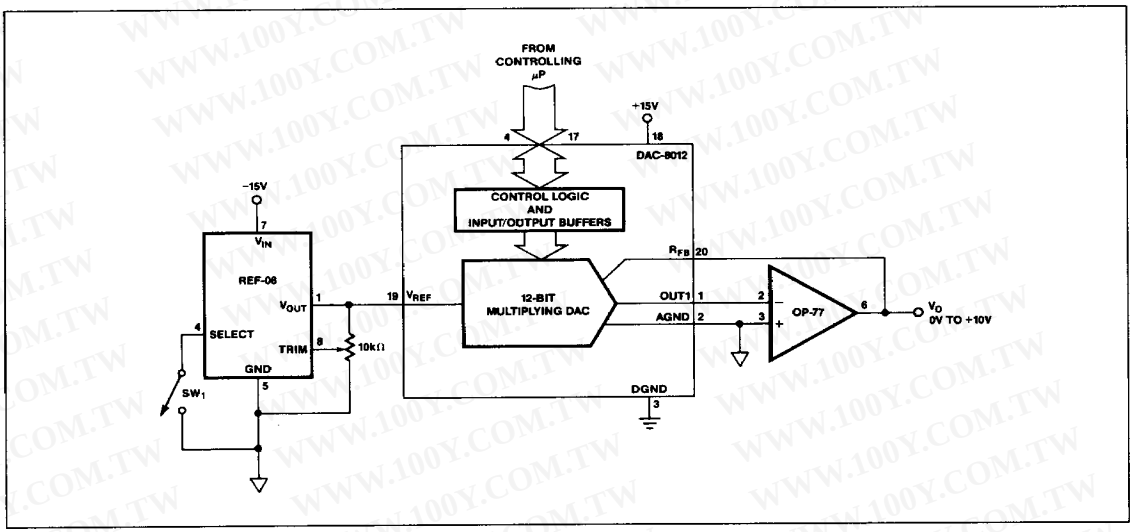

FIGURE 6: *12-Bit CMOS DAC with 0V to 10V Output*

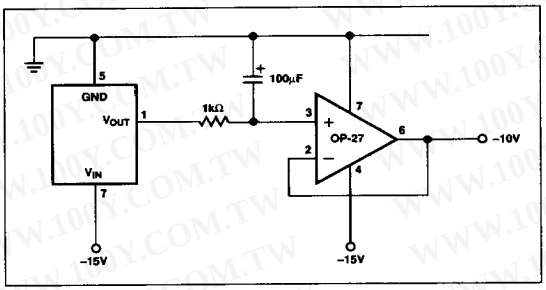

FIGURE 7: *Precision Reference with Filtering*