NEC
NEC Electronics Inc.

μPC6012 12-BIT HIGH-SPEED MULTIPLYING D/A CONVERTER

Description

The μPC6012 monolithic multiplying digital-to-analog converter is designed to set new standards of speed and accuracy for 12-bit converters. This device is the first 12-bit DAC to use standard processing without the need of thin film resistors and/or active trimming of individual devices. The μPC6012 features high voltage compliance, and high impedance dual complementary outputs, which enable differential operation to effectively double the peak-to-peak output swing. The outputs can be used without op-amps in many applications.

Features

- Differential nonlinearity to ±0.025% FS max
- Fast setting time: 400 ns typical
- Full scale current 4 mA
- High output impedance and compliance: −5 to +10 V
- Differential current output
- High speed multiplying capability
- Direct interface to TTL, CMOS, ECL, HTL, NMOS
- Am6012 direct replacement

Ordering Information

Part Number	Package	Operating Temperature Range
μPC6012C	Plastic DIP	0°C to −70°C

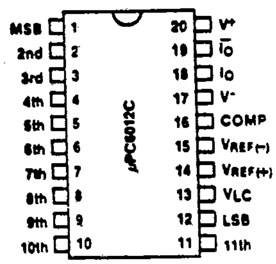
Absolute Maximum Ratings

$T_A = 25°C$

Power Supply Voltage Range, $V^{+} - V^{-}$	36 V
Logic Input Voltage Range, $V^{=}$	−5 to −18 V
Output Voltage Range, V_O	−8 to +12 V
Reference Input Voltage Range, V^{-}_{REF}	V− to V−
Reference Input Differential Voltage Range, $V^{+}_{REF} - V^{-}_{REF}$	±18 V
Reference Input Current Range, I_{REF}	0 − 1.25 mA
Total Power Dissipation, P_T	500 mW
Operating Temperature Range	0 to +70°C
Storage Temperature Range	−55 to +125°C

Comment: Stress above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Pin Configuration

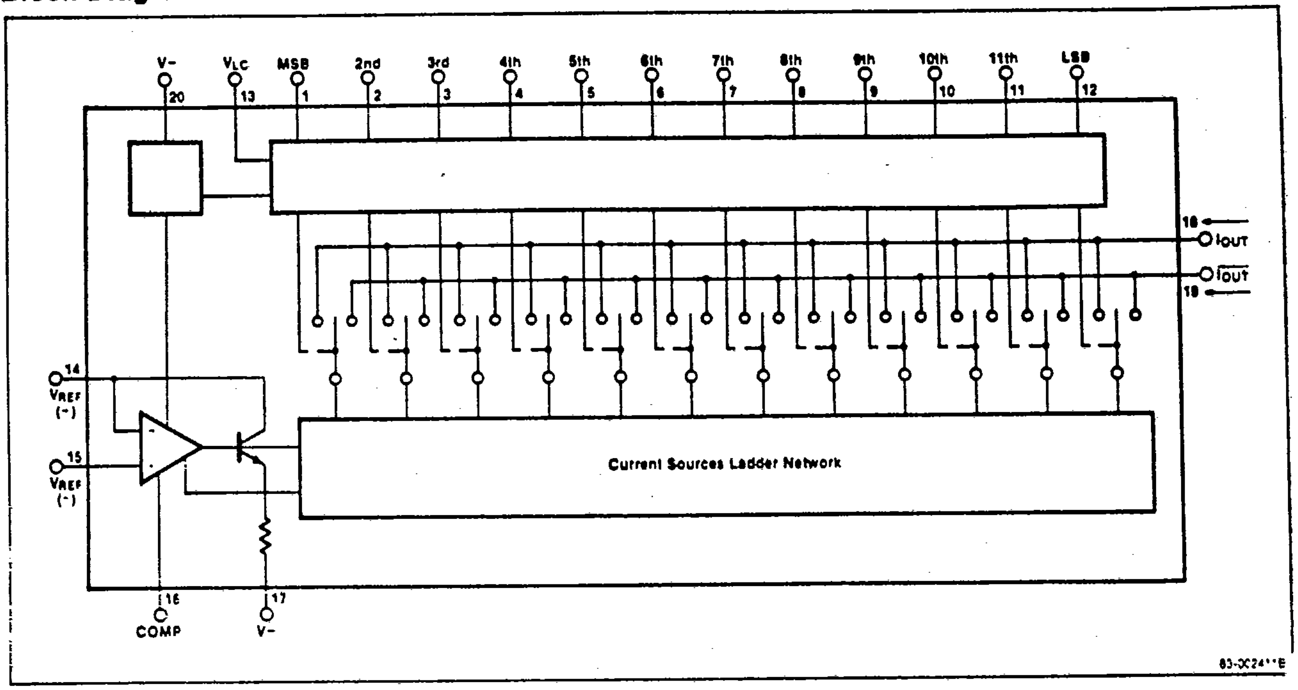


83-0024*2A

Pin Identification Table

Pin	Name	Function
1	MSB	Data Bit 1
2	2nd	Data Bit 2
3	3rd	Data Bit 3
4	4th	Data Bit 4
5	5th	Data Bit 5
6	6th	Data Bit 6
7	7th	Data Bit 7
8	8th	Data Bit 8
9	9th	Data Bit 9
10	10th	Data Bit 10
11	11th	Data Bit 11
12	LSB	Data Bit 12
13	V_{LC}	Threshold Control
14	V_{REF+}	Positive Reference Voltage
15	V_{REF-}	Negative Reference Voltage
16	Compensation	Amp Compensation
17	V− Supply	Negative Supply Voltage
18	I_O	Current Out +
19	$\overline{I_O}$	Current Out −
20	V+ Supply	Positive Supply Voltage

Block Diagram



Recommended Operating Conditions

Parameter	Symbol	Limits Min.	Typ.	Max.	Unit	Test Conditions
Power Supply Voltage	V^+	+4.5	+15		V	
	V^-		−15	−10.8	V	
Ambient Temperature	T_A	0	+25	+70	°C	
Reference Input Current	I_{REF}	0.2	1.0	1.1	mA	
High Level Input Voltage	V_{IH}	+2.0		+18	V	$V_{LC} = 0$ V
Low Level Input Voltage	V_{IL}	−5.0		+0.8	V	$V_{LC} = 0$ V
Output Voltage Compliance	V_{OC}	−5.0	0	+10	V	DNL ≤ ±0.025% FSR

Electrical Characteristics

$T_A = 0$ to 70°C, V± = ±15 V, I_{REF} − 1.0000 mA

Parameter	Symbol	Limits Min.	Limits Typ.	Limits Max.	Unit	Test Conditions
Resolution		12	12	12	Bit	
Monotonicity		12	12	12	Bit	
Differential Nonlinearity	DNL			±0.025	%FSR	
Nonlinearity	NL			±0.05	%FSR	
Full Scale Output Current	I_{FS}	3.935	3.999	4.063	mA	V_{REF} = 10.000 V, T_A = 25°C, $R_{14} = R_{15}$ = 10.000 kΩ
Full Scale Temperature Coefficient	$\frac{\Delta I_{FS}}{I_{FS} - \Delta T}$			±40	ppm/°C	
Full Scale Symmetry	$I_{FS} - I_{FS}$			±2.0	μA	
Zero Scale Current	I_{ZS}			0.10	μA	
Settling Time	t_s		400		ns	½ LSB, T_A = 25°C, all bits ON or OFF
Propagation Delay	t_{PLH}, t_{PHL}			50	ns	50% to 50%
Output Capacitance	C_O		35		pF	
Logic Input Current	I_{IN}			40	μA	−5 V < V_I < +18 V
Reference Bias Current	I_{b-}			−2.0	μA	
Reference Input Slew Rate	$\Delta I_{REF}/\Delta t$	4.0	8.0		mA/μs	C_C = 0, R_{14} = 800 Ω
Supply Voltage Rejection Ratio	SVRR−			±0.001	%FSR/%	V− = −13.5 to −16.5 V, V− = −15 V
	SVRR−			±0.001	%FSR/%	V− = +13.5 to −16.5 V, V− = −15 V
Power Supply Current	I^-1			8.5	mA	V^- = +5 V
	I^-1			−18.0	mA	V^- = −15 V
	I^-2			8.5	mA	V^- = +15 V
	I^-2			−18.0	mA	V^- = −15 V
Power Dissipation	P_{D1}			312	mW	V^+ = +5 V, V^- = −15 V
	P_{D2}			397	mW	V^+ = +15 V, V^- = −15 V

Typical Applications

There is a 1 to 4 scale factor between the reference current (I_{REF}) and the full scale output current (I_{FS}).

If $V_{REF} = +10$ V and $I_{FS} = 4$ mA, the value of the R_{REF} is:

$$R^{+}_{REF} = \frac{4 \times 10\ V}{4\ mA}$$

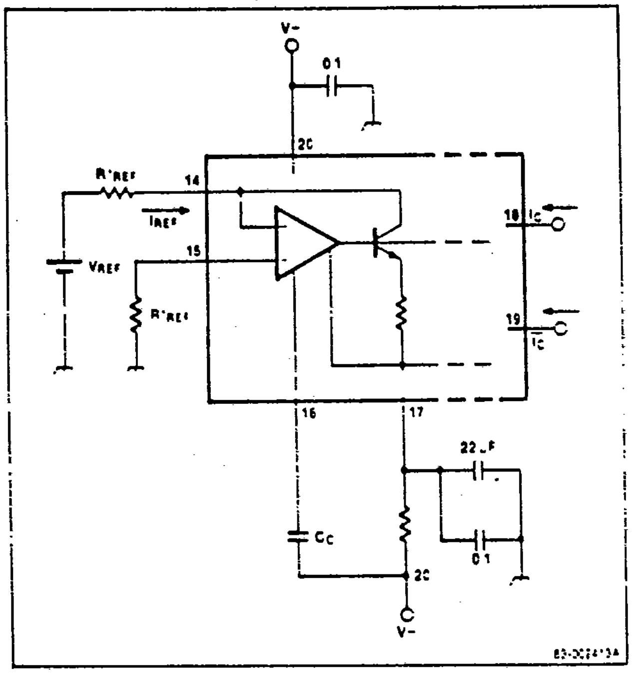
$$R^{+}_{REF} = R^{-}_{REF}$$

The compensation capacitor is a function of the impedance seen at the $+V_{REF}$ input and is determined by the following expression:

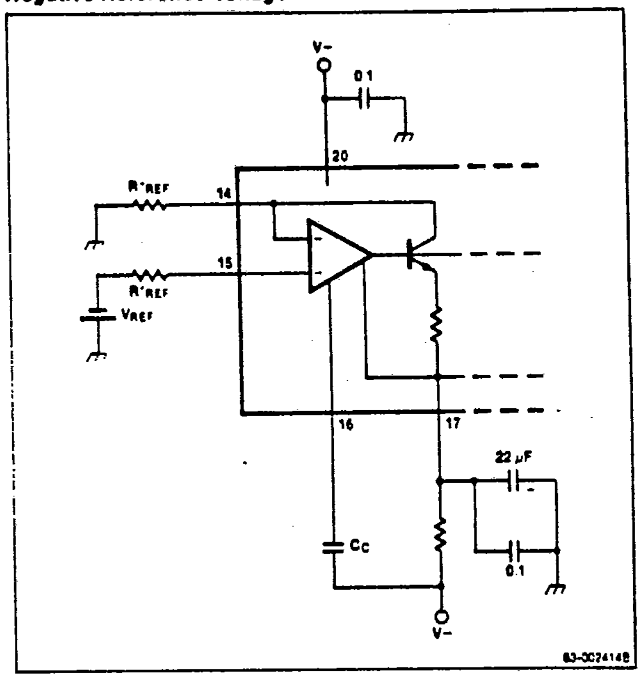
$C = (5\ pF)\ (R^{+}_{REF\ (k\ \Omega)})$.

For $R_{14} < 800\Omega$, no capacitor is necessary.

Positive Reference Voltage

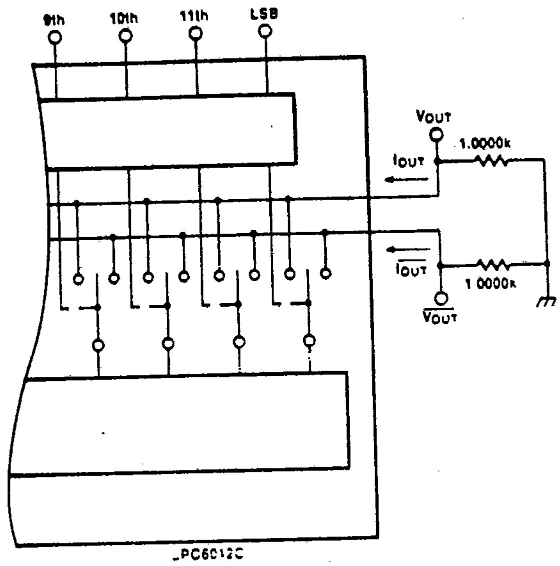


Negative Reference Voltage



Typical Applications (Cont.)

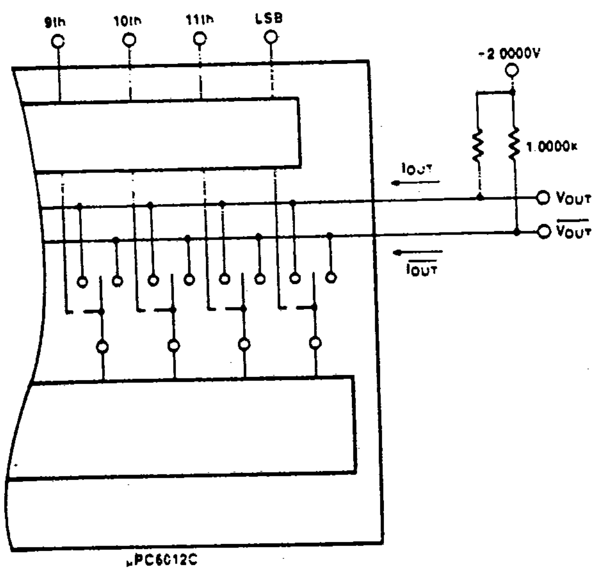
Unipolar Negative Output



I_{REF} = 1.0000 mA

Input Code MSB LSB	I_O (mA)	$\overline{I_O}$ (mA)	V_O (V)	$\overline{V_O}$ (V)
1 1 1 1 1 1 1 1 1 1 1 1	3.999	0.000	−3.999	0.000
1 1 1 1 1 1 1 1 1 1 1 0	3.998	0.001	−3.998	−0.001
1 0 0 0 0 0 0 0 0 0 0 0	2.000	1.999	−2.000	−1.999
0 0 0 0 0 0 0 0 0 0 0 1	0.001	3.998	−0.001	−3.998
0 0 0 0 0 0 0 0 0 0 0 0	0.000	3.999	0.000	−3.999

Bipolar Output

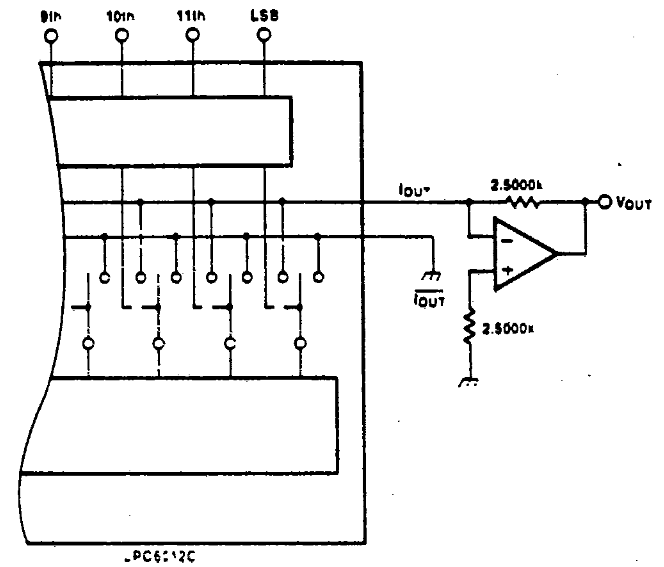


I_{REF} = 1.0000 mA

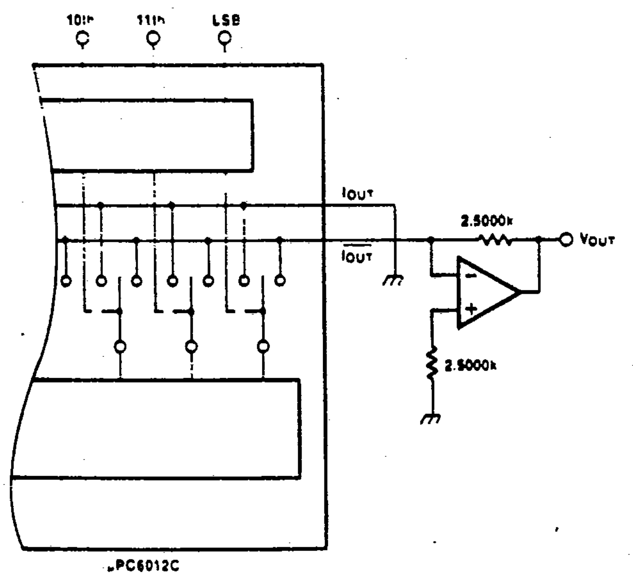
Input Code MSB LSB	I_O (mA)	$\overline{I_O}$ (mA)	V_O (V)	$\overline{V_O}$ (V)
1 1 1 1 1 1 1 1 1 1 1 1	3.999	0.000	−1.999	+2.000
1 1 1 1 1 1 1 1 1 1 1 0	3.998	0.001	−1.998	+1.999
1 0 0 0 0 0 0 0 0 0 0 1	2.001	1.998	−0.001	+0.002
1 0 0 0 0 0 0 0 0 0 0 0	2.000	1.999	0.000	+0.001
0 1 1 1 1 1 1 1 1 1 1 1	1.999	2.000	+0.001	0.000
0 0 0 0 0 0 0 0 0 0 0 1	0.001	3.998	+1.999	−1.998
0 0 0 0 0 0 0 0 0 0 0 0	0.000	3.999	+2.000	−1.999

Typical Applications (Cont.)

Unipolar Positive Output (Straight Binary)



Unipolar Negative Output (Complementary Binary)



Typical Applications (Cont.)

Symmetrical Offset