**MP1814**High Performance
General Purpose**14-Bit D/A CONVERTER****GENERAL DESCRIPTION**

The Analogic MP1814 is a premium quality digital-to-analog converter which provides genuine 14-bit resolution, linearity, and stability at only slightly more than 12-bit prices. Every contributing element to the MP1814 Error Budget has been designed and engineered to provide a converter that meets the requirements for economical, high-speed, accurate, and stable 14-bit resolution in high-precision, wide-dynamic-range applications.

PERFORMANCE ACHIEVEMENTS

The MP1814 incorporates high-speed, thermal tracking, monolithic voltage switches; precise, ultra-stable, network resistors; and a reference source servoed to an aged, temperature-compensated precision reference Zener for accurate, stable operation over wide temperature ranges. The MP1814 also includes a high speed voltage amplifier that slews at 10V/ μ sec and supports the throughput settling time of less than 15 μ sec for conversion to within $\pm 0.005\%$ of a full 20-volt step.

The versatile MP1814 provides the user with pin-selectable full scale ranges of $\pm 10V$, $\pm 5V$, $+10V$, and $+5V$ analog outputs for computer-compatible binary or offset binary input data codes.

The MP1814 small size (2" x 2"), low profile (0.375"), metal case provides RFI and EMI shielding, and encloses a repairable assembly that includes high-quality power supply by-pass capacitors to prevent power supply transients from interfering with conversion performance.

APPLICATIONS

The Analogic MP1814 provides a capability for instrumenting true 14-bit information translation systems at hitherto unobtainable economy. When combined with other Analogic system-compatible modules, the MP1814 delivers value-added accuracy for instrumenting a multitude of wide-dynamic range display and control systems at significantly less cost than that of available instrumentation for comparable performance.

FEATURES

- True 14-bit Accuracy and Linearity
- Maximum Interface Compatibility
 - ... Selectable $\pm 10V$, $\pm 5V$, $+5V$, $+10V$ Output Voltage
 - ... Positive True Logic Input Coding (TTL Compatible)
- High Speed
 - ... 15 μ sec max to 0.005% of 20-volt step
- Separate Digital and Analog Grounds
 - ... Up to 250mV potential difference
- Guaranteed Monotonicity
 - ... Differential Linearity within 0.003%
 - ... Tempco of Differential Linearity 1ppm/ $^{\circ}C$ typ
- Low Profile
 - ... 0.375" high metal shielding case

APPLICATIONS

- Wide Dynamic Range, Computer Controlled, Industrial Processes
- High Precision CRT Display Systems
- Automated Test Instrumentation
- Waveform Synthesis and Recovery
- High Resolution Information Translation Systems
- Programmable Control Instrumentation (Gain, Offset, etc.)
- High Resolution Oscillographic Recordings

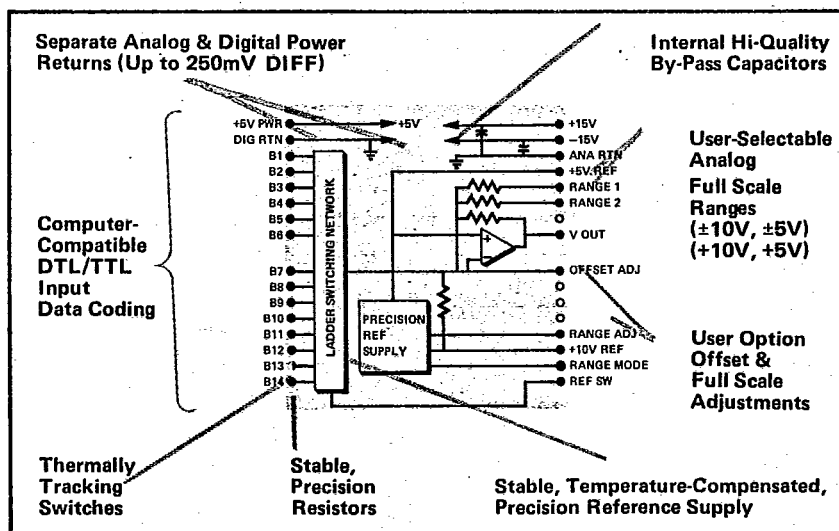


Figure 1. MP1814 Functional Block Diagram

ANALOGIC

... The Digitizer

MP1814 SPECIFICATIONS

DIGITAL INPUTS

No. of Bits	14
Coding	Binary, Offset Binary Positive "TRUE" Logic
Compatibility	1TTL/Bits 2-14; 2TTL/MSB-1

ANALOG OUTPUT

Full Scale Ranges	$\pm 5V$, $\pm 10V$, $+5V$, $+10V$
Impedance	$< 0.1\Omega$ (DC)
Maximum Load	$2K\Omega \parallel 1000pF$ for rated settling time

INTERNAL REFERENCE OUTPUT

Voltage	$+10V$, $+5V$
Impedance	$< 0.1\Omega$

SPEED

Settling Time	$10\mu\text{sec}$ typ., $15\mu\text{sec}$ max for 20-V step to 0.005%
Slew Rate	$10V/\mu\text{sec}$

ACCURACY

Absolute Accuracy	$\pm 0.006\%$ FSR*
Linearity	$\pm \frac{1}{2}$ LSB ($\pm 0.003\%$ FSR)
Differential Linearity	$\pm \frac{1}{2}$ LSB ($\pm 0.003\%$ FSR)
Zero Offset	Adjustable to zero

*Adjustable to $\pm 0.003\%$ with proper adjustment of external trim pots.

STABILITY

Diff. Linearity Tempco	$1\text{ppm}/^\circ\text{C}$ typ., $3.0\text{ppm}/^\circ\text{C}$ max
Range (Gain) Tempco	$7\text{ppm}/^\circ\text{C}$ typ., $10\text{ppm}/^\circ\text{C}$ max
Zero Offset Tempco	
Unipolar	$5\text{ppm}/^\circ\text{C}$ typ., $7.5\text{ppm}/^\circ\text{C}$ max
Bipolar	$7\text{ppm}/^\circ\text{C}$ typ., $10\text{ppm}/^\circ\text{C}$ max
Noise	$\pm 0.005\%$ FSR p-p (3 σ)
Power Supply Sensitivity	$\pm 0.0005\%$ P.S. Change, nominal
Warm Up Time	5 minutes

POWER SUPPLY GROUNDS

Separate Analog and Digital Grounds; 250mV max allowable difference of potential

POWER REQUIREMENTS

$+15V \pm 3\%$	34mA max + Load
$-15V \pm 3\%$	30mA max + Load
$+5V \pm 5\%$	35mA max + Load

ENVIRONMENTAL AND PACKAGING

Operating Temp.	0° to 70°C
Relative Humidity (Non-condensing)	5% to 95%
Size	2" x 2" x 0.375"
Shielding	RFI 6 sides, EMI 5 sides
Storage Temp.	-25°C to $+85^\circ\text{C}$

COMMENTARY

The trend toward increased resolution in Information Translation and Data Acquisition Systems has created increased demand for 14-bit converters. Until now, most available 14-bit digital-to-analog units have demonstrated poor PERFORMANCE/COST ratios. That is, relatively low-cost 14-bit units have been "extended-bit 12-bit units" and yield 14-bit performance in name only. On the other hand, until the availability of the Analogic MP1814, true 14-bit conversion modules have been offered at only slightly less cost than the very high-priced 15-16-bit converters. Thus, the system designer has been faced with a cost-performance dilemma.

True 14-bit performance within 1 LSB implies a total ERROR BUDGET which does not exceed 0.006% (or 60ppm) of full scale. Clearly, merely adding two least significant input control bits (and appropriate resistor network elements) to a 12-bit unit to provide 14-bit input switching does not improve the 12-bit performance.

The specifications of many 14-bit converters, that are offered at moderate prices, may appear to provide 14-bit performance,

but, on closer scrutiny, reveal their 12-bit limitations. For example, a differential linearity specification of $\pm 0.005\%$ FSR and a differential linearity stability of $5\text{ppm}/^\circ\text{C}$ provide excellent 12-bit performance (where 0.025% FSR is 1 LSB). However, when these performance specifications are carried over for the nominal 14-bit converter, they are marginal at best. An error of 0.005% (50ppm) is 80% of an LSB, and very little temperature shift (only 2°C) at $5\text{ppm}/^\circ\text{C}$ will introduce significant errors, inducing missing codes in the conversion. For the MP1814, the initial differential linearity accuracy of 0.003% (30ppm) allows a temperature variation of 30°C for the typical differential linearity temperature coefficient and 10°C for the maximum temperature coefficient. In addition, the MP1814 specifications are presented without any reservations, such as the phrase "typical @ 25°C " that appears on a number of competitor data sheets.

Obviously, it is a simple matter to eliminate one or two of the input data bits of a 15 or 16-bit digital-to-analog converter, to obtain a 14-bit unit. Furthermore it may be possible to reduce or omit some in-process and final test and calibration procedures, thereby reducing the cost somewhat. One may thus obtain a 14-bit converter, but at a high price!

APPLICATION DATA

CALIBRATION

Linearity and relative accuracy for 14-bit performance are designed in. Absolute accuracy calibration may be set externally as shown in Figure 2 and described below.

Offset Adjustment

The analog output is adjusted for zero, or other desired offset, by connecting R1 (10-turn 20kohm potentiometer) and R3 (2 megohms) as shown in Figure 2. Use thermally stable components of 50ppm/°C or better, and keep the connection leads as short as possible to maintain the MP1814 performance integrity of 14-bit conversion.

After making the required connections, (Table 2) apply the appropriate "ZERO" code (See Table 1), and adjust R1 for 0.0000 volts output.

Range Adjustment

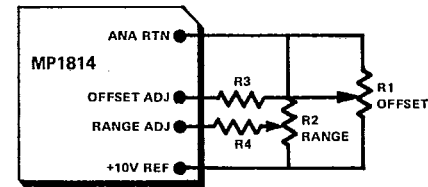
The MP1814 analog output may be calibrated for the desired full scale range by connecting R2 (10-turn 20kohm potentiometer) and R4 (1 megohm) as shown in Figure 2. (See stability and lead length requirements described above.) Apply the full scale code as indicated in Table 1, and adjust R2 for the appropriate full scale voltage output.

AN1814M (CARD-MOUNTED MP1814)

Analogic's AN1814M is a complete digital-to-analog converter in a standard PC-card configuration. It includes the low-profile MP1814 Modupac and the calibration circuitry as described earlier, instrumented with precise, stable resistance elements to maintain the accuracy and stability of 14-bit performance.

The AN1814M may be ordered with storage registers (AN1814ML) for increased versatility in user information translation systems. The registers perform a parallel-to-parallel bit transfer under control of a transfer STROBE signal. When the STROBE goes HIGH, the input data bits are transferred through the registers to the MP1814 inputs. Input loading of each bit is 1 unit load (TTL 40μA high and 1.6mA low), while the STROBE loading is 2 unit loads. Timing relationships for changing data input bits and STROBE are shown in Figure 3.

The 1814ML terminals are configured so that data inputs may be connected directly to the MP1814, even when the registers are not installed.



R1, R2 = 20KΩ (10 TURNS)
R3 = 2MΩ ±5%
R4 = 1MΩ ±5%

Figure 2. Connecting External Adjustment Potentiometers for MP1814 OFFSET and RANGE

CODE	UNIPOLAR (Binary)		BIPOLAR (Offset Binary)	
	0 to +10V	0 to +5V	±10V	±5V
111 111 111 11 11	9.9994	4.9997	9.9988	4.9994
100 000 000 000 00	5.0000	2.5000	0.0000	0.0000
000 000 000 000 01	0.0006	0.0003	-9.9988	-4.9994
000 000 000 000 00	0.0000	0.0000	-10.0000	-5.0000

Table 1. MP1814 Coding Translation Table

FOR FSR ↓	CONNECT		
	RANGE MODE TO ↓	RANGE 1 TO ↓	RANGE 2 TO ↓
±10V	REF SW	+5V REF	ANA RTN
±5V	REF SW	+5V REF	V _{OUT}
+10V	ANA RTN	ANA RTN	V _{OUT}
+5V	ANA RTN	V _{OUT}	V _{OUT}

Table 2. Connection Matrix for Full Scale Outputs

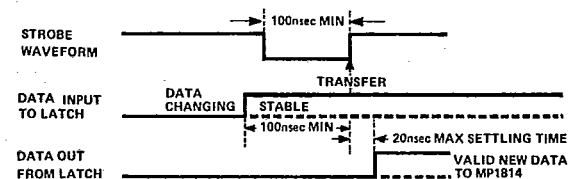


Figure 3. Strobe and Data Input Timing

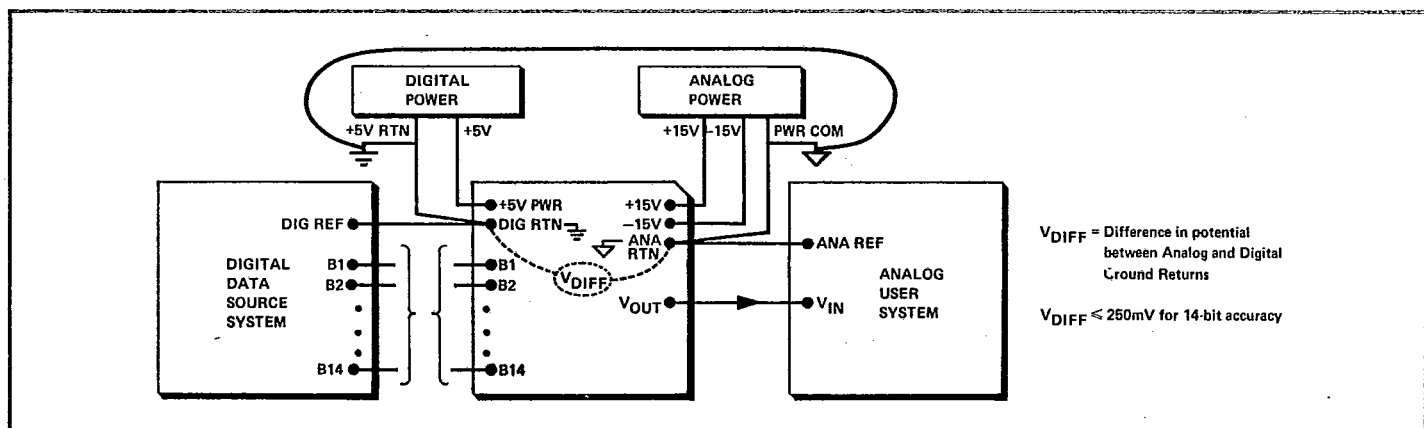


Figure 4. MP1814 in System Configuration, showing Connections of Data Inputs, Analog Output, and Power Sources. Connect Analog Power Return to Digital Power Return as shown (with short, heavy duty conductor) to keep Digital IR Transients from ANA Signal.

ORDERING GUIDE

Simply Specify

For
14-Bit Modupac
MP1814 on P.C. card

Enter
MP1814
AN1814M* — ☐ — ☐

For FS Range

0 to +10V
-10V to +10V
-5V to +5V
0 to +5V

Enter

1
2
3
4

For Input Code

Binary or Offset Binary

Enter

A
C
D

** { 1's Complement } AN Version Only
 { 2's Complement }

*Includes OFFSET and RANGE ADJ potentiometers. To include optional latches, add "L" to basic part number.

For Example

AN1814ML-2-C is a card-mounted MP1814 with input storage latches; connected for $\pm 10V$ full scale range and 1's complement input code.

**NOTE: To configure MP version for a 1's complement or 2's complement input, MSB must be inverted. When ordering AN types, inversion is included on P.C. Card.

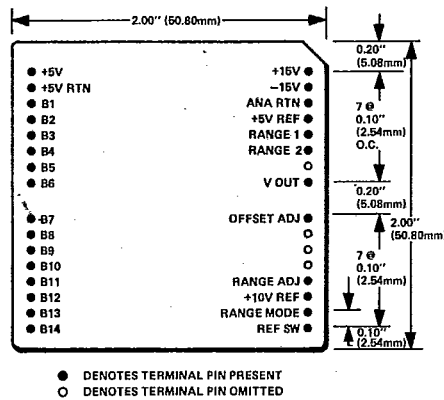
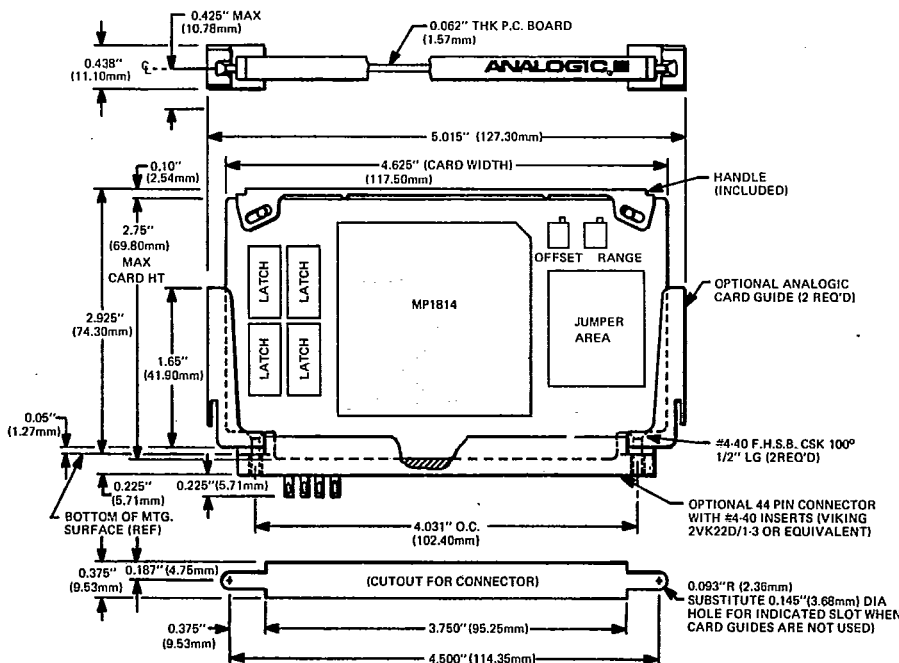


Figure 5. MP1814 Outline Dimensions

OUTLINE DRAWING



PIN DESIGNATIONS

+5V REF	A	1	+10V REF
	B	2	STROBE**
	C	3	
	D	4	
*B14 OUT	E	5	B14 IN
*B13 OUT	F	6	B13 IN
*B12 OUT	H	7	B12 IN
*B11 OUT	J	8	B11 IN
*B10 OUT	K	9	B10 IN
*B9 OUT	L	10	B9 IN
B8 IN	M	11	+5V IN
*B8 OUT	N	12	+5V RTN
*B7 OUT	P	13	B7 IN
*B6 OUT	R	14	B6 IN
*B5 OUT	S	15	B5 IN
*B4 OUT	T	16	B4 IN
*B3 OUT	U	17	B3 IN
*B2 OUT	V	18	B2 IN
ANA RTN	W	19	ANA RTN
*B1 OUT	X	20	-15V
(MSB)B1 IN	Y	21	+15V
DAC OUT	Z	22	DAC OUT

*LATCH OUTPUTS, use as Direct Inputs if LATCH Register is not installed

**Data Transfer control signal, see Fig. 6.

Figure 6. AN1814 Outline Drawing, Mounting Dimensions and PC-Board Edge Connector.

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