



ANALOGIC

MP8037

17-Bit, Moderate Speed
Triple-Slope Integrating
A/D Converter

Description

Analogic's MP8037 is a ultra-high resolution, integrating A/D converter that provides exceptional performance in a smaller size and at a lower cost than previously available. The MP8037 is the first integrating converter to offer true 17-bit resolution. Its conversion speed of 250 conversions per second and TTL compatibility make it ideal for universal interfacing with the high precision data acquisition and control systems used in industrial, analytical and environments.

Performance Features

The MP8037 features an innovative quadruphasic triple-slope integrating conversion design that completes the 17-bit conversion, including autozero, in 4.0 ms maximum. The MP8037 automatically autozeros whenever it is in the standby mode, guaranteeing accurate conversions each and every time by effectively eliminating internal drifts. MP8037 relative accuracy (linearity), stability, and differential linearity are consistent with the unit's high 0.00075% FSR resolution. Absolute accuracy traceable to NBS standards is factory set to $\pm 0.005\%$ FSR and is adjustable to within $\pm 0.002\%$ FSR. Integral linearity within $\pm 0.00075\%$ FSR, differential linearity of $\pm 0.00025\%$ FSR, which guarantees monotonicity, assure meaningful 17-bit information.

Features

- **Ultra-high Resolution**
17 bits (16 data, 1 polarity)
- **High Speed**
Up to 250 conversions/second
External trigger control
- **Small Size**
Standard 2 x 4" Modupac™
- **High Accuracy & Stability**
Linearity error <7.5 ppm FSR
Auto-stabilized Zero
- **High Differential Linearity**
 ± 2.5 ppm FSR
- **Guaranteed Monotonicity**
- **True Ratio Measurements**
Pin-programmable precision internal reference
Or user supplied external reference
- **Low Input Current**
50 nA @ 100 conversions/second
- **High Input Impedance**
1000 M Ω , minimum
50 pF, maximum
- **Universal Data Systems Compatibility**
Data fanout for 2 TTL loads

Applications

- Precision Chemical Process Control Systems
- Digital Signal Processing Systems
- High Resolution Monitoring and Control Systems
- Precision Pharmaceutical Mixing & Grading Systems
- High Resolution Laboratory and R & D Systems
- Gas Chromatography
- Analytical Instrumentation

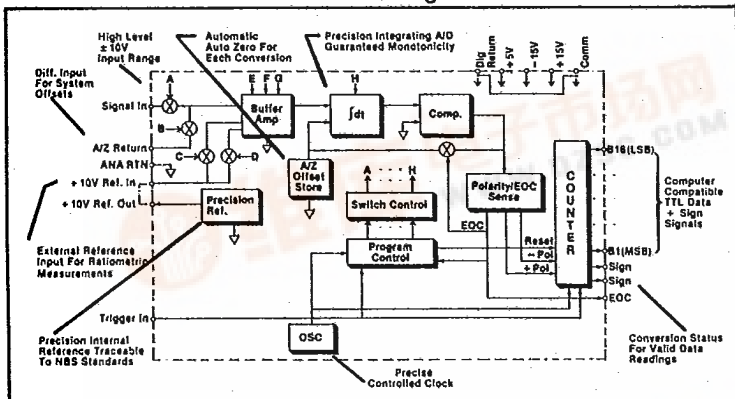


Figure 1. MP8037 Block Diagram.

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SPECIFICATIONS

T-51-10-90

(All specifications guaranteed at 25°C unless otherwise noted)

ANALOG

Input Configuration
Differential (See Figure 4)

Input Range (Operating)
± 10V max.*

Input Range (Without Damage)
± 15V max.

Input Impedance
1000 MΩ min., 50 pF max.

Input Current
50 nA @ 100 conversions/second

Input Integration Time
640 μs*

ACCURACY (@ 25°C ± 5°C)

Relative Accuracy
± 7.5 ppm FSR max.

Differential Linearity
± 2.5 ppm FSR max.

Resolution
16 bits and sign

Noise
15 μV rms

Absolute Accuracy
± 0.005% FSR, without adjustment; ± 0.0027 FSR, adjusted

STABILITY

Zero Tempco
± 6 μV/°C max.

Gain Tempco
± 10 ppm/°C max.

CONVERSION

Technique
4-phase, triple slope integrating analog-to-digital conversion, autozeroed before each conversion

Rate
250 conversions per second, max., controlled by external command

SYSTEM INPUTS

External Trigger
0.1 μs min., negative pulse, TTL compatible, must drive 6 loads; 3 CMOS and 3 low-powered Schotky. Conversion starts on positive transition. See Figure 2

*Other values of Input Full Scale Range, Conversion Rate, or Integration Time are available on special order. Consult Factory.

DIGITAL OUTPUTS

Data Output
16 data bits, SIGN, and $\overline{\text{SIGN}}$

EOC
High level indicates conversion is in process; low level indicates outputs are valid. Allow 10 ns delay from EOC high to low transition before reading data

Compatibility
1 LS load each for 16 data bits; 2 TTL loads each for SIGN, $\overline{\text{SIGN}}$, and EOC

Code Format
Sign and absolute value

POWER SUPPLY

+ 5 Vdc ± 5%
200 mA, typ.

+ 15 Vdc ± 3%
20 mA, typ.

- 15 Vdc ± 3%
16 mA, typ.

ENVIRONMENTAL & MECHANICAL

Operating Temperature
0°C to 70°C

Storage Temperature
- 25°C to + 85°C

Relative Humidity
0 to 95%, non-condensing

Modupac™ Dimensions
2 x 4 x 0.440 in., (50.8 x 101.6 x 111.8 mm) (See Figure 7)

Shielding
RFI 6 sides; EMI 5 sides

SPECIAL FEATURES

Ratiometric Measurements
+ 10V ± 0% external reference may be used in place of internal reference. Connect to REF IN

External System Offset Compensation
± 50 mV max. may be compensated. Connect to A/Z RTN



Performance Features T-51-10-90

The guaranteed differential linearity of the MP8037 makes it adaptable for use in computer-based data acquisition systems to accomplish statistical processing and achieve an effective resolution up to 20-bits. Simple pin programming achieves true ratiometric measurements with 17-bit resolution by connecting an external in place of the precision internal reference.

The high quality performance of the MP8037 is confirmed by comprehensive computer-controlled factory acceptance tests, whose results are shipped with each module. Reliable performance is further supported by the Analogic standard QC procedure, including vendor qualification, rigid incoming inspection, and 100% burn-in cycling under power of all critical components.

Principles of Operation

The innovative quadraphasic design of the MP8037 completes a conversion in 4 phases, the operation of which may be best understood with reference to Figures 1 and 2. The four phases are: the autozeroing phase (AZ), the signal integration phase ($\int x$), integration of ref high ($\int \text{ref hi}$), and integration of ref low ($\int \text{ref lo}$). Timing signals for each of the phases is developed in pro-

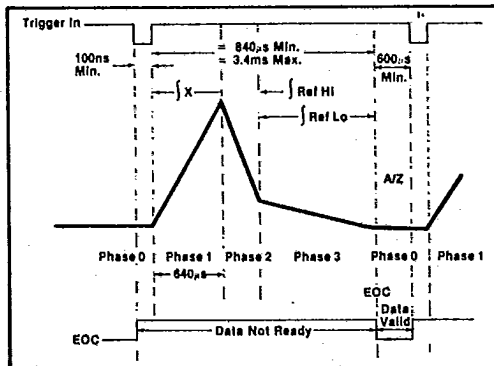


Figure 2. Quadraphasic Timing Waveforms.

grammed read-only memory (PROM's) in response to input signal magnitude and polarity. When not in a conversion mode, the converter is placed automatically into its auto zero phase. The unit need only remain in this phase for a minimum of 600 μs to assure that the charge on the integrating capacitor is reduced to reference zero level. It also assures that the memory capacitor is charged to balance out any internal drifts as well as compensate for any external offsets introduced at the module pin connections.

When the trigger pulse is received, the low level transition causes the counters to be reset to zero. The rising edge generated by the return of the pulse to a positive level triggers the converter, and phase 1 begins. The input signal (and any stored AZ offset) is integrated for a period of 640 μs . Program control shifts the unit into phase 2, where the input signal is replaced by a high current, opposite polarity reference. This discharges the integrating capacitor at a high rate as shown in Figure 2. During this phase, the counters are incremented beginning with B9 counting up to B1 (MSB).

When the integrating capacitor has been discharged to a preset level, the program control begins phase 3. The high current reference is then replaced by a low current reference, and the low bit counters beginning with B16 (LSB) are incremented. This phase continues until the integrating capacitor is discharged to its initial value, when an end of conversion signal (EOC) is generated. At this time, the output data is valid, and program control is returned to the AZ phase. Suitable pauses are introduced between phases to eliminate conversion errors which could result from the settling of the program-switching circuits. The result is true 17-bit performance.

Initial Installation

As shown in Figure 3, the MP8037 is connected to the signal source, a trigger command, two sources of power (5 Vdc and ± 15 Vdc), and an optional external reference. The second signal input may be used to remove common mode voltages that may exist between signal and MP8037 grounds, or to introduce corrections to the input signal resulting from other system considerations.

The external reference, if used, should be within $\pm 10\%$ of the internal value of 10 Vdc. If an external reference is not used, then the REF OUT and REF IN pin terminals must be jumpered.

Be sure the MP8037 completes a conversion before applying a new trigger.

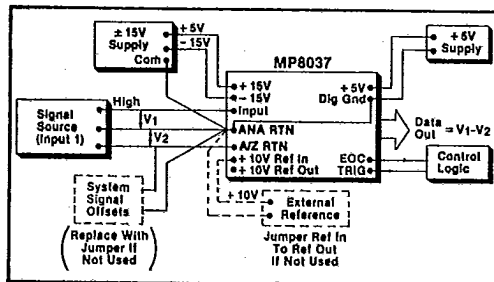


Figure 3. Connecting Power & signals to MP8037.

Calibrating The MP8037

The MP8037 is calibrated at the factory traceable to NBS Standards and is ready for immediate use. For special system applications, the 3-wire Input capability of the MP8037 provides for high accuracy systems recalibration of the module to achieve true 17-bit system converter performance. As shown in Figure 4, connecting the system calibrating voltage source COM to the MP8037 AZ RTN effectively removes up to ± 50 mV of CMV between the two units.

Procedure:

Set the input for a value of $+9.999977$ Vdc Trigger the MP8037; read the binary data output.

Adjust the + RANGE control for a positive full scale binary output (1111111111111111), where the positive true SIGN bit is sensed, and set the control just past the transition of the LSB.

Reverse the input leads.

Adjust the - RANGE control for a negative full scale binary output (0111111111111111), where the positive true SIGN bit is sensed, and set the control just past the transition of the LSB.

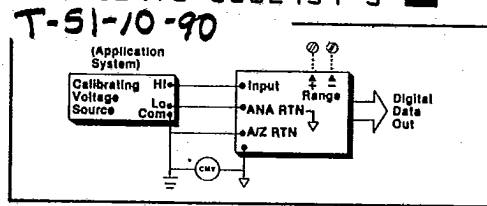


Figure 4. MP8037 Calibration Setup.

Input Connections to MP8037

Input Signals: The MP8037 encodes the difference between two input signals (Figure 5), thereby providing a differential input for systems applications. Small system ground-loop voltages, (up to 50 mV) common mode voltages, and minor system offsets are almost completely removed by using this 3-terminal input configuration as shown in the illustration.

Reference: True Ratiometric Measurements may be made with the MP8037 by replacing the internal reference with an external reference. Simply remove the jumper between pin terminals REF OUT and REF IN, and connect $+10$ Vdc $\pm 10\%$ between REF IN and ANA RTN.

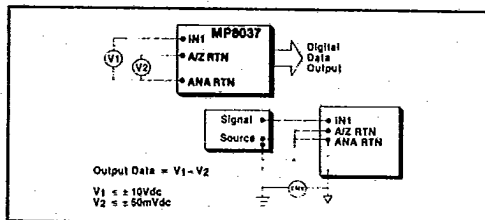


Figure 5. Connecting Input Signals to Remove CMV.

Typical Application

The MP8037 can be used to provide very wide dynamic range when connected as shown in Figure 6. Here the output of the Gas Chromatograph is connected to a programmable gain amplifier (PGA). The output of the PGA is fed to the MP8037 and the selected gain is indicated by 3 output bits.

Once the gain has been properly set and sufficient time has been allotted after EOC for autozero, the Control Logic issues a convert command to the MP8037. When the EOC signal is obtained, valid 20-bit data digitizing a 21-bit input dynamic range is available at the output. In this system, the MP8037 A/Z RTN is jumpered to ANA RTN, and any CMV between source, system and measuring system grounds is rejected in the PGA.

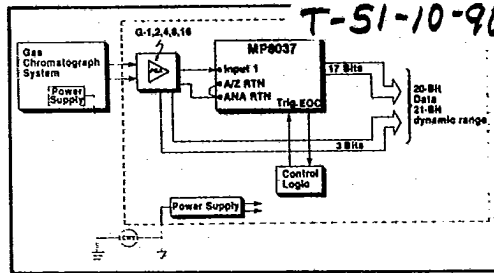


Figure 6. Using MP8037 for 20-bit Data Gas Chromatograph Instrumentation.

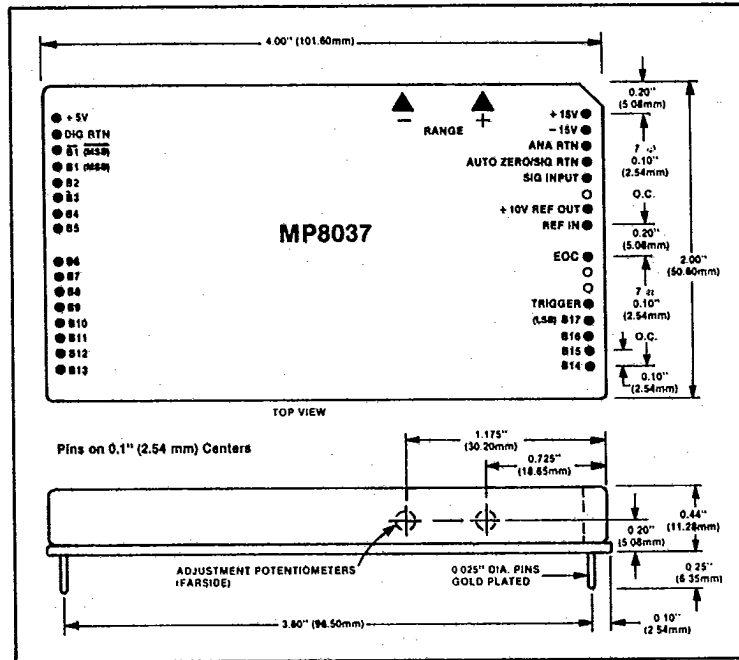


Figure 7. MP8037 Outline & Mounting Dimensions.

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ORDERING GUIDE

Specify MP8037.

For Full Scale Ranges other than $\pm 10V$, or for Signal Integration times other than $640 \mu s$, or for Conversion Rates greater than 250 per second, Consult Factory.