# PM-0820

CMOS HIGH-SPEED 8-BIT A/D CONVERTER

Precision Monolithics Inc.

PRELIMINARY

## FEATURES

- Built-In Track-and-Hold Function
- No Missing Codes
- No External Clocking
- Operates from Single +5V Supply with 0 to 5V Analog Input Voltage
- Easily Interfaced to Microprocessors, or Stand-Alone
- Latched 3-State Outputs
- Logic Inputs/Outputs are CMOS or TTL Compatible
- No Zero or Full-Scale Adjustment Required
- Ratiometric Operation, or Uses Reference Voltage Up to $V_{CC}$
- Overflow Output Available for Cascading
- Pin and Function Campatible with ADC0820, AD7820
- Conversion Speed 1.3µs

## ORDERING INFORMATION †

| PACKAGE | | OPERATING TEMPERATURE RANGE |
|---|---|---|
| CERDIP 20-PIN | PLASTIC 20-PIN | |
| PM0820AR* | — | MIL |
| PM0820BR* | — | MIL |
| PM0820ER | PM0820EP | XIND |
| PM0820FR | PM0820FP†† | 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 and plastic DIP packages. For ordering information, see PMI'S Data Book, Section 2.

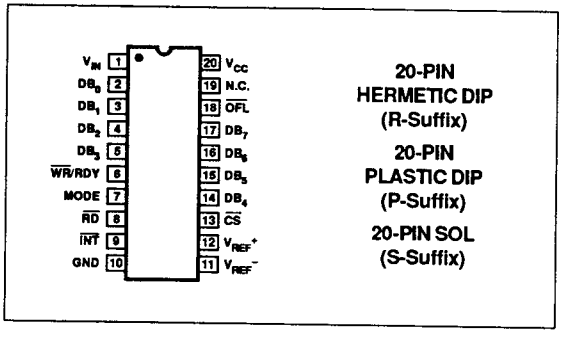
†† Also available in surface mount package.

## GENERAL DESCRIPTION

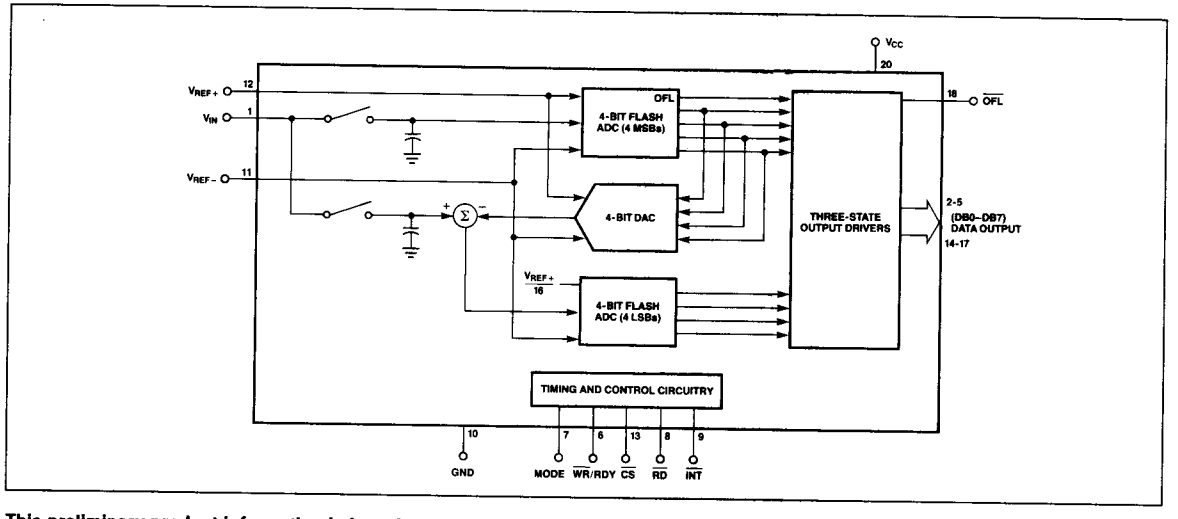
The PM-0820 is an 8-bit resolution analog-to-digital converter, with digital inputs and outputs designed for ease of use in microprocessor-based systems. A half-flash conversion technique is used, with the input signal tracked and held by on-chip circuitry. No external sample-and-hold amplifier is needed for input signals moving at less than 100mV/µs.

This CMOS device offers 1.3µs conversion time and uses only 75mW of power. It is ideally suited to a variety of A/D applications where high speed, low power, ease of use, and economy of space are required.

## PIN CONNECTIONS




## FUNCTIONAL DIAGRAM




**This preliminary product information is based on testing of a limited number of devices. Final specifications may vary. Please contact local sales office or distributor for final data sheet.**

## ABSOLUTE MAXIMUM RATINGS

$V_{CC}$ to GND ..... –0.3V to +7V
All Digital Pins (Control and Output)
to GND ..... –0.3V to $V_{CC}$ + 0.3V
$V_{IN}$ to GND ..... –0.3V to $V_{CC}$ + 0.3V
$V_{REF}$+ to GND ..... $V_{REF}$–, $V_{CC}$
$V_{REF}$– to GND ..... 0V, $V_{REF}$+
Junction Temperature ..... +150°C
Storage Temperature ..... –65°C to +150°C
Lead Temperature (Soldering, 60 sec) ..... +300°C
Operating Temperature Range
PM-0820AR/BR ..... –55°C to +125°C
PM-0820ER/FR/EP/FP ..... –40°C to +85°C

| PACKAGE TYPE | $\Theta_{JA}$ (Note 3) | $\Theta_{JC}$ | UNITS |
|---|---|---|---|
| 20-Pin Hermetic DIP (R) | 70 | 7 | °C/W |
| 20-Pin Plastic DIP (P) | 61 | 24 | °C/W |
| 20-Pin SOL (S) | 80 | 22 | °C/W |

**NOTES:**
1. Absolute maximum ratings are those values beyond which the life of the device may be impaired.
2. Digital inputs are zener protected; however, ESD handling precautions are recommended.
3. $\Theta_{JA}$ is specified for worst case mounting conditions, i.e., $\Theta_{JA}$ is specified for device in socket for CerDIP and P-DIP packages; $\Theta_{JA}$ is specified for device soldered to printed circuit board for SOL package.

**ELECTRICAL CHARACTERISTICS** at $V_{CC}$ = +5V, $V_{REF}$+ = 5V, $V_{REF}$– = 0V = GND, Pin 7 = 0 (RD Mode) unless otherwise specified. $T_A$ = Full Temperature Range as shown under Absolute Maximum Ratings, unless otherwise specified.

| | | | PM-0820 | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
| **ACCURACY** | | | | | | |
| Resolution | N | | 8 | – | – | Bits |
| No Missing Codes Resolution | N | | 8 | – | – | Bits |
| Total Unadjusted Error (Note 1) | TUE | PM-0820A/E/G | – | – | ±1/2 | LSB |
| | | PM-0820B/F/H | – | – | ±1 | |
| **REFERENCE INPUT** | | | | | | |
| Input Resistance | $R_{REF}$ | $T_A$ = +25°C | 1.4 | – | 5.3 | kΩ |
| | | $T_A$ = Full Temperature Range | 1.25 | – | 6.0 | |
| $V_{REF}$+ Input Voltage Range | $V_{REF}$+ | | $V_{REF}$– | – | $V_{DD}$ | V |
| $V_{REF}$– Input Voltage Range | $V_{REF}$– | | GND | – | $V_{REF}$+ | V |
| **ANALOG INPUT** | | | | | | |
| Input Voltage Range | $V_{INR}$ | | GND – 0.1 | – | $V_{DD}$ + 0.1 | V |
| Input Current | $I_{IN}$ | $V_{IN}$ = 0V to +5V<br>$\overline{CS}$ = $V_{CC}$ | – | – | ±3.0 | µA |
| Input Capacitance | $C_{IN}$ | (Note 3) | – | 45 | – | pF |
| Slew Rate Tracking | SR | (Note 2) | – | 0.2 | 0.1 | V/µs |

**ELECTRICAL CHARACTERISTICS** at $V_{CC}$ = +5V, $V_{REF}$+ = 5V, $V_{REF}$– = 0V = GND, Pin 7 = 0 (RD Mode) unless otherwise specified. $T_A$ = Full Temperature Range as shown under Absolute Maximum Ratings, unless otherwise specified. *Continued*

| PARAMETER | SYMBOL | CONDITIONS | PM-0820 MIN | PM-0820 TYP | PM-0820 MAX | UNITS |
|---|---|---|---|---|---|---|
| **LOGIC INPUTS** | | | | | | |
| Input High Voltage | $V_{INH}$ | $V_{CC}$ = +5.25V<br>$\overline{CS}$, $\overline{WR}$, $\overline{RD}$<br>MODE | 2<br>3.5 | –<br>– | –<br>– | V |
| Input Low Voltage | $V_{INL}$ | $V_{CC}$ = ±4.75V<br>$\overline{CS}$, $\overline{WR}$, $\overline{RD}$<br>MODE | –<br>– | –<br>– | 0.8<br>1.5 | V |
| Input High Current | $I_{INH}$ | $T_A$ = Full Temperature Range<br>$\overline{CS}$, $\overline{RD}$<br>$\overline{WR}$<br>MODE | –<br>–<br>– | –<br>–<br>– | 1.0<br>3.0<br>200 | µA |
| Input Low Current | $I_{INL}$ | $\overline{CS}$, $\overline{RD}$, $\overline{WR}$, MODE | – | – | 1 | µA |
| Input Capacitance (Note 3) | $C_{IN}$ | $\overline{CS}$, $\overline{RD}$, $\overline{WR}$, MODE | – | 5 | 8 | pF |
| **LOGIC OUTPUTS** | | | | | | |
| Output High Voltage | $V_{OH}$ | $DB_0$ - $DB_7$, $\overline{OFL}$, $\overline{INT}$, $V_{CC}$ = +4.75V<br>$I_{OUT}$ = –360µA<br>$I_{OUT}$ = –10µA | 2.4<br>– | –<br>– | –<br>4.5 | V |
| Output Low Voltage | $V_{OL}$ | $DB_0$ - $DB_7$, $\overline{OFL}$, $\overline{INT}$, RDY<br>$V_{CC}$ = +4.75V, $I_{OUT}$ = 1.6mA | – | – | 0.4 | V |
| 3-State Output Current | $I_{OZ}$ | $DB_0$ - $DB_7$, RDY<br>$V_{OUT}$ = 0V and +5V | –0.3 | – | +3.0 | µA |
| Output Source Current | $I_{SOURCE}$ | $V_{OUT}$ = 0V<br>$DB_0$ - $DB_7$, $\overline{OFL}$<br>$\overline{INT}$ | –<br>– | –<br>– | –6<br>–4.5 | mA |
| Output Sink Current | $I_{SINK}$ | $V_{OUT}$ = +5V, $DB_0$ - $DB_7$, $\overline{OFL}$<br>$\overline{INT}$, RDY | – | – | 7 | mA |
| Output Capacitance (Note 3) | $C_{OUT}$ | $DB_0$ - $DB_7$, $\overline{OFL}$, $\overline{INT}$, RDY | – | – | 8 | pF |
| **POWER SUPPLY** | | | | | | |
| Supply Current | $I_{CC}$ | $\overline{CS}$ = $\overline{WR}$ = $\overline{RD}$ = 0V | – | – | 15 | mA |
| **DIGITAL INTERFACE TIMING** (Notes 2, 4) | | | | | | |
| Conversion Time (RD MODE) (Note 7) | $t_{CRD}$ | Pin 7 = 0V, (Figure 1) | – | – | 2.5 | µs |
| Conversion Time (WR-RD MODE) | $t_{CWR-RD}$ | Pin 7 = +5V, $t_{WR}$ = 600ns<br>$t_{RD}$ = 600ns | 1.3 | – | – | µs |

**ELECTRICAL CHARACTERISTICS** at $V_{CC}$ = +5V, $V_{REF}+$ = 5V, $V_{REF}-$ = 0V = GND, Pin 7 = 0 (RD Mode) unless otherwise specified. $T_A$ = Full Temperature Range as shown under Absolute Maximum Ratings, unless otherwise specified. *Continued*

| PARAMETER | SYMBOL | CONDITIONS | PM-0820 MIN | PM-0820 TYP | PM-0820 MAX | UNITS |
|---|---|---|---|---|---|---|
| Chip Select to RD, WR Set-up Time | $t_{CSS}$ | | 0 | – | – | ns |
| Chip Select to RD, WR Hold Time | $t_{CSH}$ | | 0 | – | – | ns |
| Chip Select to RDY Delay (RD MODE) | $t_{RDY}$ | $C_L$ = 50pF, Pin 7 = 0V | – | – | 100 | ns |
| Data Access Time (RD MODE) (Note 5) | $t_{ACC0}$ | Pin 7 = 0V | – | – | $t_{CRD}$ + 70 | ns |
| $\overline{RD}$ to $\overline{INT}$ Delay | $t_{INTH}$ | $C_L$ = 50pF | – | – | 225 | ns |
| Data Hold Time (Note 6) | $t_{DH}$ | $R_L$ = 1kΩ, $C_L$ = 10pF | – | – | 200 | ns |
| Delay Time Between Conversion | $t_P$ | | 600 | – | – | ns |
| Write Pulse Width | $t_{WR}$ | Pin 7 = +5V | 0.6 | – | 50 | µs |
| Read Delay (WR-RD MODE) | $t_{RD}$ | Pin 7 = +5V | 600 | – | – | ns |
| Data Access Time WR-RD MODE | $t_{ACC1}$ | Pin 7 = +5V, $t_{RD} < t_{INTL}$ $C_L$ = 15pF (Figure 3) | – | – | 280 | ns |
| | | $C_L$ = 100pF | – | – | 320 | |
| $\overline{RD}$ to $\overline{INT}$ Delay (WR-RD MODE) | $t_{RI}$ | Pin 7 = +5V, $t_{RD}$ < INTL | – | – | 290 | ns |
| $\overline{WR}$ to $\overline{INT}$ Delay (WR-RD MODE) | $t_{INTL}$ | Pin 7 = +5V, $C_L$ = 50pF | – | – | 1.3 | µs |
| Data Access Time (WR-RD MODE) (Note 6) | $t_{ACC2}$ | Pin 7 = +5V, $t_{RD}$ > INTL $C_L$ = 15pF (Figure 2) | – | – | 120 | ns |
| | | $C_L$ = 100pF | – | – | 150 | |
| $\overline{WR}$ to $\overline{INT}$ Delay (Stand-Alone MODE) | $t_{IHWR}$ | Pin 7 = +5V, $C_L$ = 50pF | – | – | 270 | ns |
| Data Access Time (Stand-Alone MODE) | $t_{ID}$ | Pin 7 = +5V | – | – | 50 | ns |

**NOTES:**
1. Total unadjusted error includes offset, full-scale, and linearity errors.
2. Sample tested.
3. Guaranteed by design.
4. All input control signals are specified with $t_R = t_F$ = 20ns (10% to 90% of $V_{DD}$) and timed from a voltage level of 1.6V.
5. Defined as the time required for an output to cross 0.8V to 2.4V.
6. Defined as the time required for the data lines to change 0.5V.
7. For faster conversions use WR-RD MODE.

## DIGITAL INTERFACE

The PM-0820 can operate in two modes: RD mode and WR-RD mode (for faster conversion speeds, use the WR-RD mode). Mode selection is determined by the MODE pin. The two modes of operation are discussed below.

**RD MODE – Pin 7 = 0V (See Figure 1)** — This mode allows the microprocessor to start a conversion and read the data at the end of conversion with a single READ instruction. The PM-0820 also provides an INT output which goes low at the end of conversion; it is reset by the rising edge of the RD or CS when CS is low.

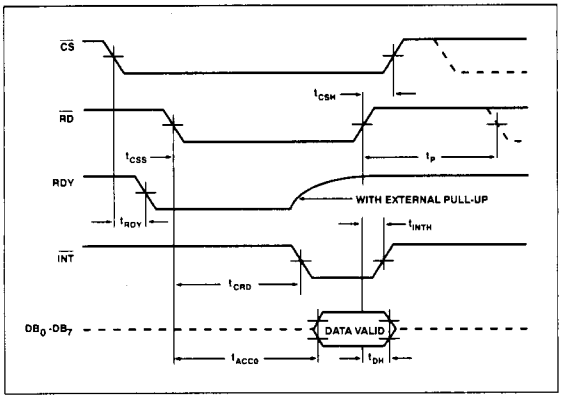



**Figure 1:** *RD Mode (Pin 7 = 0V)*

Before a conversion can start, CS must first be taken low; a conversion is then started by taking RD low. RD must be held low until data appears at the outputs (at the end of conversion). Also, RD will enable pin 6 (WR/RDY) and allow it to function as a status output; it can be used as a BUSY or READY signal with microprocessors that can accommodate WAIT states. Pin 6 is an open collector output, it goes low following the falling edge of RD, and goes into 3-state (high impedance) at the end of conversion.

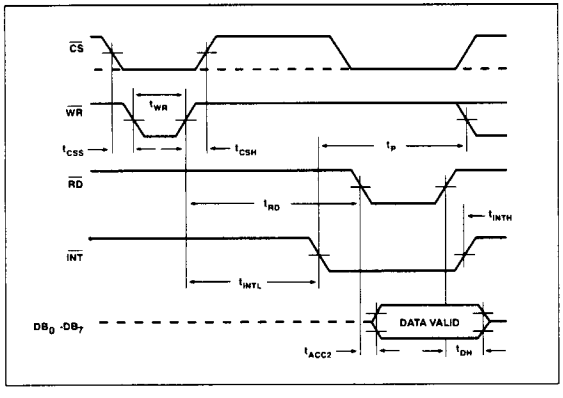



**Figure 2:** *WR-RD Mode (Pin 7 = +5V, $t_{RD} > t_{INTL}$)*

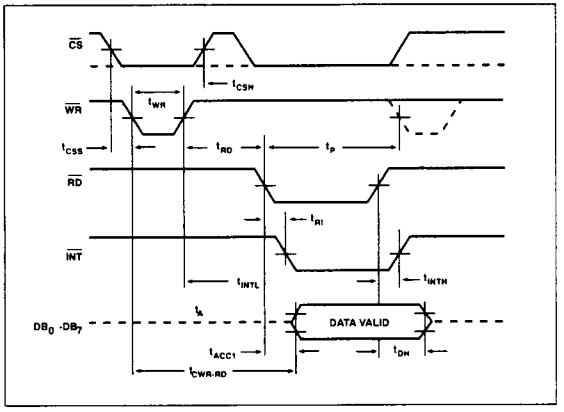



**Figure 3:** *WR-RD Mode (Pin 7 = +5V, $t_{RD} < t_{INTL}$)*

**WR-RD MODE – Pin 7 = +5V (See Figure 3)** — Pin 6 (WR/RDY) is configured as the WRITE input when the PM-0820 is used in the WR-RD mode. With the CS line low, conversion starts on the falling edge of the WR signal. The PM-0820 allows several options for reading output data.

**Interrupt Scheme (Slower Conversion Speed) (See Figure 2)** — In this scheme, the microprocessor waits until INT goes low before reading data. INT goes low approximately 800ns after the rising edge of the WR signal/ this indicates the end of conversion. Data outputs are then active when RD is taken low.

**Non-Interrupt Scheme (Faster Conversion Speed) (See Figure 3)** — A faster conversion speed is possible by not waiting for INT to go low. Taking RD low approximately 600ns after WR goes high completes the conversion cycle; this enables the data outputs. INT goes low on the falling edge of RD.

**Stand-Alone Configuration (See Figure 4)** — Stand-alone operation is possible with the PM-0820 by operating it in the WR-RD mode. CS and RD are first tied low, conversion is then started when WR is taken low. Data valid occurs approximately 800ns after the rising edge of the WR signal.

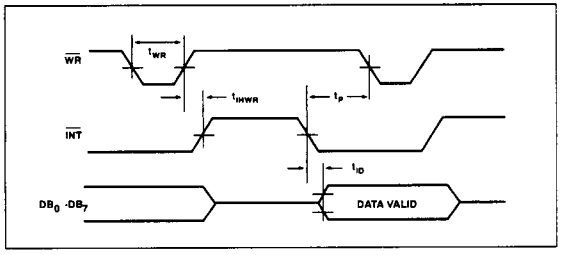



**Figure 4:** *WR-RD Mode – Stand-Alone Operation (Pin 7 = +5V, CS = RD = 0V)*

**TABLE 1:** Fin Function Description

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | $V_{IN}$ | Analog Input; Range = $V_{REF}$– to $V_{REF}$+ |
| 2 | $DB_0$ (LSB) | 3-State Data Output; Bit 0 |
| 3 | $DB_1$ | 3-State Data Output; Bit 1 |
| 4 | $DB_2$ | 3-State Data Output, Bit 2 |
| 5 | $DB_3$ | 3-State Data Output, Bit 3 |
| 6 | $\overline{WR}$/RDY | Write Control Input/Ready Status Output |
| 7 | MODE | Mode Selection Intput – Internally tied to GND through a 50μA current source. |
| 8 | $\overline{RD}$ | READ Input – Activates 3-State Data Outputs |
| 9 | $\overline{INT}$ | Interrupt Output – Goes low at end of conversion. |
| 10 | GND | Ground |
| 11 | $V_{REF}$– | Lower Limit of Reference Input Voltage. Range: GND to $V_{REF}$+ |
| 12 | $V_{REF}$+ | Upper Limit of Reference Input Voltage. Range: $V_{REF}$– to $V_{CC}$ |
| 13 | $\overline{CS}$ | Chip Select Input. Must be low before the start of conversion (or before $\overline{WR}$ or $\overline{RD}$ is accepted by the converter). |
| 14 | $DB_4$ | 3-State Output; Bit 4 |
| 15 | $DB_5$ | 3-State Output; Bit 5 |
| 16 | $DB_6$ | 3-State Output; Bit 6 |
| 17 | $DB_7$ | 3-State Output; Bit 7 |
| 18 | $\overline{OFL}$ | Overflow Output – $\overline{OFL}$ will be low at the end of conversion if $V_{IN}$ is higher than $V_{REF}$+. Can be used to cascade two or more devices for more resolutuion. This output is not a 3-State Output. |
| 19 | NC | No Connection |
| 20 | $V_{CC}$ | Power Supply Voltage |