

OVERVIEW

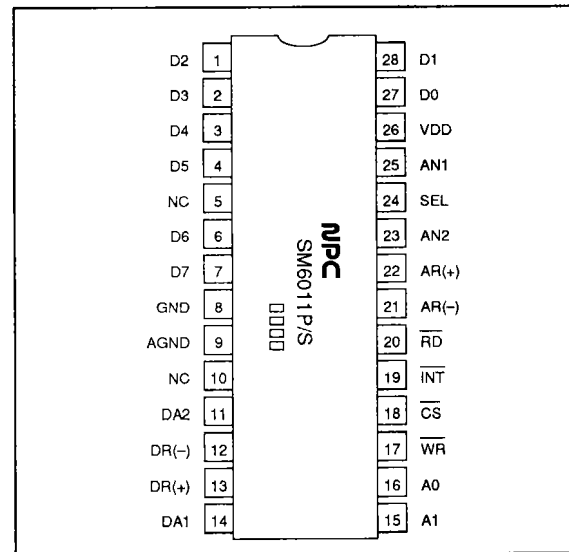
The SM6011 is a high-speed data converter fabricated in Molybdenum-gate CMOS. It comprises one 8-bit A/D converter, which uses a half-flash conversion method, and two 8-bit voltage-output D/A converters. The A/D converter does not require an external sample-and-hold circuit. Digital data can easily be interfaced with the data bus of common CPUs.

The SM6011 is available in 28-pin plastic DIPs and 28-pin SOPs.

FEATURES

- A/D converter
 - 8-bit resolution
 - 1.0 μ s (max) conversion time
 - Internal sample-and-hold circuits not required
 - Built-in 2-channel multiplexer
- D/A converter
 - 8-bit resolution
 - 2.5 μ s (max) settling time
 - Voltage output waveform
 - 2 channels
- Internal clock not required
- Low power consumption
- Can be connected directly to a CPU
- Single 5 V supply
- 28-pin plastic DIP and 28-pin SOP
- Molybdenum-gate CMOS process

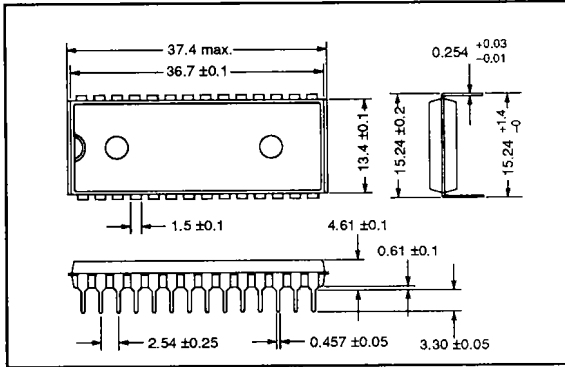
PINOUT



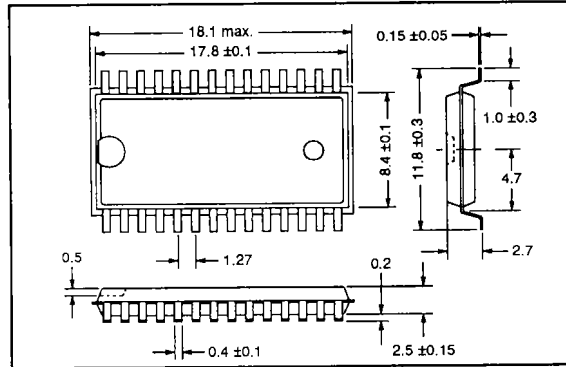
PACKAGE DIMENSIONS

Unit: mm

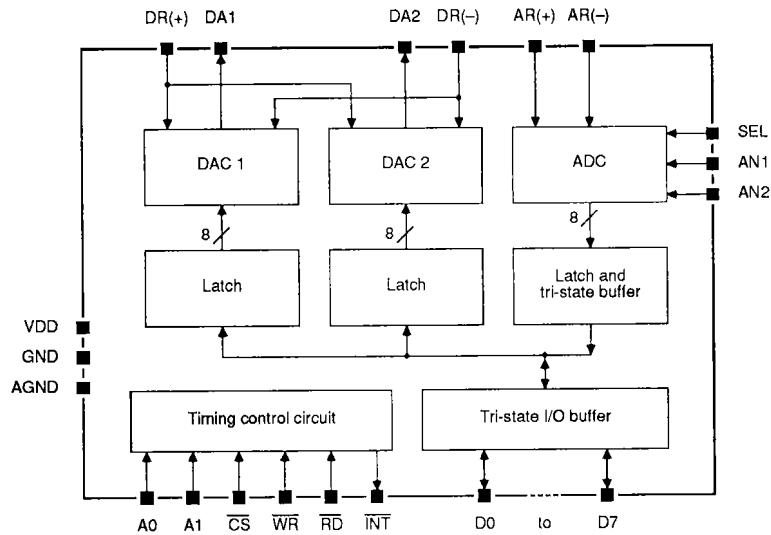
28-pin plastic DIP



28-pin SOP



BLOCK DIAGRAM



PIN DESCRIPTION

| Number | Name | Description |
|--------|------|-------------------------------|
| 1 | D2 | Parallel I/O port bit 2 |
| 2 | D3 | Parallel I/O port bit 3 |
| 3 | D4 | Parallel I/O port bit 4 |
| 4 | D5 | Parallel I/O port bit 5 |
| 5 | NC | No connection |
| 6 | D6 | Parallel I/O port bit 6 |
| 7 | D7 | Parallel I/O port bit 7 (MSB) |
| 8 | GND | Digital ground |
| 9 | AGND | Analog ground |
| 10 | NC | No connection |

SM6011

| Number | Name | Description |
|--------|------------------|--|
| 11 | DA2 | D/A converter analog output 2 |
| 12 | DR- | D/A converter reference voltage (low end voltage) |
| 13 | DR+ | D/A converter reference voltage (high end voltage) |
| 14 | DA1 | D/A converter analog output 1 |
| 15 | A1 | Function select pin 2 |
| 16 | A0 | Function select pin 1 |
| 17 | \overline{WR} | A/D converter start signal D/A converter write signal |
| 18 | \overline{CS} | Chip select |
| 19 | \overline{INT} | A/D converter interrupt output (conversion completed) |
| 20 | \overline{RD} | A/D converter data read out |
| 21 | AR- | A/D converter reference voltage (low end voltage) |
| 22 | AR+ | A/D converter reference voltage (high end voltage) |
| 23 | AN2 | A/D converter channel 2 analog input |
| 24 | SEL | A/D converter analog channel input select (Ch. 1/Ch. 2) |
| 25 | AN1 | A/D converter channel 1 analog input |
| 26 | VDD | Power supply |
| 27 | D0 | Parallel I/O port bit 0 (LSB) |
| 28 | D1 | Parallel I/O port bit 1 |

GENERAL SPECIFICATIONS

Absolute Maximum Ratings

| Parameter | Symbol | Rating | Unit |
|---------------------------|-----------|-----------------------------------|--------|
| Supply voltage range | V_{DD} | $V_{GND} - 0.3$ to 7.0 | V |
| Input voltage range | V_{IN} | $V_{GND} - 0.3$ to $V_{DD} + 0.3$ | V |
| Output voltage range | V_{OUT} | $V_{GND} - 0.3$ to $V_{DD} + 0.3$ | V |
| Power dissipation | P_D | 450 | mW |
| Storage temperature range | T_{stg} | -40 to 125 | deg. C |
| Soldering temperature | T_{sld} | 260 | deg. C |
| Soldering time | t_{sld} | 10 | s |

Recommended Operating Conditions

| Parameter | Symbol | Rating | | | Unit |
|-----------------------|-----------|--------|-----|------|--------|
| | | Min | Typ | Max | |
| Supply voltage | V_{DD} | 4.75 | 5.0 | 5.25 | V |
| Operating temperature | T_{opr} | -20 | - | 70 | deg. C |

Logic DC Electrical Characteristics

$V_{DD} = 5\text{ V} \pm 5\%$, $T_a = -20$ to 70 deg. C unless otherwise noted

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|-----------|---------------------------|--------|-----|-----|---------------|
| | | | Min | Typ | Max | |
| D0 to D7, A0, A1, SEL, \overline{CS} , \overline{WR} and \overline{RD} HIGH-level input voltage | V_{IH} | | 3.5 | – | – | V |
| D0 to D7, A0, A1, SEL, \overline{CS} , \overline{WR} and \overline{RD} LOW-level input voltage | V_{IL} | | – | – | 1.0 | V |
| A0, A1, SEL, \overline{CS} , \overline{WR} and \overline{RD} HIGH-level input current | I_{IH1} | $V_{IH} = V_{DD}$ | – | – | 1 | μA |
| D0 to D7 HIGH-level input current | I_{IH2} | $V_{IH} = V_{DD}$ | – | – | 3 | μA |
| A0, A1, SEL, \overline{CS} , \overline{WR} and \overline{RD} LOW-level input current | I_{IL1} | $V_{IL} = V_{GND}$ | –1 | – | – | μA |
| D0 to D7 LOW-level input current | I_{IL2} | $V_{IL} = V_{GND}$ | –3 | – | – | μA |
| D0 to D7 and \overline{INT} HIGH-level output voltage | V_{OH} | $I_{OH} = -0.4\text{ mA}$ | 3.5 | – | – | V |
| D0 to D7 and \overline{INT} LOW-level output voltage | V_{OL} | $I_{OL} = 1.6\text{ mA}$ | – | – | 0.4 | V |
| Current consumption | I_{DD} | | – | 8 | 15 | mA |
| Input pin capacitance | C_{IN} | | – | 5 | – | pF |
| Output pin capacitance | C_{OUT} | | – | 5 | – | pF |

A/D CONVERTER SPECIFICATIONS**Conversion Characteristics**

$V_{DD} = 5\text{ V} \pm 5\%$, $V_{AR+} = 5\text{ V} \pm 5\%$, $V_{AR-} = V_{GND}$, $T_a = -20$ to 70 deg. C

| Parameter | Rating | | | Unit |
|----------------------------|--------|-----|------------|------|
| | min | typ | max | |
| Resolution | 8 | – | – | bit |
| Non-linearity | – | – | ± 0.7 | LSB |
| Differential non-linearity | – | – | ± 0.7 | LSB |
| Offset error | 0 | 1.0 | 2.0 | LSB |
| Full-scale error | – | – | ± 0.75 | LSB |

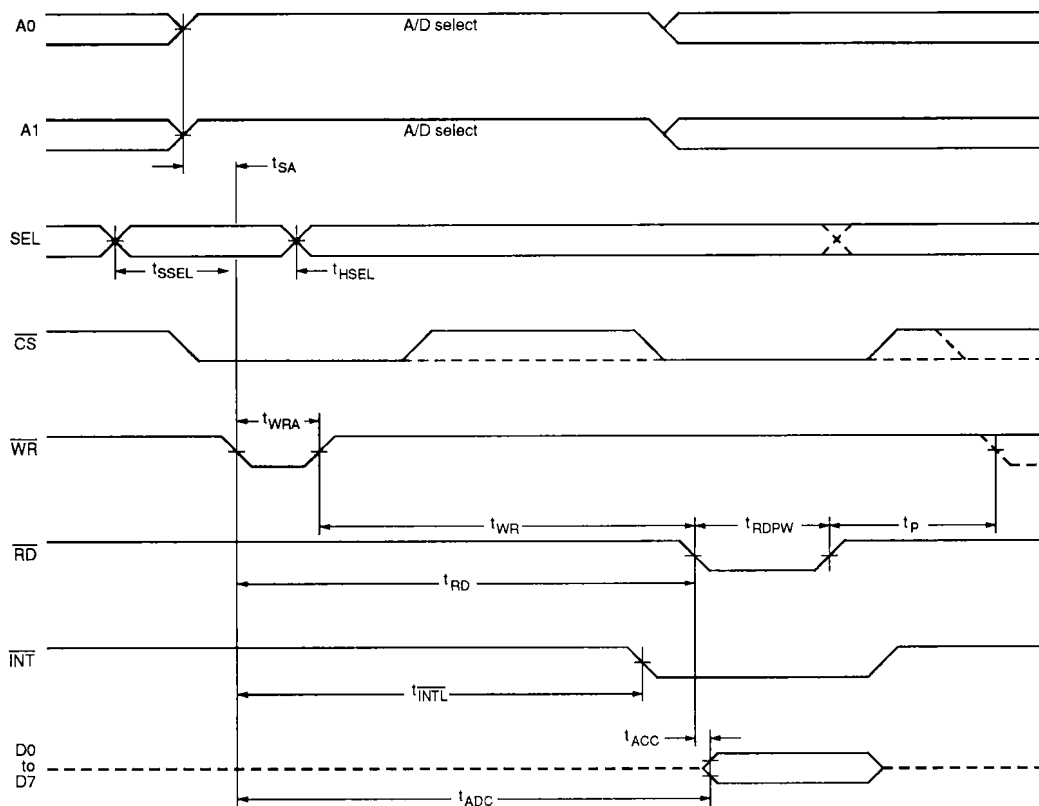
DC Electrical characteristics
 $V_{DD} = 5\text{ V} \pm 5\%$, $T_a = -20\text{ to }70\text{ deg. C}$

| Parameter | Symbol | Condition | Rating | | | Unit |
|---------------------------------|-----------|--|-----------------|-----------|----------------|---------------|
| | | | min | typ | max | |
| AR+ to AR- reference resistance | | | 0.5 | 0.85 | 1.3 | k Ω |
| AR+ input voltage | V_{AR+} | | V_{AR-} | – | $V_{DD} + 0.3$ | V |
| AR- input voltage | V_{AR-} | | V_{GND} | – | V_{AR+} | V |
| Analog input voltage | | | $V_{GND} - 0.1$ | – | $V_{DD} + 0.1$ | V |
| Analog input leakage current | | $V_{IN} = V_{GND}\text{ to }V_{DD}$, $V_{CS} = V_{DD}$ | – | ± 0.1 | ± 3 | μA |
| Analog input capacitance | | | – | 25 | – | pF |

AC Electrical characteristics
 $V_{DD} = 5\text{ V} \pm 5\%$, $T_a = -20\text{ to }70\text{ deg. C}$

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|------------|--|--------|-----|-----|---------------|
| | | | min | typ | max | |
| Conversion time | t_{ADC} | $t_{RD} = 850\text{ ns}$ | – | – | 1.0 | μs |
| \overline{WR} pulsewidth | t_{WRA} | | 200 | – | 700 | ns |
| \overline{WR} to \overline{RD} setup time | t_{RD} | | 850 | – | – | ns |
| Data access time | t_{ACC} | $R_L = 10\text{ k}\Omega$, $C_L = 15\text{ pF}$ | – | – | 150 | ns |
| \overline{WR} to \overline{INT} delay time | t_{INTL} | | – | – | 850 | ns |
| \overline{RD} pulsewidth | t_{RDPW} | | 150 | – | – | ns |
| Input select setup time | t_{SSEL} | | 500 | – | – | ns |
| Input select hold time | t_{HSEL} | | 100 | – | – | ns |
| Succeeding conversion wait time | t_P | | 500 | – | – | ns |
| \overline{WR} to \overline{RD} pulse interval | t_{WR} | | 20 | – | – | ns |

A/D Converter to Data Read Out Timing



Note

When converter data is to be transmitted to a D/A converter, A0 and A1 must be set after \overline{WR} goes HIGH and before \overline{RD} goes LOW.

D/A CONVERTER SPECIFICATIONS

Conversion Characteristics

$V_{DD} = 5\text{ V} \pm 5\%$, $V_{DR+} = 3\text{ V}$, $V_{DR-} = 1.0\text{ V}$, $T_a = -20\text{ to }70\text{ deg. C}$

| Parameter | Rating | | | Unit |
|----------------------------|--------|------|-----------|------|
| | min | typ | max | |
| Resolution | 8 | - | - | bit |
| Non-linearity | - | - | ± 1 | LSB |
| Differential non-linearity | - | - | ± 0.5 | LSB |
| Offset error | -2.0 | -0.5 | 1.0 | LSB |
| Full-scale error | -2.5 | -1.0 | 0.5 | LSB |

DC Electrical Characteristics

$V_{DD} = 5\text{ V} \pm 5\%$, $T_a = -20\text{ to }70\text{ deg. C}$

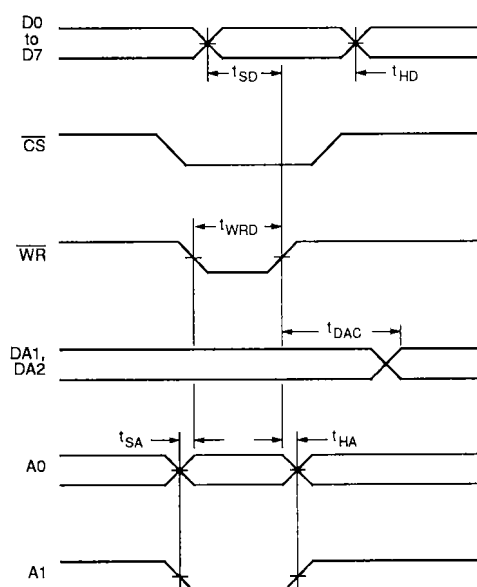
| Parameter | Symbol | Condition | Rating | | | Unit |
|---------------------------------|-----------|---------------------------|-----------|-----|--------------------------|------------|
| | | | min | typ | max | |
| DR+ to DR- reference resistance | | | 6 | 10 | – | k Ω |
| DR+ input voltage | V_{DR+} | | V_{DR-} | – | 3.25 | V |
| DR- input voltage | V_{DR-} | | 0.5 | | V_{DR+} | V |
| Output voltage range | | | V_{DR-} | | $V_{DR+} - 1\text{ LSB}$ | V |
| Load error | | $R_L = 10\text{ k}\Omega$ | – | – | ± 0.5 | LSB |

AC Electrical Characteristics

$V_{DD} = 5\text{ V} \pm 5\%$, $V_{DR+} = 3\text{ V}$, $V_{DR-} = 1.0\text{ V}$, $T_a = -20\text{ to }70\text{ deg. C}$

| Parameter | Symbol | Condition | Rating | | | Unit |
|---------------------------------------|-----------|--|--------|-----|-----|---------------|
| | | | min | typ | max | |
| Settling time (full-scale transition) | t_{DAC} | $R_L = 10\text{ k}\Omega$, $C_L = 15\text{ pF}$ | – | – | 2.5 | μs |
| Data setup time | t_{SD} | | 150 | – | – | ns |
| Data hold time | t_{HD} | | 10 | – | – | ns |
| WR pulsewidth | t_{WRD} | | 150 | – | – | ns |
| Mode switching setup time | t_{SA} | | 20 | – | – | ns |
| Mode switching hold time | t_{HA} | | 20 | – | – | ns |

D/A Converter Data Write Timing



FUNCTIONAL DESCRIPTION

The SM6011 comprises one 8-bit A/D half-flash converter and two 8-bit voltage-output D/A converters. The reference voltages for the A/D and D/A converters are generated independently.

The A/D converter analog input is a 2-channel multiplexed signal where the level on SEL determines which input is active.

The A/D converter output and D/A converter input is a common, parallel input/output bus (D0 to D7). The SM6011 can also transfer A/D converter output directly to either of the D/A converters at the same time as the output appears on the input/output bus. These functions are selected by control signals as shown in the following table.

Table 1. Function select

| \overline{CS} | \overline{RD} | \overline{WR} | A0 | A1 | Function |
|-----------------|-----------------|-----------------|------|------|--------------------------------|
| HIGH | × | × | × | × | No operation |
| × | HIGH | HIGH | × | × | No operation |
| LOW | HIGH | LOW | HIGH | HIGH | A/D converter start |
| LOW | LOW | HIGH | HIGH | HIGH | A/D converter read out |
| LOW | HIGH | LOW | LOW | LOW | DA1 data write |
| LOW | HIGH | LOW | HIGH | LOW | DA2 data write |
| LOW | LOW | HIGH | LOW | LOW | A/D converter data → DA1 write |
| LOW | LOW | HIGH | HIGH | LOW | A/D converter data → DA2 write |

Note

× = don't care

Table 2. A/D Converter input channel select

| SEL | Channel |
|------|---------|
| LOW | AN1 |
| HIGH | AN2 |

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