

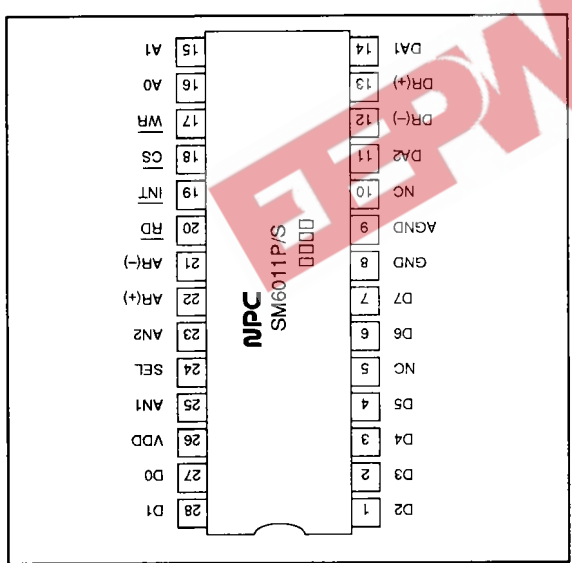
**OVERVIEW**

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**

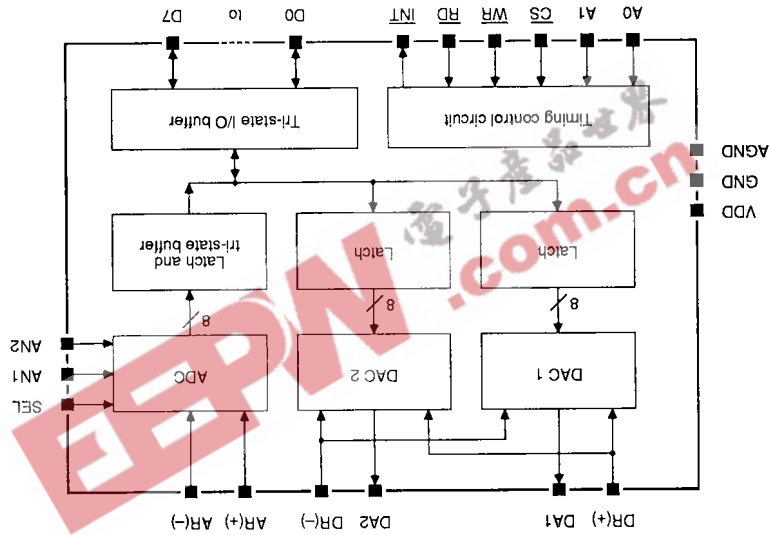
- A/D converter
  - 8-bit resolution
  - 1.0 μs (max) conversion time
  - Internal sample-and-hold circuits not required
  - Built-in 2-channel multiplexer
  - D/A converter
    - 8-bit resolution
    - 2.5 μs (max) settling time
    - Voltage output waveform
    - 2 channels
  - Internal clock not required
  - 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



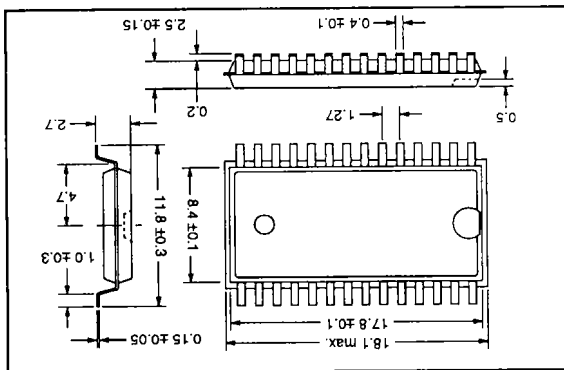
**PINOUT**

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

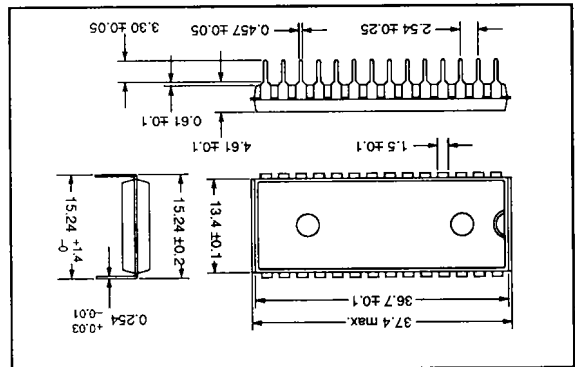
PIN DESCRIPTION



BLOCK DIAGRAM



28-pin SOP



28-pin plastic DIP

Unit: mm

PACKAGE DIMENSIONS

Parameter	Symbol	Rating			Unit
		Min	Typ	Max	
Supply voltage	V <sub>DD</sub>	4.75	5.0	5.25	V
Operating temperature	T <sub>op</sub>	-20	-	70	deg. C

**Recommended Operating Conditions**

Parameter	Symbol	Rating	Unit
Supply voltage range	V <sub>DD</sub>	V <sub>GND</sub> - 0.3 to 7.0	V
Input voltage range	V <sub>IN</sub>	V <sub>GND</sub> - 0.3 to V <sub>DD</sub> + 0.3	V
Output voltage range	V <sub>OUT</sub>	V <sub>GND</sub> - 0.3 to V <sub>DD</sub> + 0.3	V
Power dissipation	P <sub>D</sub>	450	mW
Storage temperature range	T <sub>stg</sub>	-40 to 125	deg. C
Soldering temperature	T <sub>sld</sub>	260	deg. C
Soldering time	t <sub>sld</sub>	10	s

**Absolute Maximum Ratings**

**GENERAL SPECIFICATIONS**

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	WR	D/A converter write signal
18	CS	Chip select
19	INT	A/D converter interrupt output (conversion completed)
20	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

## 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, CS, WR and RD HIGH-level input voltage	$V_{IH}$		3.5	-	-	V
D0 to D7, A0, A1, SEL, CS, WR and RD LOW-level input voltage	$V_{IL}$		-	-	1.0	V
A0, A1, SEL, CS, WR and RD HIGH-level input current	$I_{IH1}$	$V_{IH} = V_{DD}$	-	-	1	$\mu\text{A}$
D0 to D7 HIGH-level input current	$I_{IH2}$	$V_{IH} = V_{DD}$	-	-	3	$\mu\text{A}$
A0, A1, SEL, CS, WR and RD LOW-level input current	$I_{IL1}$	$V_{IL} = V_{GND}$	-1	-	-	$\mu\text{A}$
D0 to D7 LOW-level input current	$I_{IL2}$	$V_{IL} = V_{GND}$	-3	-	-	$\mu\text{A}$
D0 to D7 and INT HIGH-level output voltage	$V_{OH}$	$I_{OH} = -0.4\text{ mA}$	3.5	-	-	V
D0 to D7 and 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	-	-	$\pm 0.7$	LSB
Differential non-linearity	-	-	$\pm 0.7$	LSB
Offset error	0	1.0	2.0	LSB
Full-scale error	-	-	$\pm 0.75$	LSB

## DC Electrical characteristics

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

Parameter	Symbol	Condition	Rating		Unit
			min	typ	
AR+ to AR- reference resistance			0.5	0.85	k $\Omega$
AR+ input voltage	VAR+	VAR-	-	-	V
AR- input voltage	VAR-	V <sub>GND</sub>	V <sub>GND</sub> - 0.1	-	V
Analog input voltage			V <sub>GND</sub> - 0.1	V <sub>DD</sub> + 0.1	V
Analog input leakage current		$V_{IN} = V_{GND}$ to $V_{DD}$ , $V_{CS} = V_{DD}$	-	$\pm 0.1$	$\mu$ A
Analog input capacitance			-	25	pF

## AC Electrical characteristics

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

Parameter	Symbol	Condition	Rating		Unit
			min	typ	
Conversion time	t <sub>ADC</sub>	t <sub>RD</sub> = 850 ns	-	-	$\mu$ s
WR pulsewidth	t <sub>WRA</sub>		200	-	ns
WR to RD setup time	t <sub>RD</sub>		850	-	ns
Data access time	t <sub>ACC</sub>	R <sub>L</sub> = 10 k $\Omega$ , C <sub>L</sub> = 15 pF	-	-	ns
WR to INT <sub>L</sub> delay time	t <sub>INTL</sub>		-	-	ns
RD pulsewidth	t <sub>RDPM</sub>		150	-	ns
Input select setup time	t <sub>SSEL</sub>		500	-	ns
Input select hold time	t <sub>HSEL</sub>		100	-	ns
Succeeding conversion wait time	t <sub>p</sub>		500	-	ns
WR to RD pulse interval	t <sub>WR</sub>		20	-	ns

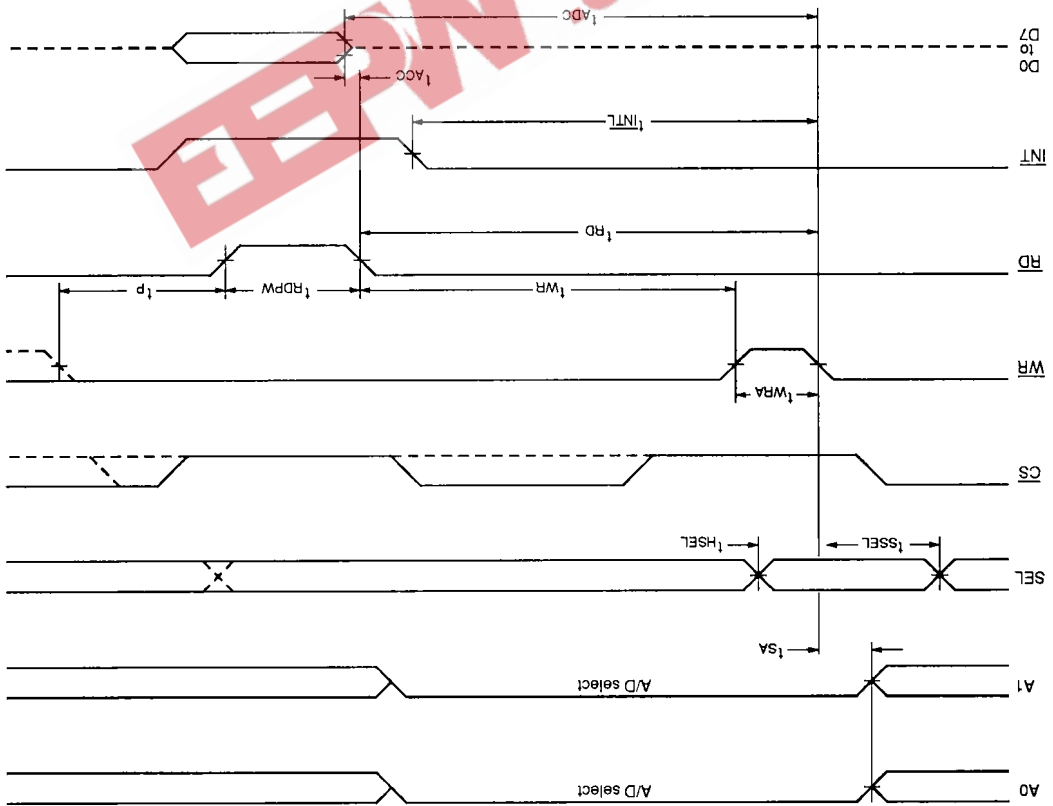
Parameter	Rating			Unit
	min	typ	max	
Resolution	8	-	-	bit
Non-linearity	-	-	±1	LSB
Differential non-linearity	-	-	±0.5	LSB
Offset error	-2.0	-0.5	1.0	LSB
Full-scale error	-2.5	-1.0	0.5	LSB

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

Conversion Characteristics

D/A CONVERTER SPECIFICATIONS

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



A/D Converter to Data Read Out Timing

**DC Electrical Characteristics**

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

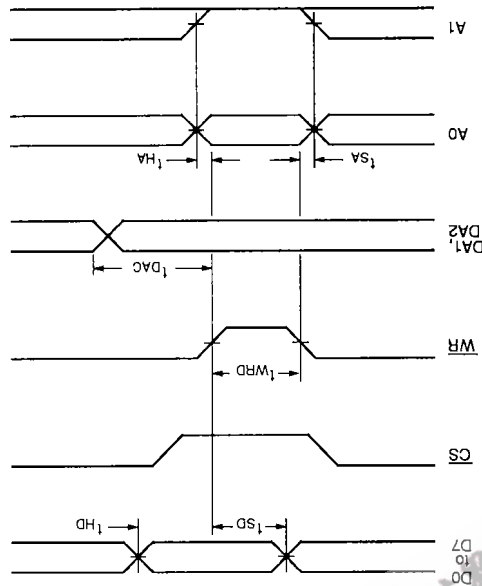
Parameter	Symbol	Condition	Rating		Unit
			min	typ	
DR+ to DR- reference resistance			6	10	k $\Omega$
DR+ input voltage	$V_{DR+}$		$V_{DR-}$	-	V
DR- input voltage	$V_{DR-}$		0.5		V
Output voltage range			$V_{DR-}$		V
Load error		$R_L = 10\text{ k}\Omega$	-	-	LSB

**AC Electrical Characteristics**

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

Parameter	Symbol	Condition	Rating		Unit
			min	typ	
Setting time (full-scale transition)	$t_{DAC}$	$R_L = 10\text{ k}\Omega$ , $C_L = 15\text{ pF}$	-	-	$\mu\text{s}$
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 convert 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

Function	A1	A0	WR	RD	CS
No operation	×	×	×	×	HIGH
No operation	×	×	×	×	×
A/D converter start	HIGH	HIGH	HIGH	LOW	HIGH
A/D converter read out	HIGH	HIGH	HIGH	LOW	LOW
DA1 data write	LOW	LOW	HIGH	HIGH	LOW
DA2 data write	LOW	LOW	HIGH	LOW	LOW
A/D converter data → DA1 write	LOW	LOW	LOW	LOW	LOW
A/D converter data → DA2 write	LOW	LOW	HIGH	LOW	LOW

**Note**

× = don't care

Table 2. A/D Converter input channel select

SEL	Channel
LOW	AN1
HIGH	AN2

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**DESIGN NOTE**

The SM6011 uses CMOS chopper comparators where the analog input is alternately connected and disconnected from the input circuits. The analog input should, therefore, have a low impedance. Also, input buffering is recommended.