NIPPON PRECISION CIRCUITS LTD.

SM6011

High-speed Data Converter

OVERVIEW

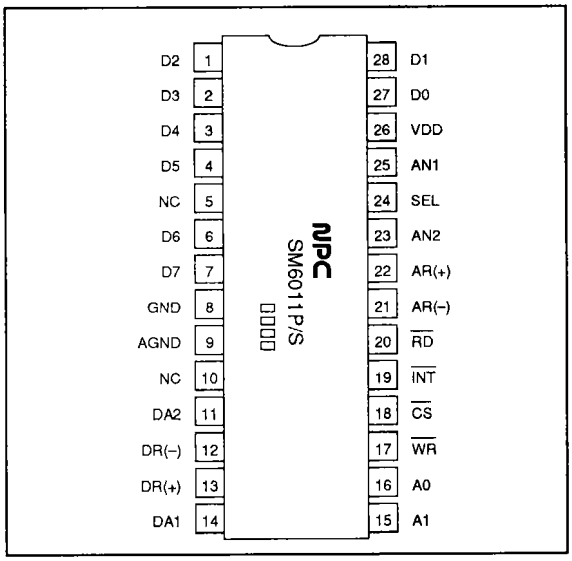
The SM6011 is a high-speed data converter fabricated in Molybdenum-gate CMOS. It comprises one 8-bit A/D converter, which uses a half-flash conversion method, and two 8-bit voltage-output D/A converters. The A/D converter does not require an external sample-and-hold circuit. Digital data can easily be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

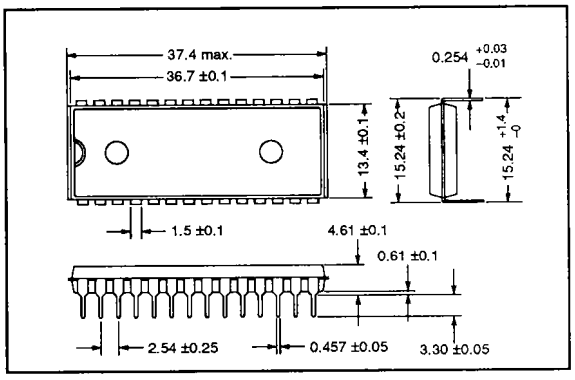
PINOUT



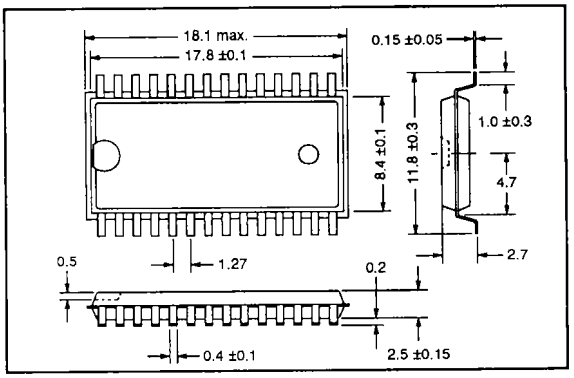
PACKAGE DIMENSIONS

Unit: mm

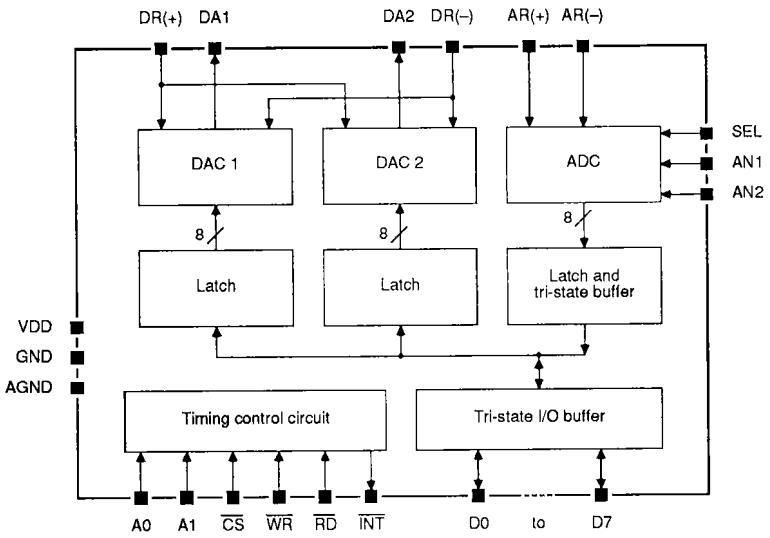
28-pin plastic DIP



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

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 tempeature 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 V ±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 mA	3.5	–	–	V
D0 to D7 and $\overline{INT}$ LOW-level output voltage	V_{OL}	I_{OL} = 1.6 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 V ±5%, V_{AR+} = 5 V ±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 V ±5%, T_a = −20 to 70 deg. C

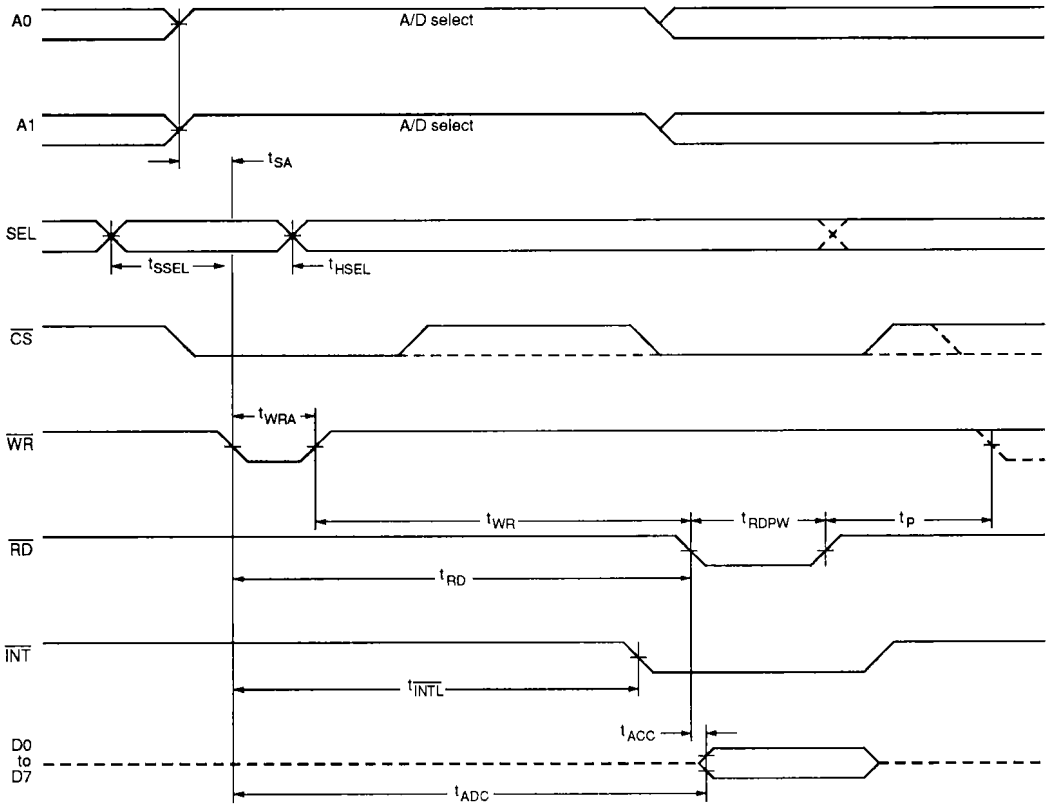
Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
AR+ to AR− reference resistance			0.5	0.85	1.3	kΩ
AR+ input voltage	V_{AR+}		V_{AR-}	–	V_{DD} + 0.3	V
AR− input voltage	V_{AR-}		V_{GND}	–	V_{AR+}	V
Analog input voltage			V_{GND} − 0.1	–	V_{DD} + 0.1	V
Analog input leakage current		V_{IN} = V_{GND}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

AC Electrical characteristics

V_{DD} = 5 V ±5%, T_a = −20 to 70 deg. C

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Conversion time	t_{ADC}	t_{RD} = 850 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 kΩ, C_L = 15 pF	–	–	150	ns
$\overline{WR}$ to $\overline{INT}$ delay time	$t_{\overline{INTL}}$		–	–	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 V ±5%, V_{DR+} = 3 V, V_{DR-} = 1.0 V, T_a = –20 to 70 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 V ±5%, T_a = −20 to 70 deg. C

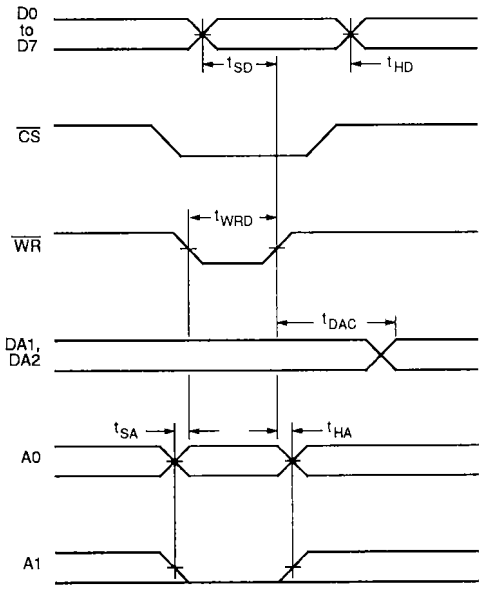
Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
DR+ to DR− reference resistance			6	10	–	kΩ
DR+ input voltage	V_{DR+}		V_{DR-}	–	3.25	V
DR− input voltage	V_{DR-}		0.5		V_{DR+}	V
Output voltage range			V_{DR-}		V_{DR+} − 1 LSB	V
Load error		R_L = 10 kΩ	–	–	±0.5	LSB

AC Electrical Characteristics

V_{DD} = 5 V ±5%, V_{DR+} = 3 V, V_{DR-} = 1.0 V, T_a = −20 to 70 deg. C

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Settling time (full-scale transition)	t_{DAC}	R_L = 10 kΩ, C_L = 15 pF	–	–	2.5	µs
Data setup time	t_{SD}		150	–	–	ns
Data hold time	t_{HD}		10	–	–	ns
$\overline{WR}$ 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

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.

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