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10181
Arithmetic Unit

4-Bit Arithmetic Logic Unit/Function Generator

FEATURES

- **Typical propagation delay: 4.2ns**
- **Typical supply current ($-I_{EE}$): 130mA**

DESCRIPTION

The 10181 is a high-speed, Arithmetic Logic Unit. If performs 16 logic operations and 16 arithmetic operations on two 4-bit words. Arithmetic or logic mode of operation is selected by the mode control (M). Arithmetic logic operations are selected by a 4-bit select input (S_0 - S_3) in accordance with the function table. The device provides a group Carry Propagate (PG) and a Carry Generate (GG) for high-speed operations on very long words, using a 10179 as a high order look-ahead carry block. The internal carry is enabled while the mode control input (M) is Low (arithmetic operation).

All unused inputs can be left open due to integrated pull-down resistors which avoid the need for a supply voltage.

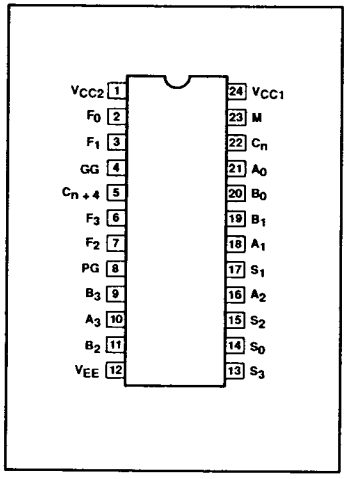
ORDERING INFORMATION

DESCRIPTION	ORDER CODE
24-Pin Plastic DIP	10181N
24-Pin Ceramic DIP	10181F

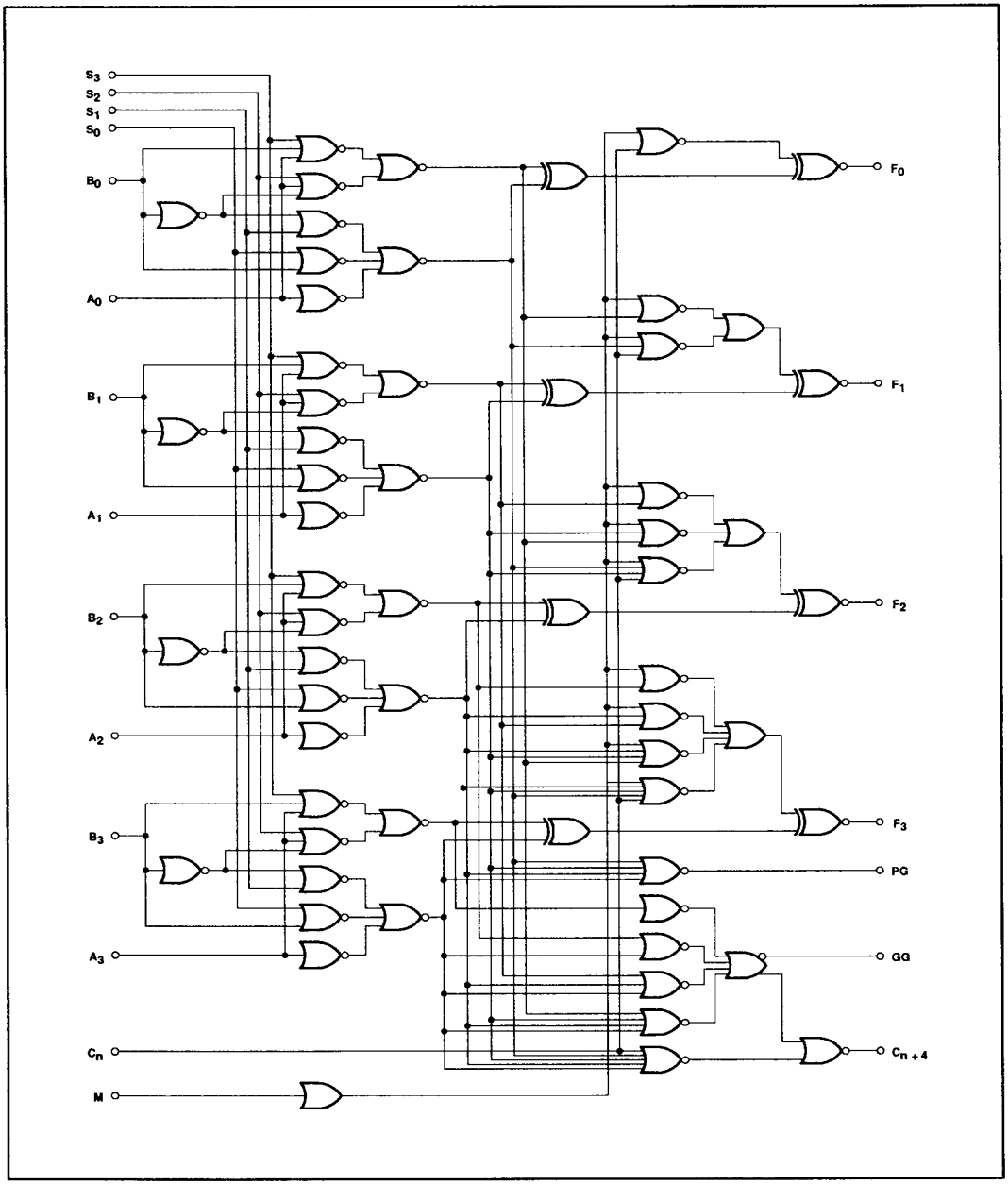
PIN DESCRIPTION

PINS	DESCRIPTION
M	Mode Control Input
$A_0 - A_3$, $B_0 - B_3$	Operand Inputs
$S_0 - S_3$	Function Select Inputs
C_n	Carry Inputs
$F_0 - F_3$	Data Outputs
C_{n+4}	Carry Output
GG	Carry Generate Output
PG	Carry Propagate Output

PIN CONFIGURATION



LOGIC DIAGRAM



FUNCTION TABLE

FUNCTION SELECT INPUTS				OUTPUT FUNCTION F		
				M = HIGH (Logic Mode)	M = LOW (Arithmetic Mode)	
S_3	S_2	S_1	S_0	C_n = H or L	C_n = LOW	C_n = HIGH
L	L	L	L	$\overline{A}$	A	A plus 1
L	L	L	H	$\overline{A} + \overline{B}$	A plus $A\overline{B}$	A plus $A\overline{B}$ plus 1
L	L	H	L	$\overline{A} + B$	A plus AB	A plus AB plus 1
L	L	H	H	HIGH	A plus A (2 times A)	A plus A plus 1
L	H	L	L	$\overline{A\,B}$	A + B	(A + B) plus 1
L	H	L	H	$\overline{B}$	(A + B) plus $A\overline{B}$	(A + B) plus $A\overline{B}$ plus 1
L	H	H	L	$\overline{A \oplus B}$	A plus B	A plus B plus 1
L	H	H	H	$A + \overline{B}$	(A + B) plus A	(A + B) plus A plus 1
H	L	L	L	$\overline{A}B$	$A + \overline{B}$	$(A + \overline{B})$ plus 1
H	L	L	H	$A \oplus B$	A minus B minus 1	A minus B
H	L	H	L	B	$(A + \overline{B})$ plus AB	$(A + \overline{B})$ plus AB plus 1
H	L	H	H	A + B	$(A + \overline{B})$ plus A	$(A + \overline{B})$ plus A plus 1
H	H	L	L	LOW	− 1 (2's complement)	Zero
H	H	L	H	$A\overline{B}$	$A\overline{B}$ minus 1	$A\overline{B}$
H	H	H	L	AB	AB minus 1	AB
H	H	H	H	A	A minus 1	A

H = High Voltage Level
L = Low Voltage Level

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER		LIMITS	UNIT
V_{EE}	Supply voltage		–8.0	V
V_{IN}	Input voltage (V_{IN} should never be more negative than V_{EE})		0 to V_{EE}	V
I_O	Output source current (continuous)		–50	mA
T_S	Storage temperature range		–55 to +150	°C
T_J	Maximum junction temperature	Ceramic Package	+165	°C
		Plastic Package	+150	°C

NOTE:
Operation beyond the limits set forth in this table may impair the useful life of the device. Unless otherwise noted, these limits are specified over the operating ambient temperature range.

DC OPERATING CONDITIONS

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS MIN.	LIMITS NOM.	LIMITS MAX.	UNIT
V_{CC1}, V_{CC2}	Circuit ground		0	0	0	V
V_{EE}	Supply voltage (negative)			–5.2		V
V_{IH}	High level input voltage	T_A = –30°C			–890	mV
		T_A = +25°C			–810	mV
		T_A = +85°C			–700	mV
V_{IHT}	High level input threshold voltage	T_A = –30°C	–1205			mV
		T_A = +25°C	–1105			mV
		T_A = +85°C	–1035			mV
V_{ILT}	Low level input threshold voltage	T_A = –30°C			–1500	mV
		T_A = +25°C			–1475	mV
		T_A = +85°C			–1440	mV
V_{IL}	Low level input voltage	T_A = –30°C	–1890			mV
		T_A = +25°C	–1850			mV
		T_A = +85°C	–1825			mV
T_A	Operating ambient temperature range		–30	+25	+85	°C

NOTE:
When operating at other than the specified V_{EE} voltage (–5.2V), the DC and AC Electrical Characteristics will vary slightly from specified values.

DC ELECTRICAL CHARACTERISTICS

$V_{CC1} = V_{CC2}$ = ground, V_{EE} = –5.2V ± 0.010V, T_A = –30°C to +85°C output loading 50Ω to –2.0V ± 0.010V unless otherwise specified[1,3]

SYMBOL	PARAMETER		TEST CONDITIONS[2]		LIMITS MIN.	LIMITS TYP.	LIMITS MAX.	UNIT
V_{OH}	High level output voltage		T_A = –30°C	All input/output combinations in accordance with the Functional Table. Input conditions: V_{ILMIN}, V_{IHMAX} (for V_{OH} and V_{OL}) or V_{ILT}, V_{IHT} (for V_{OHT} and V_{OLT}). Only one input at a time should be at V_{IHT} or V_{ILT}. Al other inputs should be at V_{IHMAX} or V_{ILMIN} curing test.	–1060		–890	mV
			T_A = +25°C		–960		–810	mV
			T_A = +85°C		–890		–700	mV
V_{OHT}	High level output threshold voltage		T_A = –30°C		–1080			mV
			T_A = +25°C		–980			mV
			T_A = +85°C		–910			mV
V_{OLT}	Low level output threshold voltage		T_A = –30°C				–1655	mV
			T_A = +25°C				–1630	mV
			T_A = +85°C				–1595	mV
V_{OL}	Low level output voltage		T_A = –30°C		–1890		–1675	mV
			T_A = +25°C		–1850		–1650	mV
			T_A = +85°C		–1825		–1615	mV
I_{IH}	High level input current	A_n inputs	T_A = –30°C	Apply V_{IHMAX} to each input under test, one at a time, with V_{ILMIN} applied to all other inputs.			350	µA
			T_A = +25°C				220	µA
			T_A = +85°C				220	µA
		B_n inputs	T_A = –30°C				390	µA
			T_A = +25°C				245	µA
			T_A = +85°C				245	µA
		S_n inputs	T_A = –30°C				425	µA
			T_A = +25°C				265	µA
			T_A = +85°C				265	µA
		C_n input	T_A = –30°C	Apply V_{IHMAX} to C_n input with V_{ILMIN} applied to all other inputs.			460	µA
			T_A = +25°C				290	µA
			T_A = +85°C				290	µA
		M input	T_A = –30°C	Apply V_{IHMAX} to M input with V_{ILMIN} applied to all other inputs.			320	µA
			T_A = +25°C				200	µA
			T_A = +85°C				200	µA
I_{IL}	Low level input current		T_A = –30°C	Apply V_{ILMIN} to each input under test, one at a time, with V_{IHMAX} applied to all other inputs.	0.5			µA
			T_A = +25°C		0.5			µA
			T_A = +85°C		0.3			µA
$-I_{EE}$	V_{EE} supply current		T_A = –30°C	Apply V_{IHMAX} to all inputs.			150	mA
			T_A = +25°C			130	145	mA
			T_A = +85°C				150	mA

DC ELECTRICAL CHARACTERISTICS (Continued)

SYMBOL	PARAMETER	TEST CONDITIONS[2]	LIMITS MIN.	LIMITS TYP.	LIMITS MAX.	UNIT
$\frac{\Delta V_{OH}}{\Delta V_{EE}}$	High level output voltage compensation	T_A = +25°C		0.016		V/V
$\frac{\Delta V_{OL}}{\Delta V_{EE}}$	Low level output voltage compensation			0.250		V/V
$\frac{\Delta V_{BB}}{\Delta V_{EE}}$	Reference bias voltage compensation			0.148		V/V

NOTES:

4. The specified limits represent the worst case values for the parameter. Since these worst case values normally occur at the supply voltage and temperature extremes, additional noise immunity can be achieved by decreasing the allowable operating condition ranges.
5. Conditions for testing shown in the tables are not necessarily worst case. For worst case testing guidelines, refer to DC Testing, Chapter 1, Section 3.
6. The specified limits shown in the DC Electrical Characteristics table can be met only after thermal equilibrium has been established. Thermal equilibrium is established by applying power for at least 2 minutes, while maintaining transverse airflow of 2.5 meters/sec (500 linear feet/min) over the device, mounted either in a test socket or on a printed circuit board. Test voltage values are given in the DC Operating Conditions table.

AC ELECTRICAL CHARACTERISTICS $V_{CC1} = V_{CC2}$ = ground, $V_{EE} = -5.2V \pm 0.010V$

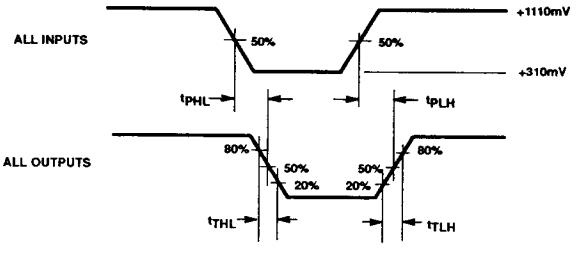
SYMBOL	PARAMETER	TEST CONDITIONS[1]	LIMITS T_A = −30°C MIN.	LIMITS T_A = −30°C MAX.	LIMITS T_A = +25°C MIN.	LIMITS T_A = +25°C TYP.	LIMITS T_A = +25°C MAX.	LIMITS T_A = +85°C MIN.	LIMITS T_A = +85°C MAX.	UNIT
t_{PLH} t_{PHL}	Propagation delay C_n to C_{n+4}	Waveform 1 A_0, A_1, A_2, A_3	1.00 1.00	5.10 5.10	1.10 1.10	3.10 3.10	5.00 5.00	1.10 1.10	5.40 5.40	ns ns
t_{TLH} t_{THL}	Transition time[2] C_n to C_{n+4}	Waveform 1 A_0, A_1, A_2, A_3	1.00 1.00	3.20 3.20	1.00 1.00	2.00 2.00	3.00 3.00	1.00 1.00	3.20 3.20	ns ns
t_{PLH} t_{PHL}	Propagation delay C_n to F_1	Waveform 1 A_0	1.70 1.70	7.20 7.20	2.00 2.00	4.50 4.50	7.00 7.00	2.00 2.00	7.50 7.50	ns ns
t_{TLH} t_{THL}	Transition time[2] C_n to F_1	Waveform 1 A_0	1.30 1.30	5.30 5.30	1.50 1.50	3.00 3.00	5.00 5.00	1.50 1.50	5.30 5.30	ns ns
t_{PLH} t_{PHL}	Propagation delay A_1 to F_1	Waveform 1	2.60 2.60	10.40 10.40	3.00 3.00	6.50 6.50	10.00 10.00	3.00 3.00	10.80 10.80	ns ns
t_{TLH} t_{THL}	Transition time[2] A_1 to F_1	Waveform 1	1.30 1.30	5.40 5.40	1.50 1.50	3.00 3.00	5.00 5.00	1.50 1.50	5.30 5.30	ns ns
t_{PLH} t_{PHL}	Propagation delay A_1 to PG	Waveform 1 S_0, S_3	1.60 1.60	7.00 7.00	2.00 2.00	5.00 5.00	6.50 6.50	2.00 2.00	7.00 7.00	ns ns
t_{TLH} t_{THL}	Transition time[2] A_1 to PG	Waveform 1 S_0, S_3	0.80 0.80	3.70 3.70	1.10 1.10	2.00 2.00	3.50 3.50	1.10 1.10	3.80 3.80	ns ns
t_{PLH} t_{PHL}	Propagation delay A_1 to GG	Waveform 1 A_0, A_2, A_3, C_n	1.10 1.10	7.40 7.40	2.00 2.00	4.50 4.50	7.00 7.00	1.30 1.30	7.70 7.70	ns ns
t_{TLH} t_{THL}	Transition time[2] A_1 to GG	Waveform 1 A_0, A_2, A_3, C_n	1.20 1.20	5.10 5.10	1.50 1.50	4.00 4.00	5.00 5.00	1.20 1.20	5.30 5.30	ns ns
t_{PLH} t_{PHL}	Propagation delay A_1 to C_{n+4}	Waveform 1 A_0, A_2, A_3, C_n	1.70 1.70	7.30 7.30	2.00 2.00	5.00 5.00	7.00 7.00	2.00 2.00	7.80 7.80	ns ns
t_{TLH} t_{THL}	Transition time[2] A_1 to C_{n+4}	Waveform 1 A_0, A_2, A_3, C_n	1.00 1.00	3.10 3.10	1.00 1.00	2.00 2.00	3.00 3.00	1.00 1.00	3.20 3.20	ns ns
t_{PLH} t_{PHL}	Propagation delay B_1 to F_1	Waveform 1 S_3, C_n	2.70 2.70	11.30 11.30	3.00 3.00	8.00 8.00	11.00 11.00	3.00 3.00	11.90 11.90	ns ns
t_{TLH} t_{THL}	Transition time[2] B_1 to F_1	Waveform 1 S_3, C_n	1.20 1.20	5.30 5.30	1.50 1.50	3.50 3.50	5.00 5.00	1.50 1.50	5.30 5.30	ns ns
t_{PLH} t_{PHL}	Propagation delay B_1 to PG	Waveform 1 S_0, S_3	1.60 1.60	7.70 7.70	2.00 2.00	6.00 6.00	7.50 7.50	2.00 2.00	8.00 8.00	ns ns
t_{TLH} t_{THL}	Transition time[2] B_1 to PG	Waveform 1 S_0, S_3	1.00 1.00	3.60 3.60	1.00 1.00	2.00 2.00	3.50 3.50	1.10 1.10	3.90 3.90	ns ns

AC ELECTRICAL CHARACTERISTICS (Continued)

SYMBOL	PARAMETER	TEST CONDITIONS[1]	LIMITS							UNIT
			$T_A = -30°C$		$T_A = +25°C$			$T_A = +85°C$		
			MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
t_{PLH} t_{PHL}	Propagation delay B_1 to GG	Waveform 1 S_3, C_n	1.70 1.70	8.20 8.20	2.00 2.00	6.00 6.00	8.00 8.00	2.00 2.00	8.60 8.60	ns ns
t_{TLH} t_{THL}	Transition time[2] B_1 to GG	Waveform 1 S_3, C_n	1.40 1.40	5.20 5.20	1.50 1.50	3.00 3.00	5.00 5.00	1.20 1.20	5.40 5.40	ns ns
t_{PLH} t_{PHL}	Propagation delay B_1 to C_{n+4}	Waveform 1 S_3, C_n	1.80 1.80	8.20 8.20	2.00 2.00	6.00 6.00	8.00 8.00	2.00 2.00	8.70 8.70	ns ns
t_{TLH} t_{THL}	Transition time[2] B_1 to C_{n+4}	Waveform 1 S_3, C_n	0.90 0.90	3.10 3.10	1.00 1.00	2.00 2.00	3.00 3.00	1.00 1.00	3.20 3.20	ns ns
t_{PLH} t_{PHL}	Propagation delay M to F_1	Waveform 1	2.40 2.40	10.30 10.30	3.00 3.00	6.50 6.50	10.00 10.00	3.00 3.00	10.80 10.80	ns ns
t_{TLH} t_{THL}	Transition time[2] M to F_1	Waveform 1	1.10 1.10	5.10 5.10	1.50 1.50	4.00 4.00	5.00 5.00	1.50 1.50	5.30 5.30	ns ns
t_{PLH} t_{PHL}	Propagation delay S_1 to F_1	Waveform 1 A_1, B_1	2.50 2.50	10.70 10.70	3.00 3.00	6.50 6.50	10.00 10.00	3.00 3.00	10.80 10.80	ns ns
t_{TLH} t_{THL}	Transition time[2] S_1 to F_1	Waveform 1 A_3, B_3	1.00 1.00	5.40 5.40	1.50 1.50	3.00 3.00	5.00 5.00	1.50 1.50	5.40 5.40	ns ns
t_{PLH} t_{PHL}	Propagation delay S_1 to PG	Waveform 1 A_3, B_3	1.70 1.70	8.30 8.30	2.00 2.00	6.00 6.00	8.00 8.00	2.00 2.00	8.40 8.40	ns ns
t_{TLH} t_{THL}	Transition time[2] S_1 to PG	Waveform 1 A_3, B_3	0.80 0.80	5.10 5.10	1.10 1.10	3.00 3.00	5.00 5.00	1.10 1.10	5.20 5.20	ns ns
t_{PLH} t_{PHL}	Propagation delay S_1 to C_{n+4}	Waveform 1 A_3, B_3	1.60 1.60	9.30 9.30	2.00 2.00	6.00 6.00	9.00 9.00	2.00 2.00	9.90 9.90	ns ns
t_{TLH} t_{THL}	Transition time[2] S_1 to C_{n+4}	Waveform 1 A_3, B_3	0.90 0.90	5.30 5.30	1.10 1.10	3.00 3.00	5.00 5.00	1.00 1.00	5.20 5.20	ns ns
t_{PLH} t_{PHL}	Propagation delay S_1 to GG	Waveform 1 A_3, B_3	1.50 1.50	9.60 9.60	2.00 2.00	6.00 6.00	9.00 9.00	1.90 1.90	9.70 9.70	ns ns
t_{TLH} t_{THL}	Transition time[2] S_1 to GG	Waveform 1 A_3, B_3	0.80 0.80	6.20 6.20	0.80 0.80	3.00 3.00	6.00 6.00	0.80 0.80	6.50 6.50	ns ns

NOTES:
1. Apply 1110mV to pins listed with 310mV applied to all other inputs.
2. All transition times are from 20% to 80% and 80% to 20% (refer to Waveform 1).
3. For AC test setup information, see AC Testing, Chapter 2, Section 3.

AC WAVEFORMS



Waveform 1. Propagation Delay and Transition Times