NEC

Section 5
Electrical Characteristics

The electrical characteristics of a particular gate array design are determined after evaluation of samples. This section describes the standard characteristics by a series of tables and graphs.

Tables

Exposure to the absolute maximum ratings in table 5-1 for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The gate array device should not be operated under conditions outside those recommended in table 5-2. The input signal specifications depend on whether the interface is with a CMOS-level or TTL-level device.

Tables 5-3 and 5-4 show dc characteristics and ac characteristics. Some of these signal specifications are dependent on an external CMOS or TTL interface, also. If all input and output signals interface with CMOS-level devices, the supply voltage and ambient temperature limits of the gate array chip are:

$V_{DD} = 5.0$ volts $\pm 10\%$
$T_A = -40$ to $+85$ °C

If one or more of the signals interface with TTL-level devices:

$V_{DD} = 5.0$ volts $\pm 5\%$
$T_A = -40$ to $+85$ °C

Table 5-5 lists the maximum internal capacitance that you may expect at the signal ports of the gate array chip.

Table 5-1. Absolute Maxium Ratings

$T_A = +25$ °C

Power supply voltage, V_{DD}	−0.5 to +7.0 V
Input voltage, V_I	−0.5 V to V_{DD} + 0.5 V
Input current, I_I	40 mA
Output current, I_O	40 mA
Operating temperature, T_{OPT}	−40 to +85 °C
Storage temperature, T_{STG}	−65 to +150 °C

Table 5-2. Recommended Operating Conditions

		CMOS Level		TTL Level		
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Unit**
Power supply voltage	V_{DD}	4.5	5.5	4.75	5.25	V
Ambient temperature	T_A	−40	+85	0	+70	°C
Low-level input voltage	V_{IL}	0	0.3 V_{DD}	0	0.8	V
High-level input voltage	V_{IH}	0.7 V_{DD}	V_{DD}	2.0	V_{DD}	V
Input rise or fall time (1)	t_R, t_F	0	10	0	10	μs
Positive Schmitt trigger voltage (2)	V_P	1.8	4.0	1.2	2.3	V
Negative Schmitt trigger voltage (2)	V_N	0.6	3.1	0.6	1.8	V
Hysteresis voltage (2)	V_H	0.3	1.5	0.3	1.5	V

Note:

(1) For Schmitt trigger input buffers.

(2) $V_{DD} = 5.0$ V

Table 5-3. DC Characteristics

V_{DD} = 5 V ±10%; T_A = −40 to +85 °C

Parameter	Symbol	Limits Min	Typ	Max	Unit	Test Conditions
Static current (Note 1)	IL		0.1	200	μA	$V_I = V_{DD}$ or GND
Input current						
With pull-up	I_I	25	80	250	μA	V_I = GND
With pull-down	I_I	25	80	250	μA	$V_I = V_{DD}$
Without resistor (Note 1)	I_I		10^{-5}	10	μA	$V_I = V_{DD}$ or GND
Dynamic current	I_{DD}		3		μA	Per cell at 1 MHz
Off-state output leakage current	I_{OZ}			10	μA	$V_O = V_{DD}$ or GND
Low-level output current (Note 2)						
Buffer FO01 (Note 3)	I_{OL}	4.0 (4.3)	11		mA	V_{OL} = 0.4 V
Buffer FO02	I_{OL}	5.6 (6.0)	15		mA	
Buffer FO03 (Note 4)	I_{OL}	12 (13)	15		mA	
High-level output current (Note 2)						
Buffer FO01 (Note 3)	I_{OH}	4.0 (4.3)	8		mA	$V_{OH} = V_{DD}$ − 0.4 V
Buffer FO02	I_{OH}	5.6 (6.0)	11		mA	
Buffer FO03 (Note 4)	I_{OH}	12 (13)	11		mA	
Low-level output voltage	V_{OL}			0.1	V	I_O = 0 mA
High-level output voltage	V_{OH}	V_{DD} − 0.1			V	

Note:

(1) Not applicable to blocks with a pull-up or pull-down resistor or to oscillator blocks.

(2) Current values in parentheses are for TTL level interface. V_{DD} = 5 V ±5% and T_A = −40 to +85 °C.

(3) Current values for FO01 are applicable to these low-drive output buffers:
B003, B004, B008
B0D3, B0D4, B0D8
B0U3, B0U4, B0U8
EXT1, EXT2, EXT3, EXT4

(4) Current values for FO03 are applicable to these high-drive output buffers:
B005, B006, B009
B0D5, B0D6, B0D9
B0U5, B0U6, B0U9
EXT5, EXT6, EXT7, EXT8

Table 5-4. AC Characteristics

V_{DD} = 5 V ±10%; T_A = −40 to +85 °C

Parameter	Symbol	Limits Min	Typ	Max	Unit	Test Conditions
Max operating frequency (Note 1)	f_{max}			70 (75)	MHz	Internal toggle; F/O = 1
Delay time, internal gate	t_{PD}		1.4		ns	F/O = 3; L = 3 mm
Delay time, input buffer	t_{PD}		2.0		ns	
Delay time, output buffer	t_{PD}		4.0		ns	C_L = 15 pF
Output rise time	t_R		3.2		ns	
Output fall time	t_F		2.2		ns	

Note:

(1) Frequency in parentheses is for TTL level interface. V_{DD} = 5 V ±5% and T_A = −40 to +85 °C.

Table 5-5. Input/Output Capacitance

Terminal	Symbol	Limits Typ	Max	Unit	Test Conditions
Input	C_{IN}		10	pF	$V_{DD} = V_I$ = 0 V; f = 1 MHz
Output	C_{OUT}		30	pF	
I/O	$C_{I/O}$		35	pF	

Graphs

Figures 5-1 through 5-5 are graphs depicting the operating characteristics.

Figure	Description
5-1	Input buffers (V_O vs V_I)
5-2	Input buffers (V_I vs V_{DD})
5-3	Input buffers (V_I vs T_A)
5-4	Internal gate delay time
5-5	Output buffers (also see Section 4)

Figure 5-1. Input Buffers; Output Voltage vs Input Voltage

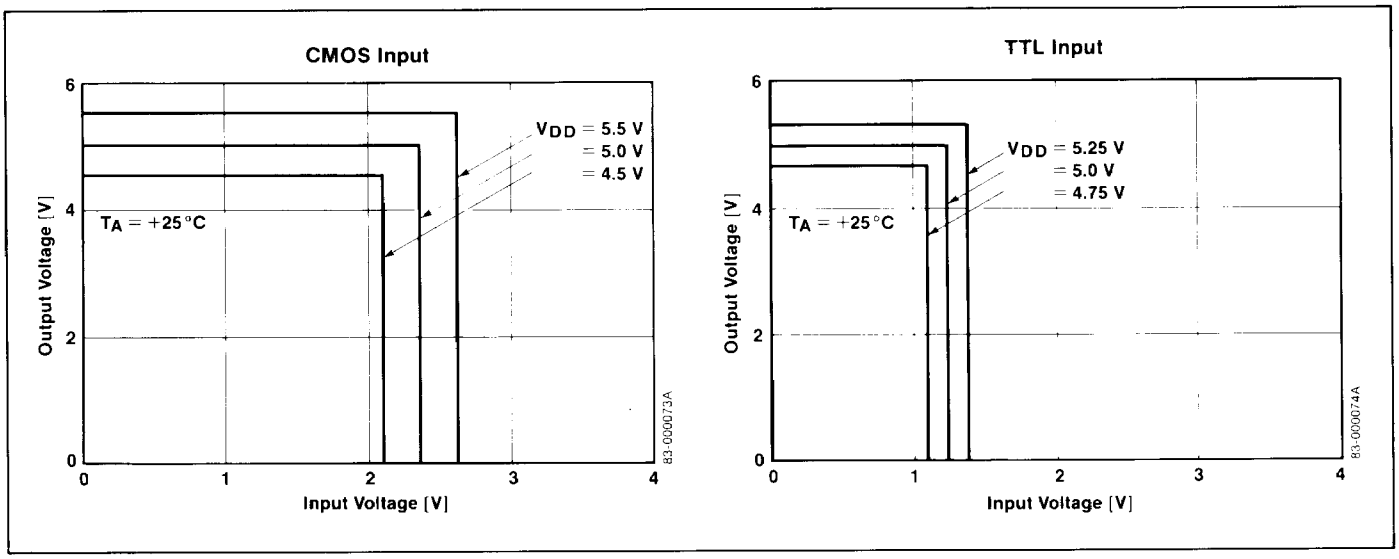

Figure 5-2. Input Buffers; Threshold Voltage vs Supply Voltage

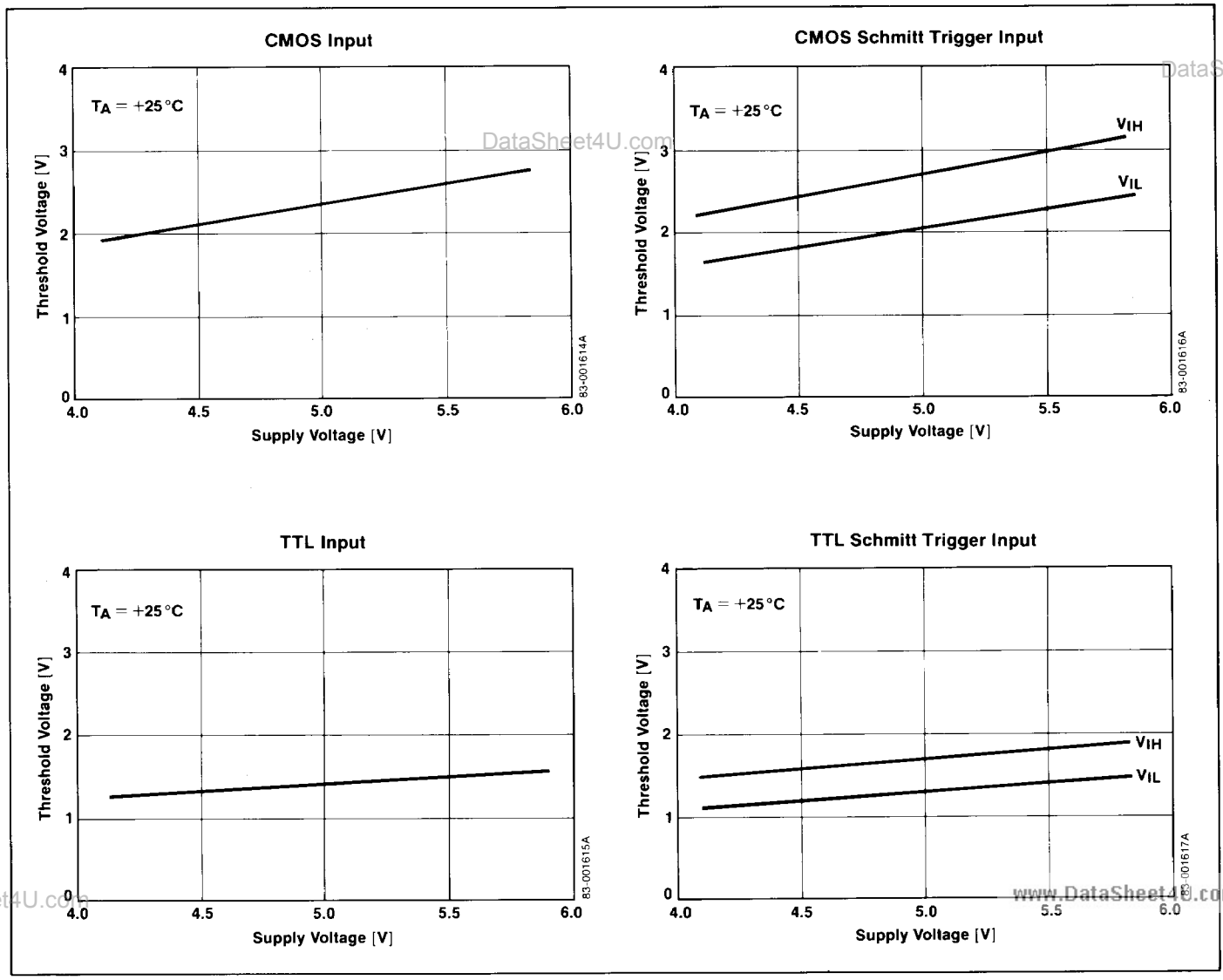

Figure 5-3. Input Buffers; Threshold Voltage vs Ambient Temperature

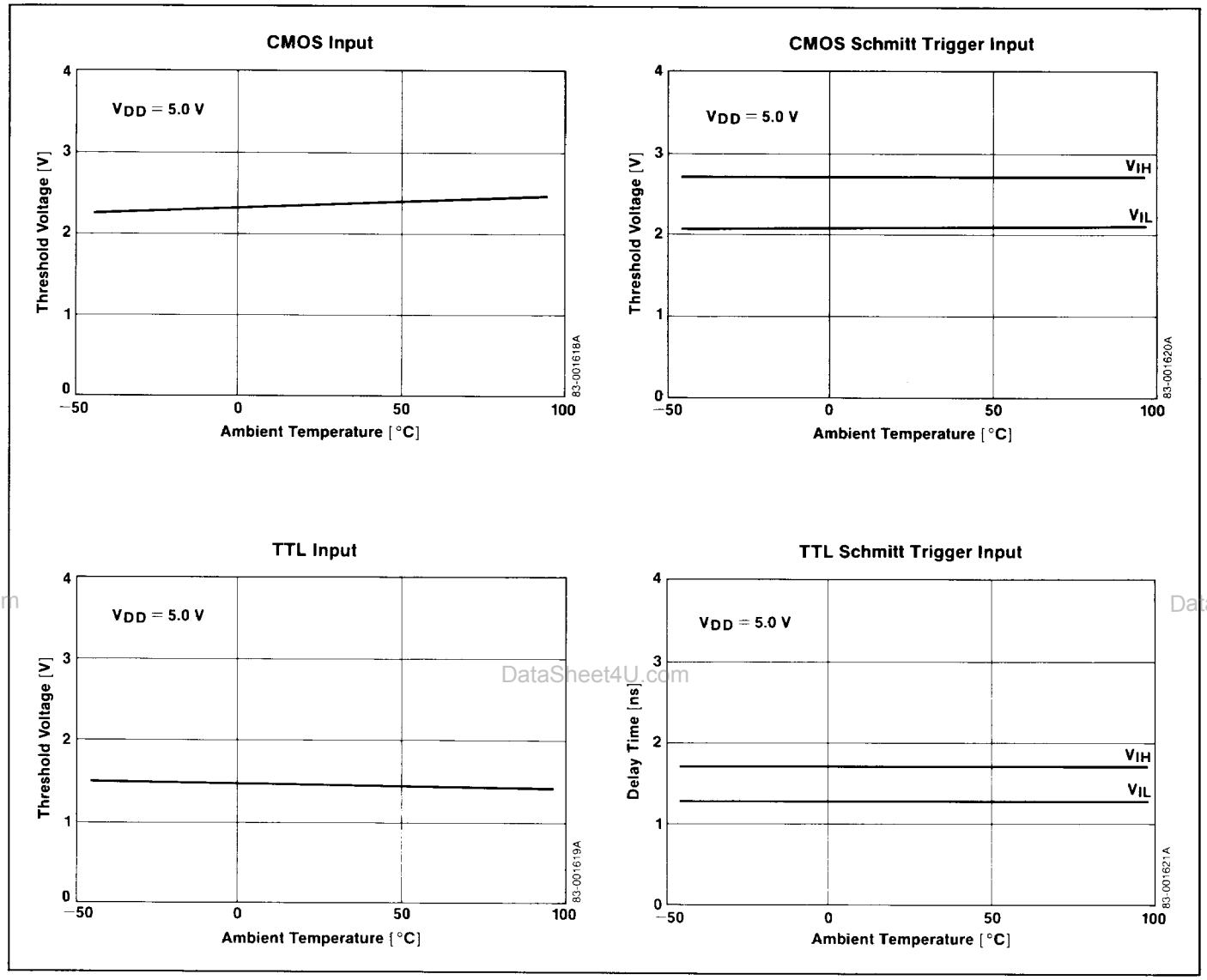

Figure 5-4. Internal Gate Delay Time

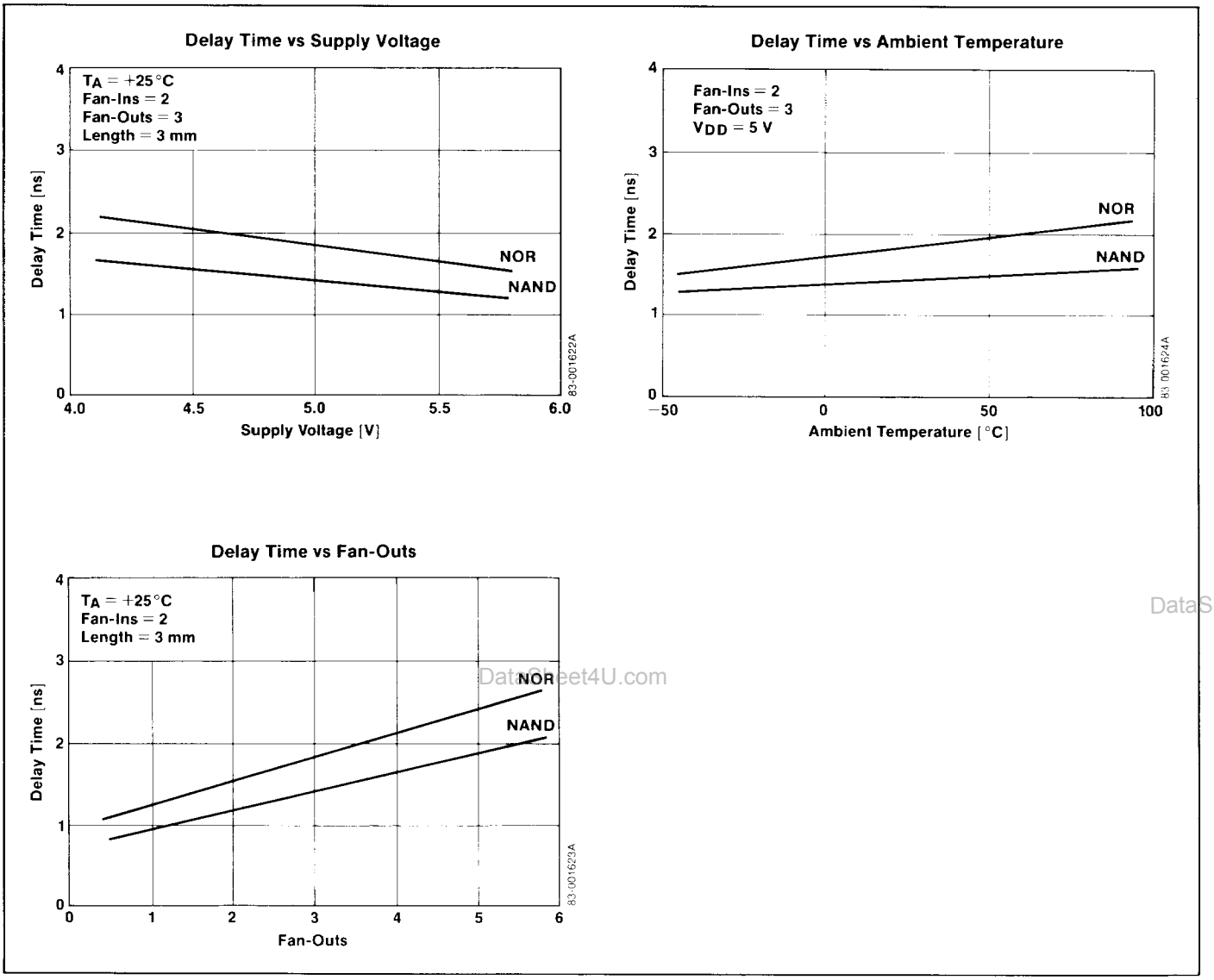

Figure 5-5. Output Buffers (FO01); Output Current vs Output Voltage