FUJITSU SEMICONDUCTOR
DATA SHEET

DS06-20112-2E

Semicustom

CMOS

Embedded array

CE77 Series

■ DESCRIPTION

The CE77 series 0.25 μm CMOS embedded array is a line of highly integrated CMOS ASICs featuring high speed and low power consumption at the same time.

CE77 series is available in 15 frames with the enhanced lineup of 470 K to 6980 K gates.

■ FEATURES

- Technology : 0.25 μm silicon-gate CMOS, 3- to 4-layer wiring
- Supply voltage : +2.5 V ± 0.2 V (normal) to +1.5 V ± 0.1 V
- Junction temperature range : –40 °C to +125 °C
- Gate delay time : t_{pd} = 33 ps (2.5 V, inverter cell High Speed type, F/O = 1, No load)
- Gate power consumption : 0.02 μW/MHz (1.5 V, F/O = 1, No load)
- High-load driving capability : I_{OL} = 2 mA/4 mA/8 mA/12 mA mixable
- Output buffer cells with noise reduction circuits
- Inputs with on-chip input pull-up/pull-down resistors (25 kΩ typical) and bidirectional buffer cells
- Buffer cells dedicated to crystal oscillator
- Special interface (P-CML, LVDS, T-LVTTL, SSTL, PCI, USB, GTL+, and others including those under development)
- IP macros (CPU, PCI, USB, IrDA, PLL, DAC, ADC, and others including those under development)
- Capable of incorporating compiled cells (RAM/ROM/FIFO/Delay line, and others.)
- Configurable internal bus circuits
- Advanced hardware/software co-design environment
- Support for static timing sign-off
  Dramatically reducing the time for generating test vectors for timing verification and the simulation time
- Hierarchical design environment for supporting large-scale circuits
- Simulation (before layout) considering the input slew rate and detailed RC delay calculation (after layout) , supporting development with minimized timing trouble after trial manufacture

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- Support for memory (RAM/ROM) SCAN
- Support for memory (RAM) BIST
- Support for boundary SCAN
- Support for path delay test
- A variety of package options
  (SQFP, HQFP, PBGA, LQFP, FBGA under development)

■ MACRO LIBRARY (Including macros being prepared)

1. Logic cells (about 700 types)

- Adder
- AND-OR Inverter
- Clock Buffer
- Latch
- NAND
- AND
- NOR
- SCAN Flip Flop
- BUS Driver
- EOR
- Others
- AND-OR
- Decoder
- Non-SCAN Flip Flop
- Inverter
- Buffer
- OR-AND Inverter
- OR
- Selector
- ENOR
- Boundary Scan Register

2. IP macros

CPU	SPARClite, ARM7
Interface macro	USB, IrDA, etc.
Multimedia processing macros	JPEG, etc.
Mixed signal macros	ADC, DAC, Analog switch, etc.
Compiled macros	RAM, ROM, FIFO, Delay Line,
PLL	Analog PLL

3. Special I/O interface macros

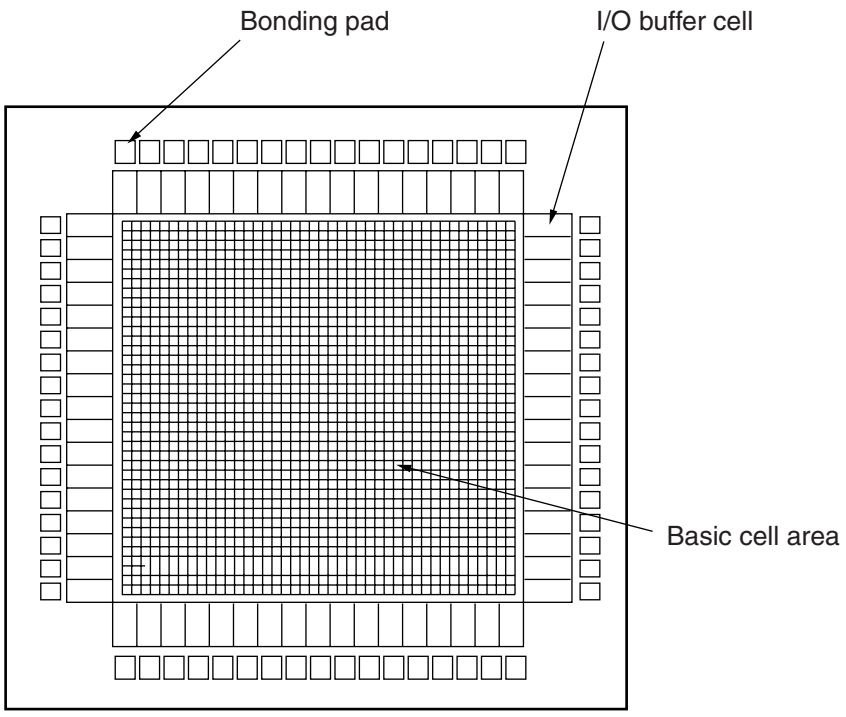
- P-CML
- USB

■ CHIP STRUCTURE

The chip layout of the CE77 series consists of two major areas : chip peripheral area and basic cell area.

The chip peripheral area contains the input/output buffer cells for interfacing with external devices and the associated bonding pads. The basic cell area contains some of input/output buffer cells, the unit cells and the compiled cells.

- Chip configuration



■ COMPILED CELLS

Compiled cells are macro cells which are automatically generated with the bit/word configuration specified. The CE77 series has the following types of compiled cells (Note that each macro is different in word/bit range depending on the column type) .

1. Clock synchronous single-port RAM (1 address, 1 RW)

(High density type) / (Partial write type)

Column type	Memory capacity	Word range	Bit range	Unit
4	16 to 72 K	16 to 1 K	1 to 72	bit
16	64 to 72 K	64 to 4 K	1 to 18	bit

(Ultra high density type)

Column type	Memory capacity	Word range	Bit range	Unit
4	64 to 72 K	32 to 1 K	2 to 72	bit
4	2064 to 512 K	1032 to 4 K	2 to 128	bit
16	4160 to 512 K	2080 to 16 K	2 to 32	bit

(Low power consumption type)

Column type	Memory capacity	Word range	Bit range	Unit
4	128 to 72 K	32 to 1 K	4 to 72	bit
8	256 to 72 K	64 to 2 K	4 to 36	bit

(High speed type)

Column type	Memory capacity	Word range	Bit range	Unit
8	128 to 144 K	32 to 2 K	4 to 72	bit

2. Clock synchronous dual-port RAM (2 addresses, 1 RW/1 R)

Column type	Memory capacity	Word range	Bit range	Unit
4	16 to 72 K	16 to 1 K	1 to 72	bit
16	64 to 72 K	64 to 4 K	1 to 18	bit

3. Clock synchronous register file (3 addresses, 1W/2R)

Column type	Memory capacity	Word range	Bit range	Unit
1	4608	4 to 64	1 to 72	bit

4. Clock synchronous register file (4 addresses, 2W/2R)

Column type	Memory capacity	Word range	Bit range	Unit
1	4608	4 to 64	1 to 72	bit

5. Clock synchronous ROM (1 address, 1R)

Column type	Memory capacity	Word range	Bit range	Unit
8	128 to 512 K	32 to 4 K	4 to 128	bit
16	128 to 512 K	64 to 8 K	2 to 64	bit

6. Clock synchronous delay line memory (2 addresses, 1W/1R)

Column type	Memory capacity	Word range	Bit range	Unit
8	512 to 32 K	32 to 1 K	16 to 32	bit
16	512 to 32 K	64 to 2 K	8 to 16	bit
32	512 to 32 K	128 to 4 K	4 to 8	bit

7. Clock synchronous FIFO memory (2 addresses, 1W/1R)

Column type	Memory capacity	Word range	Bit range	Unit
8	512 to 32 K	32 to 1 K	16 to 32	bit
16	512 to 32 K	64 to 2 K	8 to 16	bit
32	512 to 32 K	128 to 4 K	4 to 8	bit

■ ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Application	Rating		Unit
				Min	Max	
Power supply voltage*1		V_{DD}	V_{DD} = 1.4 V to 2.7 V	− 0.5	+3.0*4	V
			V_{DD} = 2.7 V to 3.6 V		+4.0*5	
Input voltage *1		V_I	—	− 0.5	V_{DD} + 0.5 (≤ 3.0 V) *4	V
					V_{DD} + 0.5 (≤ 4.0 V) *5	
Output voltage*1		V_O	—	− 0.5	V_{DD} + 0.5 (≤ 3.0 V) *4	V
					V_{DD} + 0.5 (≤ 4.0 V) *5	
Storage temperature		Tst	—	−55	+125	°C
Junction temperature		Tj	—	−40	+125	°C
Output current*2	L type	I_O	Powerless type (I_{OL} = 2 mA)	—	±13	mA
	M type		Normal type (I_{OL} = 4 mA)	—	±13	
	H type		Power type (I_{OL} = 8 mA)	—	±13	
	V type		High power type (I_{OL} = 12 mA)	—	±26	
Power-supply pin current *3		I_D	Per V_{DD}, GND pin	—	60	mA

*1 : V_{SS} = 0 V

*2 : Maximum output current which can be supplied constantly.

*3 : Maximum supply current which can be supplied constantly.

*4 : Internal gate part in case of single power supply or dual power supply.

*5 : I/O part in case 3.3 V I/F or 2.5 V I/F is used by dual power supply.

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

■ RECOMMENDED OPERATING CONDITIONS

1. Single power supply

• Conditions: V_{DD} = 2.5 V±0.2 V, V_{SS} = 0 V

Parameter		Symbol	Value			Unit
			Min	Typ	Max	
Power supply voltage		V_{DD}	2.3	2.5	2.7	V
"H" level input voltage	CMOS normal	V_{IH}	1.7	—	V_{DD} + 0.3	V
	CMOS schmitt		V_{DD} × 0.8			
"L" level input voltage	CMOS normal	V_{IL}	–0.3	—	+0.7	V
	CMOS schmitt				V_{DD} × 0.2	
Junction temperature		T_j	–40	—	+125	°C

• Conditions: V_{DD} = 1.8 V±0.15 V, V_{SS} = 0 V

Parameter		Symbol	Value			Unit
			Min	Typ	Max	
Power supply voltage		V_{DDI}	1.65	1.8	1.95	V
"H" level input voltage	CMOS normal	V_{IH}	V_{DD} × 0.65	—	V_{DD} + 0.3	V
	CMOS schmitt		V_{DD} × 0.8			
"L" level input voltage	CMOS normal	V_{IL}	–0.3	—	V_{DD} × 0.35	V
	CMOS schmitt				V_{DD} × 0.2	
Junction temperature		T_j	–40	—	+125	°C

• Conditions: V_{DD} = 1.5 V±0.1 V, V_{SS} = 0 V

Parameter		Symbol	Value			Unit
			Min	Typ	Max	
Power supply voltage		V_{DDI}	1.4	1.5	1.6	V
"H" level input voltage	CMOS normal	V_{IH}	V_{DD} × 0.7	—	V_{DD} + 0.3	V
	CMOS schmitt		V_{DD} × 0.8			
"L" level input voltage	CMOS normal	V_{IL}	–0.3	—	V_{DD} × 0.3	V
	CMOS schmitt				V_{DD} × 0.2	
Junction temperature		T_j	–40	—	+125	°C

2. Dual power supply

• Conditions: V_{DDE} = 3.3 V±0.3 V/V_{DDI} = 2.5 V±0.2 V, V_{DDI} = 1.8 V±0.15 V, V_{DDI} = 1.5 V±0.1 V, V_{SS} = 0 V

Parameter		Symbol	Value			Unit
			Min	Typ	Max	
Power supply voltage		V_{DDE}	3.0	3.3	3.6	V
		V_{DDI}	1.4	—	2.7	
“H” level input voltage	1.5 V CMOS normal	V_{IH}	$V_{DDI} \times 0.7$	—	$V_{DDI} + 0.3$	V
	1.8 V CMOS normal		$V_{DDI} \times 0.65$			
	2.5 V CMOS normal		1.7			
	3.3 V CMOS normal		2.0		$V_{DDE} + 0.3$	
	1.5 V CMOS schmitt		$V_{DDI} \times 0.8$		$V_{DDI} + 0.3$	
	1.8 V CMOS schmitt					
	2.5 V CMOS schmitt					
	3.3 V CMOS schmitt		$V_{DDE} \times 0.8$		$V_{DDE} + 0.3$	
	5 V Tolerant		2.0		5.5	
“L” level input voltage	1.5 V CMOS normal	V_{IL}	–0.3	—	$V_{DDI} \times 0.3$	V
	1.8 V CMOS normal				$V_{DDI} \times 0.35$	
	2.5 V CMOS normal				+ 0.7	
	3.3 V CMOS normal				+ 0.8	
	1.5 V CMOS schmitt				$V_{DDI} \times 0.2$	
	1.8 V CMOS schmitt					
	2.5 V CMOS schmitt					
	3.3 V CMOS schmitt				$V_{DDE} \times 0.2$	
	5 V Tolerant				+ 0.8	
Junction temperature		T_j	–40	—	+125	°C

• **Conditions:** V_{DDE} = 2.5 V±0.2 V/V_{DDI} = 1.8 V±0.15 V, V_{DDI} = 1.5 V±0.1 V, V_{SS} = 0 V

Parameter		Symbol	Value			Unit
			Min	Typ	Max	
Power supply voltage		V_{DDE}	2.3	2.5	2.7	V
		V_{DDI}	1.4	—	1.95	
"H" level input voltage	1.5 V CMOS normal	V_{IH}	$V_{DDI} \times 0.7$	—	$V_{DDI} + 0.3$	V
	1.8 V CMOS normal		$V_{DDI} \times 0.65$			
	2.5 V CMOS normal		1.7		$V_{DDE} + 0.3$	
	1.5 V CMOS schmitt		$V_{DDI} \times 0.8$		$V_{DDI} + 0.3$	
	1.8 V CMOS schmitt					
	2.5 V CMOS schmitt		$V_{DDE} \times 0.8$		$V_{DDE} + 0.3$	
"L" level input voltage	1.5 V CMOS normal	V_{IL}	–0.3	—	$V_{DDI} \times 0.3$	V
	1.8 V CMOS normal				$V_{DDI} \times 0.35$	
	2.5 V CMOS normal				0.7	
	1.5 V CMOS schmitt				$V_{DDI} \times 0.2$	
	1.8 V CMOS schmitt					
	2.5 V CMOS schmitt				$V_{DDE} \times 0.2$	
Junction temperature		T_j	–40	—	+125	°C

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

■ DC CHARACTERISTICS

- **Single power supply** : V_{DD} = **2.5 V** (**Standard**)

(V_{DD} = 2.5 V ± 0.2 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C)

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Power supply current*1	I_{DDS}	T2	—	—	0.1	mA
		T3, T4	—	—	0.2	
		T5 to T7	—	—	0.3	
		T8, T9	—	—	0.4	
		TA	—	—	0.5	
		TB, TC	—	—	0.6	
		TD	—	—	0.8	
		TE	—	—	1.0	
		TF	—	—	1.1	
		TG	—	—	1.3	
“H” level output voltage	V_{OH}	I_{OH} = –100 µA	V_{DD} – 0.2	—	V_{DD}	V
“L” level output voltage	V_{OL}	I_{OL} = 100 µA	0	—	0.2	V
“H” level output voltage V-I characteristics	—	2.5 V V_{DD} = 2.5 V±0.2 V	*2	—	—	—
“L” level output current V-I characteristics	—	2.5 V V_{DD} = 2.5 V±0.2 V	*2	—	—	—
Input leakage current	I_L	—	—	—	±5	µA
Pull-up/pull-down resistance	R_P	Pull-up V_{IL} = 0 V Pull-down V_{IH} = V_{DD}	10	25	120	kΩ

*1 : When the memory is in a standby mode and analog macro is in a power-down mode. At both cases, conditions are V_{IH} = V_{DD}, V_{IL} = V_{SS}, and T_j = +25 °C. The above values may not be guaranteed when the input buffer with a pull-up/pull-down resistor or a crystal oscillator buffer is used.

*2 : Refer to “(2) 2.5 V” in ■ V-I CHARACTERISTICS.

- **Single power supply** : V_{DD} = **1.8 V**

(V_{DD} = 1.8 V ± 0.15 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C)

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Power supply current*1	I_{DDS}	T2	—	—	0.1	mA
		T3, T4	—	—	0.2	
		T5 to T7	—	—	0.3	
		T8, T9	—	—	0.4	
		TA	—	—	0.5	
		TB, TC	—	—	0.6	
		TD	—	—	0.8	
		TE	—	—	1.0	
		TF	—	—	1.1	
		TG	—	—	1.3	
"H" level output voltage	V_{OH}	I_{OH} = –100 µA	V_{DD} – 0.2	—	V_{DD}	V
"L" level output voltage	V_{OL}	I_{OL} = 100 µA	0	—	0.2	V
"H" level output voltage V-I characteristics	—	1.8 V V_{DD} = 1.8 V±0.15 V	*2	—	—	—
"L" level output current V-I characteristics	—	1.8 V V_{DD} = 1.8 V±0.15 V	*2	—	—	—
Input leakage current	I_L	—	—	—	±5	µA
Pull-up/pull-down resistance	R_P	Pull-up V_{IL} = 0 V Pull-down V_{IH} = V_{DD}	10	40	120	kΩ

*1 : When the memory is in a standby mode and analog macro is in a power-down mode. At both cases, conditions are V_{IH} = V_{DD}, V_{IL} = V_{SS}, and T_j = +25 °C. The above values may not be guaranteed when the input buffer with a pull-up/pull-down resistor or a crystal oscillator buffer is used.

*2 : Refer to "(3) 1.8 V" in ■ V-I CHARACTERISTICS.

- **Single power supply** : V_{DD} = **1.5 V**

(V_{DD} = 1.5 V ± 0.1 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C)

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Power supply current*1	I_{DDS}	T2	—	—	0.1	mA
		T3, T4	—	—	0.2	
		T5 to T7	—	—	0.3	
		T8, T9	—	—	0.4	
		TA	—	—	0.5	
		TB, TC	—	—	0.6	
		TD	—	—	0.8	
		TE	—	—	1.0	
		TF	—	—	1.1	
		TG	—	—	1.3	
"H" level output voltage	V_{OH}	I_{OH} = –100 µA	V_{DD} – 0.2	—	V_{DD}	V
"L" level output voltage	V_{OL}	I_{OL} = 100 µA	0	—	0.2	V
"H" level output voltage V-I characteristics	—	1.5 V V_{DD} = 1.5 V±0.1 V	*2	—	—	—
"L" level output current V-I characteristics	—	1.5 V V_{DD} = 1.5 V±0.1 V	*2	—	—	—
Input leakage current	I_L	—	—	—	±5	µA
Pull-up/pull-down resistance	R_P	Pull-up V_{IL} = 0 V Pull-down V_{IH} = V_{DD}	10	55	120	kΩ

*1 : When the memory is in a standby mode and analog macro is in a power-down mode. At both cases, conditions are V_{IH} = V_{DD}, V_{IL} = V_{SS}, and T_j = +25 °C. The above values may not be guaranteed when the input buffer with a pull-up/pull-down resistor or a crystal oscillator buffer is used.

*2 : Refer to "(4) 1.5 V" in ■ V-I CHARACTERISTICS.

- **Dual power supply** : V_{DDE} = **3.3 V/**V_{DDI} = **2.5 V**, **1.8 V**, **1.5 V**
  (V_{DDE} = 3.3 V ± 0.3 V/V_{DDI} = 2.5 V±0.2 V, 1.8 V ± 0.15 V, 1.5 V ±0.1 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C)

Parameter	Symbol	Conditions		Value			Unit
				Min	Typ	Max	
Power supply current*1	I_{DDS}	T2		—	—	0.1	mA
		T3, T4		—	—	0.2	
		T5 to T7		—	—	0.3	
		T8, T9		—	—	0.4	
		TA		—	—	0.5	
		TB, TC		—	—	0.6	
		TD		—	—	0.8	
		TE		—	—	1.0	
		TF		—	—	1.1	
		TG		—	—	1.3	
"H" level output voltage	V_{OH4}	3.3 V output I_{OH} = –100 µA		V_{DDE} – 0.2	—	V_{DDE}	V
	V_{OH3}	2.5 V output I_{OH} = –100 µA		V_{DDI} – 0.2	—	V_{DDI}	
	V_{OH2}	1.8 V output I_{OH} = –100 µA		V_{DDI} – 0.2	—	V_{DDI}	
	V_{OH1}	1.5 V output I_{OH} = –100 µA		V_{DDI} – 0.2	—	V_{DDI}	
"L" level output voltage	V_{OL4}	3.3 V output I_{OL} = 100 µA		0	—	0.2	V
	V_{OL3}	2.5 V output I_{OL} = 100 µA		0	—	0.2	
	V_{OL2}	1.8 V output I_{OL} = 100 µA		0	—	0.2	
	V_{OL1}	1.5 V output I_{OL} = 100 µA		0	—	0.2	
"H" level output V-I characteristics	—	3.3 V V_{DDE} = 3.3 V±0.3 V		*2	—	—	—
	—	2.5 V V_{DDI} = 2.5 V±0.2 V		*3	—	—	
	—	1.8 V V_{DDE} = 1.8 V±0.15 V		*4	—	—	
	—	1.5 V V_{DDI} = 1.5 V±0.1 V		*5	—	—	
"L" level output V-I characteristics	—	3.3 V V_{DDE} = 3.3 V±0.3 V		*2	—	—	—
	—	2.5 V V_{DDI} = 2.5 V±0.2 V		*3	—	—	
	—	1.8 V V_{DDE} = 1.8 V±0.15 V		*4	—	—	
	—	1.5 V V_{DDI} = 1.5 V±0.1 V		*5	—	—	
Input leakage current	I_L	—		—	—	±5	µA
Pull-up/pull-down resistance	R_P	3.3 V	Pull-up V_{IL} = 0 Pull-down V_{IH} = V_{DDE}	10	25	70	kΩ
		2.5 V	Pull-up V_{IL} = 0 Pull-down V_{IH} = V_{DDI}	10	25	120	
		1.8 V	Pull-up V_{IL} = 0 Pull-down V_{IH} = V_{DDI}	10	40	120	
		1.5 V	Pull-up V_{IL} = 0 Pull-down V_{IH} = V_{DDI}	10	55	120	

*1: When the memory is in a standby mode and analog macro is in a power-down mode. At both cases, conditions are V_{IH} = V_{DD}, V_{IL} = V_{SS}, and T_j = +25 °C. The above values may not be guaranteed when the input buffer with a pull-up/pull-down resistor or a crystal oscillator buffer is used.
*2: Refer to "(1) 3.3 V" in ■ V-I CHARACTERISTICS.
*3: Refer to "(2) 2.5 V" in ■ V-I CHARACTERISTICS.
*4: Refer to "(3) 1.8 V" in ■ V-I CHARACTERISTICS".
*5: Refer to "(4) 1.5 V" in ■ V-I CHARACTERISTICS.

- **Dual power supply** : V_{DDE} = **2.5 V**/V_{DDI} = **2.5 V**, **1.8 V**, **1.5 V**

(V_{DDE} = 2.5 V ± 0.2 V/V_{DDI} = 1.8 V±0.15 V, 1.5 V ± 0.1 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C)

Parameter	Symbol	Conditions		Value			Unit
				Min	Typ	Max	
Power supply current*1	I_{DDS}	T2		—	—	0.1	mA
		T3, T4		—	—	0.2	
		T5 to T7		—	—	0.3	
		T8, T9		—	—	0.4	
		TA		—	—	0.5	
		TB, TC		—	—	0.6	
		TD		—	—	0.8	
		TE		—	—	1.0	
		TF		—	—	1.1	
		TG		—	—	1.3	
"H" level output voltage	V_{OH3}	2.5 V output I_{OH} = –100 µA		V_{DDE} – 0.2	—	V_{DDE}	V
	V_{OH2}	1.8 V output I_{OH} = –100 µA		V_{DDI} – 0.2	—	V_{DDI}	
	V_{OH1}	1.5 V output I_{OH} = –100 µA		V_{DDI} – 0.2	—	V_{DDI}	
"L" level output voltage	V_{OL3}	2.5 V output I_{OL} = 100 µA		0	—	0.2	V
	V_{OL2}	1.8 V output I_{OL} = 100 µA		0	—	0.2	
	V_{OL1}	1.5 V output I_{OL} = 100 µA		0	—	0.2	
"H" level output V-I characteristics	—	2.5 V V_{DDE} = 2.5 V±0.2 V		*2	—	—	—
	—	1.8 V V_{DDI} = 1.8 V±0.15 V		*3	—	—	
	—	1.5 V V_{DDI} = 1.5 V±0.1 V		*4	—	—	
"L" level output V-I characteristics	—	2.5 V V_{DDE} = 2.5 V±0.2 V		*2	—	—	—
	—	1.8 V V_{DDI} = 1.8 V±0.15 V		*3	—	—	
	—	1.5 V V_{DDI} = 1.5 V±0.1 V		*4	—	—	
Input leakage current	I_L	—		—	—	±5	µA
Pull-up/pull-down resistance	R_P	2.5 V	Pull-up V_{IL} = 0 Pull-down V_{IH} = V_{DDE}	10	25	120	kΩ
		1.8 V	Pull-up V_{IL} = 0 Pull-down V_{IH} = V_{DDI}	10	40	120	
		1.5 V	Pull-up V_{IL} = 0 Pull-down V_{IH} = V_{DDI}	10	55	120	

*1: When the memory is in a standby mode and analog macro is in a power-down mode. At both cases, conditions are V_{IH} = V_{DD}, V_{IL} = V_{SS}, and T_j = +25 °C. The above values may not be guaranteed when the input buffer with a pull-up/pull-down resistor or a crystal oscillator buffer is used.

*2: Refer to "(2) 2.5 V" in ■ V-I CHARACTERISTICS.

*3: Refer to "(3) 1.8 V" in ■ V-I CHARACTERISTICS".

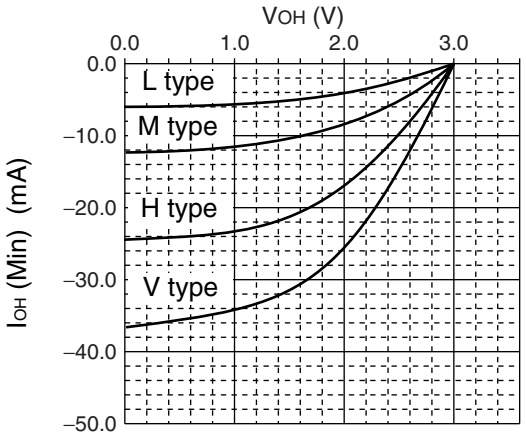
*4: Refer to "(4) 1.5 V" in ■ V-I CHARACTERISTICS.

■ V-I CHARACTERISTICS

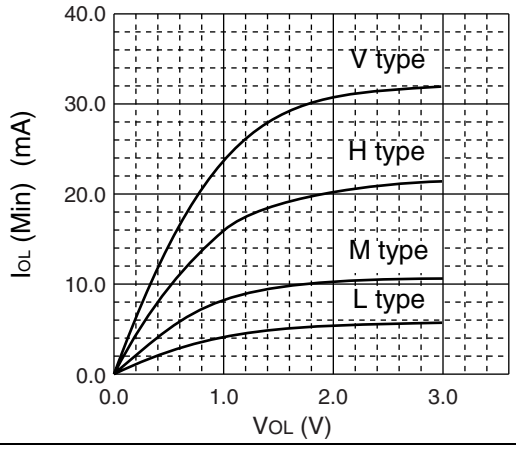
(1) 3.3 V

- 3.3 V normal I/O V-I characteristics [Condition : V_{DD} = 3.0 V]

"H" level output V-I characteristics (V_{DD} = 3.0 V)
3.0 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 3.0 V>

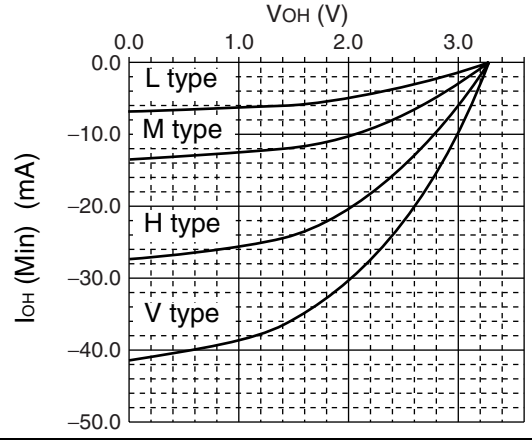


"L" level output V-I characteristics (V_{DD} = 3.0 V)
3.0 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 3.0 V>

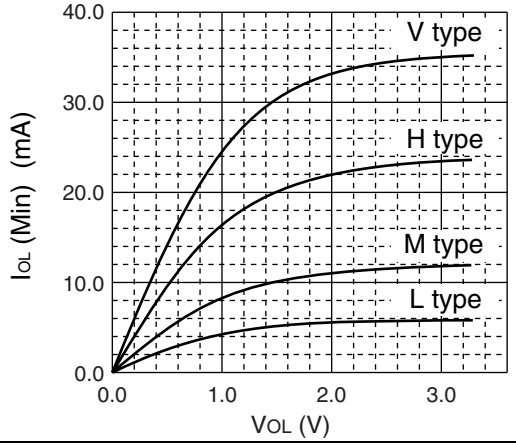


- 3.3 V normal I/O V-I characteristics [Condition : V_{DD} = 3.3 V]

"H" level output V-I characteristics (V_{DD} = 3.3 V)
3.3 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 3.3 V>

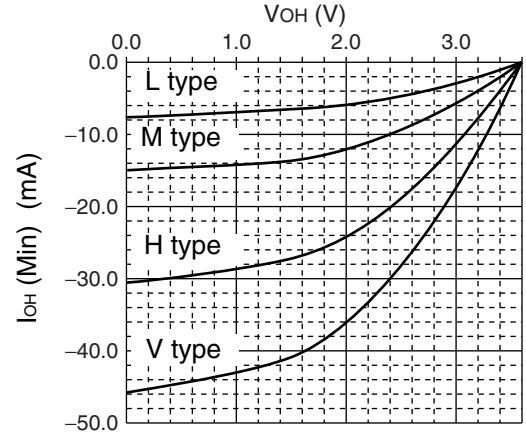


"L" level output V-I characteristics (V_{DD} = 3.3 V)
3.3 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 3.3 V>

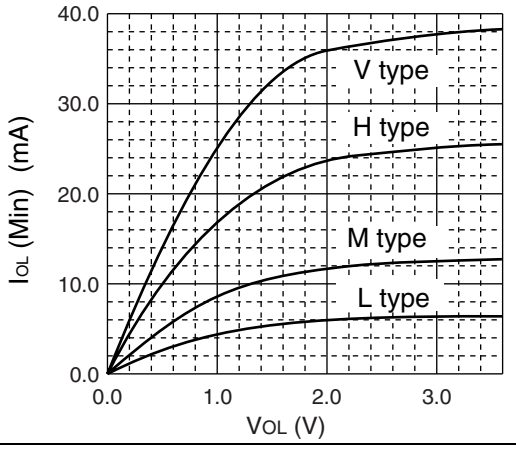


- 3.3 V normal I/O V-I characteristics [Condition : V_{DD} = 3.6 V]

"H" level output V-I characteristics (V_{DD} = 3.6 V)
3.3 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 3.6 V>



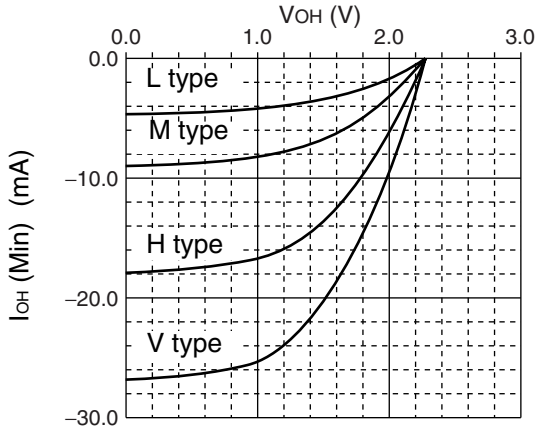
"L" level output V-I characteristics (V_{DD} = 3.6 V)
3.3 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 3.6 V>



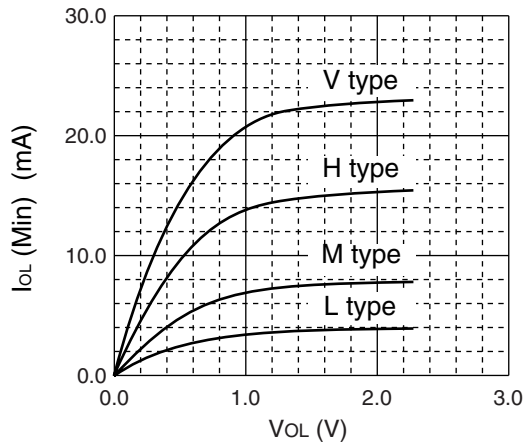
(2) 2.5 V

- 2.5 V normal I/O V-I characteristics [Condition : V_{DD} = 2.3 V]

"H" level output V-I characteristics (V_{DD} = 2.3 V)
2.5 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 2.3 V>

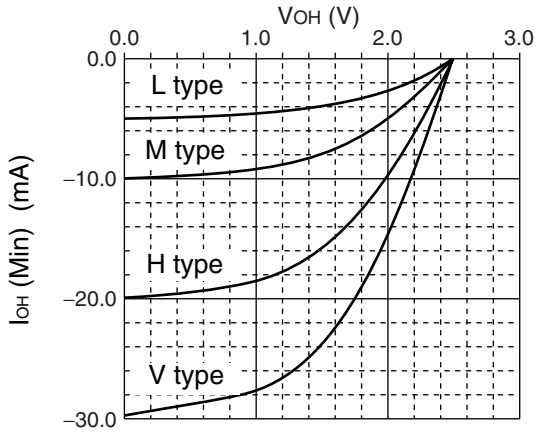


"L" level output V-I characteristics (V_{DD} = 2.3 V)
2.5 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 2.3 V>

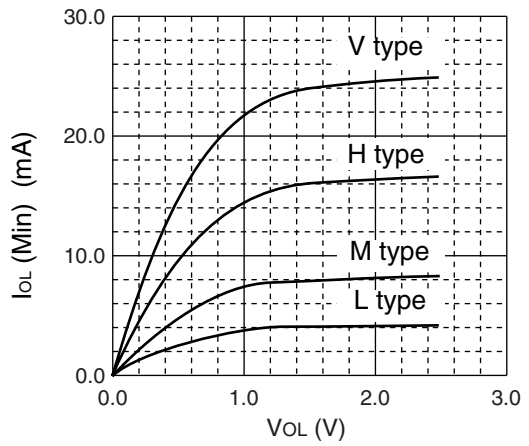


- 2.5 V normal I/O V-I characteristics [Condition : V_{DD} = 2.5 V]

"H" level output V-I characteristics (V_{DD} = 2.5 V)
2.5 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 2.5 V>

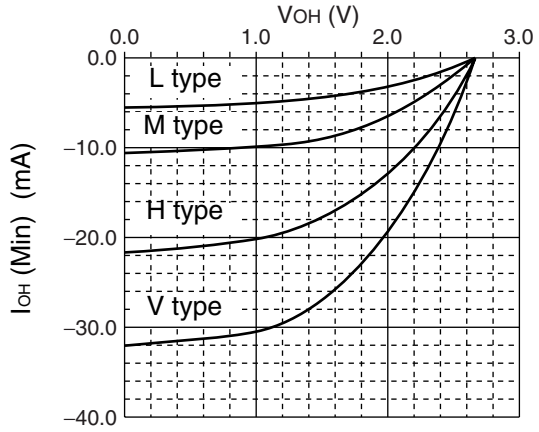


"L" level output V-I characteristics (V_{DD} = 2.5 V)
2.5 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 2.5 V>

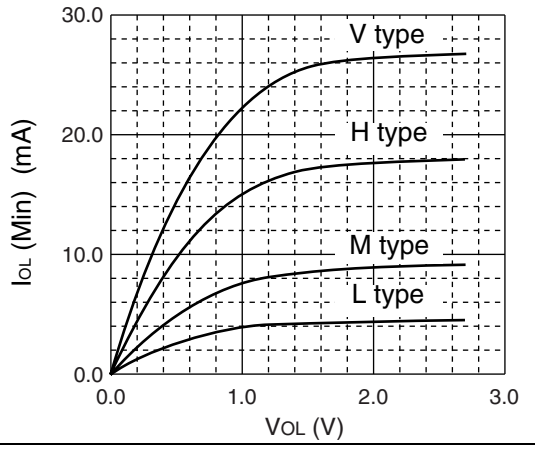


- 2.5 V normal I/O V-I characteristics [Condition : V_{DD} = 2.7 V]

"H" level output V-I characteristics (V_{DD} = 2.7 V)
2.5 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 2.7 V>



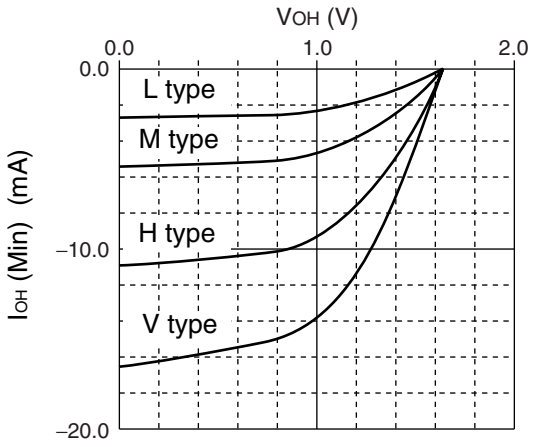
"L" level output V-I characteristics (V_{DD} = 2.7 V)
2.5 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 2.7 V>



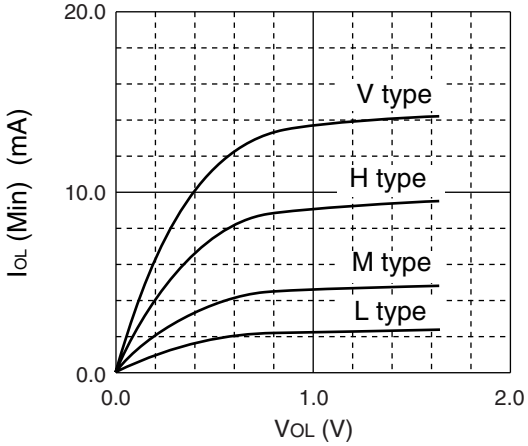
(3) 1.8 V

- 1.8 V normal I/O V-I characteristics [Condition : V_{DD} = 1.65 V]

"H" level output V-I characteristics (V_{DD} = 1.65 V)
1.8 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 1.65 V>

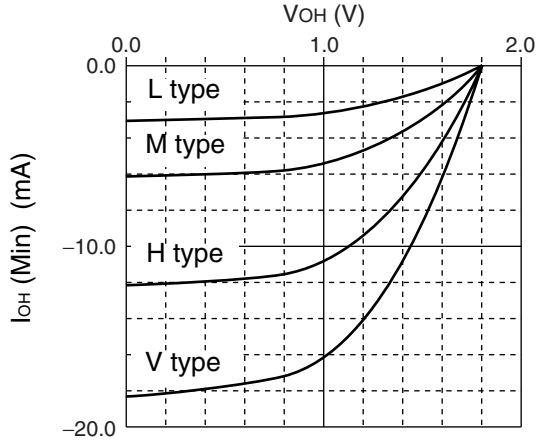


"L" level output V-I characteristics (V_{DD} = 1.65 V)
1.8 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 1.65 V>

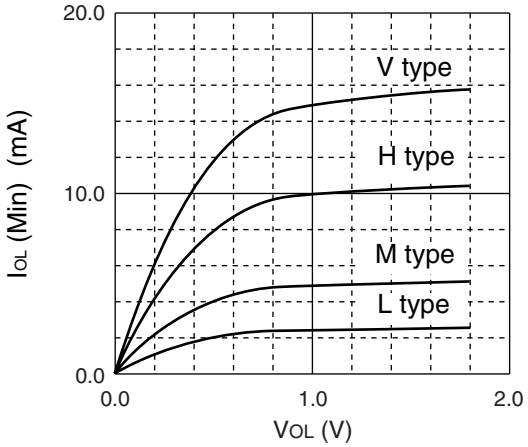


- 1.8 V normal I/O V-I characteristics [Condition : V_{DD} = 1.8 V]

"H" level output V-I characteristics (V_{DD} = 1.8 V)
1.8 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 1.8 V>

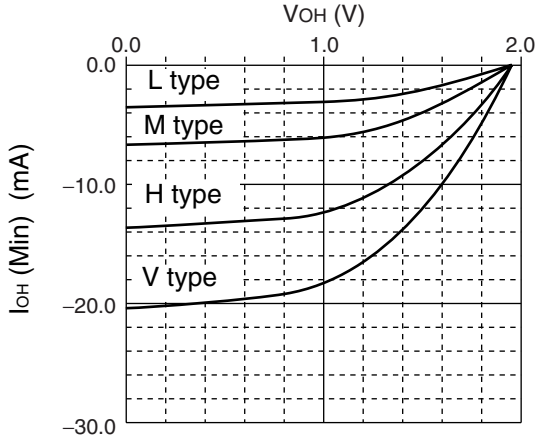


"L" level output V-I characteristics (V_{DD} = 1.8 V)
1.8 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 1.8 V>

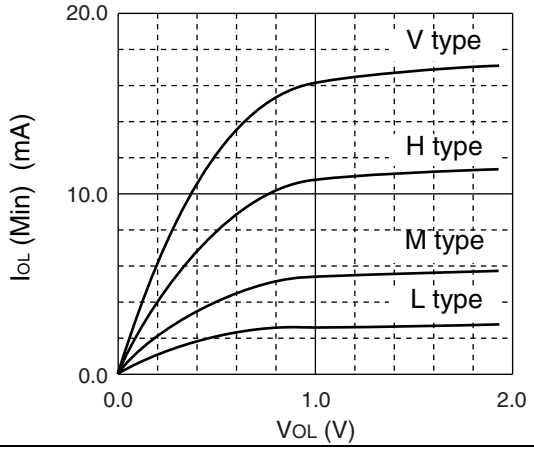


- 1.8 V normal I/O V-I characteristics [Condition : V_{DD} = 1.95 V]

"H" level output V-I characteristics (V_{DD} = 1.95 V)
1.8 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 1.95 V>



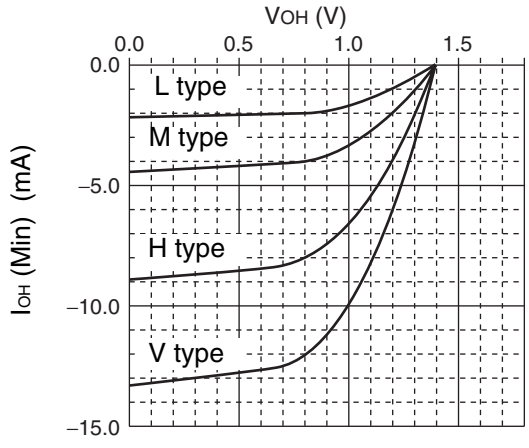
"L" level output V-I characteristics (V_{DD} = 1.95 V)
1.8 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 1.95 V>



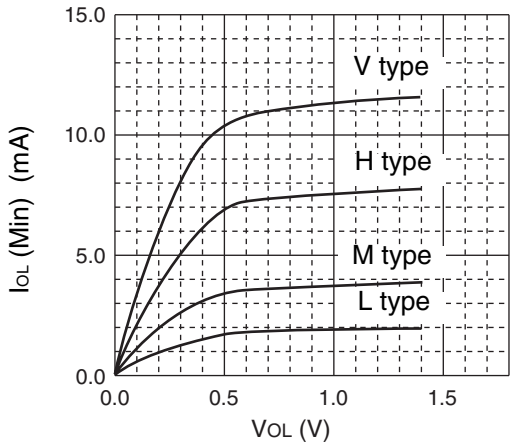
(4) 1.5 V

- 1.5 V normal I/O V-I characteristics [Condition : V_{DD} = 1.4 V]

"H" level output V-I characteristics (V_{DD} = 1.4 V)
1.5 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 1.4 V>

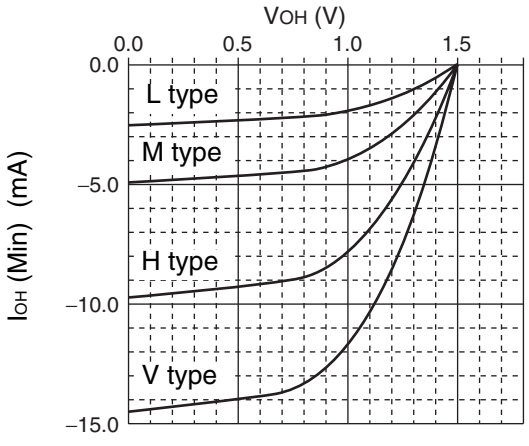


"L" level output V-I characteristics (V_{DD} = 1.4 V)
1.5 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 1.4 V>

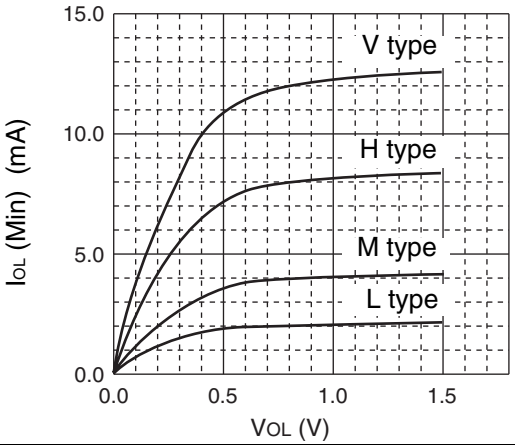


- 1.5 V normal I/O V-I characteristics [Condition : V_{DD} = 1.5 V]

"H" level output V-I characteristics (V_{DD} = 1.5 V)
1.5 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 1.5 V>

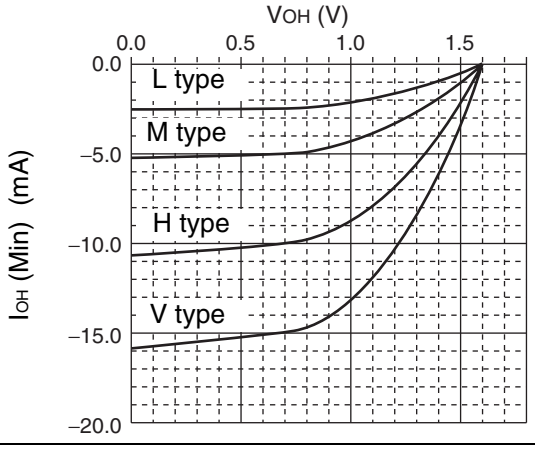


"L" level output V-I characteristics (V_{DD} = 1.5 V)
1.5 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 1.5 V>

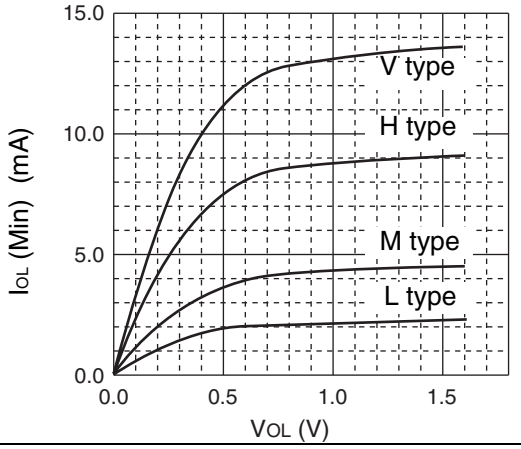


- 1.5 V normal I/O V-I characteristics [Condition : V_{DD} = 1.6 V]

"H" level output V-I characteristics (V_{DD} = 1.6 V)
1.5 V normal I/O V_{OH}-I_{OH} (Min) <V_{DD} = 1.6 V>



"L" level output V-I characteristics (V_{DD} = 1.6 V)
1.5 V normal I/O V_{OL}-I_{OL} (Min) <V_{DD} = 1.6 V>



■ AC CHARACTERISTICS

(V_{DD} = 1.8 V ± 0.15 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C)

Parameter	Symbol	Value			Unit
		Min	Typ	Max	
Delay time	t_{pd}*1	typ*2 × tmin*3	typ*2 × ttyp*3	typ*2 × tmax*3	ns

*1 : Delay time = propagation delay time, enable time, disable time

*2 : “typ” is calculated from the cell specification.

*3 : Measurement condition

Measurement condition	tmin	ttyp	tmax
V_{DD} = 2.5V ± 0.2 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C	0.60	1.00	1.64
V_{DD} = 1.8V ± 0.15 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C	0.84	1.57	2.84
V_{DD} = 1.5V ± 0.1 V, V_{SS} = 0 V, T_j = –40 °C to +125 °C	1.14	2.22	4.09

Note : tpd Max is calculated according to the maximum junction temperature (T_j) .

■ INPUT/OUTPUT CAPACITANCE

(f = 1 MHz, V_{DD} = V_I = 0 V, Tj = +25 °C)

Parameter	Symbol	Value	Unit
Input pin	C_{IN}	Max 16	pF
Output pin	C_{OUT}	Max 16	pF
Input/output capacitance	$C_{I/O}$	Max 16	pF

■ DESIGN METHOD

Linking a floor plan tool and a logic synthesis tool enables automatic circuit optimization using floor plan information. In addition, CDDM (Clock Driven Design Method) clock tree synthesis tools using floor plan information is also available. Using floor plan information at a pre-layout stage prevents major problems with setup and hold timings which can occur after layout. Using a hierarchical layout method to support larger-scale circuit design considerably shortens the overall design cycle time.

■ THE NUMBER OF GATES USED AND PACKAGES

1. Counting the number of the gates used

Evaluation of the basic cell count used has revealed some problems including the circuit complexities, difference of the utilization depending on the circuit design scheme (whether it is designed with the logic synthesis) or being unable to achieve the minimum layout with the logically synthesized circuit.

To cope with those problems, Fujitsu developed the AREA as a criteria where the circuit size and the layout feasibility is determined. The AREA is a basic cell conceived from the viewpoint of congestion of the wiring; it has been calculated from the actual basic cell count and pin count in units of BC.

Estimate method for the frame include the conventional one by the basic cell count and the one by the AREA for more detailed estimate.

Hard macro basic cell count and AREA count for unit cell, I/O buffer cell or compiled cell are listed in the respective cell characteristic table.

2. Packages

The table below lists the package types available and the reference number of gates used.

Consult Fujitsu for the combination of each package and the availability.

CE77 (V-FRAME)

Package & Pin Count		Pin Pitch (mm)	0k 1000k 2000k 3000k 4000k 5000k 6000k 7000k 8000k~
SQFP	176	0.5	274k
	208	0.5	803k
	240	0.5	965k
HQFP	208	0.5	1776k
	240	0.5	2276k
	256	0.4	1776k
	304	0.5	7128k
PBGA	256	1.27	618k

Note : The packages that can be used depend on the circuit configuration. For details, contact Fujitsu.

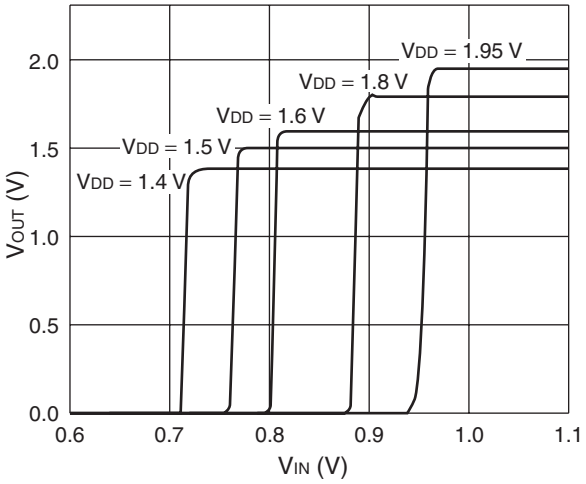
CE77 (T-FRAME)

Package & Pin Count		Pin Pitch (mm)	0k 500k 1000k 1500k 2000k 2500k 3000k 3500k 4000k 4500k 5000k 5500k
LQFP	144	0.5	1241k
	176	0.5	744k
	208	0.5	1375k
	256	0.4	2109k
HQFP	208	0.5	2678k
	240	0.5	2109k
	256	0.4	2109k
	304	0.5	4538k
FBGA	144	0.8	461k
	176	0.8	646k
	224	0.8	1375k
	228	0.75	2109k
PBGA	256	1.27	2109k
	352	1.27	2678k
	420	1.27	3789k

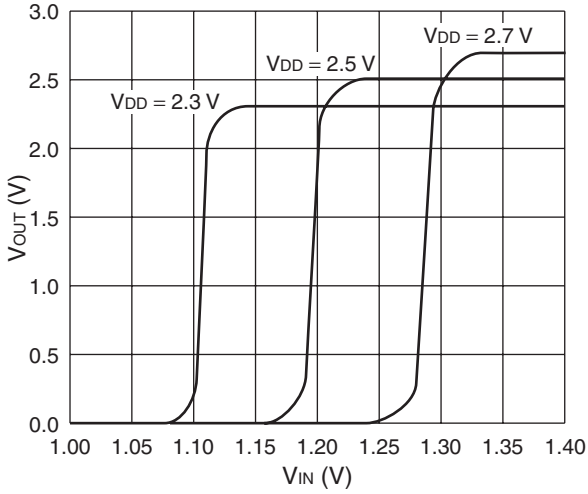
Note : The packages that can be used depend on the circuit configuration. For details, contact Fujitsu.

■ BASIC CHARACTERISTICS

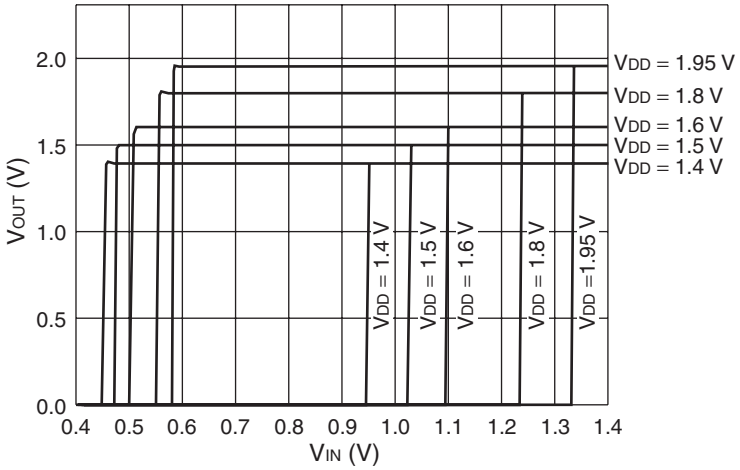
Transfer characteristics
(Typical CMOS input buffer) 1



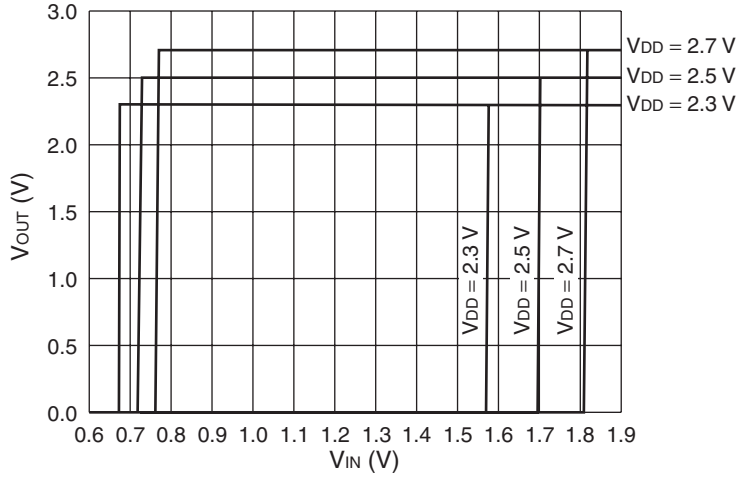
Transfer characteristics
(Typical CMOS input buffer) 2



Transfer characteristics (Typical schmitt input buffer) 1



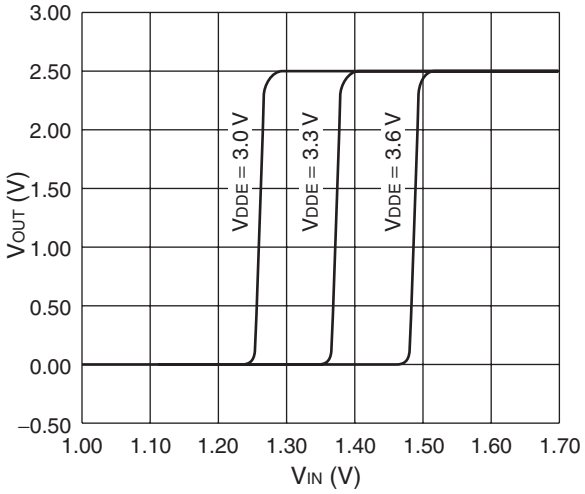
Transfer characteristics (Typical schmitt input buffer) 2



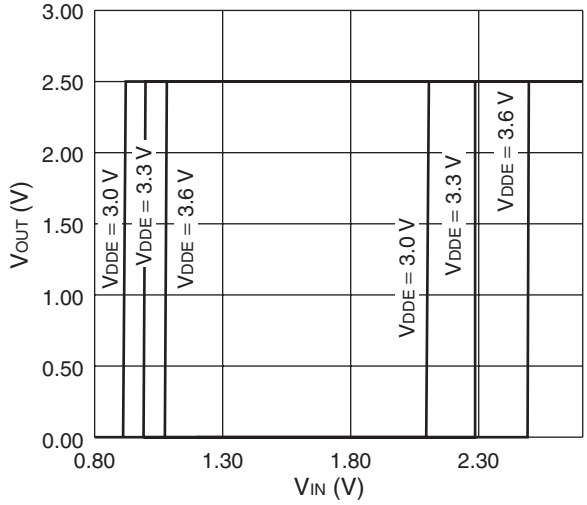
(Continued)

(Continued)

Transfer characteristics (3.3 V normal CMOS input buffer V_{DDI} = 2.5 V)



Transfer characteristics (3.3 V normal schmitt input buffer V_{DDI} = 2.5 V)



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