

TECHNOLOGIE TTL - CMOS

Il existe deux classes de circuits intégrés inventées au début des années 60 :

La classe TTL (Transistor-Transistor Logic) : Développé en 1958 par Fairchild Semiconductor, ils sont introduits sous forme de circuits intégrés de référence commençant par **74XX**. Ils sont constitués de transistors bipolaires.



Figure 1

La classe CMOS (Complementary Metal-Oxide-Semiconductor) : Sortent en 1963. Leur référence commence par **CD40XX** ou **74HXX** (attention, très ressemblant à la référence des TTL). Ils sont constitués de transistors à effet de champs.

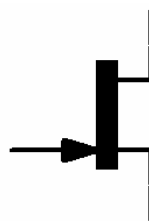


Figure 2

Par conséquent, deux types de familles de circuits intégrés génèrent aussi des caractéristiques électriques différentes entre elles (tension d'alimentation par exemple). Elles sont comparées dans ce document.

Familles des TTL

La famille TTL correspond à plusieurs technologies de circuits intégrés : L'uns sont plus rapides, d'autres consomment moins etc. La liste suivante presente ces familles :

TTL « standard »
 TTL **L** (*Low power*)
 TTL **S** (*Schottky*)
 TTL **LS** (*Low Schottky*)
 TTL **F** (*Fast*)
 TTL **AS** et **ALS**

La famille est inscrite directement dans la reference constructeur du composant. Par exemple pour une fonction logique NON, la référence peut-être **SN74LS00N** :

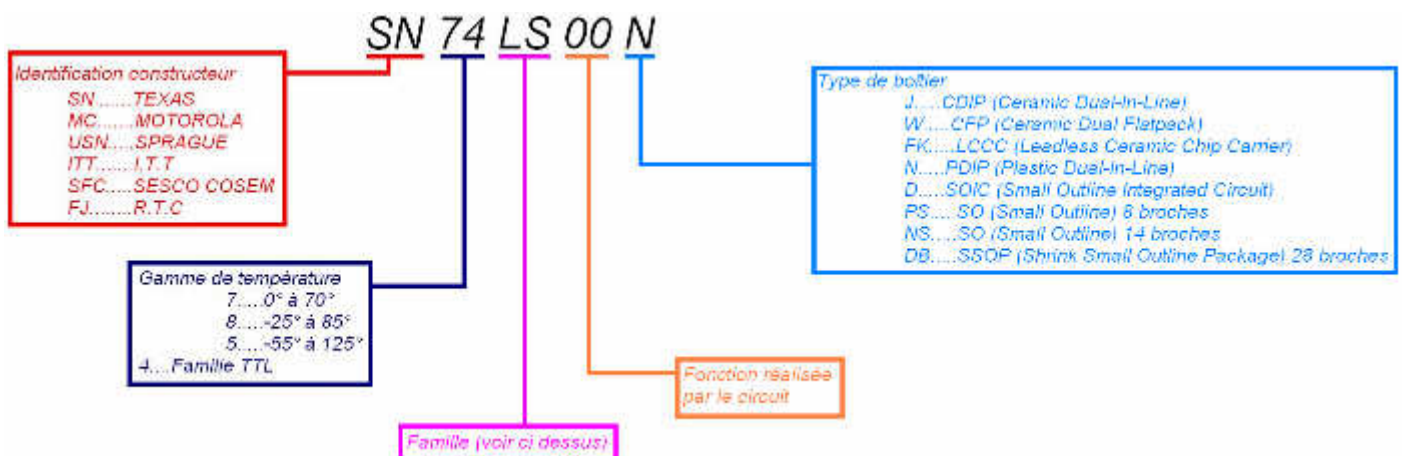


Figure 3

PS : La série 54XX correspond à la série « militaire »

Regardons sur une datasheet *Texas Instrument* d'un 7400 les différences sur les caractéristiques techniques de ces sous-types de TTL :

7400, famille « Standard »

recommended operating conditions (see Note 3)

		SN5400			SN7400			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			-0.4			-0.4	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature	-55		125	0		70	°C

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†			SN5400			SN7400			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	$V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$					-1.5			-1.5	V
V_{OH}	$V_{CC} = \text{MIN}, V_{IL} = 0.8 \text{ V}, I_{OH} = -0.4 \text{ mA}$			2.4	3.4		2.4	3.4		V
V_{OL}	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 16 \text{ mA}$				0.2	0.4		0.2	0.4	V
I_I	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$					1			1	mA
I_{IH}	$V_{CC} = \text{MAX}, V_I = 2.4 \text{ V}$					40			40	μA
I_{IL}	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$					-1.6			-1.6	mA
$I_{OS}^{\dagger\dagger}$	$V_{CC} = \text{MAX}$			-20		-55	-18		-55	mA
I_{OCH}	$V_{CC} = \text{MAX}, V_I = 0 \text{ V}$				4	8		4	8	mA
I_{OCL}	$V_{CC} = \text{MAX}, V_I = 4.5 \text{ V}$				12	22		12	22	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$.

†† Not more than one output should be shorted at a time.

switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	SN5400 SN7400			UNIT
				MIN	TYP	MAX	
t_{PLH}	A or B	Y	$R_L = 400 \Omega, C_L = 15 \text{ pF}$		11	22	ns
t_{PHL}					7	15	

74S00, famille S**recommended operating conditions (see Note 5)**

		SN54S00			SN74S00			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			-1			-1	mA
I_{OL}	Low-level output current			20			20	mA
T_A	Operating free-air temperature	-55		125	0		70	°C

NOTE 5: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†			SN54S00			SN74S00			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$					-1.2			-1.2	V
V_{OH}	$V_{CC} = \text{MIN}, V_{IL} = 0.8 \text{ V}, I_{OH} = -1 \text{ mA}$			2.5	3.4		2.7	3.4		V
V_{OL}	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 20 \text{ mA}$					0.5			0.5	V
I_I	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$					1			1	mA
I_{IH}	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$					50			50	µA
I_{IL}	$V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$					-2			-2	mA
$I_{OS}§$	$V_{CC} = \text{MAX}$			-40		-100	-40		-100	mA
I_{OCH}	$V_{CC} = \text{MAX}, V_I = 0 \text{ V}$			10	16		10	16		mA
I_{OCL}	$V_{CC} = \text{MAX}, V_I = 4.5 \text{ V}$			20	36		20	36		mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$.

§ Not more than one output should be shorted at a time.

switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	SN54S00 SN74S00			UNIT
				MIN	TYP	MAX	
t_{PLH}	A or B	Y	$R_L = 280 \Omega, C_L = 15 \text{ pF}$		3	4.5	ns
t_{PHL}					3	5	
t_{PLH}	A or B	Y	$R_L = 280 \Omega, C_L = 50 \text{ pF}$		4.5		ns
t_{PHL}					5		

74LS00, famille LS**recommended operating conditions (see Note 4)**

		SN54LS00			SN74LS00			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.7			0.8	V
I_{OH}	High-level output current			-0.4			-0.4	mA
I_{OL}	Low-level output current			4			8	mA
T_A	Operating free-air temperature	-55		125	0		70	°C

NOTE 4: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		SN54LS00			SN74LS00			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$				-1.5			-1.5	V
V_{OH}	$V_{CC} = \text{MIN}, V_{IL} = \text{MAX}, I_{OH} = -0.4 \text{ mA}$		2.5	3.4		2.7	3.4		V
V_{OL}	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}$	$I_{OL} = 4 \text{ mA}$		0.25	0.4		0.25	0.4	V
		$I_{OL} = 8 \text{ mA}$					0.35	0.5	
I_I	$V_{CC} = \text{MAX}, V_I = 7 \text{ V}$				0.1			0.1	mA
I_{IH}	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$				20			20	µA
I_{IL}	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$				-0.4			-0.4	mA
$I_{OS}§$	$V_{CC} = \text{MAX}$		-20		-100	-20		-100	mA
I_{CCH}	$V_{CC} = \text{MAX}, V_I = 0 \text{ V}$			0.8	1.6		0.8	1.6	mA
I_{CCL}	$V_{CC} = \text{MAX}, V_I = 4.5 \text{ V}$			2.4	4.4		2.4	4.4	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$.

§ Not more than one output should be shorted at a time.

switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	SN54LS00 SN74LS00			UNIT
				MIN	TYP	MAX	
t_{PLH}	A or B	Y	$R_L = 2 \text{ k}\Omega, C_L = 15 \text{ pF}$		9	15	ns
t_{PHL}					10	15	

74F00, famille F**recommended operating conditions**

		SN54F00			SN74F00			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V _{CC}	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
V _{IH}	High-level input voltage	2			2			V
V _{IL}	Low-level input voltage			0.8			0.8	V
I _{IK}	Input clamp current			-18			-18	mA
I _{OH}	High-level output current			-1			-1	mA
I _{OL}	Low-level output current			20			20	mA
T _A	Operating free-air temperature	-55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN54F00			SN74F00			UNIT
			MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	
V _{IK}	V _{CC} = 4.5 V, I _I = -18 mA				-1.2			-1.2	V
V _{OH}	V _{CC} = 4.5 V, I _{OH} = -1 mA		2.5	3.4		2.5	3.4		V
	V _{CC} = 4.75 V, I _{OH} = -1 mA					2.7			
V _{OL}	V _{CC} = 4.5 V, I _{OL} = 20 mA		0.3	0.5		0.3	0.5		V
I _I	V _{CC} = 5.5 V, V _I = 7 V			0.1			0.1		mA
I _{IH}	V _{CC} = 5.5 V, V _I = 2.7 V			20			20		μA
I _{IL}	V _{CC} = 5.5 V, V _I = 0.5 V			-0.6			-0.6		mA
I _{OS} [§]	V _{CC} = 5.5 V, V _O = 0		-60		-150	-60		-150	mA
I _{CCH}	V _{CC} = 5.5 V, V _I = 0		1.9	2.8		1.9	2.8		mA
I _{CCL}	V _{CC} = 5.5 V, V _I = 4.5 V		6.8	10.2		6.8	10.2		mA

[‡] All typical values are at V_{CC} = 5 V, T_A = 25°C.[§] Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.**switching characteristics (see Note 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V _{CC} = 5 V, C _L = 50 pF, R _L = 500 Ω, T _A = 25°C			V _{CC} = 4.5 V to 5.5 V, C _L = 50 pF, R _L = 500 Ω, T _A = MIN to MAX†			UNIT	
			F00			SN54F00		SN74F00		
			MIN	TYP	MAX	MIN	MAX	MIN		MAX
t _{PLH}	A or B	Y	1.6	3.3	5	2	7	1.6	6	ns
t _{PHL}			1	2.8	4.3	1.5	6.5	1	5.3	

[†] For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

NOTE 2: Load circuits and waveforms are shown in Section 1.

74AS00, famille AS**recommended operating conditions**

		SN54AS00			SN74AS00			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			-2			-2	mA
I_{OL}	Low-level output current			20			20	mA
T_A	Operating free-air temperature	-55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN54AS00			SN74AS00			UNIT
			MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	
V_{IK}	$V_{CC} = 4.5\text{ V}$, $I_I = -18\text{ mA}$			-1.2			-1.2		V
V_{OH}	$V_{CC} = 4.5\text{ V to } 5.5\text{ V}$, $I_{OH} = -2\text{ mA}$		$V_{CC} - 2$			$V_{CC} - 2$			V
V_{OL}	$V_{CC} = 4.5\text{ V}$, $I_{OL} = 20\text{ mA}$		0.35	0.5		0.35	0.5		V
I_I	$V_{CC} = 5.5\text{ V}$, $V_I = 7\text{ V}$			0.1			0.1		mA
I_{IH}	$V_{CC} = 5.5\text{ V}$, $V_I = 2.7\text{ V}$			20			20		μA
I_{IL}	$V_{CC} = 5.5\text{ V}$, $V_I = 0.4\text{ V}$			-0.5			-0.5		mA
$I_{OS}^§$	$V_{CC} = 5.5\text{ V}$, $V_O = 2.25\text{ V}$		-30	-112		-30	-112		mA
I_{CCH}	$V_{CC} = 5.5\text{ V}$, $V_I = 0$		2	3.2		2	3.2		mA
I_{CCL}	$V_{CC} = 5.5\text{ V}$, $V_I = 4.5\text{ V}$		10.8	17.4		10.8	17.4		mA

[‡] All typical values are at $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$.[§] The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS} .**switching characteristics (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 4.5\text{ V to } 5.5\text{ V}$, $C_L = 50\text{ pF}$, $R_L = 500\ \Omega$, $T_A = \text{MIN to MAX}^{\dagger\dagger}$				UNIT
			SN54AS00		SN74AS00		
			MIN	MAX	MIN	MAX	
t_{PLH}	A or B	Y	1	5	1	4.5	ns
t_{PHL}			1	5	1	4	

^{††} For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

74ALS00, famille ALS**recommended operating conditions**

		SN54ALS00A			SN74ALS00A			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V _{CC}	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
V _{IH}	High-level input voltage	2			2			V
V _{IL}	Low-level input voltage			0.8‡			0.8	V
				0.7§				
I _{OH}	High-level output current			−0.4			−0.4	mA
I _{OL}	Low-level output current			4			8	mA
T _A	Operating free-air temperature	−55		125	0		70	°C

‡ Applies over temperature range −55°C to 70°C

§ Applies over temperature range 70°C to 125°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN54ALS00A			SN74ALS00A			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
V _{IK}	V _{CC} = 4.5 V, I _I = −18 mA				−1.2			−1.5	V
V _{OH}	V _{CC} = 4.5 V to 5.5 V, I _{OH} = −0.4 mA		V _{CC} − 2			V _{CC} − 2			V
V _{OL}	V _{CC} = 4.5 V, I _{OL} = 4 mA		0.25		0.4	0.25		0.4	V
		I _{OL} = 8 mA				0.35		0.5	
I _I	V _{CC} = 5.5 V, V _I = 7 V				0.1			0.1	mA
I _{IH}	V _{CC} = 5.5 V, V _I = 2.7 V				20			20	μA
I _{IL}	V _{CC} = 5.5 V, V _I = 0.4 V				−0.1			−0.1	mA
I _O ‡	V _{CC} = 5.5 V, V _O = 2.25 V		−20		−112	−30		−112	mA
I _{CCH}	V _{CC} = 5.5 V, V _I = 0		0.5		0.85	0.5		0.85	mA
I _{CCL}	V _{CC} = 5.5 V, V _I = 4.5 V		1.5		3	1.5		3	mA

† All typical values are at V_{CC} = 5 V, T_A = 25°C.‡ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current, I_{OS}.**switching characteristics (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V _{CC} = 4.5 V to 5.5 V, C _L = 50 pF, R _L = 500 Ω, T _A = MIN to MAX§				UNIT
			SN54ALS00A		SN74ALS00A		
			MIN	MAX	MIN	MAX	
t _{PLH}	A or B	Y	3	15	3	11	ns
t _{PHL}			2	9	2	8	

§ For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

Résumé famille des TTL

STANDARD					
PARAMETRES		MIN	TYP	MAX	UNITES
Vcc	Alimentation	4,75	5	5,25	V
ICCH	Consommation courant état haut		4	8	mA
ICCL	Consommation courant état bas		12	22	mA
tPLH	Temps de commutation état bas vers haut		11	22	ns
tPHL	Temps de commutation état haut vers bas		7	15	ns

S					
PARAMETRES		MIN	TYP	MAX	UNITES
Vcc	Alimentation	4,75	5	5,25	V
ICCH	Consommation courant état haut		10	16	mA
ICCL	Consommation courant état bas		20	36	mA
tPLH	Temps de commutation état bas vers haut		3	4,5	ns
tPHL	Temps de commutation état haut vers bas		3	5	ns

Consomment plus que les standards mais sont plus rapides.

LS					
PARAMETRES		MIN	TYP	MAX	UNITES
Vcc	Alimentation	4,75	5	5,25	V
ICCH	Consommation courant état haut		0,8	1,6	mA
ICCL	Consommation courant état bas		2,4	4,4	mA
tPLH	Temps de commutation état bas vers haut		9	15	ns
tPHL	Temps de commutation état haut vers bas		10	15	ns

Consomment moins que les standards pour une vitesse presque équivalente.

F					
PARAMETRES		MIN	TYP	MAX	UNITES
Vcc	Alimentation	4,5	5	5,5	V
ICCH	Consommation courant état haut		1,9	2,8	mA
ICCL	Consommation courant état bas		6,8	10,2	mA
tPLH	Temps de commutation état bas vers haut		1,6	6	ns
tPHL	Temps de commutation état haut vers bas		1	5,3	ns

Circuits rapides, plage d'alimentation plus large.

AS					
PARAMETRES		MIN	TYP	MAX	UNITES
Vcc	Alimentation	4,5	5	5,5	V
ICCH	Consommation courant état haut		2	3,2	mA
ICCL	Consommation courant état bas		10,8	17,4	mA
tPLH	Temps de commutation état bas vers haut		1	4,5	ns
tPHL	Temps de commutation état haut vers bas		1	4	ns

Un peu plus rapide que les AS.

ALS					
PARAMETRES		MIN	TYP	MAX	UNITES
Vcc	Alimentation	4,5	5	5,5	V
ICCH	Consommation courant état haut		0,5	0,85	mA
ICCL	Consommation courant état bas		1,5	3	mA
tPLH	Temps de commutation état bas vers haut		3	11	ns
tPHL	Temps de commutation état haut vers bas		2	8	ns

Consomment très peu, très rapides, plage d'alimentation +/- 500mV.

Famille des CMOS

Comme pour le TTL, il existe des sous-famille de circuit CMOS :

Série 4000
Série 74C
Série 74HC
Série 74HCT
Série 74AC
Série 74ACT

C Désigne Technologie CMOS
H désigne High speed (haute rapidité)
T désigne Compatible avec la technologie TTL
A désigne Technologie avancée.

La famille est inscrite dans la référence du constructeur : Exemple pour la série 4000, une fonction NON-ET *CD4000B*.

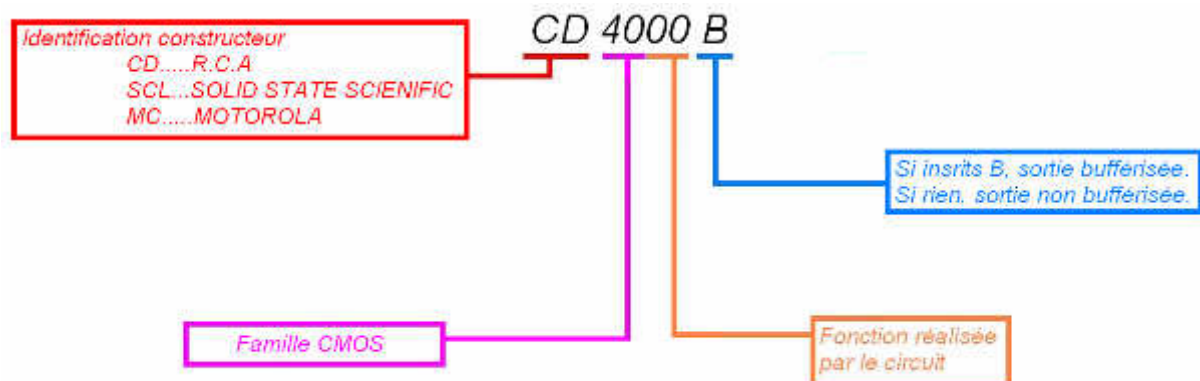


Figure 4

Sur les pages suivantes, comparons les types de CMOS commençant par 74CXX. La référence est structurée de la même manière qu'en TTL.

74C00, doc FairChild

MM74C00 • MM74C02 • MM74C04

Absolute Maximum Ratings (Note 1)

Lead Temperature

(Soldering, 10 seconds)

300°C

Voltage at Any Pin	-0.3V to $V_{CC} + 0.3V$
Operating Temperature Range	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Operating V_{CC} Range	3.0V to 15V
Maximum V_{CC} Voltage	18V
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

DC Electrical Characteristics

Min/Max limits apply across the guaranteed temperature range unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
CMOS TO CMOS						
$V_{IN(1)}$	Logical "1" Input Voltage	$V_{CC} = 5.0V$	3.5			V
		$V_{CC} = 10V$	8.0			V
$V_{IN(0)}$	Logical "0" Input Voltage	$V_{CC} = 5.0V$			1.5	V
		$V_{CC} = 10V$			2.0	V
$V_{OUT(1)}$	Logical "1" Output Voltage	$V_{CC} = 5.0V, I_O = -10 \mu A$	4.5			V
		$V_{CC} = 10V, I_O = -10 \mu A$	9.0			V
$V_{OUT(0)}$	Logical "0" Output Voltage	$V_{CC} = 5.0V, I_O = 10 \mu A$			0.5	V
		$V_{CC} = 10V, I_O = 10 \mu A$			1.0	V
$I_{N(1)}$	Logical "1" Input Current	$V_{CC} = 15V, V_{IN} = 15V$		0.005	1.0	μA
$I_{N(0)}$	Logical "0" Input Current	$V_{CC} = 15V, V_{IN} = 0V$	-1.0	-0.005		μA
I_{CC}	Supply Current	$V_{CC} = 15V$		0.01	15	μA

LOW POWER TO CMOS

$V_{IN(1)}$	Logical "1" Input Voltage	74C, $V_{CC} = 4.75V$	$V_{CC} - 1.5$			V
$V_{IN(0)}$	Logical "0" Input Voltage	74C, $V_{CC} = 4.75V$			0.8	V
$V_{OUT(1)}$	Logical "1" Output Voltage	74C, $V_{CC} = 4.75V, I_O = -10 \mu A$	4.4			V
$V_{OUT(0)}$	Logical "0" Output Voltage	74C, $V_{CC} = 4.75V, I_O = 10 \mu A$			0.4	V

CMOS TO LOW POWER

$V_{IN(1)}$	Logical "1" Input Voltage	74C, $V_{CC} = 4.75V$	4.0			V
$V_{IN(0)}$	Logical "0" Input Voltage	74C, $V_{CC} = 4.75V$			1.0	V
$V_{OUT(1)}$	Logical "1" Output Voltage	74C, $V_{CC} = 4.75V, I_O = -360 \mu A$	2.4			V
$V_{OUT(0)}$	Logical "0" Output Voltage	74C, $V_{CC} = 4.75V, I_O = 360 \mu A$			0.4	V

OUTPUT DRIVE (see Family Characteristics Data Sheet) $T_A = 25^\circ C$ (short circuit current)

I_{SOURCE}	Output Source Current	$V_{CC} = 5.0V, V_{IN(0)} = 0V, V_{OUT} = 0V$	-1.75			mA
I_{SOURCE}	Output Source Current	$V_{CC} = 10V, V_{IN(0)} = 0V, V_{OUT} = 0V$	-8.0			mA
I_{SINK}	Output Sink Current	$V_{CC} = 5.0V, V_{IN(1)} = 5.0V, V_{OUT} = V_{CC}$	1.75			mA
I_{SINK}	Output Sink Current	$V_{CC} = 10V, V_{IN(1)} = 10V, V_{OUT} = V_{CC}$	8.0			mA

AC Electrical Characteristics (Note 2) $T_A = 25^\circ C, C_L = 50 \text{ pF}$, unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
MM74C00, MM74C02, MM74C04						
t_{pd0}, t_{pd1}	Propagation Delay Time to Logical "1" or "0"	$V_{CC} = 5.0V$		50	90	ns
		$V_{CC} = 10V$		30	60	ns
C_{IN}	Input Capacitance	(Note 3)		6.0		pF
C_{PD}	Power Dissipation Capacitance	Per Gate or Inverter (Note 4)		12		pF

Note 2: AC Parameters are guaranteed by DC correlated testing.

Note 3: Capacitance is guaranteed by periodic testing.

Note 4: C_{PD} determines the no load AC power consumption of any CMOS device. For complete explanation see Family Characteristics Application Note—AN-90.

SN74HC00, doc Texas Instrument**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

Supply voltage range, V_{CC}	-0.5 V to 7 V
Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1)	± 20 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1)	± 20 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC})	± 25 mA
Continuous current through V_{CC} or GND	± 50 mA
Package thermal impedance, θ_{JA} (see Note 2):	
D package	86°C/W
DB package	96°C/W
N package	80°C/W
NS package	76°C/W
PW package	113°C/W
Storage temperature range, T_{stg}	-65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The package thermal impedance is calculated in accordance with JEDEC 51-7.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		V_{CC}	$T_A = 25^\circ\text{C}$			SN54HC00		SN74HC00		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}	$V_I = V_{IH}$ or V_{IL}	$I_{OH} = -20\ \mu\text{A}$	2 V	1.9	1.998		1.9		1.9		V
			4.5 V	4.4	4.499		4.4		4.4		
			6 V	5.9	5.999		5.9		5.9		
		$I_{OH} = -4\ \text{mA}$	4.5 V	3.98	4.3		3.7		3.84		
		$I_{OH} = -5.2\ \text{mA}$	6 V	5.48	5.8		5.2		5.34		
V_{OL}	$V_I = V_{IH}$ or V_{IL}	$I_{OL} = 20\ \mu\text{A}$	2 V		0.002	0.1		0.1		0.1	V
			4.5 V		0.001	0.1		0.1		0.1	
			6 V		0.001	0.1		0.1		0.1	
		$I_{OL} = 4\ \text{mA}$	4.5 V		0.17	0.26		0.4		0.33	
		$I_{OL} = 5.2\ \text{mA}$	6 V		0.15	0.26		0.4		0.33	
I_I	$V_I = V_{CC}$ or 0		6 V		± 0.1	± 100		± 1000		± 1000	nA
I_{CC}	$V_I = V_{CC}$ or 0, $I_O = 0$		6 V			2		40		20	μA
C_i			2 V to 6 V		3	10		10		10	pF

switching characteristics over recommended operating free-air temperature range, $C_L = 50\ \text{pF}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC}	$T_A = 25^\circ\text{C}$			SN54HC00		SN74HC00		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	A or B	Y	2 V		45	90		135		115	ns
			4.5 V		9	18		27		23	
			6 V		8	15		23		20	
t_t		Y	2 V		38	75		110		95	ns
			4.5 V		8	15		22		19	
			6 V		6	13		19		16	

SN74HCT00, doc Texas Instrument**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

Supply voltage range, V_{CC}	−0.5 V to 7 V
Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1)	±20 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1)	±20 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC})	±25 mA
Continuous current through V_{CC} or GND	±50 mA
Package thermal impedance, θ_{JA} (see Note 2):	
D package	86°C/W
DB package	96°C/W
N package	80°C/W
NS package	76°C/W
PW package	113°C/W
Storage temperature range, T_{stg}	−65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		VCC	TA = 25°C			SN54HCT00		SN74HCT00		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
VOH	VI = VIH or VIL	IOH = -20 µA	4.5 V	4.4	4.499	MAX	4.4	MAX	4.4	MAX	V
		IOH = -4 mA		3.98	4.3	MAX	3.7	MAX	3.84	MAX	
VOL	VI = VIH or VIL	IOL = 20 µA	4.5 V	0.001 0.1			0.1 0.1			V	
		IOL = 4 mA		0.17 0.26			0.4 0.33				
II	VI = VCC or 0		5.5 V	±0.1	±100		±1000		±1000		nA
Icc	VI = VCC or 0, IO = 0		5.5 V	2			40		20		µA
ΔIcc†	One input at 0.5 V or 2.4 V, Other inputs at 0 or VCC		5.5 V	1.4 2.4			3		2.9		mA
Ci			4.5 V to 5.5 V	3 10			10		10		pF

† This is the increase in supply current for each input that is at one of the specified TTL voltage levels, rather than 0 V or V_{CC} .

switching characteristics over recommended operating free-air temperature range, $C_L = 50\ \text{pF}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC}	$T_A = 25^\circ\text{C}$			SN54HCT00		SN74HCT00		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	A or B	Y	4.5 V		11	20		30		25	ns
			5.5 V		10	18		27		22	
t_t		Y	4.5 V		9	15		22		19	ns
			5.5 V		8	14		20		17	

SN74AC00, doc Texas Instrument

recommended operating conditions (see Note 3)

			SN54AC00		SN74AC00		UNIT
			MIN	MAX	MIN	MAX	
V _{CC}	Supply voltage		2	6	2	6	V
V _{IH}	High-level input voltage	V _{CC} = 3 V	2.1		2.1		V
		V _{CC} = 4.5 V	3.15		3.15		
		V _{CC} = 5.5 V	3.85		3.85		
V _{IL}	Low-level input voltage	V _{CC} = 3 V	0.9		0.9		V
		V _{CC} = 4.5 V	1.35		1.35		
		V _{CC} = 5.5 V	1.65		1.65		
V _I	Input voltage		0	V _{CC}	0	V _{CC}	V
V _O	Output voltage		0	V _{CC}	0	V _{CC}	V
I _{OH}	High-level output current	V _{CC} = 3 V	-12		-12		mA
		V _{CC} = 4.5 V	-24		-24		
		V _{CC} = 5.5 V	-24		-24		
I _{OL}	Low-level output current	V _{CC} = 3 V	12		12		mA
		V _{CC} = 4.5 V	24		24		
		V _{CC} = 5.5 V	24		24		
Δt/Δv	Input transition rise or fall rate		8		8		ns/V
T _A	Operating free-air temperature		-55	125	-40	85	°C

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

PARAMETER	TEST CONDITIONS	V _{CC}	T _A = 25°C			SN54AC00		SN74AC00		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V _{OH}	I _{OH} = -50 μA	3 V	2.9			2.9		2.9		V
		4.5 V	4.4			4.4		4.4		
		5.5 V	5.4			5.4		5.4		
	I _{OH} = -12 mA	3 V	2.56			2.4		2.46		
		4.5 V	3.86			3.7		3.76		
		5.5 V	4.86			4.7		4.76		
	I _{OH} = -50 mA†	5.5 V				3.85				
	I _{OH} = -75 mA†	5.5 V						3.85		
V _{OL}	I _{OL} = 50 μA	3 V		0.002	0.1		0.1		0.1	V
		4.5 V		0.001	0.1		0.1		0.1	
		5.5 V		0.001	0.1		0.1		0.1	
	I _{OL} = 12 mA	3 V			0.36		0.5		0.44	
		4.5 V			0.36		0.5		0.44	
		5.5 V			0.36		0.5		0.44	
	I _{OL} = 50 mA†	5.5 V					1.65			
	I _{OL} = 75 mA†	5.5 V							1.65	
I _I	V _I = V _{CC} or GND	5.5 V			±0.1		±1		±1	μA
I _{CC}	V _I = V _{CC} or GND, I _O = 0	5.5 V			2		40		20	μA
C _i	V _I = V _{CC} or GND	5 V		2.6						pF

† Not more than one output should be tested at a time, and the duration of the test should not exceed 2 ms.

**switching characteristics over recommended operating free-air temperature range,
V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	T _A = 25°C			SN54AC00		SN74AC00		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t _{PLH}	A or B	Y	2	7	9.5	1	11	2	10	ns
t _{PHL}			1.5	5.5	8	1	9	1	8.5	

**switching characteristics over recommended operating free-air temperature range,
V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	T _A = 25°C			SN54AC00		SN74AC00		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t _{PLH}	A or B	Y	1.5	6	8	1	8.5	1.5	8.5	ns
t _{PHL}			1.5	4.5	6.5	1	7	1	7	

SN74ACT00, doc Texas Instrument

recommended operating conditions (see Note 3)

		SN54ACT00		SN74ACT00		UNIT
		MIN	MAX	MIN	MAX	
V _{CC}	Supply voltage	4.5	5.5	4.5	5.5	V
V _{IH}	High-level input voltage	2		2		V
V _{IL}	Low-level input voltage		0.8		0.8	V
V _I	Input voltage	0	V _{CC}	0	V _{CC}	V
V _O	Output voltage	0	V _{CC}	0	V _{CC}	V
I _{OH}	High-level output current		-24		-24	mA
I _{OL}	Low-level output current		24		24	mA
Δt/Δv	Input transition rise or fall rate	0	8	0	8	ns/V
T _A	Operating free-air temperature	-55	125	-40	85	°C

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	V _{CC}	T _A = 25°C			SN54ACT00		SN74ACT00		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V _{OH}	I _{OH} = -50 μA	4.5 V	4.4	4.49		4.4		4.4		V
		5.5 V	5.4	5.49		5.4		5.4		
	I _{OH} = -24 mA	4.5 V	3.86			3.7		3.76		
		5.5 V	4.86			4.7		4.76		
	I _{OH} = -50 mA†	5.5 V				3.85				
V _{OL}	I _{OL} = 50 μA	4.5 V		0.001	0.1		0.1		0.1	V
		5.5 V		0.001	0.1		0.1		0.1	
	I _{OL} = 24 mA	4.5 V			0.36		0.5		0.44	
		5.5 V			0.36		0.5		0.44	
	I _{OL} = 50 mA†	5.5 V				1.65				
I _I	V _I = V _{CC} or GND	5.5 V			±0.1		±1		±1	μA
		5.5 V			2		40		20	
I _{CC}	V _I = V _{CC} or GND, I _O = 0	5.5 V			2		40		20	μA
ΔI _{CC} ‡	One input at 3.4 V, Other inputs at GND or V _{CC}	5.5 V		0.6			1.6		1.5	mA
C _I	V _I = V _{CC} or GND	5 V		2.6						pF

† Not more than one output should be tested at a time, and the duration of the test should not exceed 2 ms.

‡ This is the increase in supply current for each input that is at one of the specified TTL voltage levels rather than 0 V or V_{CC}.

switching characteristics over recommended operating free-air temperature range, V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	T _A = 25°C			SN54ACT00		SN74ACT00		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t _{PLH}	A or B	Y	1.5	5.5	9	1	9.5	1	9.5	ns
t _{PHL}			1.5	4	7	1	8	1	8	

Résumé famille des CMOS

C					
PARAMETRES		MIN	TYP	MAX	UNITES
V _{cc}	Alimentation	3		18	V
I _{cc}	Consommation courant quand V _{cc} = 15V		0,01	15	μA
t _{pd0} , t _{pd1}	Temps de propagation quand V _{cc} = 5V		50	90	ns
	Temps de propagation quand V _{cc} = 10V		30	60	ns

La consommation est très dérisoire : Quelques microampères.

HC					
PARAMETRES		MIN	TYP	MAX	UNITES
V _{cc}	Alimentation	-0,5		7	V
I _{cc}	Consommation courant quand V _{cc} = 6V			20	μA
t _{pd}	Temps de propagation quand V _{cc} = 2V			115	ns
	Temps de propagation quand V _{cc} = 6V			20	ns

HCT					
PARAMETRES		MIN	TYP	MAX	UNITES
V _{cc}	Alimentation	-0,5		7	V
I _{cc}	Consommation courant état haut			20	μA
t _{pd}	Temps de propagation quand V _{cc} = 4,5V			25	ns
	Temps de propagation quand V _{cc} = 5,5V			22	ns

AC					
PARAMETRES		MIN	TYP	MAX	UNITES
V _{cc}	Alimentation	2		6	V
I _{cc}	Consommation courant état haut			20	μA
t _{PLH}	Temps de commutation état bas vers haut quand V _{cc} = 3,3V	2		10	ns
t _{PHL}	Temps de commutation état haut vers bas quand V _{cc} = 3,3V	1		8,5	ns

ACT					
PARAMETRES		MIN	TYP	MAX	UNITES
V _{cc}	Alimentation	4,5		5,5	V
I _{cc}	Consommation courant état haut			20	μA
t _{PLH}	Temps de commutation état bas vers haut	1		9,5	ns
t _{PHL}	Temps de commutation état haut vers bas	1		8	ns

En générale, le CMOS consomme beaucoup moins mais sont plus long.

Niveaux de tension d'un circuit TTL et CMOS

TTL

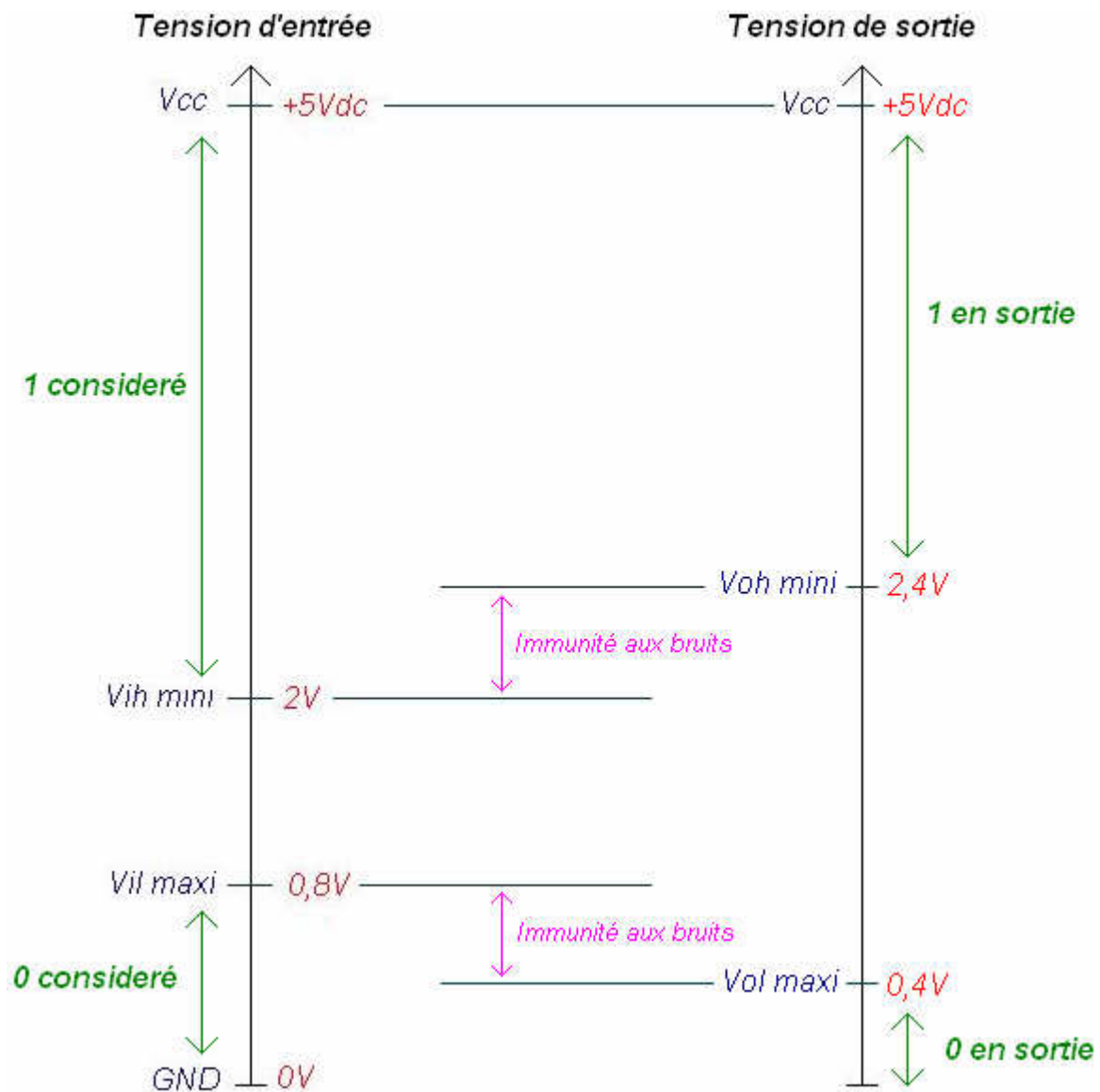


Figure 5

Entre 0,8V et 2V en entrée, le circuit considère une valeur aléatoire. Il ne sais pas si c'est un 0 ou un 1.

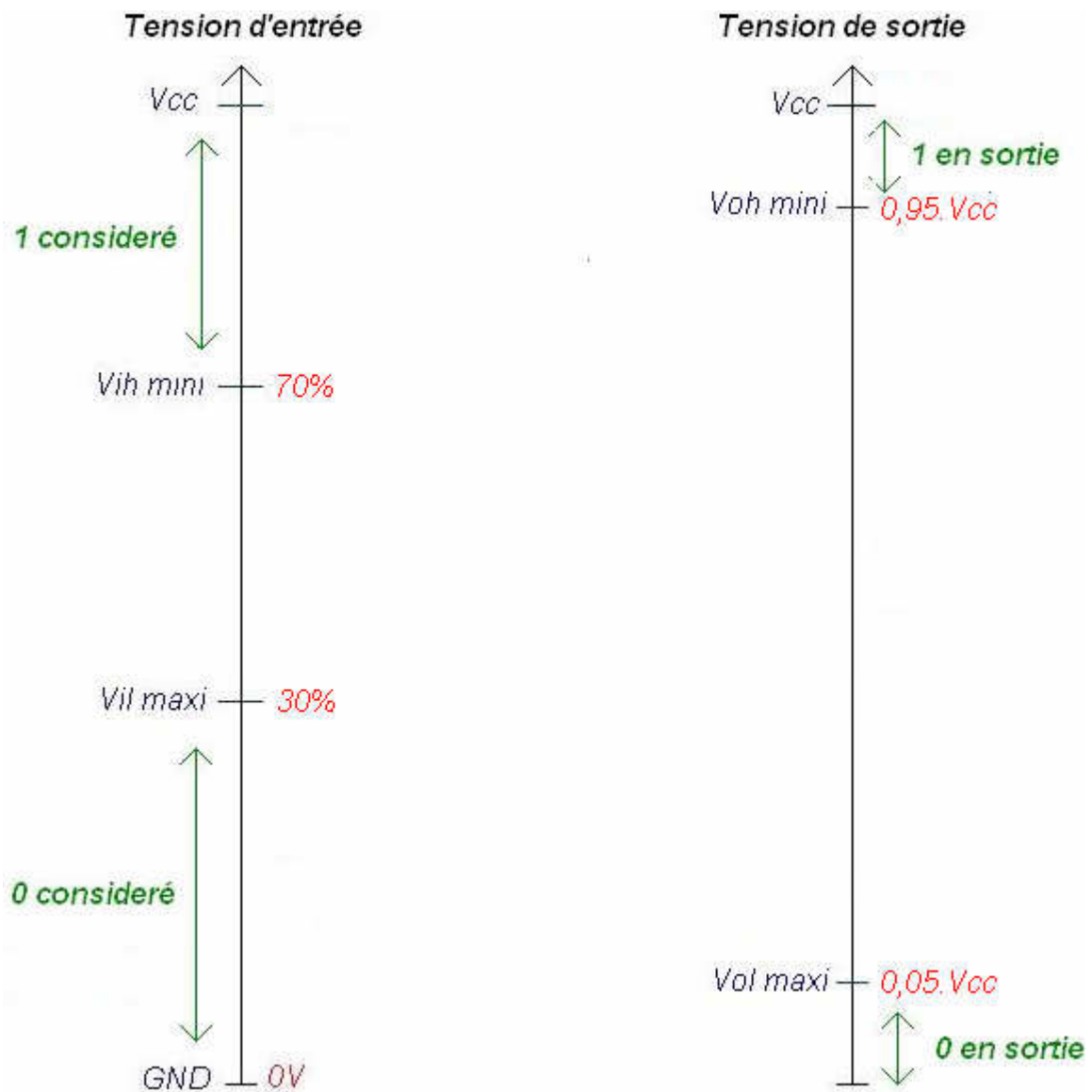
CMOS

Figure 6

Attention : Les niveaux de tensions varient selon les circuits intégrés, mais restent dans ces proportions. Se référer à la documentation constructeur du composant.

Type de sortie

Une sortie « collecteur ouvert » permet de mettre derrière le circuit une charge avec une tension plus élevée que l'alimentation du circuit. Sur la figure suivante, une sortie à collecteur ouvert.

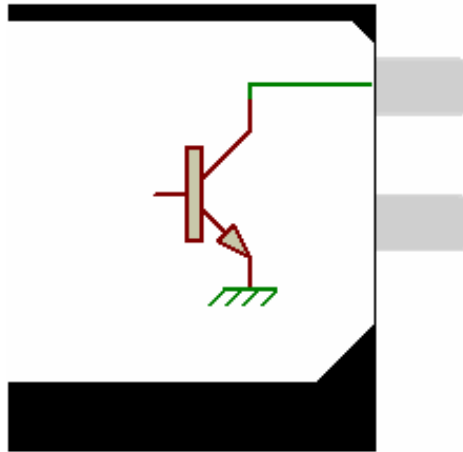


Figure 7

Sur la figure suivante, une résistance est tirée vers une tension (12V dans cet exemple). Sur la sortie on aura donc un état haut de +12V et un état bas égal à GND. On appelle une résistance de Pull-Up.

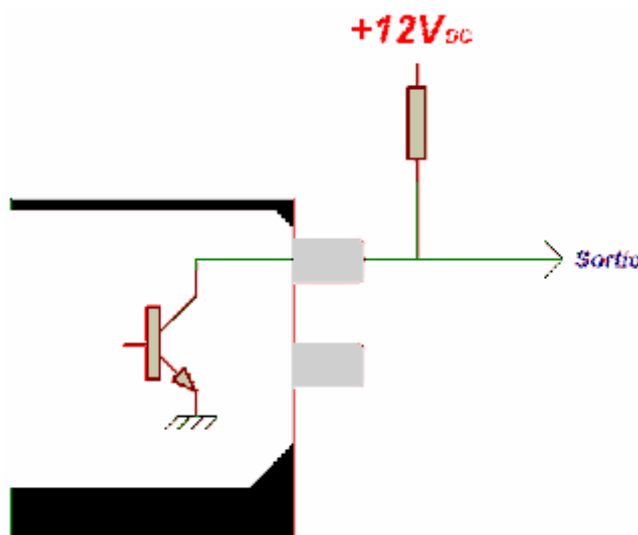


Figure 8

Si aucune tension n'est appliquée sur la base du transistor, la tension de sortie vaut 12V car il ne conduit pas. Si une tension est appliquée sur la base, le transistor relie la sortie et la masse et la sortie vaut 0.

La résistance permet de ne pas faire un court-circuit entre le 12V et la masse quand le transistor est saturé.