UNIVERSAL INDUSTRIAL LOGIC AND INTERFACE CIRCUIT

GENERAL DESCRIPTION

The SAA1029 is a universal bipolar logic and interface IC with high noise immunity and operational stability for industrial control applications. The most fundamental industrial control functions can be accomplished with only one SAA1029 IC. Figure 1 shows the logic configuration.

The IC comprises,
(1) Gate 1: 4-input AND gate with 1 inverted input,
(2) Gate 2: 3-input AND gate with 1 inverted input and adjustable propagation delay,
(3) Gate 3: 2-input AND gate with 1 inverted input.
The SAA1029 can be used as direct interface with LOCMOS (CMOS) ICs for realizing more complex functions. Therefore, the output signal can be limited to the voltage level of the common output clamping pin Z.

The propagation delay of NAND gate 2 is adjustable from microseconds to seconds by using an external capacitor at pin C. This makes it possible to adapt the control frequency limits to the system, so the optimum dynamic noise immunity can be achieved.

All the static and dynamic circuit values (including the output voltage) are independent of the supply voltage over a wide operating range. This allows the use of a simple unstabilized power supply.

The output is held to the LOW state automatically during switching on the power supply, so a special reset pulse can be omitted.

Features

- Simple realization of the basic industrial control functions (logic functions, timing functions, memory functions).
- High dynamic and static noise immunity.
- High operation stability.
- Short-circuit protection of inputs and outputs to both V_{EE} and V_{CC}.
- Wide supply voltage range, so a simple power supply can be used.
- Wire interruption results in a safe input LOW state.
- LOCMOS (CMOS) compatible.

QUICK REFERENCE DATA

Supply voltage range	V_{CC}		14 to 31,2	V
Operating ambient temperature range	T_{amb}		−30 to +85	°C
Input voltage HIGH	V_{IH}		6,5 to 44	V
Output voltage HIGH (without clamping)	V_{OH}		13 to 30	V
Output voltage HIGH (with clamping at pin Z)	V_{OH}		2,0 to (V_{CC} −0,7)	V
Input current	I_I	max.	10	mA
Quiescent supply current	I_{CC}	typ.	7,8	mA

PACKAGE OUTLINE

16-lead DIL; plastic (SOT38).

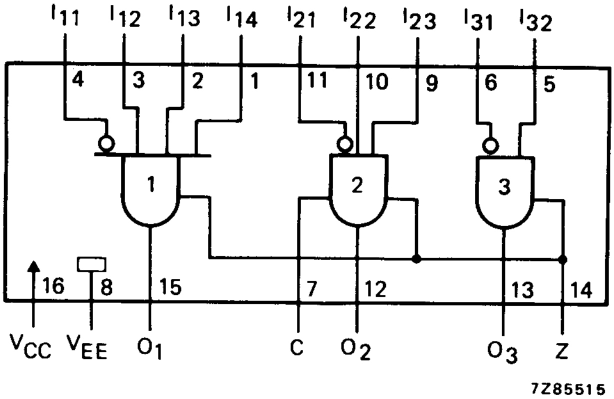

Fig. 1 Logic diagram.

Logic equations:

$O_1 = \overline{I_{11}} \cdot I_{12} \cdot I_{13} \cdot I_{14}$

$O_2 = \overline{I_{21}} \cdot I_{22} \cdot I_{23}$

$O_3 = \overline{I_{31}} \cdot I_{32}$

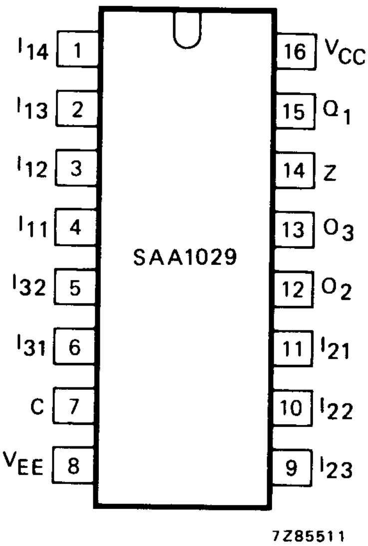

Fig. 2 Pinning diagram.

PINNING

4	I_{11}	inputs of gate 1
3	I_{12}	
2	I_{13}	
1	I_{14}	
15	O_1	output of gate 1
11	I_{21}	inputs of gate 2
10	I_{22}	
9	I_{23}	
12	O_2	output of gate 2
6	I_{31}	inputs of gate 3
5	I_{32}	
13	O_3	output of gate 3
7	C	external delay capacitor
14	Z	common output clamping
16	V_{CC}	positive supply voltage
8	V_{EE}	ground

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage range	V_{CC}		0 to + 35	V
Input voltage (independent of V_{CC})	V_I		−0,15 to + 44	V
Output clamping voltage (pin 14)	V_Z		0 to + 35	V
Voltage at any output (pins 12, 13 and 15)				
pin 14 (Z) open	V_O		−0,15 to V_{CC}	V
pin 14 (Z) at V_Z	V_O	max.	V_Z or V_{CC} if $V_{CC} < V_Z$	V
Current into any input				
d.c.	$\pm I_I$	max.	10	mA
t_p = 0,5 μs; δ = 0,1% (peak value)	$\pm I_{IM}$	max.	100	mA
Sum of input currents				
d.c.	ΣI_I		−90 to + 10	mA
t_p = 0,5 μs; δ = 0,1% (peak value)	ΣI_{IM}		−900 to + 300	mA
External applied current at any output (pins 12, 13 and 15)				
pin 14 (Z) open				
d.c.	$\pm I_O$	max.	30	mA
t_p = 0,5 μs; δ = 0,1% (peak value)	$\pm I_{OM}$	max.	500	mA
External applied current at any output (pins 12, 13 and 15)				
pin 14 (Z) at V_Z				
d.c.	I_O		−30 to + 10	mA
t_p = 0,5 μs; δ = 0,1% (peak value)	I_O		−500 to + 100	mA
Voltage at pin 7 (C)	V_C		−0,15 to + 6	V
External capacitor at pin 7 (C)	any value			
Short-circuit of outputs (pins 12, 13 and 15)				
pin 14 (Z) open	allowed to V_{CC} and V_{EE} (0 V)			
at $V_Z < V_{CC}$	allowed only to V_{EE} (0 V)			
Total power dissipation (see also Fig. 3)				
at T_{amb} = 50 °C; continuous	P_{tot}	max.	1100	mW
at T_{amb} = 65 °C; max. 1000 hours	P_{tot}	max.	1100	mW
Storage temperature range	T_{stg}		−40 to + 150	°C

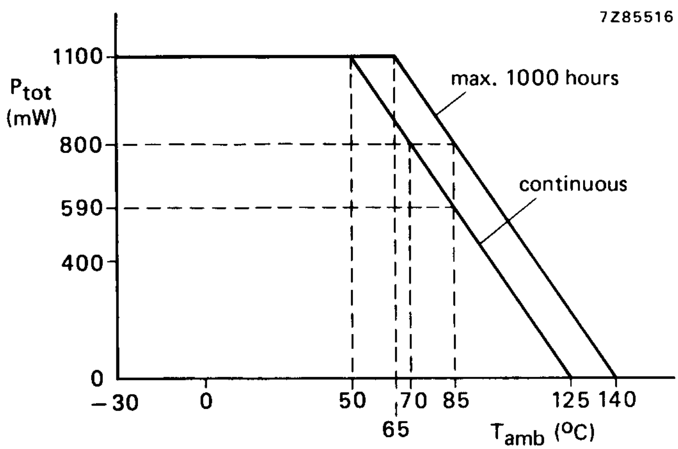

Fig. 3 Power derating curves; $R_{th\ j\text{-}a}$ = 70 K/W.

CHARACTERISTICS

At T_{amb} = −30 to + 85 °C; $T_j \leqslant 125$ °C; V_{CC} = 14 to 31,2 V; unless otherwise specified

parameter	conditions	symbol	min.	typ.	max.	unit
Supply voltage		V_{CC}	14	24	31,2	V
Quiescent supply current		I_{CC}	–	7,8	–	mA
	V_{CC} = 31 V; T_{amb} = 25 °C	I_{CC}	–	–	12,2	mA
Quiescent current ratio	$I_{CC1} = I_{CC}$ at T_j = 125 °C $I_{CC2} = I_{CC}$ at T_j = 25 °C	$\frac{I_{CC1}}{I_{CC2}}$	–	0,67	–	
Input voltage LOW		V_{IL}	–	–	5	V
Input voltage HIGH		V_{IH}	6,5	–	–	V
		V_{IH}	6,55	–	–	V
Input current LOW		$-I_{IL}$	–	–	100	μA
		$-I_{IL}$	–	–	95	μA
Input current HIGH		I_{IH}	300	–	–	μA
Rate of change of input signal		dV/dt	3	–	–	V/ms
Input current*	V_I = 1 V	$-I_I$	–	–	120	μA
	V_I = 35 V	I_I	–	–	280	μA
Output clamping voltage*	$V_Z = V_{CC} - 1$ V	V_Z	–	–	30	V
Output voltage without clamping (pin 14 open)* non-inverting input: V_I = 5,1 V inverting input: V_I = 6,3 V	V_{CC} = 14 V					
LOW	I_O = 1,32 mA	V_{OL}	–	–	1	V
	I_O = 2,91 mA	V_{OL}	–	–	1,5	V
HIGH	$-I_O$ = 5 mA	V_{OH}	V_{CC}−1,4	–	–	V
Output voltage with clamping (pin 14 at V_Z)*	V_{CC} = 31,2 V $V_Z < V_{CC}-1$ V					
LOW	I_O = 1,32 mA	V_{OL}	–	–	1	V
	I_O = 1,91 mA	V_{OL}	–	–	1,5	V

* At T_{amb} = 25 °C; V_{CC} = 24 V; unless otherwise specified.

parameter	conditions	symbol	min.	typ.	max.	unit
HIGH	I_O = 0 mA	V_{OH}	(V_Z −0,475)	–	(V_Z + 0,225)	V
	$-I_O$ = 1 mA	V_{OH}	(V_Z −0,455)	–	(V_Z + 0,12)	V
	$-I_O$ = 3 mA	V_{OH}	(V_Z −0,41)	–	(V_Z + 0,055)	V
Output short-circuit current*						
LOW-signal	output at V_{CC}	I_{OscL}	2,95	–	9,6	mA
HIGH-signal	output at V_{EE} (0 V)	$-I_{OscH}$	10,1	–	21,9	mA
Capacitor charging current*		I_C	–	30	–	μA
Propagation delays*						
gates 1, 2 and 3						
HIGH to LOW	C = 0 (at gate 2)	t_{PHL}	–	3,5	–	μs
LOW to HIGH		t_{PLH}	–	3,5	–	μs
gate 2						
HIGH to LOW	C = 47 nF ± 1%	t_{PHL}	1,85	–	5,2	ms
LOW to HIGH	$R_{insulation} > 100$ MΩ	t_{PLH}	7,5	–	14	ms

* At T_{amb} = 25 °C; V_{CC} = 24 V; unless otherwise specified.

CHARACTERISTICS (worst case conditions)

At T_j = + 125 to + 140 °C; maximum 1000 hours

parameter	conditions	symbol	min.	typ.	max.	unit
Input voltage LOW		V_{IL}	–	–	5	V
Input voltage HIGH		V_{IH}	6,55	–	–	V
Input current	V_I = 1 to 44 V	I_I	95	–	300	μA
Change of input current overdrive of other inputs $\Sigma(-I_I) < 10$ mA	$V_I < V_{CC} -1$ V	ΔI_I	–	–	120	μA
	$V_I > V_{CC} -1$ V	ΔI_I	–	–	158	μA
overdrive of other inputs $\Sigma(-I_I) < 90$ mA	$V_I < V_{CC} -1$ V	ΔI_I	–	–	280	μA
	$V_I > V_{CC} -1$ V	ΔI_I	–	–	320	μA
Input voltage by current overdrive	$\Sigma(-I_I)$ = 10 mA	V_I	46	–	65	V
Output voltage without clamping (pin 14 open) LOW	$I_{OL} \leqslant 0{,}095$ mA	V_{OL}	–	–	0,35	V
	I_{OL} = 0,095 to 1 mA	V_{OL}	–	–	1	V
	I_{OL} = 1 to 2,5 V	V_{OL}	–	–	1,5	V
HIGH	$-I_{OH} \leqslant 5$ mA	V_{OH}	$V_{CC}-1{,}5$	–	–	V
Output voltage with clamping (pin 14 at V_Z) HIGH	V_Z = 2,5 to V_{CC} −1 V; I_{OH} = 0 mA	V_{OH}	$(V_Z -0{,}5)$	–	$(V_Z + 0{,}245)$	V
	I_{OH} = 1 mA	V_{OH}	$(V_Z -0{,}5)$	–	$(V_Z + 0{,}15)$	V
	I_{OH} = 3 mA	V_{OH}	$(V_Z -0{,}5)$	–	V_Z	V
	I_{OH} = 0 mA; V_Z = 0 V	V_{OH}	–	–	0,75	V
Output short-circuit current LOW-signal	output at V_{CC}	I_{OscL}	–	–	11	mA
HIGH-signal	output at V_{EE} (0 V)	$-I_{OscH}$	5	–	28,5	mA
HIGH-signal	output at V_{EE} (0 V); T_j = 140 °C	$-I_{OscH}$	–	–	10	mA

parameter	conditions	symbol	min.	typ.	max.	unit
Current out of pin 14 (Z) when currents are forced into outputs	$-I_O \leqslant 3$ mA	$-I_Z$	–	–	2,2	mA
	$\Sigma I_O = (I_{O1} + I_{O2} + I_{O3})$	$-I_Z$	ΣI_O	–	–	mA
Current into pin 14 (Z) when inputs are set for output to be LOW	$-I_O = 30$ mA; $V_O \leqslant V_{EE}$	I_Z	–	–	300	μA
Supply current change	input and/or output voltages are negative with respect to V_{EE}	ΔI_{CCmax}	$(0,3 \times \lvert I_I \rvert) + (0,55 \times \lvert I_O \rvert)$			mA
Propagation delays						
gates 1 and 3						
HIGH to LOW		t_{PHL}	1	–	7	μs
LOW to HIGH		t_{PLH}	1	–	7	μs
gate 2						
HIGH to LOW	without capacitor	t_{PHL}	0,1	–	4	μs
LOW to HIGH	without capacitor	t_{PLH}	0,3	–	6	μs
HIGH to LOW	with capacitor; C in μF	t_{PHL}	38 x C	–	113 x C	μs
LOW to HIGH	with capacitor; C in μF	t_{PLH}	142 x C	–	334 x C	μs
Voltage spikes output LOW	see note 1	V_{OL}	–	–	2	V

Note to the characteristics

1. V_{CC} rising from 0 to 14 V; all inputs open; internally it is guaranteed that the input threshold voltage $V_{IL} > V_{OL}$.

APPLICATION INFORMATION

The following figures (Figs 4 to 11) give some examples of the basic industrial control functions.

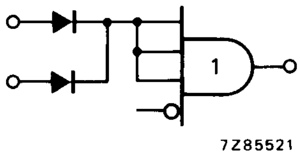

Fig. 4 OR function.

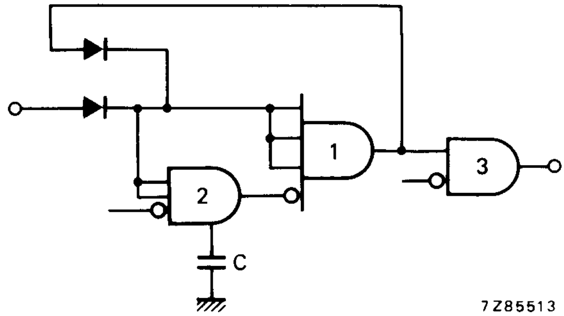

Fig. 8 Monostable flip-flop; for C = 4,7 μF, 1 s no reaction.

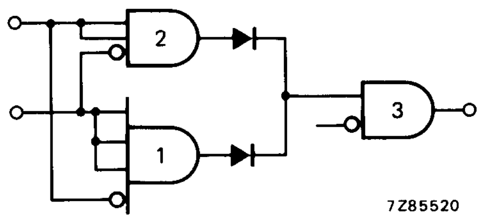

Fig. 5 EXCLUSIVE-OR function.

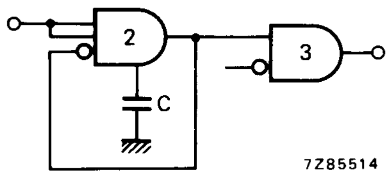

Fig. 9 Start delay function.

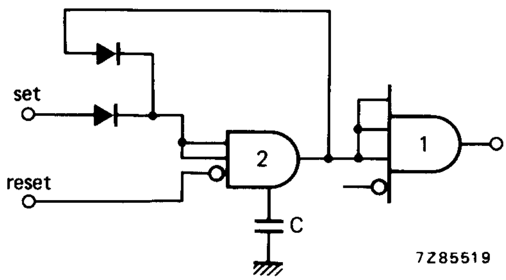

Fig. 6 Delayed memory; reset is dominating.

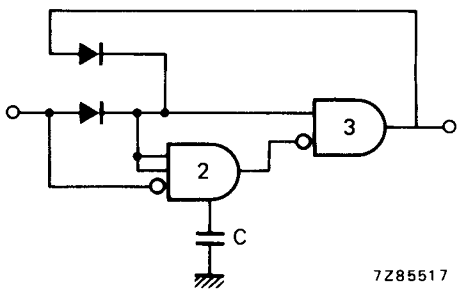

Fig. 10 Decay delay function.

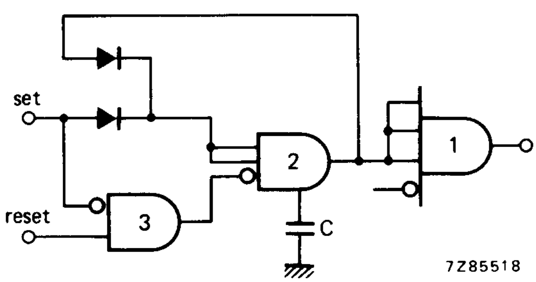

Fig. 7 Delayed memory; set is dominating.

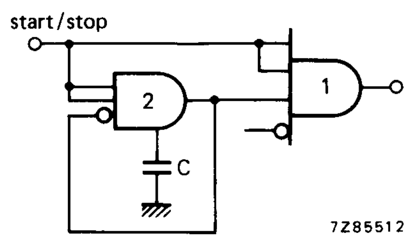

Fig. 11 Square-wave oscillator.