MAS9171A

OCTAL PORT PROTECTON

- **Parallel In, Parallel Out**
- **High Voltage Inputs**
- **Automotive**

DESCRIPTION

The MAS9171A is an eight channel protection circuit for microprocessors in automotive applications. All inputs are protected against energy rich pulses according to DIN40839/ISO7637. Internal analog filters and suitable input threshold voltages provide the functionality within a noise spectrum of 150 kHz up to 1 GHz without need of external filter components. The MAS9171A is optimized for low current consumption.

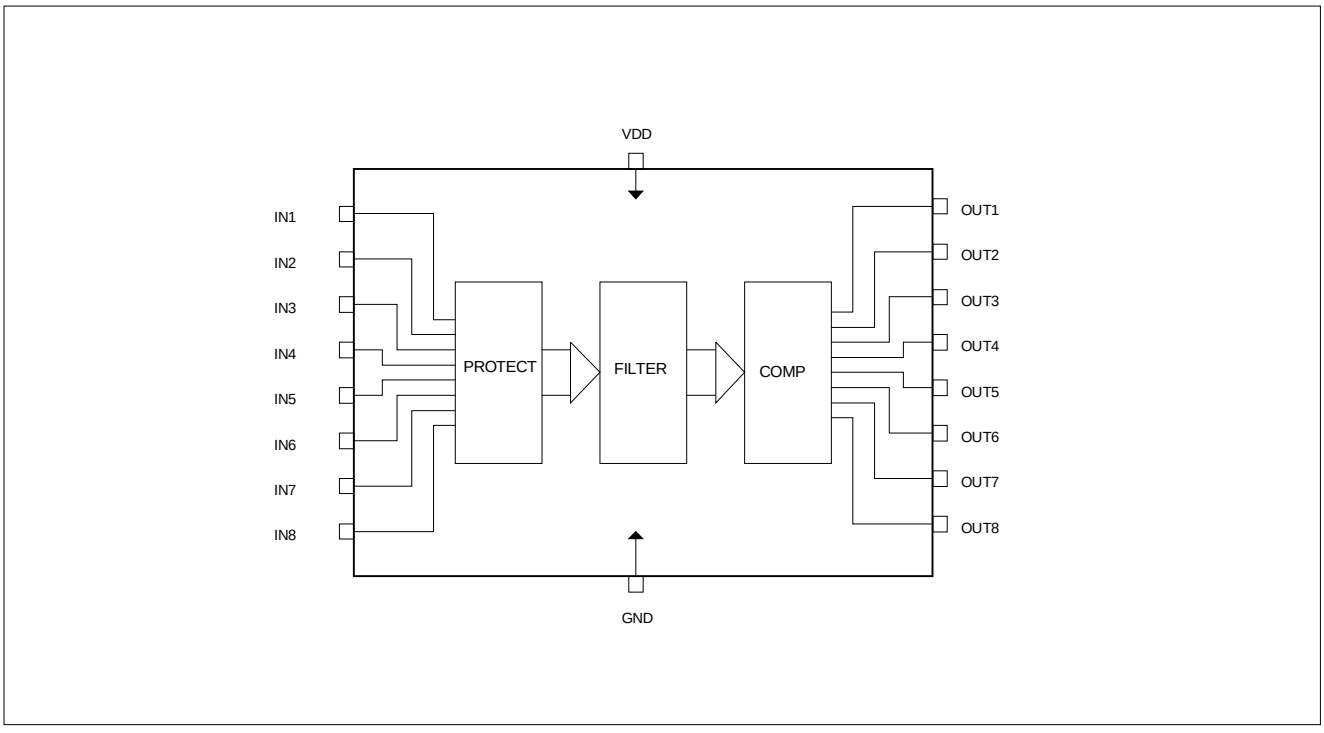
FEATURES

- 8 digital channels
- Supply voltage 3.3 V/5 V
- Low supply current
- High voltage inputs
- Internal analog filter
- -40°C to +125°C
- SO-18 package

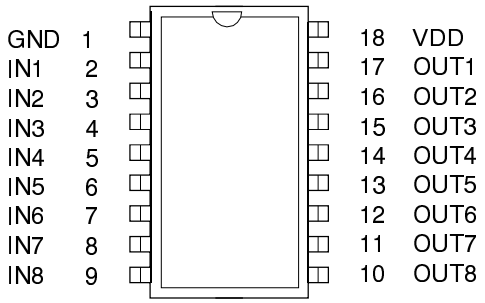
APPLICATION

- Replacement of protection circuitry in car electronics and industrial bus systems

BLOCK DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

Pin Name	Pin	Type	Function
GND	1	G	Ground
IN1	2	I	Digital Input 1
IN2	3	I	Digital Input 2
IN3	4	I	Digital Input 3
IN4	5	I	Digital Input 4
IN5	6	I	Digital Input 5
IN6	7	I	Digital Input 6
IN7	8	I	Digital Input 7
IN8	9	I	Digital Input 8
OUT8	10	O	Digital Output 8
OUT7	11	O	Digital Output 7
OUT6	12	O	Digital Output 6
OUT5	13	O	Digital Output 5
OUT4	14	O	Digital Output 4
OUT3	15	O	Digital Output 3
OUT2	16	O	Digital Output 2
OUT1	17	O	Digital Output 1
VDD	18	P	Positive Supply Voltage

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	V_{DD}		-0.5	7	V
Input Voltage	V_{IN}	T = 125°C, f=100Hz, 5% On	-200	200	V
ESD Voltage		MM (EIAJ ED-4701 Method C-111)	-500	500	V
Output Current (Note 1)	I_{OUT}	T=125°C		5	mA
Ambient Temperature	T_{amb}		-40	+125	°C
Storage Temperature	T_{Stg}		-55	+150	°C

RECOMMENDED OPERATION CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{DD}		3.3	5.0	5.5	V
Supply Current	I_{DD}	V_{DD} = 5.0 V $V_{IN\ 1...8}$ = 0 V		3nA	10	µA

ELECTRICAL CHARACTERISTICS

◆ Parallel input port

(T=-40°C .. +125°C, V_{DD} = 3.3V..5.5V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input High Voltage (Note 2)	V_{IH}	V_{DD} = 5.0 V	5.0	5.5	6.0	V
Input Low Voltage (Note 2)	V_{IL}	V_{DD} = 5.0 V	2.25	2.75	3.25	V
DC Input Voltage	V_{max}	Only 1 input at the same time	-100		VDD+100	V
Input Resistance	R_{IN1}	$-1V<V_{IN1}<V_{DD}x2.25$	140	225	320	kΩ
3 dB Frequency of Analog Filter	fd		100	150	200	kHz

◆ Parallel digital outputs

(T=-40°C .. +125°C, V_{DD} = 5V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output High Voltage	V_{OH}	I_{Source} = 3.0 mA	4.1	4.6		V
Output Low Voltage	V_{OL}	I_{Sink} = 3.0 mA		0.35	0.6	V
Signal Rise Time	t_R	no load	50	500		ns
Signal Fall Time	t_R	no load	50	500		ns

Note 1: The sum of all output currents must not exceed 16 mA
Note 2: Typical values of V_{IH} / V_{IL} can be calculated as follows: V_{IH} = 1.1 x V_{DD}
V_{IL} = 0.55 x V_{DD}

FUNCTIONS

◆ Input protection

The input protection is composed of a high voltage thin film series resistor, a metal-to-metal capacitor to ground and a Zener diode to GND. The circuit provides the ability of withstanding energy rich voltage pulses as well as fast transient high voltage bursts without damaging the MAS9171A or devices connected to it.

The resistance of each input to ground is approx. 225 kOhms. Each input is protected against electrostatic discharge (ESD) according to Machine Model EIAJ ED-4701 Method C-111 (+/-500 kV, 200 pF, 0 Ohms).

The device has been specially designed for high decoupling between Inputs and Power Supply or Outputs to prevent voltage overswing when applying test pulses according to DIN40839/ISO7637.

For a given ambient temperature the maximum pulse length is limited by the maximum silicon temperature of T=150°C.

◆ Analog filter

The input protection is followed by a passive low pass filter of 2nd order with a 3 dB frequency of 150 kHz. This filter is used to block high frequency components coupled through capacitive coupling clamps or electromagnetic field.

◆ Comparator

The output signal of the analog filter of each channel is pulse-shaped by a Schmitt-Trigger Comparator with strong output drivers. The output stage works with non-overlapping clocks to reduce current spikes at the Supply Pins caused by change of output level.

◆ Input levels

The Ouput OUTx is “High” if the corresponding input voltage VINx > 5.5 V and “Low” if VINx < 2.75 V (typical values).

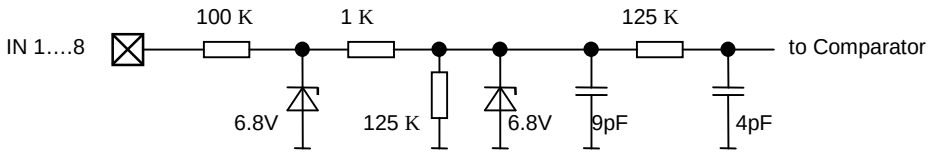


Fig 1.: Input Channel of MAS9171A

APPLICATION INFORMATION

- **GENERAL**

In the late 70ties microcontrollers have been introduced into most of the low cost applications in the field of consumer, industrial and automotive. Lowest cost 8-Bit microcontrollers are used in modern computer monitors for user programmable adjustment of the picture geometrie. A modern car can carry up to 40 microcontrollers that control motor managment, air condition, wipers, brakes, instruments,.....

The increased density of complex electronic systems results in high electromagnetic fields with a wide frequency spectrum in the environment. Examples for typical noise sources are DC-Motors, ignitors, discharge lamps, switch-mode supplies and all different kinds of transmitters like mobile phones and radio stations. The requirements on EMI immunity are defined in several DIN, ISO and IEC standards.
Design-Engineers have to think of how to protect sensitive components like microcontrollers against overvoltage pulses. Especially pulses with short rise times might cause problems because most of the standard components are not designed to work properly at frequencies above the cut-off frequency.

In addition the layout of the PCB is very critical at high frequencies. Filters components have to be placed very closely to the connectors leading to external wires that may work as antennas. It is quite common that a lot of filter and protection components have to be designed in at a very late phase of the project when starting EMI measurements with pre-production parts. This can cause delays to the product introduction phase and therefore it is very important to think about the limits of sensitive components already with the first Prototypes.

- **INPUT PROTECTION FOR MICROCONTROLLERS**

A typical protection circuit for a digital input of a HCMOS microcontrollers consists of one series resistor, one or two block capacitors to Vss and two clamping diodes to Vss/Vdd.
The series resistor shall limit the maximum current into the internal protection diodes to a value below the latch-up current of the input structure (typ. 25mA). Together with the capacitor it builds up a 1th order RC-filter.The purpose of the filter is to get a stable signal within the sampling period of the microcontroller without need of software filtering. For resistor values > 100 kOhms however, the leakage current of the port may cause unwanted dropout

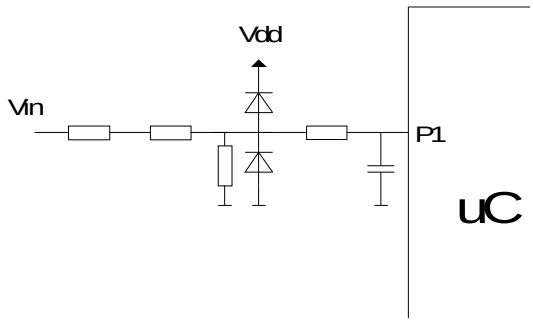


Fig.2 : Discrete protection circuit

voltage which is not any longer neglectible to the input voltage. Over the full temperature and supply voltage range this can cause severe tolerance problems. Those inputs need extra clamping diodes to the Vss/Vdd and a lower value series resistor.
Most of 0805/1204 SMD resistors are specified for voltages < 200V. For higher voltages two resistors in series are recommended. Especially for applications with a lot of input ports the protection circuitry around the microcontroller consumes a big amount of board space and therefore makes the board layout very difficult even when using SMD components. Each component is a potential source of an error in production and must be tested with In-circuit testers.

APPLICATION INFORMATION

- **INPUT PROTECTION USING MAS9171A**

The MAS9171A is a eight channel protection circuit for microprocessors in automotive applications that may be used in industrial applications as well. All inputs are protected against energy rich pulses according to DIN40839/ISO7637. Internal analog filters and suitable input threshold voltages provide the functionality within a noise spectrum of 150KHz up to 1GHz without need of external filter components. The MAS9171A is optimized for low current consumption.

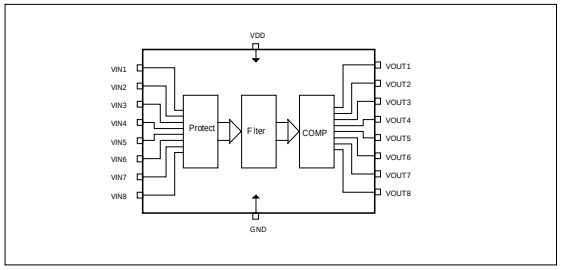


Fig. 3: Block diagram of MAS9171A

Advantages of MAS9171A

- lower price when comparing Part+Board costs
- easy layout
- better reliability
- less test time
- universal to use, less development time

- **APPLICATION EXAMPLES**

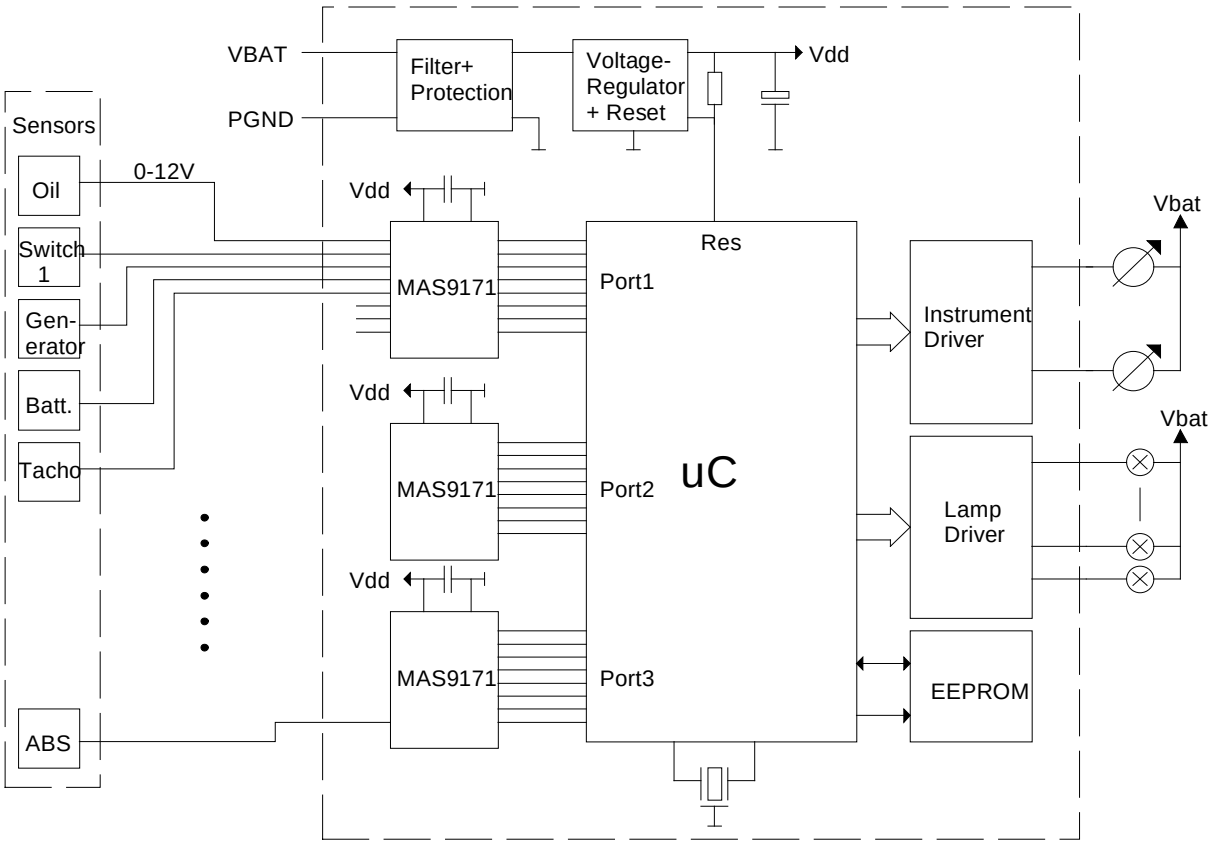


Fig.4: Electronic Dashboard for Cars

APPLICATION INFORMATION

Fig. 5 shows how to use the MAS9171A to detect the condition of switches

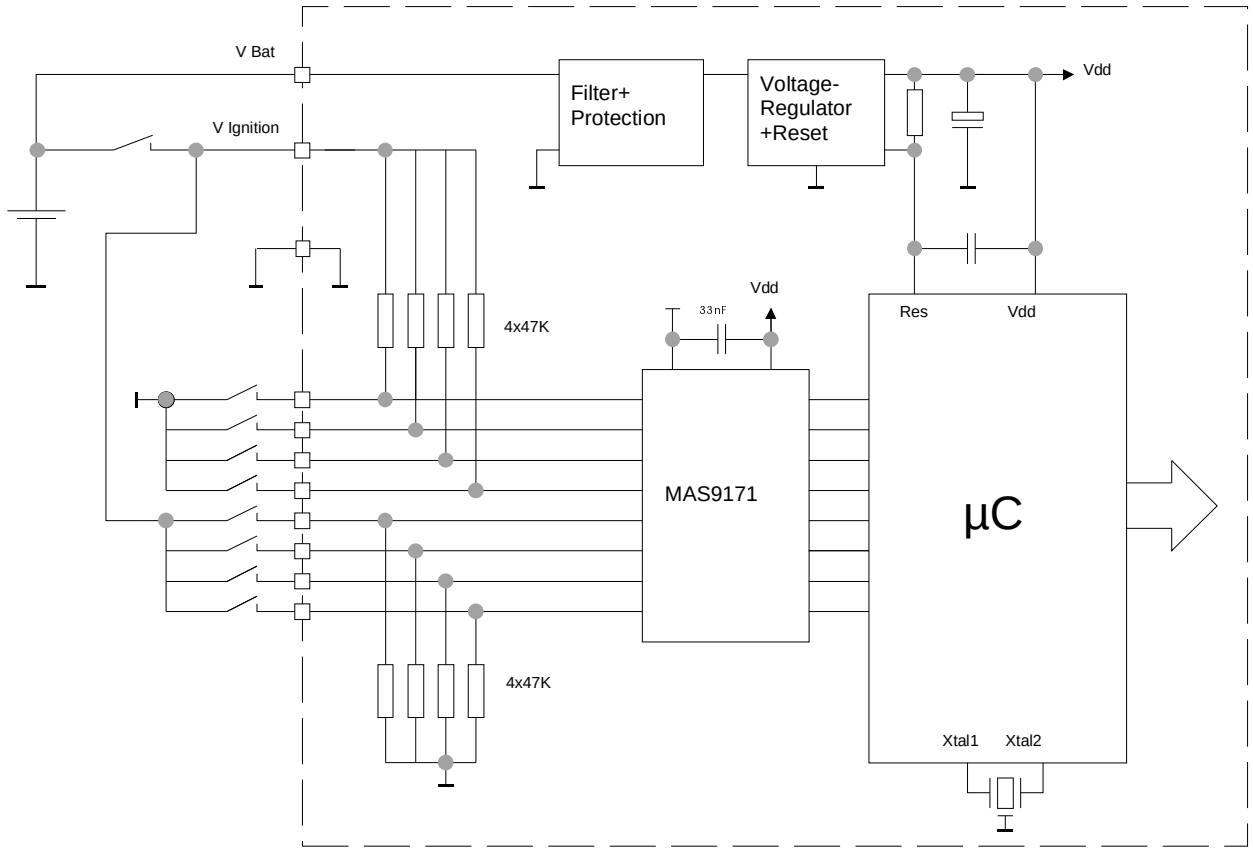


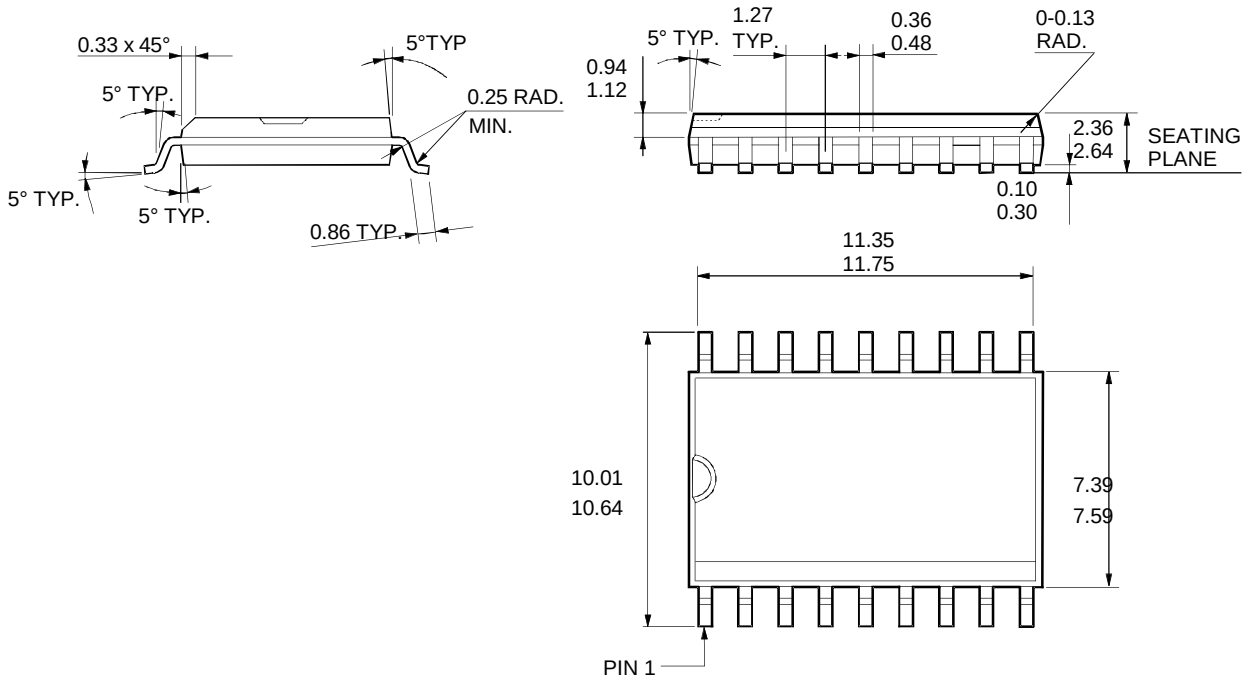
Fig. 5: Application Circuit (Detection of Switches)

IMPORTANT !

- The MAS9171A shall be placed closely to the microprocessor to avoid voltage spikes at the uC inputs caused by currents on the Supply Pins and/or Pins OUT1 to OUT8.
- A block capacitor of 33nF close to the Supply Pins is recommended
- It is important to connect external Pull-Up resistors to $V_{ignition}$ in order to prevent quiescent current into the MAS9171A (Note: MAS9171A has internal pull-down of 225Koms to Gnd).

DEVICE PACKAGE OUTLINES

18 LEAD SO OUTLINE (300 MIL BODY)



ALL MEASUREMENTS IN mm

ORDERING INFORMATION

Product Code	Product	Package	Comments
MAS9171AS	OCTAL Port Protection	18 Pin SO 0.3”	
MAS9171AS-T	OCTAL Port Protection	18 Pin SO 0.3”	Tape & Reel

LOCAL DISTRIBUTOR

MICRO ANALOG SYSTEMS OY CONTACTS

Micro Aanalog Systems Oy
Kamreerintie 2, P.O.Box 51
FIN-02771 ESPOO, FINLAND

Tel. (09) 80 521
Tel. Int. +358 9 80 521
Telefax +358 9 805 3213
E-mail: hightech@micronas.com

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