

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

Product Preview

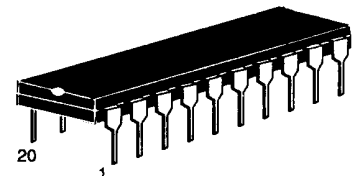
**Standard Quad Low Side Pre-driver
with Diagnostic**

The MC33195 is a high performance pre-driver specifically designed for use in inductive or resistive load control systems. It is very much dedicated to applications where several Bipolar or TMOS™ Power transistors need to be driven by only one IC also performing some diagnostic. It is well suited to both Automotive and Industrial applications.

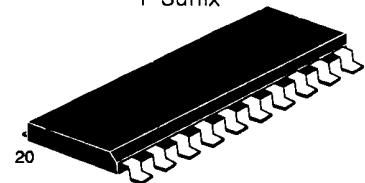
- Bidirectional Input ports, Microprocessor compatible.
- Power-ON Reset.
- Bipolar Power Transistors drive compatible.
- Standard and Logic Level Power TMOS™ drive compatible.
- SENSEFET™ input compatible.
- Tri-State working mode capability.
- Operating Voltage: 5V, outputs clamped at 20V.
- Adjustable current limit with external shunts.
- Fully compatible with Automotive environment.
- -40 °C to +125 °C operating temperature.

MC33195

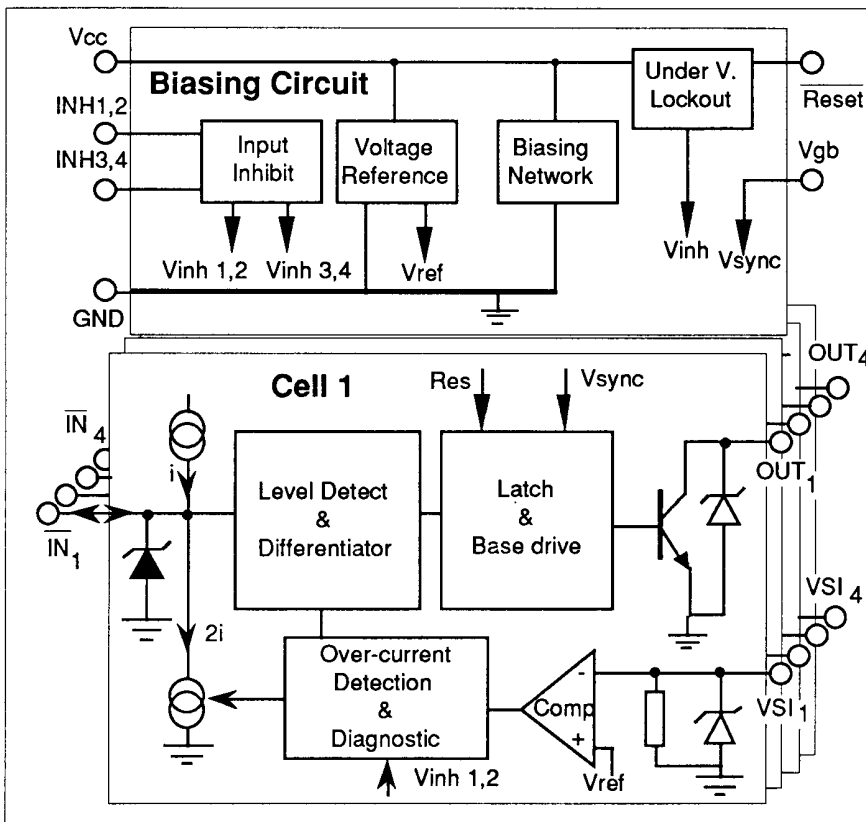
Package



Case 738-03
DIL - 20 pins
P Suffix



Case 751D-03
SO - 20L
DW Suffix



Pin Assignment

| | | | |
|--------|----|----|------|
| VCC | 1 | 20 | VS11 |
| Reset | 2 | 19 | OUT1 |
| IN1 | 3 | 18 | VS12 |
| IN2 | 4 | 17 | OUT2 |
| INH1,2 | 5 | 16 | VS13 |
| INH3,4 | 6 | 15 | OUT3 |
| IN3 | 7 | 14 | VS14 |
| IN4 | 8 | 13 | OUT4 |
| NC | 9 | 12 | GND |
| VGB | 10 | 11 | GND |

- Vcc: Logic supply voltage
- Reset: Whole circuit reset
- IN_n: Input (active low)
- INH_{x,y}: Inhibit outputs 1,2 or 3,4
- VGB: Standard TMOS gate start up bias voltage
- GND: Ground
- OUT_n: Open collector outputs
- VS_n: Voltage Sense Inputs



MAXIMUM RATINGS (Tamb = 25°C unless otherwise noted.)

| Electrical rating | Symbol | Value | Unit |
|--|---------------------|-------|------|
| Supply Current (pin 1) | Icc | 50 | mA |
| Supply positive Voltage (pin 1) | Vcc | 6.5 | V |
| Supply negative Voltage (pin 1) | Vcc | -0.7 | V |
| Driver Sink Current (pin 19, 17, 15, 13) | Iout _n | 100 | mA |
| Driver Clamping current (pin 19, 17, 15, 13) | Iclamp _n | 50 | mA |
| Sense Input Current (pin 20, 18, 16, 14) | I _{sin} | 10 | mA |
| Input Currents (pin 3, 4, 7, 8, 5, 6,10,2) | I _{in} | 10 | mA |
| VGB Input Voltage (pin 10) | Vgb | 20 | V |

| Thermal rating | Symbol | Value | Unit |
|------------------------------------|--------|------------|------|
| Storage Junction Temperature | Tstg | -60 to 150 | °C |
| Operating temperature range | Tamb | -40 to 125 | °C |
| Junction Temperature | Tj | 150 | °C |
| Power Dissipation (Tamb = 125°C) | Pd | 250 | mW |
| Thermal Resistance for SO package | Rqja | 90 | °C/W |
| Thermal Resistance for DIL package | Rqja | 80 | °C/W |

ELECTRICAL CHARACTERISTICS (4.5V ≤ Vcc ≤ 5.5V, Icc ≤ 20mA, -40°C ≤ Tamb ≤ 125°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|----------------------------|-----|-----|------------|--------|
| Driver Saturation Voltage (pin 19, 17, 15,13) Iout _n =1 mA (Vgb = Vcc) Iout _n =20 mA (Vgb = Vcc) | Vout _n (sat) | | | 0.2 0.3 | V |
| Driver leakage current (Vout _n =18V) | IL | | | 5 | μA |
| Driver Clamping Voltage (Iclamp = 10 mA) | Vclamp | 20 | | | V |
| Current Sense Threshold Voltage at 25 °C (pin 20, 18, 16, 14) | Vsin | 400 | | 430 | mV |
| Current Sense Threshold Voltage (pin 20, 18, 16, 14) | Vsin | 390 | | 440 | mV |
| Sense Input Impedance (Vsi _n = 0.4V) | Rin | 7 | 10 | 17 | K Ohms |
| Diag. reading on \overline{IN}_n when OUT _n =H with positive current = 10 μA | \overline{VIN}_n/OH | | | 0.4 | V |
| Diag. reading on \overline{IN}_n when OUT _n =L with negative current = 10 μA | \overline{VIN}_n/OL | 4 | | | V |
| Input Switching ON Current OUT _n =L/H for \overline{IN}_n = H / L (Negative input current) | Iswon | | | 50 | μA |
| Input Switching OFF Current OUT _n =H/L for \overline{IN}_n = H / L (positive input current) | Iswoff | | | 50 | μA |
| \overline{Vreset} Lower Threshold Level (pin2) | \overline{Vreset} | 1.2 | | 3 | V |
| Reset Charging Current | Ireset | 0.9 | 1.2 | 1.5 | μA |
| Reset switching hysteresis (pin2) | $\Delta \overline{Vreset}$ | 200 | | | mV |
| VGB input impedance (Vgb = 14 V) | Rvgbin | 5K | | 10K | Ohm |

SWITCHING CHARACTERISTICS (see figure 1)
 (4.5V ≤ Vcc ≤ 5.5V, Icc ≤ 20mA, -40°C ≤ Tamb ≤ 125°C (unless otherwise noted))

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|--------|-----|-----|------|------|
| Propagation delay of $\overline{\text{Reset}}$ (pin 2) (Without external capacitor) $\overline{\text{Reset}}$ from L to H (circuit functional) | t1 | | | 100 | μs |
| Input Low holding time $\overline{\text{IN}}_n = \text{L}$ to hold $\overline{\text{IN}}_n = \text{L}$ (*) | t2 | | | 1.25 | μs |
| Propagation delay $\overline{\text{IN}}_n = \text{H/L}$ to $\text{Vout}_n = \text{H}$ | t3 | | | 2 | μs |
| Input High holding time $\overline{\text{IN}}_n = \text{H}$ to hold $\overline{\text{IN}}_n = \text{H}$ (*) | t4 | | | 2.5 | μs |
| Propagation delay $\overline{\text{IN}}_n = \text{L/H}$ to $\text{Vout}_n = \text{L}$ | t5 | | | 2.5 | μs |
| Propagation delay for protection $\text{Vsi}_n = \text{L/H}$ to $\text{Vout}_n = \text{L}$ | t6 | | | 3 | μs |
| Propagation delay for diagnostic $\text{Vsi}_n = \text{L/H}$ to $\overline{\text{IN}}_n = \text{H}$ (*) | t7 | | | 4 | μs |

(*) input pin $\overline{\text{IN}}_n$ set in tri-state after turn on/off

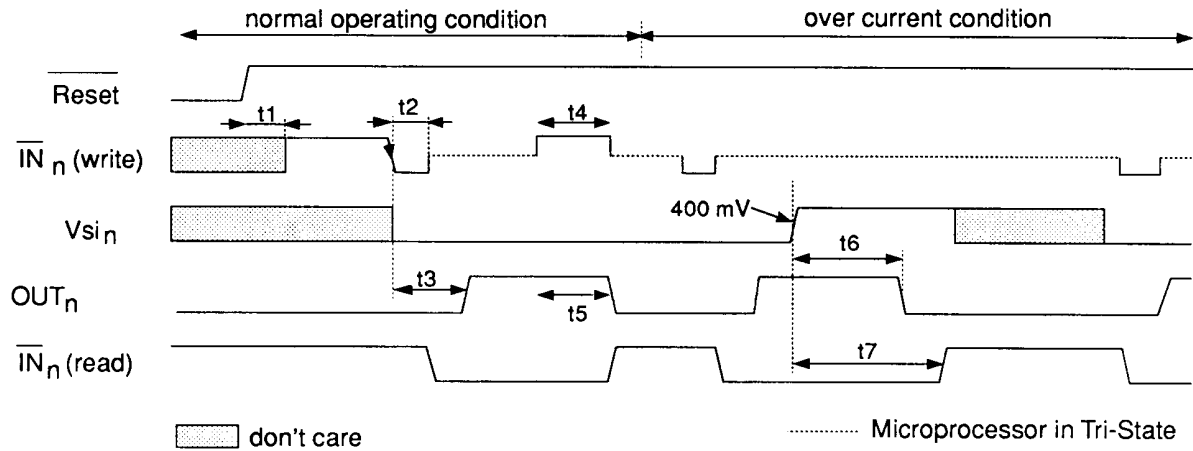


Figure 1: Switching waveforms

DEFINITION OF CURRENTS AND VOLTAGES: Positive current is defined as conventional current flow into the device. Negative current is defined as flow out of the device. All voltages are referenced to ground. Both current and voltages are specified as absolute values (i. e., -10 volts is greater than -1 volt).

Truth table

| IN_n (write) | VSI_n | \overline{Reset} | $INH_{x,y}$ | \overline{IN}_n (read) | OUT_n |
|----------------|---------|--------------------|-------------|--------------------------|----------------------------|
| X | X | L | X | H | L |
| X | X | X | H | H | L (Out_x & Out_y) |
| H | X | H | L | H | L |
| H/L | L | H | L | L | H |
| Tri-State | L | H | L | L | H |
| Tri-State | H | H | L | H | L |
| Tri-State | H/L | H | L | H | L |

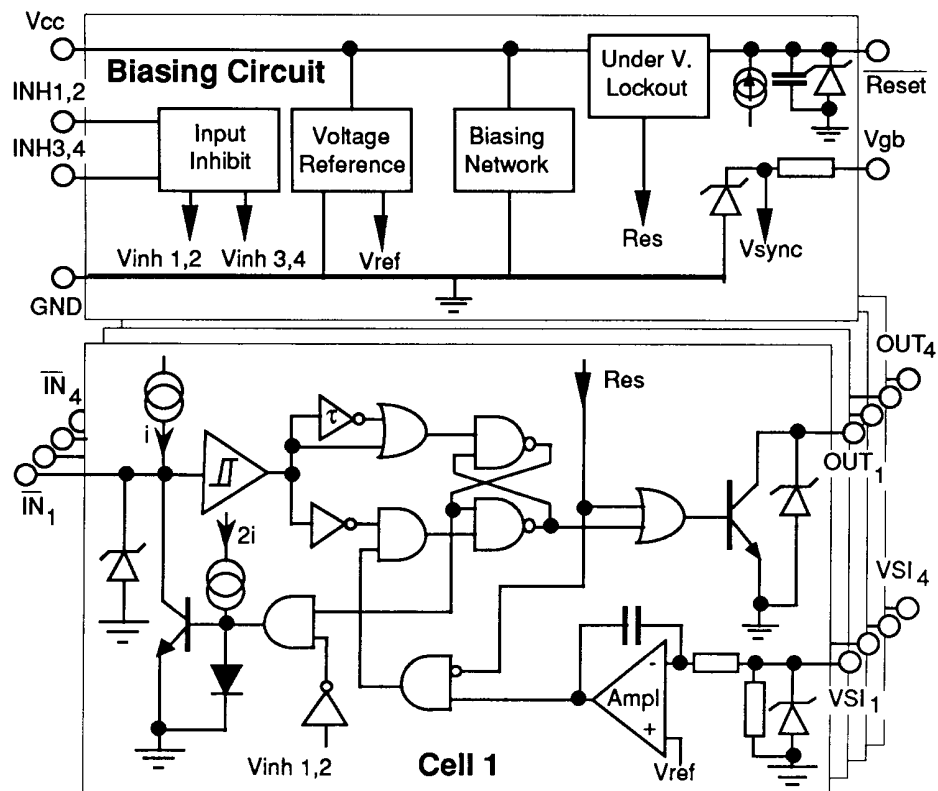


Figure 2: Functional Diagram

GENERAL DEVICE DESCRIPTION

ON/OFF input signals to be provided on pin 3, 4, 7, 8.

The main idea of this input feature is to be able to use the same pin to read the status information, and also to ensure good noise immunity when reading this status data, so the product remains in the desired state. Therefore a command in current rather than in voltage has been chosen, with internal latch ON after an edge down trigger.

Some more explanation: Assuming the input pin (\overline{IN}_n) has been pulled down for more than $1.25 \mu\text{s}$ (t_2) with a pull down (negative) current more than $50 \mu\text{A}$, the load remains latched ON (i. e. power device is ON), even if this input pin (\overline{IN}_n) becomes tri-state. This is achieved by the turn on of the bottom current source (2i). It will keep the input pulled down unless it gets over-written by a turn off signal.

The MC33195 will be definitely turned off if the input is pulled up for more than $2.5 \mu\text{s}$ with a source current more than $50 \mu\text{A}$. The load remains latched off (i. e. power device turned off), even if this input pin (\overline{IN}_n) becomes tri-state.

Other means to turn the pre-driver OFF (pin 2, 5, 6).

The MC33195 can be turned off in four different ways:

\overline{IN}_n pulled up (see description in the previous paragraph)

-Reset put at low, will turn off the four power transistors. The integrated capacitance on this pin creates an internal power up delay of around $100 \mu\text{s}$

- $INH_{1,2}$ or $INH_{3,4}$ set high will turn off outputs in pairs, either the power devices connected to OUT_1 and OUT_2 or the ones connected to OUT_3 and OUT_4 . The time required to acknowledge this turn off is the same as the one for the \overline{IN}_n input pins.

-by overcurrent detection (see next paragraph)

Current Limit and Diagnostic (pin 14, 16, 18, 20 & 3, 4, 7, 8)

Each output has its own current sensing pin (V_{sin}) which acts independently of any other. When a voltage level of 400 mV is reached on one of the four sense inputs, the corresponding output will be turned off, and remain latched off. Even if this fault disappears, the output will remain off until the microprocessor turns it on again by pulling down the corresponding input.

When such an overcurrent appears, it automatically turns off the input controlled current source (2i), pulling this input pin High (\overline{IN}_n).

A microprocessor reading the \overline{IN}_n pin with one of its I/O ports will see a High state, meaning a fault has been diagnosed and the channel has been turned off.

Overvoltage protection

All input and output pins are protected against overvoltages within the limits defined in the maximum ratings.

APPLICATION INFORMATION

This component is a general purpose product which can be used in several applications in automotive and industrial segments. Applications include injection, anti lock and active suspension systems, inductive coil driving, low power motors in inverter or push-pull configuration.

It can drive different types of power products. We shall give some application details for each of them.

The MC33195 is compatible with the Power MOSFET family, either at a logic level or standard TMOS™.

The Logic Level MOSFETs (L2FETs)

The Logic Level MOSFETs only need a pull up resistor connected to 5V (Vcc) as shown on figure 3. This solution requires the fewest external components.

The Standard TMOS

On the other hand, the standard power MOSFET requires a 10 V on its gate to be fully turned on, this usually means that a special power supply, different from the Vcc (5V), has to be provided. The Vgb pin of the MC33195 should be used in this cases to ensure that the TMOS™ is kept turned off during startup phase.

If, for example, some time is required for the Vcc supply to reach the 5V, the standard power MOSFET will remain off until the pre-driver becomes fully functional with its 5V operating voltage. (see figure 4)

Calculating the turn ON time of the power MOSFET is rather easy with the gate charge curve given on the TMOS™ databook. It gives the number of charges needed to put into the MOSFET gate to make it turn on.

Knowing the gate pull up resistance and the voltage applied (5V for a logic level) the current provided to the gate can be calculated easily and the turn on time by deduction as follow s:

$$T_{on} = \frac{Q \times R_{pu}}{V_{pu}}$$

R_{pu} is the gate pull up resistor value, V_{pu} is the gate pull up voltage value (usually 5V for L2FET and 10V for std TMOS)

The TMOS™ turn off time depends on the sink current extracted from the MOSFET gate. It can be limited by a resistor in series on the gate if the designer wants to control the dV/dt.

The typical sinking current value for a non externally limited output transistor is in the range of 50 mA. Knowing the precise sinking current we can calculate the turn off time as follows:

$$T_{off} = \frac{Q}{I_{sink}}$$

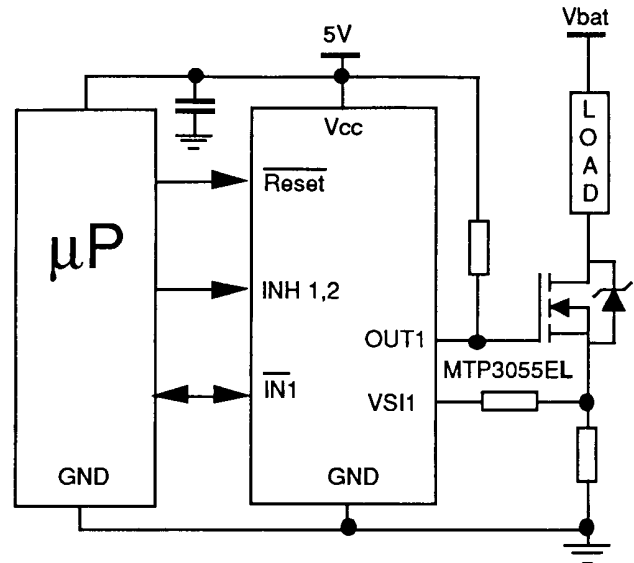


Figure 3

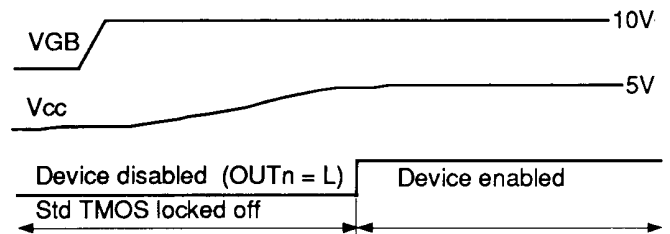
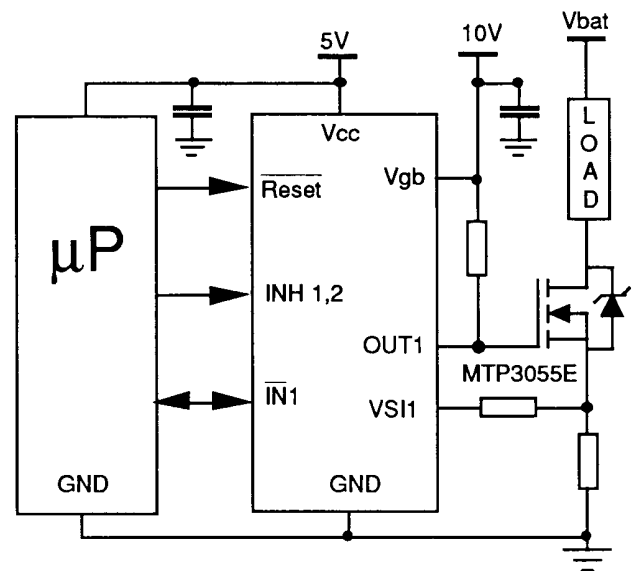


Figure 4

SENSEFETs

The current limit comparators are also compatible with SENSEFETs which enable the users to design lossless current sensing (figure 5). The sense resistance has to be calculated to provide 400 mV when the power stage reaches its current limit.

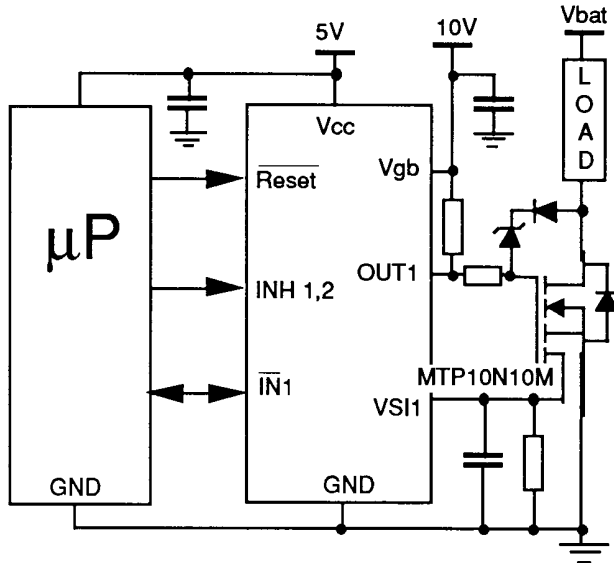


Figure 5

AUTOPROTECTED DARLINGTONs

Low cost auto-protected bipolar darlington transistors like MJE5420Z can also be driven by this interface, as shown on the application drawings. It uses a shunt resistor on the emitter to perform the current sensing. It contains an internal zener network to clamp the collector voltage to a safe level during switching off of the inductive load (figure 6).

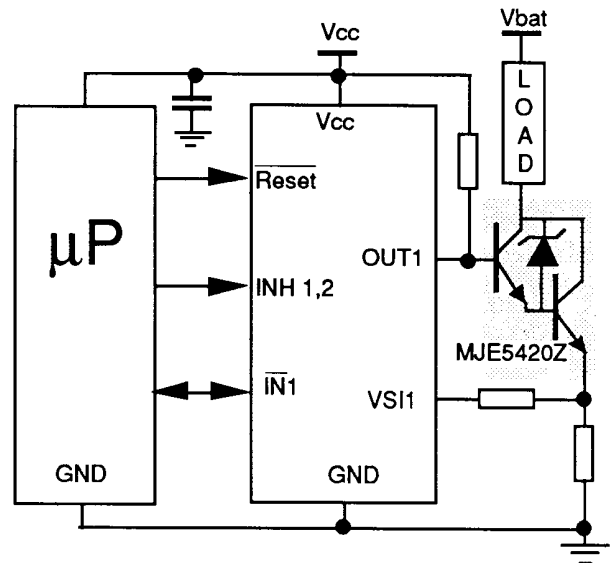


Figure 6

TEST CONDITIONS

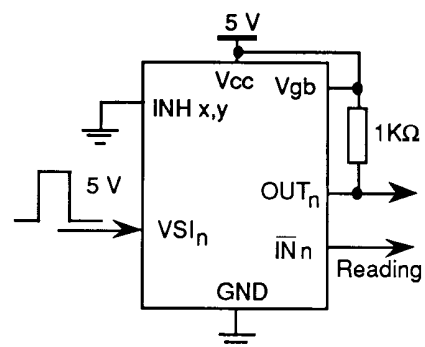
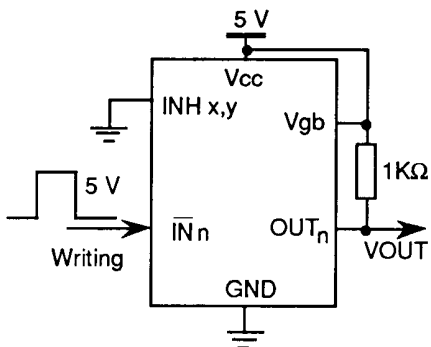



Figure 7: I/O Switching Test Circuit

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