



---

## MIC59P60

---

### 8-Bit Serial-Input Protected Latched Driver

---

#### General Description

The MIC59P60 serial-input latched driver is a high-voltage (80V), high-current (500mA) integrated circuit comprised of eight CMOS data latches, a bipolar Darlington transistor driver for each latch, and CMOS control circuitry for the common CLEAR, STROBE, CLOCK, SERIAL DATA INPUT, and OUTPUT ENABLE functions. Additional protection circuitry supplied on this device includes thermal shutdown, undervoltage lockout (UVLO), and overcurrent shutdown.

The bipolar/CMOS combination provides an extremely low-power latch with maximum interface flexibility. The MIC59P60 has open-collector outputs capable of sinking 500mA, and integral diodes for inductive load transient suppression with a minimum output breakdown voltage rating of 80V (50V sustaining). The drivers can be operated with a split supply, where the negative supply is down to -20V and may be paralleled for higher load current capability.

Using a 5V logic supply, the MIC59P60 will typically operate at better than 5MHz. With a 12V logic supply, significantly higher speeds can be obtained. The CMOS inputs are compatible with standard CMOS, PMOS, and NMOS circuits. TTL circuits may require pull-up resistors. By using the serial data output, drivers may be cascaded for interface applications requiring additional drive lines.

Each of the eight outputs has an independent overcurrent shutdown of 500mA. Upon over-current shutdown, the affected channel will turn OFF, and the flag will go low until  $V_{DD}$  is cycled or the ENABLE/RESET pin is pulsed high. Current pulses less than 2 $\mu$ s will not activate current shutdown.

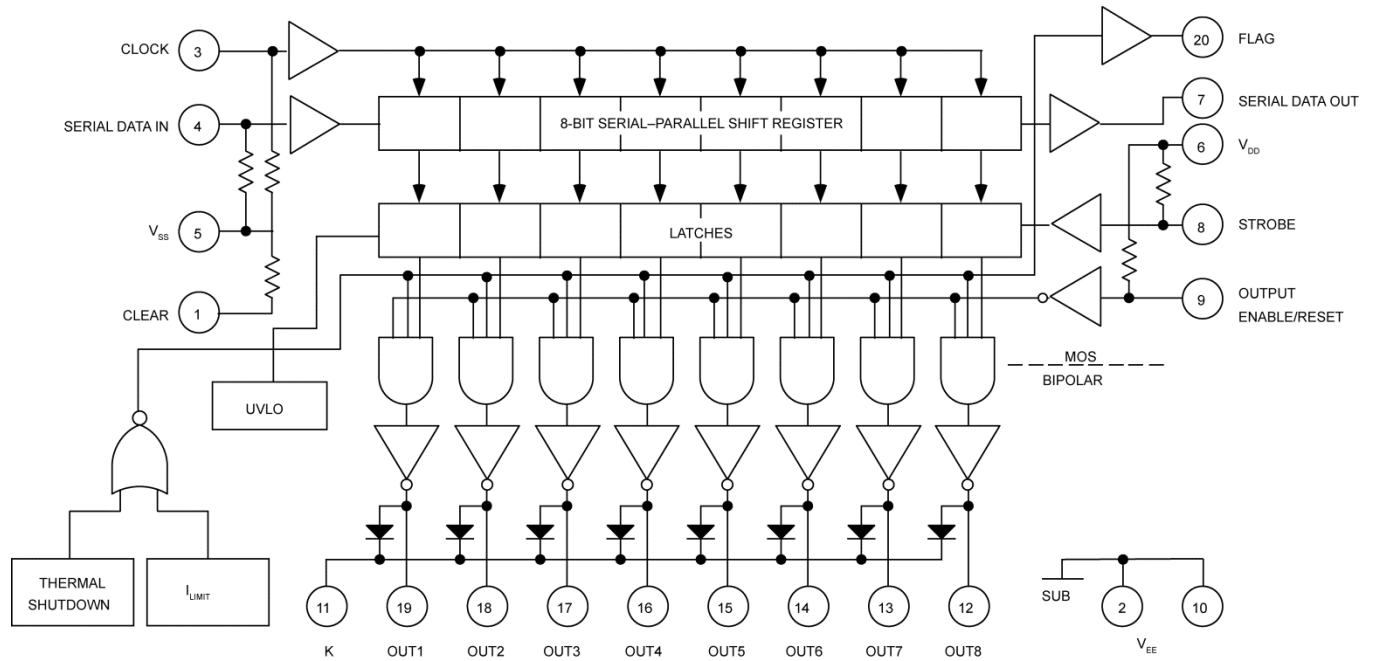
Temperatures above 165°C will shut down the device and activate the error flag. The UVLO circuit prevents operation at low  $V_{DD}$ ; hysteresis of 0.5V is provided.

Datasheets and support documentation are available on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

#### Features

- 3.3MHz minimum data input rate
- Output current shutdown (500mA typical)
- Undervoltage lockout
- Thermal shutdown
- Output fault flag
- CMOS, PMOS, NMOS, and TTL compatible
- Internal pull-up/pull-down resistors
- Low-power CMOS logic and latches
- High-voltage current sink outputs
- Output transient-protection diodes
- Single or split supply operation

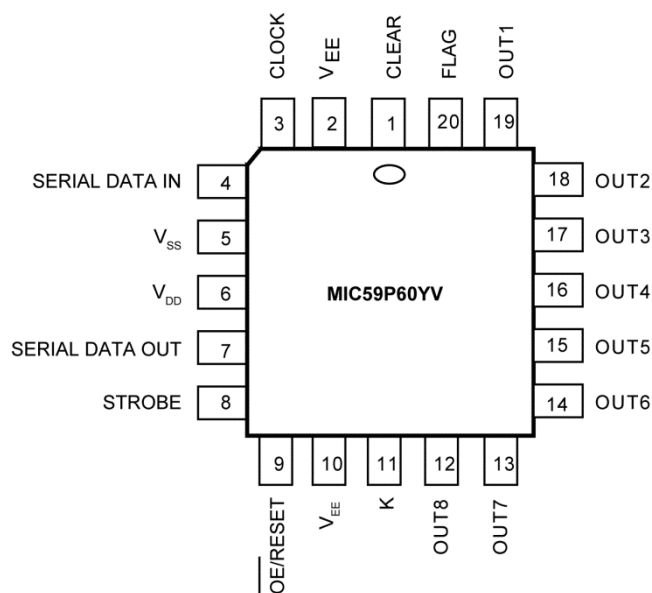
## Functional Diagram



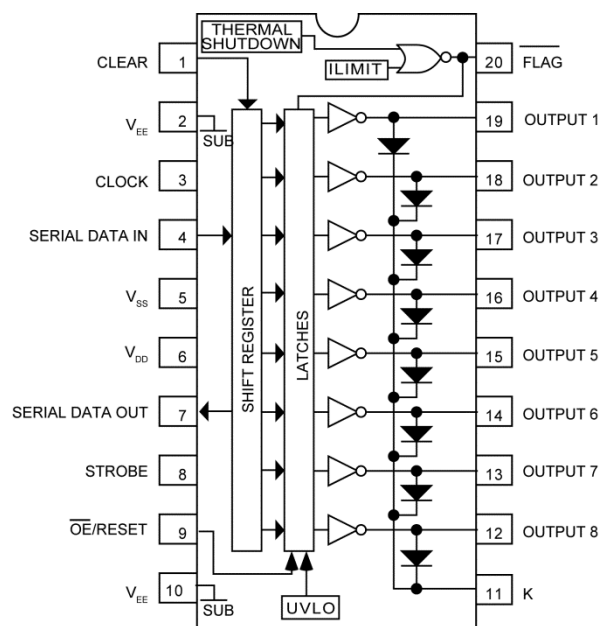
## Ordering Information

| Part Number | Junction Temperature Range | Package            | Pb-Free |
|-------------|----------------------------|--------------------|---------|
| MIC59P60YN  | -40°C to +85°C             | 20-Pin Plastic DIP | ✓       |
| MIC59P60YV  | -40°C to +85°C             | 20-Pin PLCC        | ✓       |
| MICP60YWM   | -40°C to +85°C             | 20-Pin Wide SOIC   | ✓       |

## Pin Configuration



20-Pin PLCC (V)  
(Top View)



20-Pin PDIP (N)  
20-Pin Wide SOIC (WM)  
(Top View)

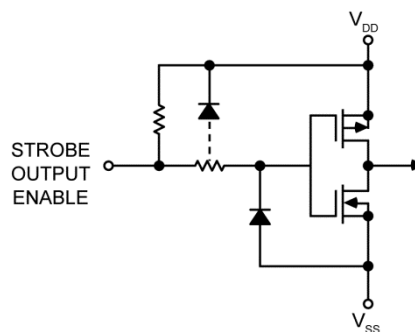
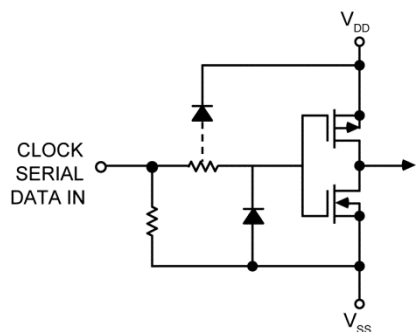
## Pin Description

| Pin Number | Pin Name                              | Pin Function                                                                                                                                             |
|------------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1          | CLEAR                                 | Sets All Latches OFF (open).                                                                                                                             |
| 2, 10      | VEE                                   | Output Ground (Substrate). Most negative voltage in the system connects here.                                                                            |
| 3          | CLOCK                                 | Serial Data Clock. A CLEAR must also be clocked into the latches.                                                                                        |
| 4          | SERIAL DATA IN                        | Serial Data Input pin.                                                                                                                                   |
| 5          | VSS                                   | Logic reference (Ground) pin.                                                                                                                            |
| 6          | VDD                                   | Logic Positive Supply voltage.                                                                                                                           |
| 7          | SERIAL DATA OUT                       | Serial Data Output pin. (Flow through).                                                                                                                  |
| 8          | STROBE                                | Output Strobe pin. Loads output latches when High. A STROBE is needed to CLEAR latches.                                                                  |
| 9          | $\overline{\text{OE}} / \text{RESET}$ | When low, outputs are active. When high, device is inactive and reset from a fault condition. An under voltage condition emulates a high OE/RESET input. |

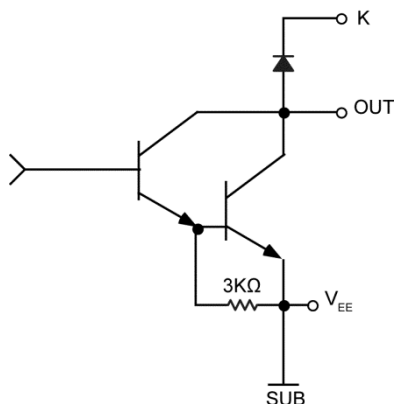
## Pin Description (Continued)

| Pin Number | Pin Name | Pin Function                                                                                                                                                                |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11         | K        | Transient suppression diode's cathode common pin.                                                                                                                           |
| 12 – 19    | OUT N    | Open collector outputs 8 through 1.                                                                                                                                         |
| 20         | FLAG     | Error flag. Open-collector output is low upon overcurrent or overtemperature fault. $\overline{OE}/\text{RESET}$ must be pulled high to reset the flag and fault condition. |

## Typical Inputs



## Typical Output Driver



**Absolute Maximum Ratings<sup>(1)</sup>**

|                                                        |                         |
|--------------------------------------------------------|-------------------------|
| Output Voltage ( $V_{CE}$ )                            | +80V                    |
| Output Voltage ( $V_{CE(SUS)}$ ) <sup>(3)</sup>        | +50V                    |
| Supply Voltage ( $V_{DD}$ ) with reference to $V_{SS}$ | +15V                    |
| Supply Voltage ( $V_{DD}$ ) with reference to $V_{EE}$ | +25V                    |
| Emitter Supply Voltage ( $V_{EE}$ )                    | –20V                    |
| Input Voltage Range ( $V_{IN}$ )                       | –0.3V to $V_{DD}$ +0.3V |
| Protective Current <sup>(4)</sup>                      | 1.5A                    |
| Storage Temperature Range ( $T_S$ )                    | –65°C to +150°C         |
| ESD Rating <sup>(5)(6)</sup>                           | ESD Sensitive           |

**Operating Ratings<sup>(2)</sup>**

|                                        |                |
|----------------------------------------|----------------|
| Package Power Dissipation, $P_D$       |                |
| Plastic DIP (N)                        | 2.0W           |
| Derate above $T_A = +25^\circ\text{C}$ | 20mW/°C        |
| PLCC (V)                               | 1.4W           |
| Derate above $T_A = +25^\circ\text{C}$ | 16mW/°C        |
| Wide SOIC (WM)                         | 1.2W           |
| Derate above $T_A = +25^\circ\text{C}$ | 12mW/°C        |
| Operating Temperature Range ( $T_A$ )  | –40°C to +85°C |

**Electrical Characteristics<sup>(7)</sup>**

$V_{DD} = 5V$ ,  $V_{SS} = V_{EE} = 0V$ ;  $T_A = +25^\circ\text{C}$ , unless noted.

| Symbol               | Parameter                               | Condition                                     | Min. | Typ. | Max. | Units |
|----------------------|-----------------------------------------|-----------------------------------------------|------|------|------|-------|
| I <sub>CEX</sub>     | Output Leakage Current                  | V <sub>OUT</sub> = 80V                        |      |      | 50   | μA    |
|                      |                                         | V <sub>OUT</sub> = 80V, T <sub>A</sub> = 70°C |      | 100  |      |       |
| V <sub>CE(SAT)</sub> | Collector-Emitter Saturation Voltage    | I <sub>OUT</sub> = 100mA                      |      | 0.9  | 1.1  | V     |
|                      |                                         | I <sub>OUT</sub> = 200mA                      |      | 1.1  | 1.3  |       |
|                      |                                         | I <sub>OUT</sub> = 350mA                      |      | 1.3  | 1.6  |       |
| V <sub>CE(SUS)</sub> | Collector-Emitter Sustaining Voltage    | I <sub>OUT</sub> = 350mA, L = 2mH             | 50   |      |      | V     |
| V <sub>IN(0)</sub>   | Input Voltage                           |                                               |      |      | 1.0  | V     |
| V <sub>IN(1)</sub>   |                                         | V <sub>DD</sub> = 12V                         | 10.5 |      |      | V     |
|                      |                                         | V <sub>DD</sub> = 10V                         | 8.5  |      |      |       |
|                      |                                         | V <sub>DD</sub> = 5V <sup>(8)</sup>           | 3.5  |      |      |       |
| R <sub>IN</sub>      | Input Resistance                        | V <sub>DD</sub> = 12V                         | 50   | 200  |      | kΩ    |
|                      |                                         | V <sub>DD</sub> = 10V                         | 50   | 300  |      |       |
|                      |                                         | V <sub>DD</sub> = 5V                          | 50   | 600  |      |       |
| I <sub>OL</sub>      | $\overline{\text{Flag}}$ Output Current | V <sub>OL</sub> = 0.4V                        |      | 15   |      | mA    |
| I <sub>OH</sub>      | $\overline{\text{Flag}}$ Output Leakage |                                               |      | 50   |      | nA    |

**Notes:**

- Exceeding the absolute maximum ratings may damage the device.
- The device is not guaranteed to function outside its operating ratings.
- For inductive load applications.
- Each channel. VEE connection must be designed to minimize inductance and resistance.
- Devices are input-static protected but can be damaged by extremely high static charges.
- Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5k $\Omega$  in series with 100pF.
- Specification for packaged product only
- Operation of these devices with standard TTL or DTL may require the use of appropriate pull-up resistors to insure a minimum logic "1".

## Electrical Characteristics<sup>(7)</sup>

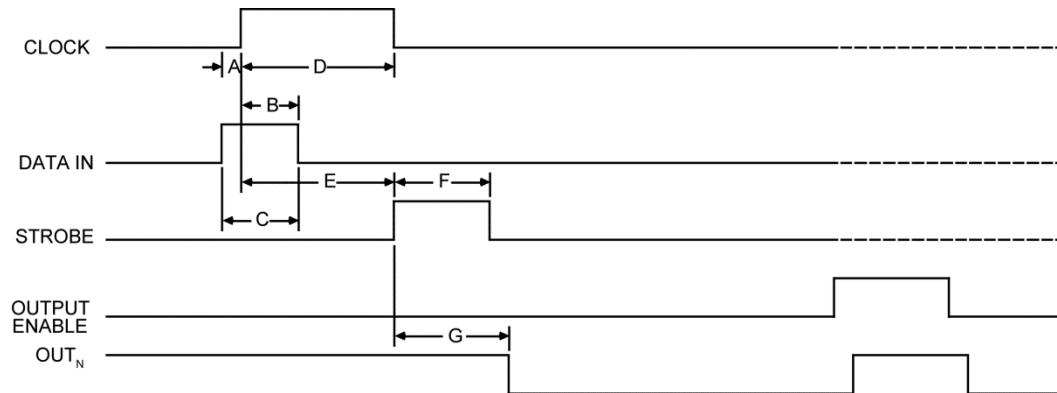
$V_{DD} = 5V$ ,  $V_{SS} = V_{EE} = 0V$ ;  $T_A = +25^{\circ}C$ , unless noted.

| Symbol                        | Parameter                         | Condition                                            | Min. | Typ. | Max. | Units |
|-------------------------------|-----------------------------------|------------------------------------------------------|------|------|------|-------|
| I <sub>DD(ON)</sub>           | Supply Current                    | All Drivers ON, V <sub>DD</sub> = 12V                |      | 6.4  | 10.0 | mA    |
|                               |                                   | All Drivers ON, V <sub>DD</sub> = 10V                |      | 6.0  | 9.0  |       |
|                               |                                   | All Drivers ON, V <sub>DD</sub> = 5V                 |      | 4.6  | 7.5  |       |
| I <sub>DD(1<br/>OUTPUT)</sub> |                                   | One Driver ON, All others OFF, V <sub>DD</sub> = 12V |      | 3.1  | 4.5  | mA    |
|                               |                                   | One Driver ON, All others OFF, V <sub>DD</sub> = 10V |      | 2.9  | 4.5  |       |
|                               |                                   | One Driver ON, All others OFF, V <sub>DD</sub> = 5V  |      | 2.3  | 3.6  |       |
| I <sub>DD(OFF)</sub>          |                                   | All Drivers OFF, V <sub>DD</sub> = 12V               |      | 2.6  | 4.2  | mA    |
|                               |                                   | All Drivers OFF, V <sub>DD</sub> = 10V               |      | 2.4  | 3.6  |       |
|                               |                                   | All Drivers OFF, V <sub>DD</sub> = 5V                |      | 1.9  | 3.0  |       |
| I <sub>R</sub>                | Clamp Diode Leakage Current       | V <sub>R</sub> = 80V                                 |      |      | 50   | μA    |
| V <sub>F</sub>                | Clamp Diode Forward Voltage       | I <sub>F</sub> = 350mA                               |      | 1.7  | 2.0  | V     |
| I <sub>LIM</sub>              | Overcurrent Shutdown Threshold    |                                                      |      | 500  |      | mA    |
| V <sub>SU</sub>               | Start-Up Voltage                  | Note 9                                               | 3.5  | 4.0  | 4.5  | V     |
| V <sub>DD MIN</sub>           | Minimum Supply (V <sub>DD</sub> ) |                                                      | 3.0  | 3.5  | 4.0  | V     |
|                               | Thermal Shutdown                  |                                                      |      | 165  |      | °C    |
|                               | Thermal Shutdown Hysteresis       |                                                      |      | 10   |      | °C    |

**Note:**

9. Undervoltage lockout is guaranteed to release device at no more than 4.5V, and disable the device at no less than 3.0V.

## Test Circuit



## Timing Conditions

(T<sub>A</sub> = +25°C, Logic Levels are V<sub>DD</sub> and V<sub>SS</sub>, V<sub>DD</sub> = 5V)

|                                                                        |       |
|------------------------------------------------------------------------|-------|
| A. Typical data active time before clock pulse (data set-up time)..... | 75ns  |
| B. Minimum data active time after clock pulse (data hold time).....    | 75ns  |
| C. Minimum data pulse width .....                                      | 150ns |
| D. Minimum clock pulse width.....                                      | 150ns |
| E. Minimum time between clock activation and strobe .....              | 300ns |
| F. Minimum strobe pulse width .....                                    | 100ns |
| G. Typical time between strobe activation and output transition .....  | 500ns |

SERIAL DATA present at the input is transferred to the shift register on the logic "0" to logic "1" transition of the CLOCK input pulse. On succeeding CLOCK pulses, the registers shift data information towards the SERIAL DATA OUTPUT. The SERIAL DATA must appear at the input prior to the rising edge of the CLOCK input waveform. Holding CLEAR high results in a data logic "0" being clocked into the shift register, turning off respective channels.

Information present at any register is transferred to its respective latch when the STROBE is high (serial-to-parallel conversion). The latches will continue to accept new data as long as the STROBE is held high. Applications where the latches are bypassed (STROBE tied high) will require that the ENABLE input be high to prevent invalid output states.

When the ENABLE input is high, all of the output buffers are disabled (OFF) without affecting information stored in the latches or shift register. With the ENABLE input low, the outputs are controlled by the state of the latches. A positive OE/RESET pulse resets the FLAG and the output after a current shutdown fault. Over-temperature faults are not latched and require no reset pulse.

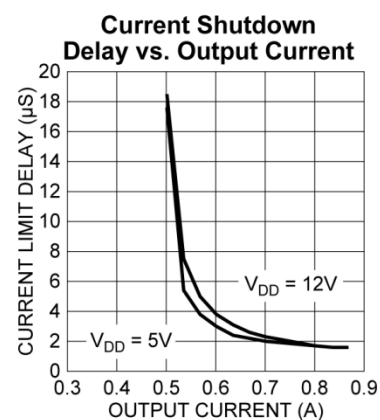
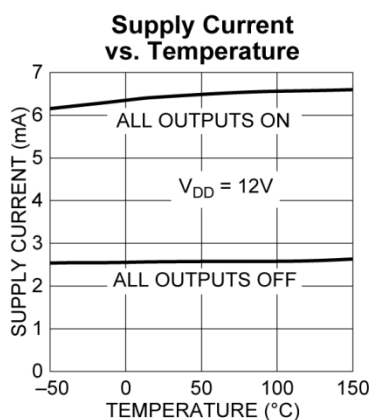
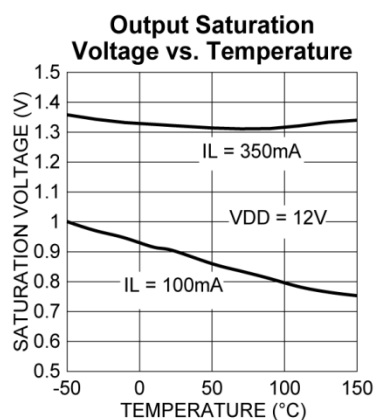
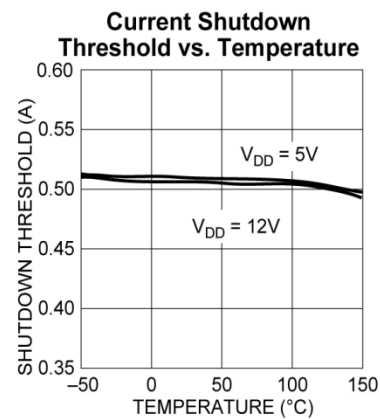
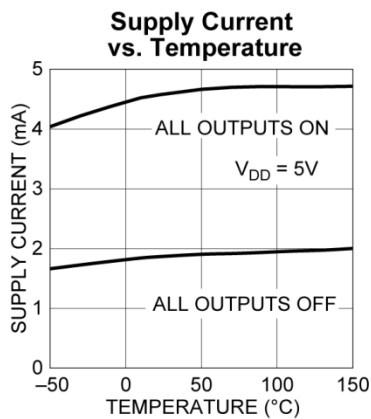
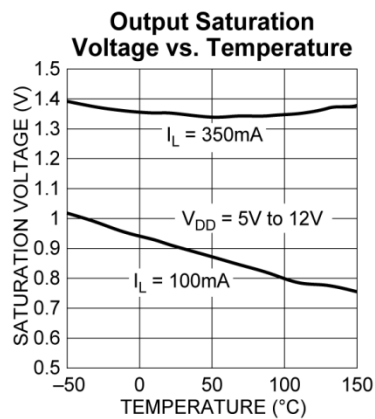
## MIC59P60 Truth Table

| Serial Data Input | Clear Input | Clock Input                                                                       | Shift Register Contents                                           | Serial Data Output | Strobe Input | Latch Contents                                                    | Output Enable | Output Contents                                                   |
|-------------------|-------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------|--------------|-------------------------------------------------------------------|---------------|-------------------------------------------------------------------|
|                   |             |                                                                                   | I <sub>1</sub> I <sub>2</sub> I <sub>3</sub> ..... I <sub>8</sub> |                    |              | I <sub>1</sub> I <sub>2</sub> I <sub>3</sub> ..... I <sub>8</sub> |               | I <sub>1</sub> I <sub>2</sub> I <sub>3</sub> ..... I <sub>8</sub> |
| H                 |             |  | H R <sub>1</sub> R <sub>2</sub> ..... R <sub>7</sub>              | R <sub>7</sub>     |              |                                                                   |               |                                                                   |
| L                 |             |  | L R <sub>1</sub> R <sub>2</sub> ..... R <sub>7</sub>              | R <sub>7</sub>     |              |                                                                   |               |                                                                   |
| X                 |             |  | R <sub>1</sub> R <sub>2</sub> R <sub>3</sub> ..... R <sub>8</sub> | R <sub>8</sub>     |              |                                                                   |               |                                                                   |
|                   | H           |  | O O O ..... O                                                     | L                  |              |                                                                   |               |                                                                   |
|                   |             |                                                                                   | X X X ..... X                                                     | X                  | L            | R <sub>1</sub> R <sub>2</sub> R <sub>3</sub> ..... R <sub>8</sub> |               |                                                                   |
|                   |             |                                                                                   | P <sub>1</sub> P <sub>2</sub> P <sub>3</sub> ..... P <sub>8</sub> | P <sub>8</sub>     | H            | P <sub>1</sub> P <sub>2</sub> P <sub>3</sub> ..... P <sub>8</sub> | L             | P <sub>1</sub> P <sub>2</sub> P <sub>3</sub> ..... P <sub>8</sub> |
|                   |             |                                                                                   |                                                                   |                    |              | X X X ..... X                                                     | H             | H H H ..... H                                                     |

**Note:**

L = Low Logic Level  
 H = High Logic Level  
 X = Irrelevant  
 P = Present State  
 R = Previous State  
 O = Output OFF

## Typical Characteristics



## Maximum Allowable Duty Cycle (Plastic DIP)

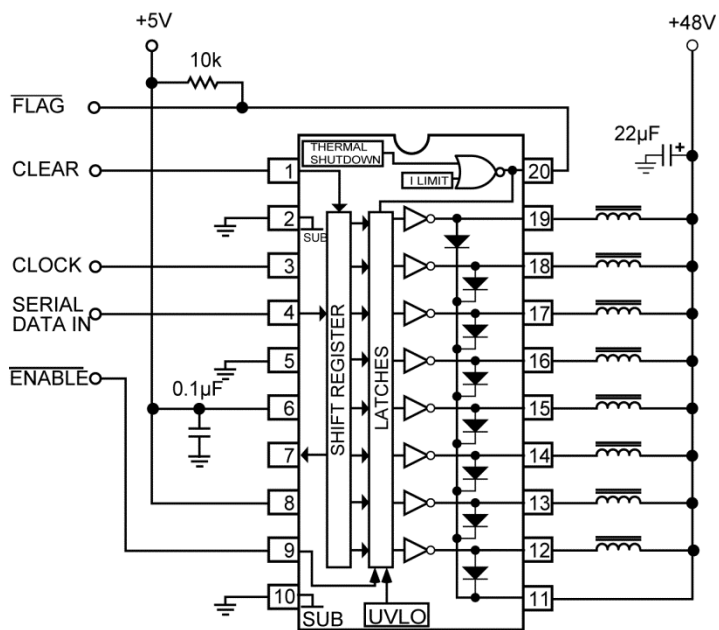
$V_{DD} = 5.0V$

| Number of<br>Outputs ON<br>( $I_{OUT} = 200mA$<br>$V_{DD} = 5.0V$ ) | Max. Allowable Duty Cycle at Ambient Temperature of |      |      |      |      |
|---------------------------------------------------------------------|-----------------------------------------------------|------|------|------|------|
|                                                                     | 25°C                                                | 40°C | 50°C | 60°C | 70°C |
| 8                                                                   | 85%                                                 | 72%  | 64%  | 55%  | 46%  |
| 7                                                                   | 97%                                                 | 82%  | 73%  | 63%  | 53%  |
| 6                                                                   | 100%                                                | 96%  | 85%  | 73%  | 62%  |
| 5                                                                   | 100%                                                | 100% | 100% | 88%  | 75%  |
| 4                                                                   | 100%                                                | 100% | 100% | 100% | 93%  |
| 3                                                                   | 100%                                                | 100% | 100% | 100% | 100% |
| 2                                                                   | 100%                                                | 100% | 100% | 100% | 100% |
| 1                                                                   | 100%                                                | 100% | 100% | 100% | 100% |

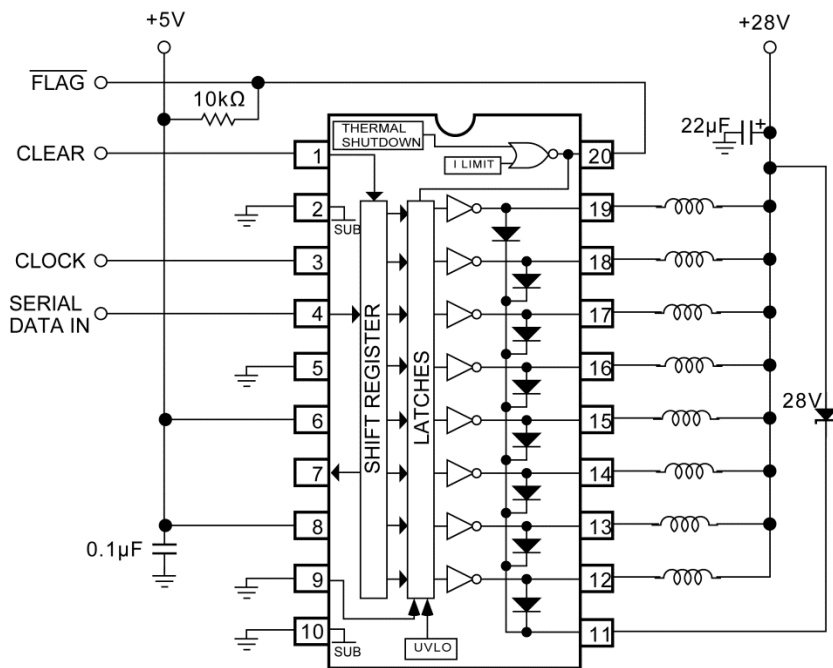
$V_{DD} = 12V$

| Number of<br>Outputs ON<br>( $I_{OUT} = 200mA$<br>$V_{DD} = 12V$ ) | Max. Allowable Duty Cycle at Ambient Temperature of |      |      |      |      |
|--------------------------------------------------------------------|-----------------------------------------------------|------|------|------|------|
|                                                                    | 25°C                                                | 40°C | 50°C | 60°C | 70°C |
| 8                                                                  | 80%                                                 | 68%  | 60%  | 52%  | 44%  |
| 7                                                                  | 91%                                                 | 77%  | 68%  | 59%  | 50%  |
| 6                                                                  | 100%                                                | 90%  | 79%  | 69%  | 58%  |
| 5                                                                  | 100%                                                | 100% | 95%  | 82%  | 69%  |
| 4                                                                  | 100%                                                | 100% | 100% | 100% | 86%  |
| 3                                                                  | 100%                                                | 100% | 100% | 100% | 100% |
| 2                                                                  | 100%                                                | 100% | 100% | 100% | 100% |
| 1                                                                  | 100%                                                | 100% | 100% | 100% | 100% |

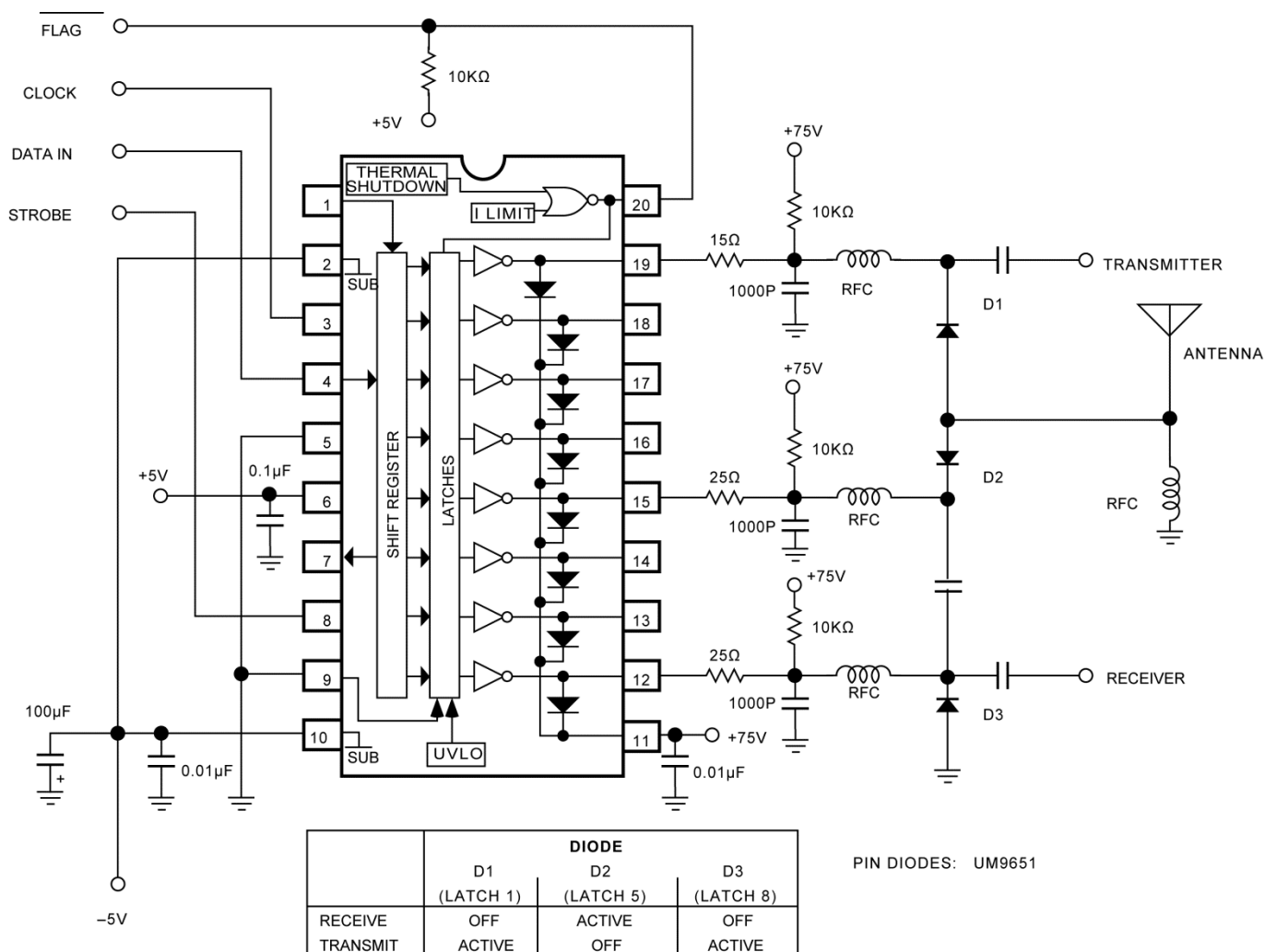
## Typical Application



**Protected Solenoid Driver with Output Enable**



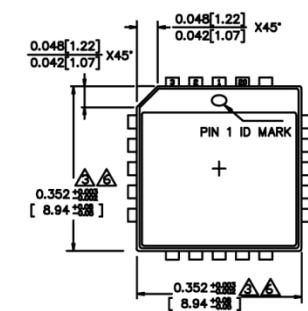
**Hammer Driver**



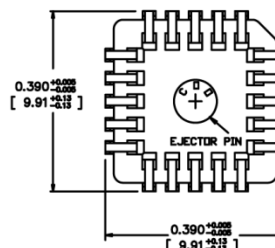
### Protected Negative/Positive PIN Diode Driver Transmit/Receive Switch

## Revision 2.0

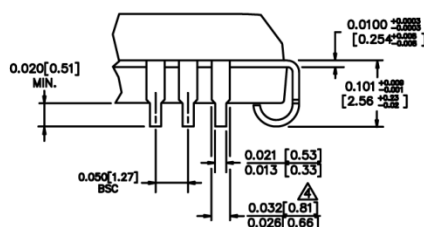
# Package Information and Recommended Landing Pattern<sup>(10)</sup> (Continued)



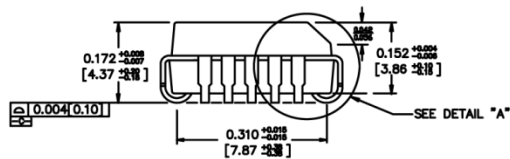
TOP VIEW



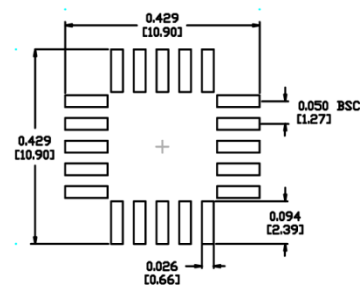
BOTTOM VIEW



DETAIL "A"



SIDE VIEW



RECOMMENDED LAND PATTERN

**NOTES:**

1. DIMENSIONS ARE IN INCHES [MM].
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.008 [0.203].
4. LEAD DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION.
5. MAXIMUM AND MINIMUM SPECIFICATIONS ARE INDICATED AS FOLLOWS: MAX/MIN
6. PACKAGE TOP DIMENSION MAY BE SLIGHTLY SMALLER THAN BOTTOM DIMENSION.

20-Pin PLCC (V)

---

**MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA**  
TEL +1 (408) 944-0800 FAX +1 (408) 474-1000 WEB <http://www.micrel.com>

Micrel, Inc. is a leading global manufacturer of IC solutions for the worldwide high performance linear and power, LAN, and timing & communications markets. The Company's products include advanced mixed-signal, analog & power semiconductors; high-performance communication, clock management, MEMs-based clock oscillators & crystal-less clock generators, Ethernet switches, and physical layer transceiver ICs. Company customers include leading manufacturers of enterprise, consumer, industrial, mobile, telecommunications, automotive, and computer products. Corporation headquarters and state-of-the-art wafer fabrication facilities are located in San Jose, CA, with regional sales and support offices and advanced technology design centers situated throughout the Americas, Europe, and Asia. Additionally, the Company maintains an extensive network of distributors and reps worldwide.

Micrel makes no representations or warranties with respect to the accuracy or completeness of the information furnished in this datasheet. This information is not intended as a warranty and Micrel does not assume responsibility for its use. Micrel reserves the right to change circuitry, specifications and descriptions at any time without notice. No license, whether express, implied, arising by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Micrel's terms and conditions of sale for such products, Micrel assumes no liability whatsoever, and Micrel disclaims any express or implied warranty relating to the sale and/or use of Micrel products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright, or other intellectual property right.

Micrel Products are not designed or authorized for use as components in life support appliances, devices or systems where malfunction of a product can reasonably be expected to result in personal injury. Life support devices or systems are devices or systems that (a) are intended for surgical implant into the body or (b) support or sustain life, and whose failure to perform can be reasonably expected to result in a significant injury to the user. A Purchaser's use or sale of Micrel Products for use in life support appliances, devices or systems is a Purchaser's own risk and Purchaser agrees to fully indemnify Micrel for any damages resulting from such use or sale.

© 2001 Micrel, Incorporated.