

### General Description

The MIC2561  $V_{CC}$  &  $V_{PP}$  Matrix controls PCMCIA (Personal Computer Memory Card International Association) memory card power supply pins, both  $V_{CC}$  and  $V_{PP}$ . The MIC2561 switches voltages from the system power supply to  $V_{CC}$  and  $V_{PP}$ . The MIC2561 switches between the three  $V_{CC}$  voltages (OFF, 3.3V and 5.0V) and the  $V_{PP}$  voltages (OFF, 0V, 3.3V, 5V, or 12.0V) required by PCMCIA cards. Output voltage is selected by two digital inputs for each output and output current ranges up to 750mA for  $V_{CC}$  and 200mA for  $V_{PP}$ . For higher  $V_{CC}$  output current, please refer to the full-performance MIC2560.

The MIC2561 provides power management capability under the control of the PC Card controller and features overcurrent and thermal protection of the power outputs, zero current “sleep” mode, suspend mode, low power dynamic mode, and ON/OFF control of the PCMCIA socket power.

The MIC2561 is designed for efficient operation. In standby (“sleep”) mode the device draws very little quiescent current, typically 0.01 $\mu$ A. The device and PCMCIA port is protected by current limiting and overtemperature shutdown. Full cross-conduction lockout protects the system power supply.

### Ordering Information

Part Number	Temperature Range	Package
MIC2561-0BM	0°C to +70°C	14-pin SOIC
MIC2561-1BM	0°C to +70°C	14-pin SOIC

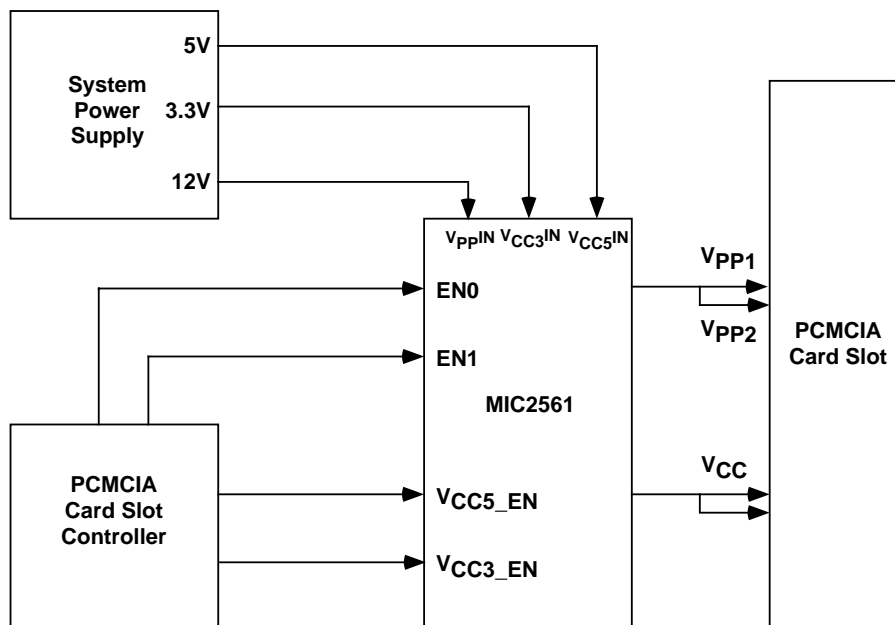
### Applications

- PCMCIA Power Supply Pin Voltage Switch
- Data Collection Systems
- Machine Control Data Input Systems
- Wireless Communications
- Bar Code Data Collection Systems
- Instrumentation Configuration/Datalogging
- Docking Stations (portable and desktop)
- Power Supply Management
- Power Analog Switching

### Features

- Complete PCMCIA  $V_{CC}$  and  $V_{PP}$  Switch Matrix in a Single IC
- No External Components Required
- Controlled Switching Times
- Logic Options for Compatible with Industry Standard PCMCIA Controllers
- No Voltage Overshoot or Switching Transients
- Break-Before-Make Switching
- Output Current Limit and Over-Temperature Shutdown
- Digital Flag for Error Condition Indication
- Ultra Low Power Consumption
- Digital Selection of  $V_{CC}$  and  $V_{PP}$  Voltages
- Over 750mA of  $V_{CC}$  Output Current
- 200mA of  $V_{PP}$  Output Current
- 14-Pin SOIC Package

### Typical Application

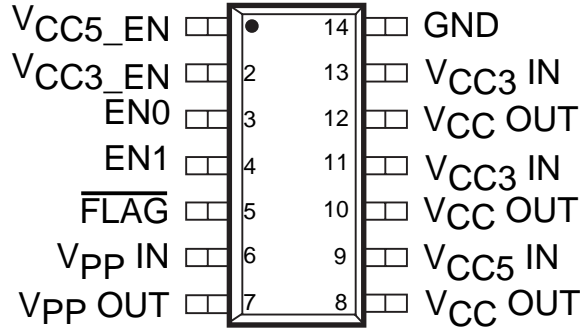


### Absolute Maximum Ratings (Notes 1 and 2)

Power Dissipation, $T_{AMBIENT} \leq 25^{\circ}C$ ....	<i>Internally Limited</i>
SOIC .....	800 mW
Derating Factors (To Ambient)	
SOIC .....	4 mW/ $^{\circ}C$
Storage Temperature .....	$-65^{\circ}C$ to $+150^{\circ}C$
Maximum Operating Temperature (Die) .....	$125^{\circ}C$
Operating Temperature (Ambient) .....	$0^{\circ}C$ to $+70^{\circ}C$
Lead Temperature (5 sec) .....	$260^{\circ}C$

Supply Voltage, $V_{PP IN}$ .....	15V
$V_{CC3 IN}$ .....	$V_{CC5 IN}$
$V_{CC5 IN}$ .....	7.5V
Logic Input Voltages .....	$-0.3V$ to $+15V$
Output Current (each Output)	
$V_{PP OUT}$ .....	<i>Internally Limited</i>
$V_{CC OUT}$ .....	<i>Internally Limited</i>
$V_{CC OUT}$ , Suspend Mode .....	600mA

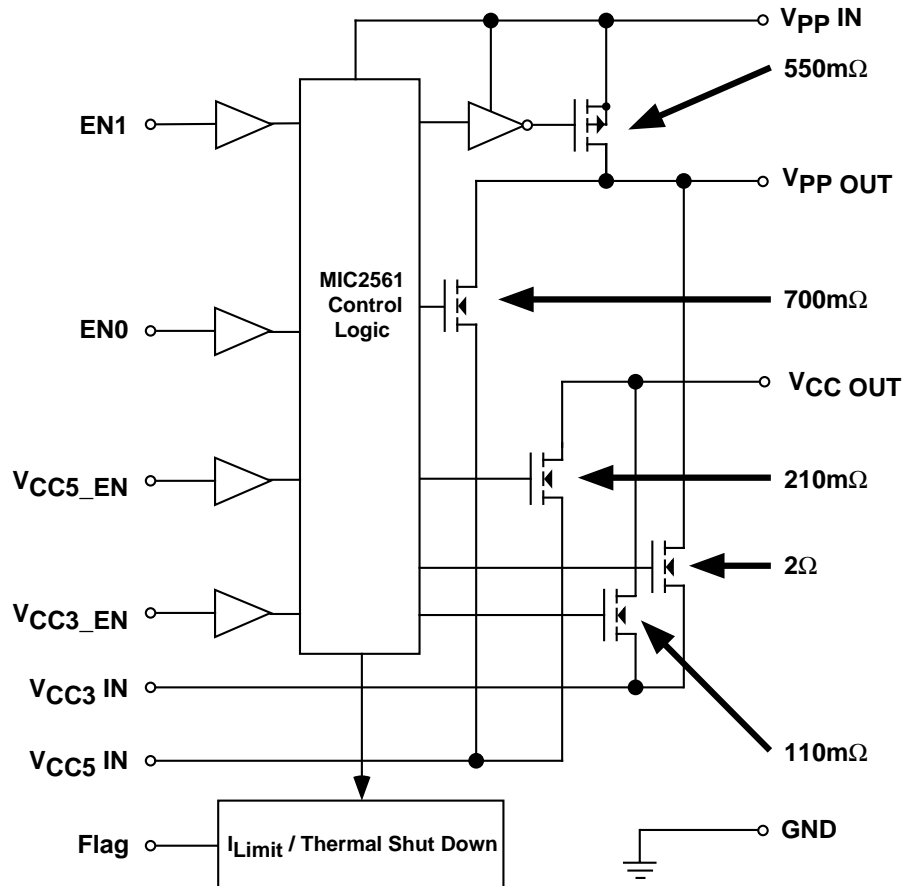
### Pin Configuration



14-Pin SO Package

Note: Both  $V_{CC3 IN}$  pins must be connected. All three  $V_{CC OUT}$  pins must be connected.

### Logic Block Diagram



**Electrical Characteristics:** (Over operating temperature range with  $V_{CC3\ IN} = 3.3V$ ,  $V_{CC5\ IN} = 5.0V$ ,  $V_{PP\ IN} = 12V$  unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>INPUT</b>						
$V_{IH}$	Logic 1 Input Voltage		2.2		15	V
$V_{IL}$	Logic 0 Input Voltage		-0.3		0.8	V
$I_{IN}$	Input Current	$0V < V_{IN} < 5.5V$			$\pm 1$	$\mu A$

 **$V_{PP}$  OUTPUT**

$I_{PP\ OUT\ Hi-Z}$	High Impedance Output Leakage Current	Shutdown Mode $0 \leq V_{PP\ OUT} \leq 12V$		0.1	50	$\mu A$
$I_{PPSC}$	Short Circuit Current Limit	$V_{PP\ OUT} = 0$		0.2		A
$R_O$	Switch Resistance, $I_{PP\ OUT} = -1000mA$ (Sourcing)	Select $V_{PP\ OUT} = 12V$ Select $V_{PP\ OUT} = 5V$ Select $V_{PP\ OUT} = 3.3V$		0.55 0.7 2	1 1 3	$\Omega$
$R_O$	Switch Resistance, $I_{PP\ OUT} = 50\mu A$ (Sinking)	Select $V_{PP\ OUT} =$ Clamped to Ground		0.75	2	k $\Omega$

 **$V_{PP}$  SWITCHING TIME** (See Figure 1)

$t_1$	Output Turn-On Rise Time	$V_{PP\ OUT} =$ Hi-Z to 5V		50		$\mu s$
$t_2$	Output Turn-On Rise Time	$V_{PP\ OUT} =$ Hi-Z to 3.3V		40		$\mu s$
$t_3$	Output Turn-On Rise Time	$V_{PP\ OUT} =$ Hi-Z to 12V		300		$\mu s$
$t_4$	Output Rise Time	$V_{PP\ OUT} = 3.3V$ or 5V to 12V		30		$\mu s$
$t_5$	Output Turn-Off Delay	$V_{PP\ OUT} = 12V$ to 3.3V or 5V		25	75	$\mu s$
$t_6$	Output Turn-Off Delay	$V_{PP\ OUT} = 5V$ to Hi-Z		75	200	ns

 **$V_{CC}$  OUTPUT**

$I_{CC\ OUT\ Hi-Z}$	High Impedance Output Leakage Current	$1 \leq V_{CC\ OUT} \leq 5V$		0.1	10	$\mu A$
$I_{CCSC}$	Short Circuit Current Limit	$V_{CC\ OUT} = 0$		1.5	2	A
$R_O$	Switch Resistance, $V_{CC\ OUT} = 5.0V$	$I_{CC\ OUT} = -650\ mA$ (Sourcing)		210	300	m $\Omega$
$R_O$	Switch Resistance, $V_{CC\ OUT} = 3.3V$	$I_{CC\ OUT} = -650\ mA$ (Sourcing)		110	185	m $\Omega$

## Electrical Characteristics (continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>V<sub>CC</sub> SWITCHING TIME</b>						
t <sub>1</sub>	Rise Time (10% to 90%)	V <sub>CC OUT</sub> = 0V to 3.3V, I <sub>OUT</sub> = 750mA	70	140		μs
t <sub>2</sub>	Rise Time (10% to 90%)	V <sub>CC OUT</sub> = 0V to 5.0V	50	60		μs
t <sub>3</sub>	Fall Time (note 3)	V <sub>CC OUT</sub> = 5.0V to 0V or 3.3V to 0V		40		μs
t <sub>4</sub>	Rise Time	V <sub>CC OUT</sub> = Hi-Z to 5V		60		μs
<b>POWER SUPPLY</b>						
I <sub>CC5</sub>	V <sub>CC5</sub> IN Supply Current	I <sub>CC OUT</sub> = 0		0.01	10	μA
I <sub>CC3</sub>	V <sub>CC3</sub> IN Supply Current	V <sub>CC OUT</sub> = 5V or 3.3V, I <sub>CC OUT</sub> = 0 V <sub>CC OUT</sub> = Hi-Z (Sleep Mode)		30 0.01	100 10	μA
I <sub>PP IN</sub>	V <sub>PP IN</sub> Supply Current I <sub>PP OUT</sub> = 0	V <sub>CC</sub> Active, V <sub>PP OUT</sub> = 5V or 3.3V V <sub>PP OUT</sub> = HiZ, 0, or V <sub>PP</sub>		15 0.01	30 10	μA
V <sub>CC5 IN</sub>	Operating Input Voltage	V <sub>CC5 IN</sub> ≥ V <sub>CC3 IN</sub>	V <sub>CC3 IN</sub>	5.0	6	V
V <sub>CC3 IN</sub>	Operating Input Voltage	V <sub>CC3 IN</sub> ≤ V <sub>CC5 IN</sub>	2.8	3.3	V <sub>CC5 IN</sub>	V
V <sub>PP IN</sub>	Operating Input Voltage		8.0	12.0	14.5	V
<b>SUSPEND MODE (NOTE 6)</b>						
I <sub>CC3</sub>	Suspend Mode Active Current (from V <sub>CC3</sub> )	V <sub>PP IN</sub> = 0V, V <sub>CC5</sub> = V <sub>CC3</sub> = 3.3V V <sub>CC5</sub> = Enabled V <sub>PP</sub> = Disabled (Hi-Z or 0V)		30	100	μA
R <sub>ON V<sub>CC</sub></sub>	V <sub>CC OUT</sub> R <sub>ON</sub>	V <sub>PP IN</sub> = 0V, V <sub>CC5</sub> = V <sub>CC3</sub> = 3.3V V <sub>CC3</sub> = Enabled V <sub>PP</sub> = Disabled (Hi-Z or 0V)		4.5	6	Ω

**NOTE 1:** Functional operation above the absolute maximum stress ratings is not implied.

**NOTE 2:** Static-sensitive device. Store only in conductive containers. Handling personnel and equipment should be grounded to prevent damage from static discharge.

**NOTE 3:** From 90% of V<sub>OUT</sub> to 10% of V<sub>OUT</sub>, R<sub>L</sub> = 2.1kΩ

**NOTE 6:** Suspend mode is a pseudo power-down mode the MIC2561 automatically allows when V<sub>PP IN</sub> = 0V, V<sub>PP OUT</sub> is deselected, and V<sub>CC OUT</sub> = 3.3V is selected. Under these conditions, the MIC2561 functions in a reduced capacity mode where V<sub>CC</sub> output of 3.3V is allowed, but at lower current levels (higher switch ON resistance).

## MIC2561-0 Control Logic Table

Pin 1 V <sub>CC5_EN</sub>	Pin 2 V <sub>CC3_EN</sub>	Pin 4 EN1	Pin 3 EN0	Pins 8 & 12 V <sub>CC</sub> OUT	Pin 7 V <sub>PP</sub> OUT
0	0	0	0	High Z	High Z
0	0	0	1	High Z	High Z
0	0	1	0	High Z	High Z
0	0	1	1	High Z	Clamped to Ground
0	1	0	0	3.3	High Z
0	1	0	1	3.3	3.3
0	1	1	0	3.3	12
0	1	1	1	3.3	Clamped to Ground
1	0	0	0	5	High Z
1	0	0	1	5	5
1	0	1	0	5	12
1	0	1	1	5	Clamped to Ground
1	1	0	0	3.3	High Z
1	1	0	1	3.3	3.3
1	1	1	0	3.3	5
1	1	1	1	3.3	Clamped to Ground

## MIC2561-1 Logic (Compatible with Cirrus Logic CL-PD6710 &amp; CL-PD6720 Controllers)

Pin 1 V <sub>CC5_EN</sub>	Pin 2 V <sub>CC3_EN</sub>	Pin 4 V <sub>PP_PGM</sub>	Pin 3 V <sub>PP_VCC</sub>	Pins 8 & 12 V <sub>CC</sub> OUT	Pin 7 V <sub>PP</sub> OUT
0	0	0	0	High Z	Clamped to Ground
0	0	0	1	High Z	High Z
0	0	1	0	High Z	High Z
0	0	1	1	High Z	High Z
0	1	0	0	5	Clamped to Ground
0	1	0	1	5	5
0	1	1	0	5	12
0	1	1	1	5	High Z
1	0	0	0	3.3	Clamped to Ground
1	0	0	1	3.3	3.3
1	0	1	0	3.3	12
1	0	1	1	3.3	High Z
1	1	0	0	High Z	Clamped to Ground
1	1	0	1	High Z	High Z
1	1	1	0	High Z	High Z
1	1	1	1	High Z	High Z

Note: other control logic patterns are available. Please contact Micrel for details.

## Applications Information

PCMCIA  $V_{CC}$  and  $V_{PP}$  control is easily accomplished using the MIC2561 voltage selector/switch IC. Four control bits determine  $V_{CC\ OUT}$  and  $V_{PP\ OUT}$  voltage and standby/operate mode condition.  $V_{PP\ OUT}$  output voltages of  $V_{CC}$  (3.3V or 5V),  $V_{PP}$ , or a high impedance state are available. When the  $V_{CC}$  high impedance condition is selected, the device switches into "sleep" mode and draws only nano-amperes of leakage current. An error flag falls low if the output is improper, because of overtemperature or overcurrent faults. Full protection from hot switching is provided which prevents feedback from the  $V_{PP\ OUT}$  to the  $V_{CC}$  inputs (from 12V to 5V, for example) by locking out the low voltage switch until  $V_{PP\ OUT}$  drops below  $V_{CC}$ . The  $V_{CC}$  output is similarly protected against 5V to 3.3V shoot through.

The MIC2561 is a low-resistance power MOSFET switching matrix that operates from the computer system main power supply. Device logic power is obtained from  $V_{CC3\ IN}$  and internal MOSFET drive is obtained from the  $V_{PP\ IN}$  pin (usually +12V) during normal operation. If +12V is not available, the MIC2561 automatically switches into "suspend" mode, where  $V_{CC\ OUT}$  can be switched to 3.3V, but at higher switch resistance. Internal break-before-make switches determine the output voltage and device mode.

## Supply Bypassing

External capacitors are not required for operation. The MIC2561 is a switch and has no stability problems. For best results however, bypass  $V_{CC3\ IN}$ ,  $V_{CC5\ IN}$ , and  $V_{PP\ IN}$  inputs with filter capacitors to improve output ripple. As all internal device logic and voltage/current comparison functions are powered from the  $V_{CC3\ IN}$  line, supply bypass of this line is the most critical, and may be necessary in some cases. In the most stubborn layouts, up to 0.47 $\mu$ F may be necessary. Both  $V_{CC\ OUT}$  and  $V_{PP\ OUT}$  pins may have 0.01 $\mu$ F to 0.1 $\mu$ F capacitors for noise reduction and electrostatic discharge (ESD) damage prevention. Larger values of output capacitor might create current spikes during transitions, requiring larger bypass capacitors on the  $V_{CC3\ IN}$ ,  $V_{CC5\ IN}$ , and  $V_{PP\ IN}$  pins.

## PCMCIA Implementation

The Personal Computer Memory Card International Association (PCMCIA) specification requires two  $V_{PP}$  supply pins per PCMCIA slot.  $V_{PP}$  is primarily used for programming Flash (EEPROM) memory cards. The two  $V_{PP}$  supply pins may be programmed to different voltages. Fully implementing PCMCIA specifications requires a MIC2561, a MIC2557 PCMCIA  $V_{PP}$  Switching Matrix, and a controller. Figure 3 shows this full configuration, supporting both 5.0V and 3.3V  $V_{CC}$  operation.

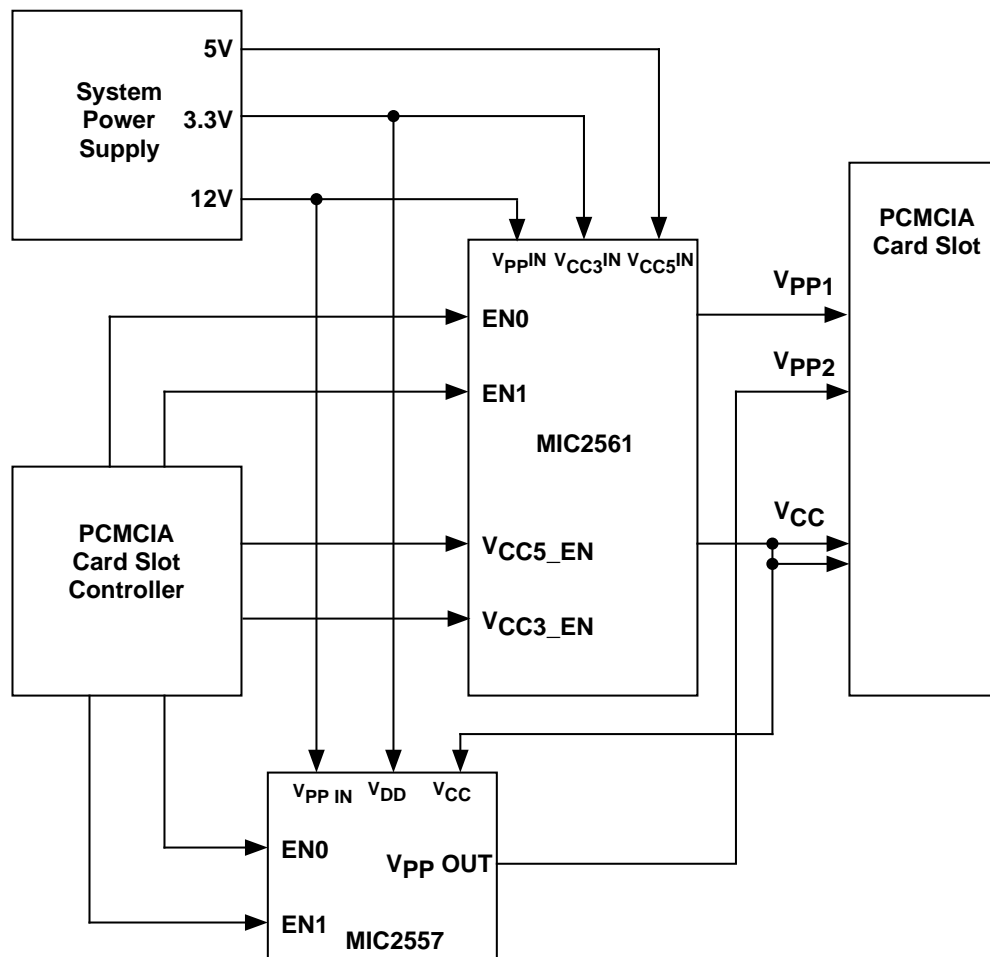
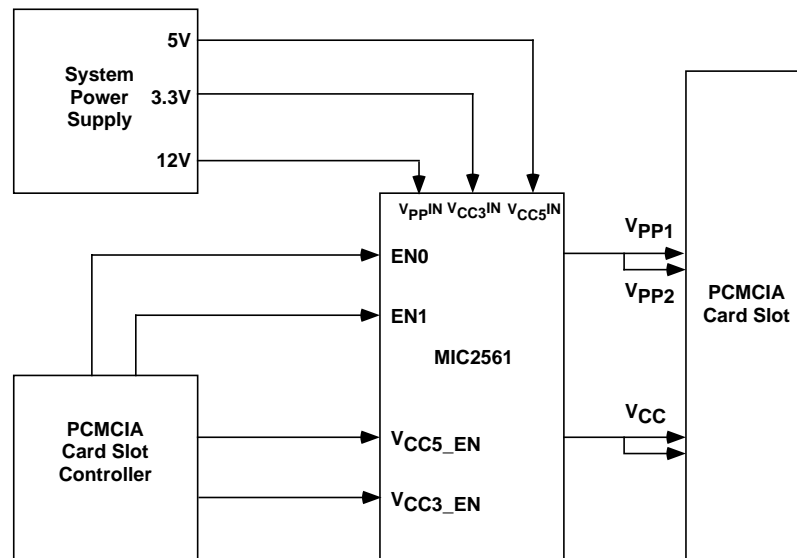


Figure 3. MIC2561 Typical PCMCIA memory card application with dual  $V_{CC}$  (5.0V or 3.3V) and separate  $V_{PP1}$  and  $V_{PP2}$ .



**Figure 4. MIC2561 Typical PCMCIA memory card application with dual  $V_{CC}$  (5.0V or 3.3V). Note that  $V_{PP1}$  and  $V_{PP2}$  are driven together.**

However, many cost sensitive designs (especially notebook/palmtop computers) connect  $V_{PP1}$  to  $V_{PP2}$  and the MIC2557 is not required. This circuit is shown in Figure 4.

When a memory card is initially inserted, it should receive  $V_{CC}$  — either  $3.3V \pm 0.3V$  or  $5.0V \pm 5\%$ . The initial voltage is determined by a combination of mechanical socket “keys” and voltage sense pins. The card sends a handshaking data stream to the controller, which then determines whether or not this card requires  $V_{PP}$  and if the card is designed for dual  $V_{CC}$ . If the card is compatible with and desires a different  $V_{CC}$  level, the controller commands this change by disabling  $V_{CC}$ , waiting at least 100ms, and then re-enabling the other  $V_{CC}$  voltage.

If no card is inserted or the system is in sleep mode, the controller outputs a  $(V_{CC3\ IN}, V_{CC5\ IN}) = (0,0)$  to the MIC2561, which shuts down  $V_{CC}$ . This also places the switch into a high impedance output shutdown (sleep) mode, where current consumption drops to nearly zero, with only tiny CMOS leakage currents flowing.

During Flash memory programming with standard (+12V) Flash memories, the PCMCIA controller outputs a (1,0) to the EN0, EN1 control pins of the MIC2561, which connects  $V_{PP\ IN}$  to  $V_{PP\ OUT}$ . The low ON resistance of the MIC2561 switches allow using small bypass capacitors (in some cases, none at all) on the  $V_{CC\ OUT}$  and  $V_{PP\ OUT}$  pins, with the main filtering action performed by a large filter capacitor on the input supply voltage to  $V_{PP\ IN}$  (usually the main power supply filter capacitor is sufficient). The  $V_{PP\ OUT}$  transition from  $V_{CC}$  to 12.0V typically takes 15 $\mu$ s. After programming is completed, the controller outputs a  $(EN1, EN0) = (0,1)$  to the MIC2561, which then reduces  $V_{PP\ OUT}$  to the  $V_{CC}$  level for read verification. Break-before-make switching action reduces switching transients and lowers maximum current spikes through the switch from the output capacitor. The flag comparator prevents having high voltage on the  $V_{PP\ OUT}$  capacitor from contaminating the  $V_{CC}$  inputs, by disabling the low voltage  $V_{PP}$  switches until  $V_{PP\ OUT}$  drops below the  $V_{CC}$

level selected. The lockout delay time varies with the load current and the capacitor on  $V_{PP\ OUT}$ . With a 0.1 $\mu$ F capacitor and nominal  $I_{PP\ OUT}$ , the delay is approximately 250 $\mu$ s.

Internal drive and bias voltage is derived from  $V_{PP\ IN}$ . Internal device control logic is powered from  $V_{CC3\ IN}$ . Input logic threshold voltages are compatible with common PCMCIA controllers using either 3.3V or 5V supplies. No pull-up resistors are required at the control inputs of the MIC2561.

## Output Current and Protection

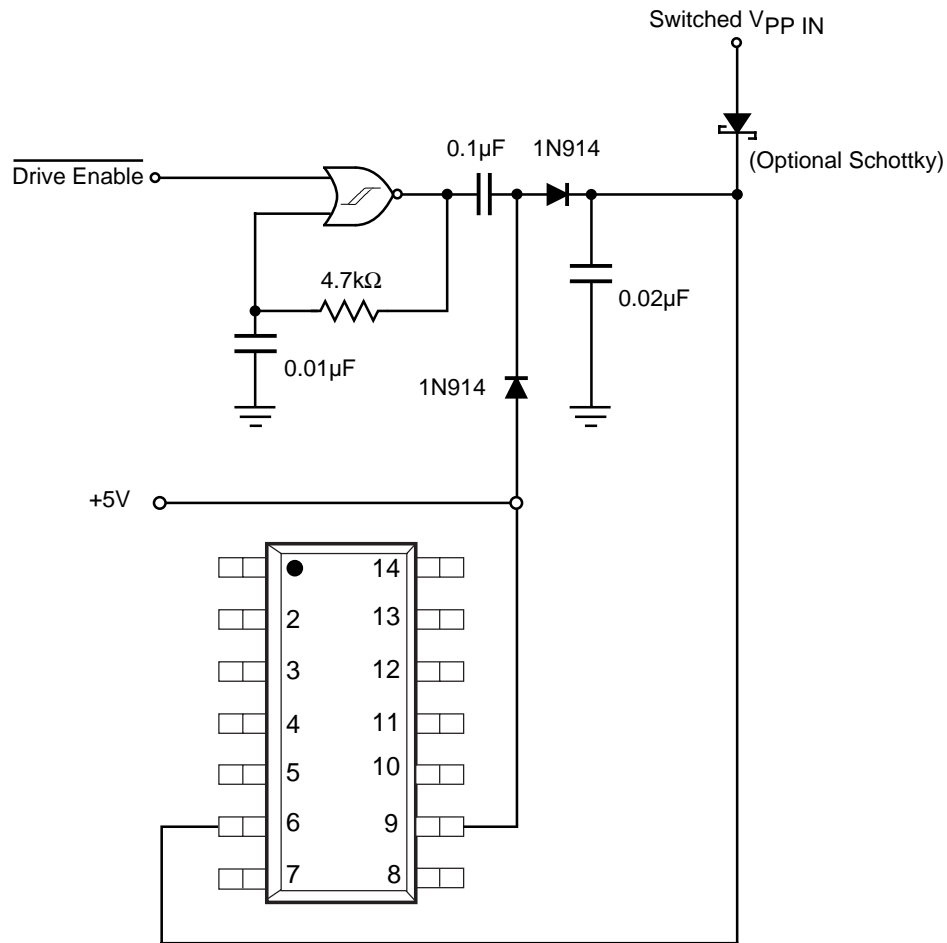
MIC2561 output switches are capable of more current than needed in PCMCIA applications and meet or exceed all PCMCIA specifications. For system and card protection, output currents are internally limited. For full system protection, long term (millisecond or longer) output short circuits invoke overtemperature shutdown, protecting the MIC2561, the system power supplies, the card socket pins, and the memory card. The MIC2561 overtemperature shutdown occurs at a die temperature of 110°C.

## Suspend Mode

An additional feature in the MIC2561 is a pseudo power-down mode, Suspend Mode, which allows operation without a  $V_{PP}$  IN supply. In Suspend Mode, the MIC2561 supplies 3.3V to  $V_{CC\ OUT}$  whenever a  $V_{CC}$  output of 3.3V is enabled by the PCMCIA controller. This mode allows the system designer the ability to turn OFF the  $V_{PP}$  supply generator to save power when it is not specifically required. The PCMCIA card receives  $V_{CC}$  at reduced capacity during Suspend Mode, as the switch resistance rises to approximately 4.5 $\Omega$ .

## High Current $V_{CC}$ Operation Without a +12V Supply

Figure 5 shows the MIC2561 with  $V_{CC}$  switch bias provided by a simple charge pump. This enables the system designer to achieve full  $V_{CC}$  performance without a +12V supply, which is often helpful in battery powered systems that only provide +12V when it is needed. These on-demand +12V



**Figure 5. Circuit for generating bias drive for the VCC switches when +12V is not readily available.**

supplies generally have a quiescent current draw of a few milliamperes, which is far more than the microamperes used by the MIC2561. The charge pump of Figure 5 provides this low current, using about 100μA when enabled. When  $V_{PP\ OUT} = 12V$  is selected, however, the on-demand  $V_{PP}$  generator must be used, as this charge pump cannot deliver the current required for Flash memory programming. The Schottky diode may not be necessary, depending on the configuration of the on-demand +12V generator and whether any other loads are on this line.