MIC2561

PCMCIA Card Socket V_{CC} & V_{PP} Switching Matrix

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 0.01µA. 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

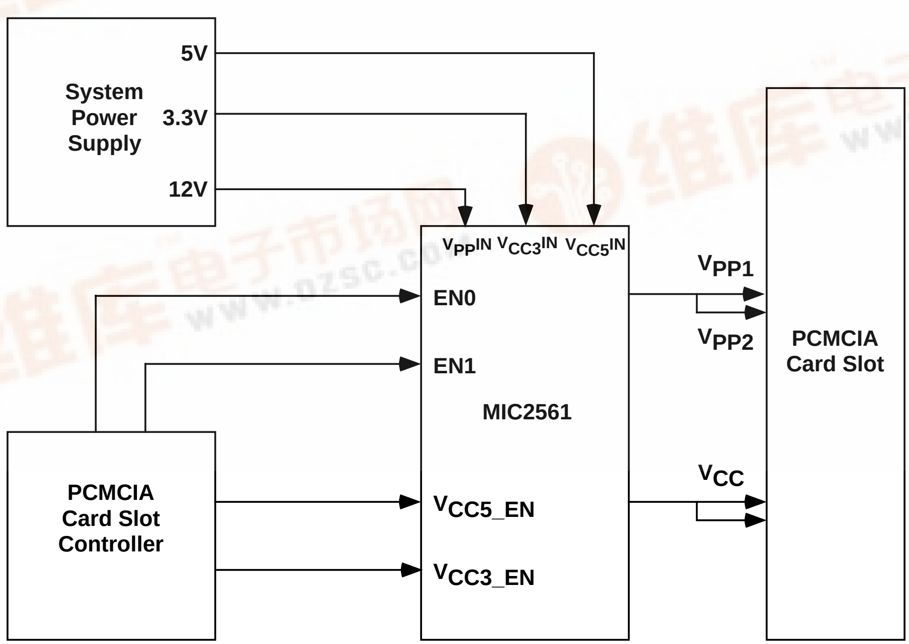
Applications

- 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

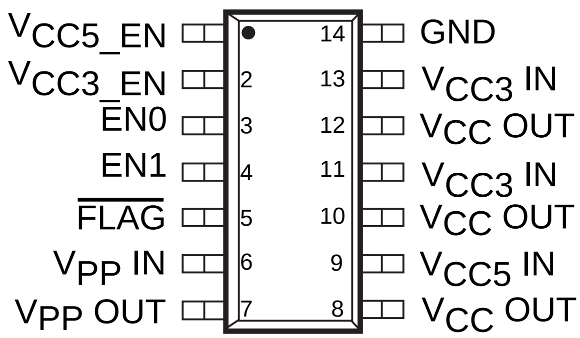


Absolute Maximum Ratings (Notes 1 and 2)

Power Dissipation, $T_{AMBIENT} \le 25°C$ .... *Internally Limited*
SOIC .... 800 mW
Derating Factors (To Ambient)
SOIC .... 4 mW/°C
Storage Temperature .... –65°C to +150°C
Maximum Operating Temperature (Die) .... 125°C
Operating Temperature (Ambient) .... 0°C to +70°C
Lead Temperature (5 sec) .... 260°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)
$V_{PP\ OUT}$ .... *Internally Limited*
$V_{CC\ OUT}$ .... *Internally Limited*
$V_{CC\ OUT}$, Suspend Mode 600mA

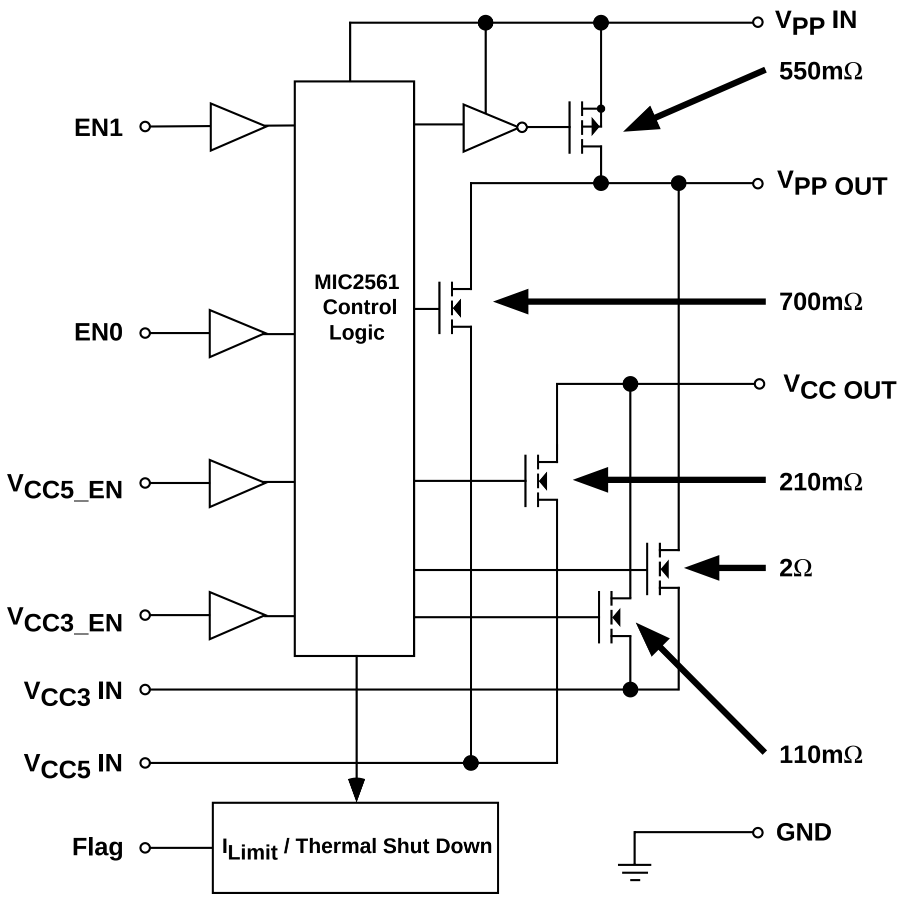
Pin Configuration



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
INPUT						
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	0 V < V_{IN} < 5.5V			±1	µA
V_{PP} OUTPUT						
$I_{PP\ OUT}$ Hi-Z	High Impedance Output Leakage Current	Shutdown Mode 0 ≤ $V_{PP\ OUT}$ ≤ 12V		0.1	50	µA
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	Ω
R_O	Switch Resistance, $I_{PP\ OUT}$ = 50µA (Sinking)	Select $V_{PP\ OUT}$ = Clamped to Ground		0.75	2	kΩ
V_{PP} SWITCHING TIME (See Figure 1)						
t_1	Output Turn-On Rise Time	$V_{PP\ OUT}$ = Hi-Z to 5V		50		µs
t_2	Output Turn-On Rise Time	$V_{PP\ OUT}$ = Hi-Z to 3.3V		40		µs
t_3	Output Turn-On Rise Time	$V_{PP\ OUT}$ = Hi-Z to 12V		300		µs
t_4	Output Rise Time	$V_{PP\ OUT}$ = 3.3V or 5V to 12V		30		µs
t_5	Output Turn-Off Delay	$V_{PP\ OUT}$ = 12V to 3.3V or 5V		25	75	µs
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 ≤ $V_{CC\ OUT}$ ≤ 5V		0.1	10	µA
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	mΩ
R_O	Switch Resistance, $V_{CC\ OUT}$ = 3.3V	$I_{CC\ OUT}$ = –650 mA (Sourcing)		110	185	mΩ

Electrical Characteristics (continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{CC} SWITCHING TIME						
t_1	Rise Time (10% to 90%)	$V_{CC\ OUT}$ = 0V to 3.3V, I_{OUT} = 750mA	70	140		µs
t_2	Rise Time (10% to 90%)	$V_{CC\ OUT}$ = 0V to 5.0V	50	60		µs
t_3	Fall Time (note 3)	$V_{CC\ OUT}$ = 5.0V to 0V or 3.3V to 0V		40		µs
t_4	Rise Time	$V_{CC\ OUT}$ = Hi-Z to 5V		60		µs
POWER SUPPLY						
I_{CC5}	V_{CC5} IN Supply Current	$I_{CC\ OUT}$ = 0		0.01	10	µA
I_{CC3}	V_{CC3} IN Supply Current	$V_{CC\ OUT}$ = 5V or 3.3V, $I_{CC\ OUT}$ = 0 $V_{CC\ OUT}$ = Hi-Z (Sleep Mode)		30 0.01	100 10	µA
I_{PP} IN	V_{PP} IN Supply Current $I_{PP\ OUT}$ =0	V_{CC} Active, $V_{PP\ OUT}$ = 5V or 3.3V $V_{PP\ OUT}$ = HiZ, 0, or V_{PP}		15 0.01	30 10	µA
V_{CC5} IN	Operating Input Voltage	V_{CC5} IN ≥ V_{CC3} IN	V_{CC3} IN	5.0	6	V
V_{CC3} IN	Operating Input Voltage	V_{CC3} IN ≤ V_{CC5} IN	2.8	3.3	V_{CC5} IN	V
$V_{PP\ IN}$	Operating Input Voltage		8.0	12.0	14.5	V
SUSPEND MODE (NOTE 6)						
I_{CC3}	Suspend Mode Active Current (from V_{CC3})	$V_{PP\ IN}$ = 0V, V_{CC5} = V_{CC3} = 3.3V V_{CC5} = Enabled V_{PP} = Disabled (Hi-Z or 0V)		30	100	µA
R_{ON} V_{CC}	$V_{CC\ OUT}$ R_{ON}	$V_{PP\ IN}$ = 0V, V_{CC5} = V_{CC3} = 3.3V V_{CC3} = Enabled V_{PP} = 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_{OUT} to 10% of V_{OUT}. R_L = 2.1kΩ
NOTE 6: Suspend mode is a pseudo power-down mode the MIC2561 automatically allows when $V_{PP\ IN}$ = 0V, V_{PP} OUT is deselected, and V_{CC} OUT = 3.3V is selected. Under these conditions, the MIC2561 functions in a reduced capacity mode where V_{CC} output of 3.3V is allowed, but at lower current levels (higher switch ON resistance).

MIC2561-0 Control Logic Table

Pin 1 V_{CC5_EN}	Pin 2 V_{CC3_EN}	Pin 4 EN1	Pin 3 EN0	Pins 8 & 12 $V_{CC\ OUT}$	Pin 7 $V_{PP\ OUT}$
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 & CL-PD6720 Controllers)

Pin 1 V_{CC5_EN}	Pin 2 V_{CC3_EN}	Pin 4 V_{PP_PGM}	Pin 3 $V_{PP\_}V_{CC}$	Pins 8 & 12 $V_{CC\ OUT}$	Pin 7 $V_{PP\ OUT}$
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} 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 0.47µF may be necessary. Both $V_{CC\ OUT}$ and $V_{PP\ OUT}$ pins may have 0.01µF to 0.1µF 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.

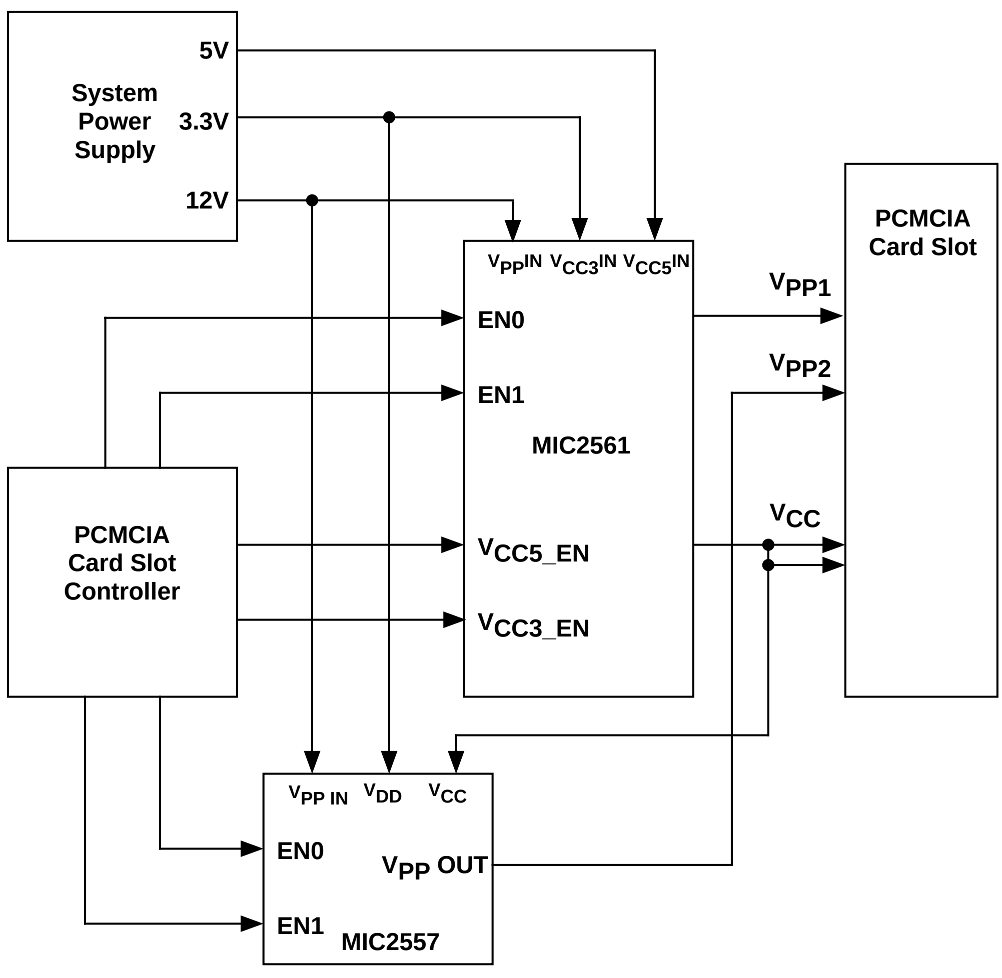


Figure 3. MIC2561 Typical PCMCIA memory card application with dual V_{CC} (5.0V or 3.3V) and separate V_{PP1} and V_{PP2}

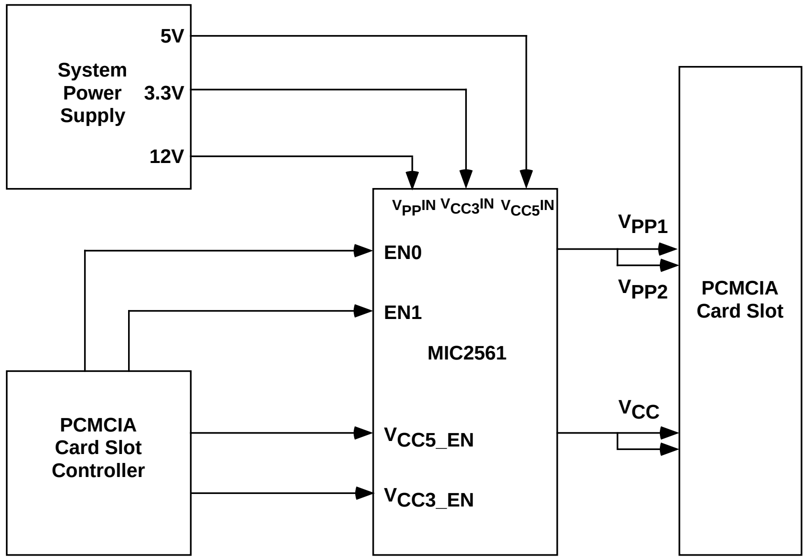


Figure 4. MIC2561 Typical PCMCIA memory card application with dual V_{CC} (5.0V or 3.3V). Note that V_{PP1} and V_{PP2} are driven together.

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 ± 0.3V or 5.0V ±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 15µs. 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 0.1µF capacitor and nominal $I_{PP\ OUT}$, the delay is approximately 250µs.

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 4.5Ω.

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

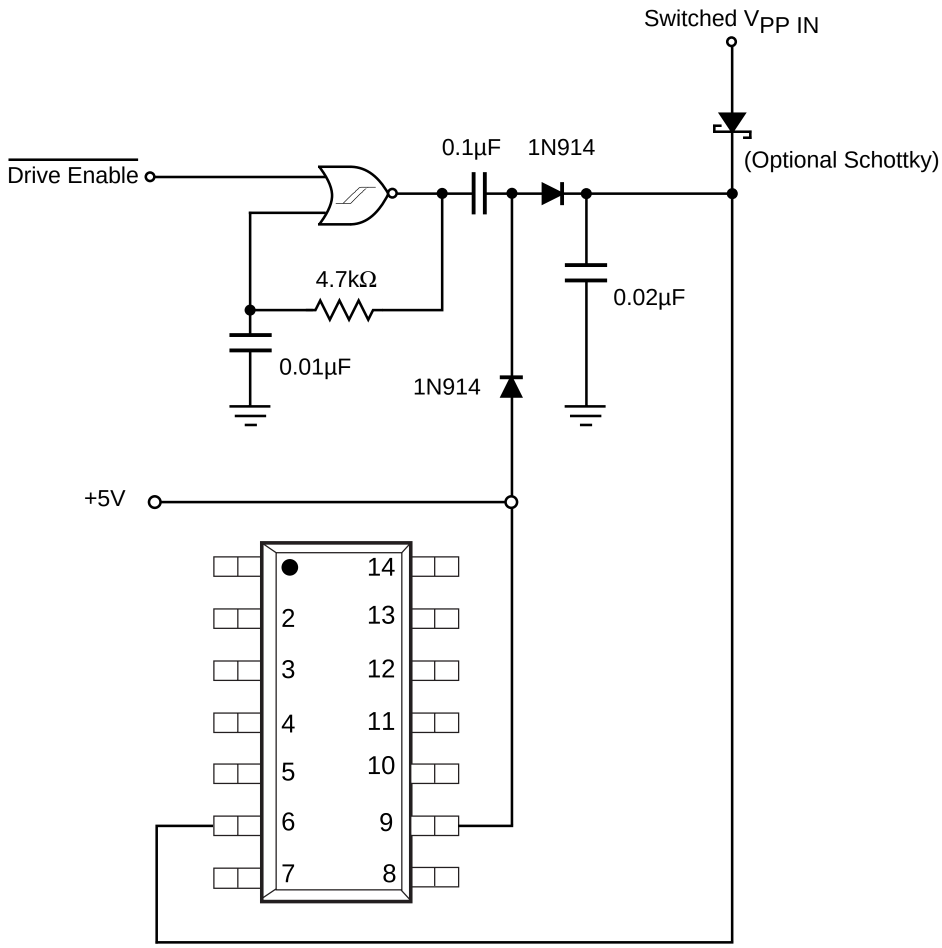


Figure 5. Circuit for generating bias drive for the VCC switches when +12V is not readily available.

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.