

# PCMCIA Switching Matrix with Built-In N-Channel V<sub>CC</sub> Switch Drivers

## FEATURES

- Output Current Capability: 120mA
- External 12V Regulator Can Be Shut Down
- Built-In N-Channel V<sub>CC</sub> Switch Drivers
- Digital Selection of 0V, V<sub>CCIN</sub>, V<sub>VPPIN</sub> or Hi-Z
- 3.3V or 5V V<sub>CC</sub> Supply
- Break-Before-Make Switching
- 0.1µA Quiescent Current in Hi-Z or 0V Mode
- No V<sub>VPPOUT</sub> Overshoot
- Logic Compatible with Standard PCMCIA Controllers

## APPLICATIONS

- Notebook Computers
- Palmtop Computers
- Pen-Based Computers
- Handi-Terminals
- Bar-Code Readers

## DESCRIPTION

The LTC<sup>®</sup>1314/LTC1315 provide the power switching necessary to control Personal Computer Memory Card International Association (PCMCIA) Release 2.0 card slots. When used in conjunction with a PC card interface controller, these devices form a complete minimum component count interface for palmtop, pen-based and notebook computers.

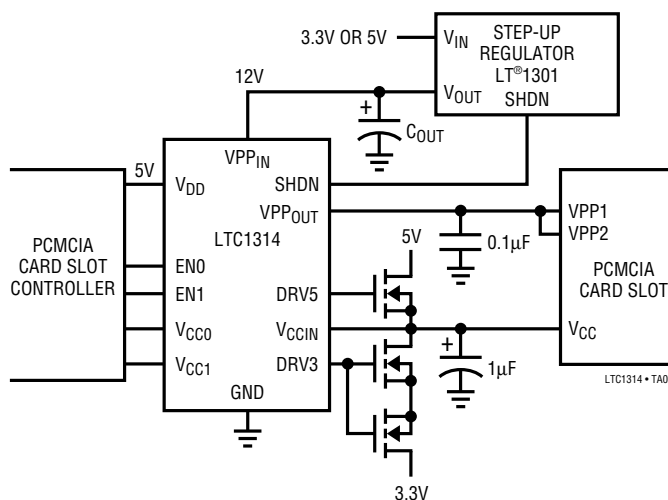
The LTC1314/LTC1315 provide 0V, 3.3V, 5V, 12V and Hi-Z power output for flash VPP programming. A built-in charge pump produces 12V of gate drive for inexpensive N-channel 3.3V/5V V<sub>CC</sub> switching. The 12V regulator can be shut down when 12V is not required at V<sub>VPPOUT</sub>. All digital inputs are TTL compatible and interface directly with industry standard PC card interface controllers.

The LTC1314 is available in 14-pin SO and the LTC1315 in 24-pin SSOP.

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## TYPICAL APPLICATION

Typical PCMCIA Single Slot Driver



### Linear Technology PCMCIA Product Family

DEVICE	DESCRIPTION	PACKAGE
LT1312	SINGLE PCMCIA VPP DRIVER/REGULATOR	8-PIN SO
LT1313	DUAL PCMCIA VPP DRIVER/REGULATOR	16-PIN SO*
LTC <sup>®</sup> 1314	SINGLE PCMCIA SWITCH MATRIX	14-PIN SO
LTC1315	DUAL PCMCIA SWITCH MATRIX	24-PIN SSOP
LTC1470	PROTECTED V <sub>CC</sub> 5V/3.3V SWITCH MATRIX	8-PIN SO
LTC1472	PROTECTED V <sub>CC</sub> AND VPP SWITCH MATRIX	16-PIN SO*

\*NARROW BODY

### LTC1314 Truth Table

EN0	EN1	V <sub>CC0</sub>	V <sub>CC1</sub>	V <sub>VPPOUT</sub>	DRV3	DRV5
0	0	X	X	GND	X	X
0	1	X	X	V <sub>CCIN</sub>	X	X
1	0	X	X	V <sub>VPPIN</sub>	X	X
1	1	X	X	Hi-Z	X	X
X	X	1	0	X	1	0
X	X	0	1	X	0	1
X	X	0	0	X	0	0
X	X	1	1	X	0	0

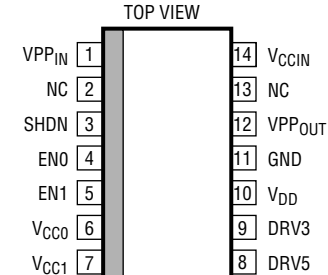
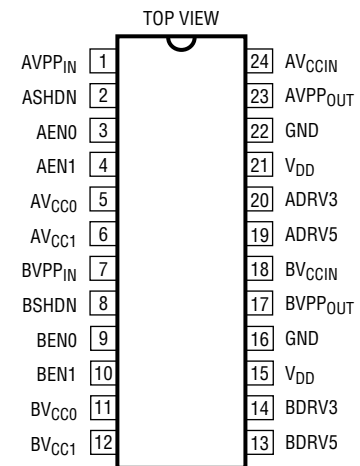
X = DON'T CARE

# LTC1314/LTC1315

## ABSOLUTE MAXIMUM RATINGS

VPP <sub>IN</sub> to GND .....	13.2V to -0.3V	Digital Input Voltage .....	7V to -0.3V
V <sub>DD</sub> to GND .....	7V to -0.3V	Operating Temperature Range .....	0°C to 70°C
V <sub>CCIN</sub> to GND .....	7V to -0.3V	Storage Temperature Range .....	-65°C to 150°C
VPP <sub>OUT</sub> to GND .....	13.2V to -0.3V	Lead Temperature (Soldering, 10 sec) .....	300°C

## PACKAGE/ORDER INFORMATION

	ORDER PART NUMBER	TOP VIEW	ORDER PART NUMBER
 <p>S PACKAGE 14-LEAD PLASTIC SO</p> <p>T<sub>JMAX</sub> = 125°C, θ<sub>JA</sub> = 110°C/W</p>	LTC1314CS	 <p>G PACKAGE 24-LEAD PLASTIC SSOP</p> <p>T<sub>JMAX</sub> = 125°C, θ<sub>JA</sub> = 95°C/W</p>	LTC1315CG

Consult factory for Industrial and Military grade parts.

## ELECTRICAL CHARACTERISTICS V<sub>DD</sub> = 5V, V<sub>CCIN</sub> = 5V, VPP<sub>IN</sub> = 12V, T<sub>A</sub> = 25°C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	LTC1314/LTC1315			UNITS
			MIN	TYP	MAX	
V <sub>CCIN</sub>	Input Voltage Range		●	3	5.5	V
VPP <sub>IN</sub>	Input Voltage Range		●	0	12.6	V
V <sub>DD</sub>	Supply Voltage Range		●	4.5	5.5	V
I <sub>CC</sub>	V <sub>CCIN</sub> Supply Current, No Load	VPP <sub>OUT</sub> = VPP <sub>IN</sub> , V <sub>CCIN</sub> , 0V or Hi-Z	●	0.1	1	μA
I <sub>PP</sub>	VPP <sub>IN</sub> Supply Current, No Load	VPP <sub>OUT</sub> = VPP <sub>IN</sub> , V <sub>CCIN</sub> VPP <sub>OUT</sub> = 0V, Hi-Z	●	15	40	μA
I <sub>DD</sub>	V <sub>DD</sub> Supply Current, No Load	VPP <sub>OUT</sub> = VPP <sub>IN</sub> or V <sub>CCIN</sub>	●	60	120	μA
		VPP <sub>OUT</sub> = 0V or Hi-Z	●	0.1	10	μA
		VPP <sub>OUT</sub> = 0V or Hi-Z, DRV3 or DRV5 On	●	85	200	μA
I <sub>IN</sub>	Input Current: EN0, EN1, V <sub>CC0</sub> or V <sub>CC1</sub>	0V < V <sub>IN</sub> < V <sub>DD</sub>	●		±1	μA
I <sub>OUT</sub>	High Impedance Output Leakage Current	EN0 = EN1 = 5V, 0V < VPP <sub>OUT</sub> < 12V	●	0.1	10	μA
R <sub>ON</sub>	On Resistance, VPP <sub>OUT</sub> = VPP <sub>IN</sub> On Resistance, VPP <sub>OUT</sub> = V <sub>CCIN</sub> On Resistance, VPP <sub>OUT</sub> = GND	VPP <sub>IN</sub> = 12V, I <sub>LOAD</sub> = 120mA	●	0.55	1.2	Ω
		V <sub>CCIN</sub> = 5V, I <sub>LOAD</sub> = 5mA	●	2	5	Ω
		V <sub>DD</sub> = 5V, I <sub>SINK</sub> = 1mA	●	100	250	Ω
V <sub>INH</sub>	Input High Voltage, Digital Inputs		●	2		V
V <sub>INL</sub>	Input Low Voltage, Digital Inputs		●		0.8	V

**ELECTRICAL CHARACTERISTICS**  $V_{DD} = 5V$ ,  $V_{CCIN} = 5V$ ,  $V_{PPIN} = 12V$ ,  $T_A = 25^\circ C$  unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	LTC1314/LTC1315			UNITS	
			MIN	TYP	MAX		
$V_{OH}$	SHDN Output High Voltage	$V_{PP_{OUT}} = V_{CCIN}$ , 0V or Hi-Z, $I_{LOAD} = 400\mu A$	●	3.5		V	
$V_{OL}$	SHDN Output Low Voltage	$V_{PP_{OUT}} = V_{PPIN}$ , $I_{SINK} = 400\mu A$	●		0.4	V	
$V_G - V_{DD}$	Gate Voltage Above Supply	$V_{DRV3}$ or $V_{DRV5}$	●	6	7	13	V
$t_{ON}$	Turn-On Time, DRV3 and DRV5	$C_{GATE} = 1000pF$ , Time for $V_{GATE} > V_{DD} + 1V$		50	150	500	$\mu s$
$t_{OFF}$	Turn-Off Time, DRV3 and DRV5	$C_{GATE} = 1000pF$ , Time for $V_{GATE} < 0.5V$		3	10	30	$\mu s$
$t_1$	Delay + Rise Time	$V_{PP_{OUT}} = GND$ to $V_{CCIN}$ , $V_{PPIN} = 0V$ , Note 1		5	15	50	$\mu s$
$t_2$	Delay + Rise Time	$V_{PP_{OUT}} = GND$ to $V_{PPIN}$ (Note 1)		5	15	50	$\mu s$
$t_3$	Delay + Rise Time	$V_{PP_{OUT}} = V_{CCIN}$ to $V_{PPIN}$ (Note 1)		5	15	50	$\mu s$
$t_4$	Delay + Fall Time	$V_{PP_{OUT}} = V_{PPIN}$ to $V_{CCIN}$ (Note 3)		2	6	20	$\mu s$
$t_5$	Delay + Fall Time	$V_{PP_{OUT}} = V_{PPIN}$ to GND (Note 2)		15	50	150	$\mu s$
$t_6$	Delay + Fall Time	$V_{PP_{OUT}} = V_{CCIN}$ to GND, $V_{PPIN} = 0V$ (Note 2)		10	25	100	$\mu s$
$t_7$	Output Turn-On Delay	$V_{PP_{OUT}} = Hi-Z$ to $V_{PPIN}$ or $V_{CCIN}$ (Notes 1, 6)		5	15	50	$\mu s$

The ● denotes specifications which apply over the full operating temperature range.

**Note 1:** To 90% of the final value,  $C_{OUT} = 0.1\mu F$ ,  $R_{OUT} = 2.9k$ .

**Note 2:** To 10% of the final value,  $C_{OUT} = 0.1\mu F$ ,  $R_{OUT} = 2.9k$ .

**Note 3:** To 50% of the initial value,  $C_{OUT} = 0.1\mu F$ ,  $R_{OUT} = 2.9k$ .

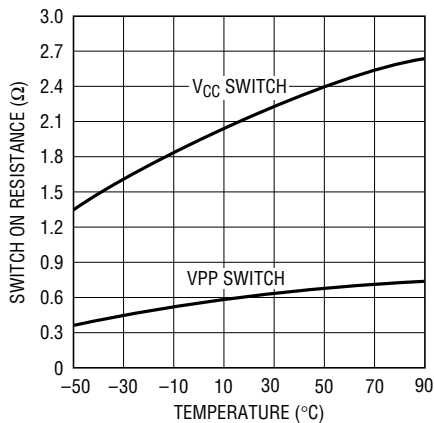
**Note 4:** Measured current data is per channel.

**Note 5:** Input logic low equal to 0V, high equal to 5V.

**Note 6:**  $V_{PPIN} = 0V$  when switching from Hi-Z to  $V_{CCIN}$ .

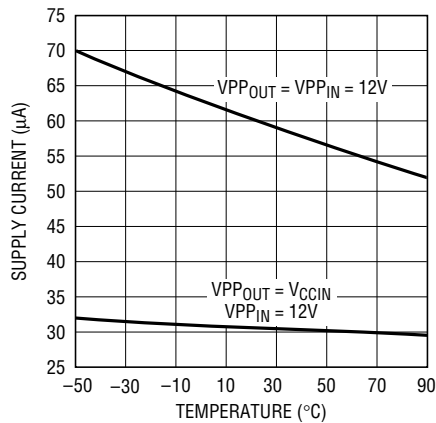
**TYPICAL PERFORMANCE CHARACTERISTICS**

Switch On Resistance vs Temperature



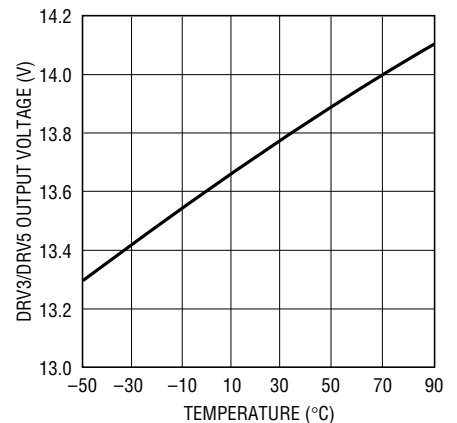
1314/15 G01

Supply Current vs Temperature



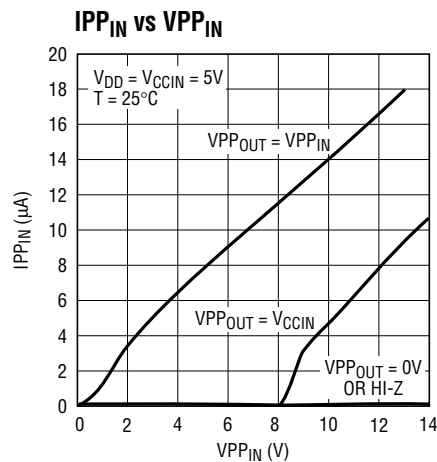
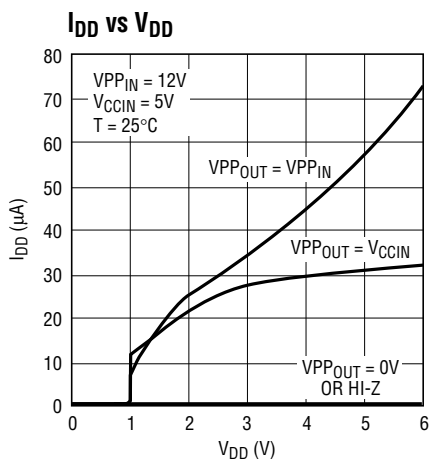
1314/15 G02

DRV3/DRV5 Output Voltage vs Temperature



1314/15 G03

## TYPICAL PERFORMANCE CHARACTERISTICS



## PIN FUNCTIONS

## LTC1314

**$V_{PP_{IN}}$  (Pin 1):** 12V Power Input.

**NC (Pin 2):** Not Connected.

**SHDN (Pin 3):** Shutdown Output. When the output is high, the external 12V regulator can be shut down to conserve power consumption.

**EN0, EN1 (Pins 4, 5):** Logic inputs that control the voltage output on  $V_{PP_{OUT}}$ . The input thresholds are compatible with TTL/CMOS levels. Refer to Truth Table.

**$V_{CC0}$  (Pin 6):** Logic input that controls the state of the MOSFET gate driver DRV3. ESD protection device limits input excursions to 0.6V below ground.

**$V_{CC1}$  (Pin 7):** Logic input that controls the state of the MOSFET gate driver DRV5. ESD protection device limits input excursions to 0.6V below ground.

**DRV5, DRV3 (Pins 8, 9):** Gate driver outputs that control the external MOSFETs that switch the  $V_{CC}$  pin of card slot to Hi-Z, 3.3V, or 5V.

**$V_{DD}$  (Pin 10):** Positive Supply,  $4.5V \leq V_{DD} \leq 5.5V$ . This pin supplies the power to the control logic and the charge pumps and must be continuously powered.

**GND (Pin 11):** Ground Connection.

**$V_{PP_{OUT}}$  (Pin 12):** Switched output that provides 0V, 3.3V, 5V, 12V, or Hi-Z to the VPP pin of the card slot. Refer to Truth Table.

**NC (Pin 13):** Not Connected.

**$V_{CC_{IN}}$  (Pin 14):** 5V or 3.3V Power Input.

## PIN FUNCTIONS

### LTC1315

**VPP<sub>IN</sub>** (Pins 1, 7): 12V Power Inputs.

**SHDN** (Pins 2, 8): Shutdown Outputs. When the output is high, the external 12V regulator can be shut down to conserve power consumption.

**EN0, EN1** (Pins 3, 4, 9, 10): Logic inputs that control the voltage output on VPP<sub>OUT</sub>. The input thresholds are compatible with TTL/CMOS levels. Refer to the Truth Table.

**V<sub>CC0</sub>** (Pins 5, 11): Logic inputs that control the state of the MOSFET gate driver DRV3. ESD protection device limits input excursions to 0.6V below ground.

**V<sub>CC1</sub>** (Pins 6, 12): Logic inputs that control the state of the MOSFET gate driver DRV5. ESD protection device limits input excursions to 0.6V below ground.

**DRV5, DRV3** (Pins 13, 14, 19, 20): Gate driver outputs that control the external MOSFETs that switch the V<sub>CC</sub> pin of card slot to Hi-Z, 3.3V, or 5V.

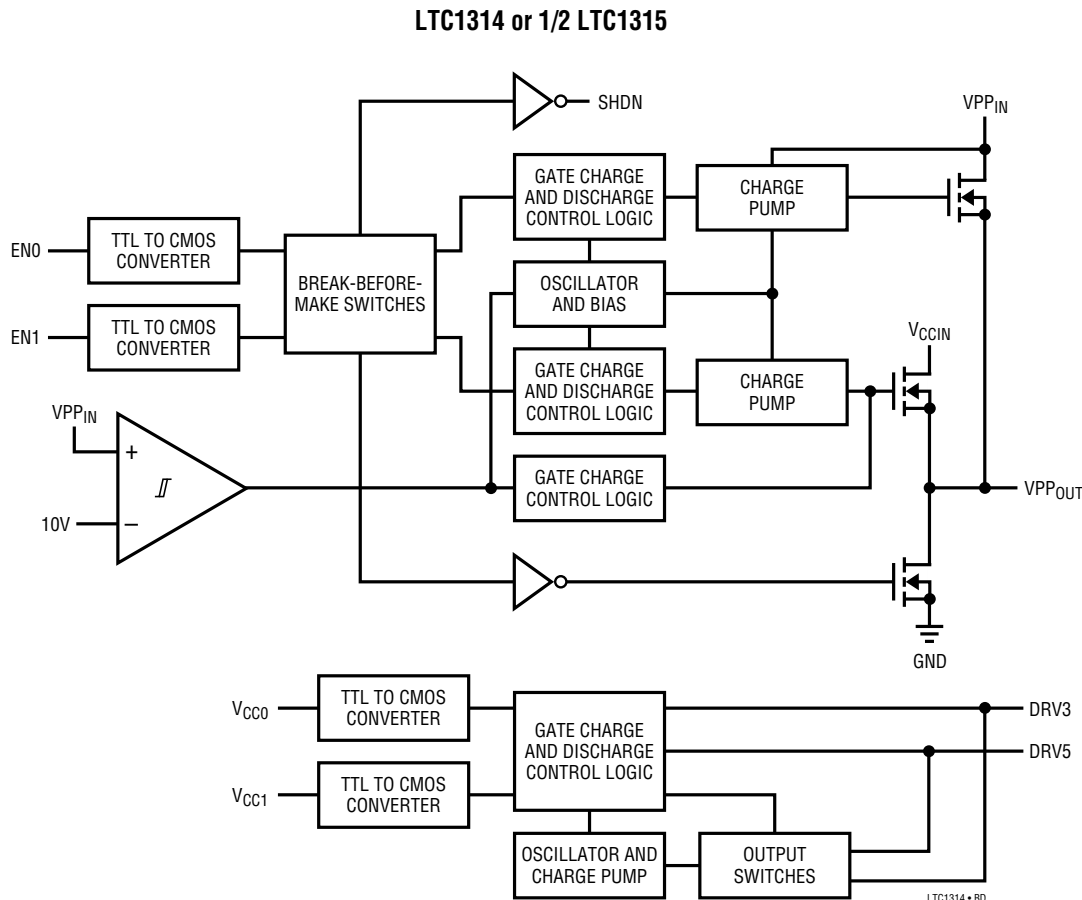
**V<sub>DD</sub>** (Pins 15, 21): Positive Supplies,  $4.5V \leq V_{DD} \leq 5.5V$ . These pins supply the power to the control logic and the charge pumps and must be continuously powered.

**GND** (Pins 16, 22): Ground Connections.

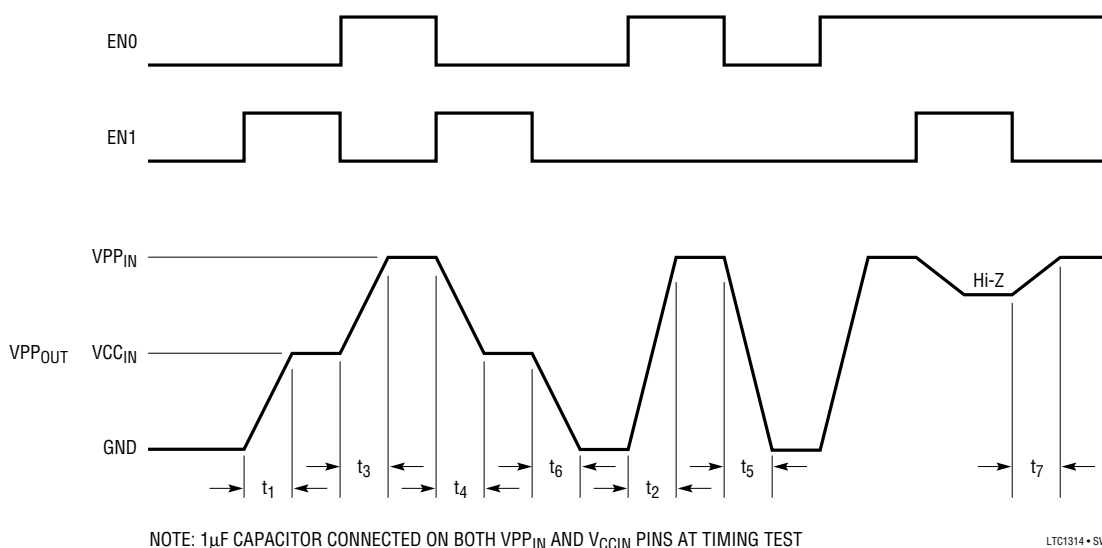
**VPP<sub>OUT</sub>** (Pins 17, 23): Switched outputs that provide 0V, 3.3V, 5V, 12V, or Hi-Z to the VPP pin of the card slot. Refer to the Truth Table.

**V<sub>CCIN</sub>** (Pins 18, 24): 5V or 3.3V Power Inputs.

## BLOCK DIAGRAM



## SWITCHING TIME WAVEFORMS



## APPLICATIONS INFORMATION

PCMCIA VPP control is easily accomplished using the LTC1314 or LTC1315 switching matrix. Two control bits (LTC1314) or four control bits (LTC1315) determine the output voltage and standby/operate mode conditions. Output voltages of 0V, V<sub>CCIN</sub> (3.3V or 5V), VPP<sub>IN</sub>, or a high impedance state are available. When either the high impedance or low voltage (0V) conditions are selected, the device switches into “sleep” mode and draws 0.1 $\mu$ A of current from the V<sub>DD</sub> supply.

The LTC1314/LTC1315 are low resistance power MOSFET switching matrices that operate from the computer system main power supply. Device power is obtained from V<sub>DD</sub>, which is 5V  $\pm$ 0.5V. The gate drives for the NFETs (both internal and external) are derived from internal charge pumps, therefore VPP<sub>IN</sub> is only required when it's switched to VPP<sub>OUT</sub>. Internal break-before-make switches determine the output voltage and device mode.

### Flash Memory Card VPP Power Considerations

PCMCIA compatible flash memory cards require tight regulation of the 12V VPP programming supply to ensure that the internal flash memory circuits are never subjected to damaging conditions. Flash memory circuits are typi-

cally rated with an absolute maximum of 13.5V and VPP must be maintained at 12V  $\pm$ 5% under all possible load conditions during erase and program cycles. Undervoltage can decrease specified flash memory reliability and overvoltage can damage the device.

### V<sub>CC</sub> Switch Driver and VPP Switch Matrix

Figures 1 and 2 show the approach that is very space and power efficient. The LTC1314/LTC1315 used in conjunction with the LT1301 DC/DC converter, provide complete power management for a PCMCIA card slot. The LTC1314/LTC1315 and LT1301 combination provides a highly efficient, minimal parts count solution. These circuits are especially good for applications that are adding a PCMCIA socket to existing systems that currently have only 5V or 3.3V available.

The LTC1314 drives three N-channel (LTC1315 six N-channel) MOSFETs that provide V<sub>CC</sub> pin power switching. On-chip charge pumps provide the necessary voltage to fully enhance the switches. With the charge pumps on-chip, the MOSFET drive is available without the need for a 12V supply. The LTC1314/LTC1315 provide a natural break-before-make action and smooth transitions due to

# APPLICATIONS INFORMATION

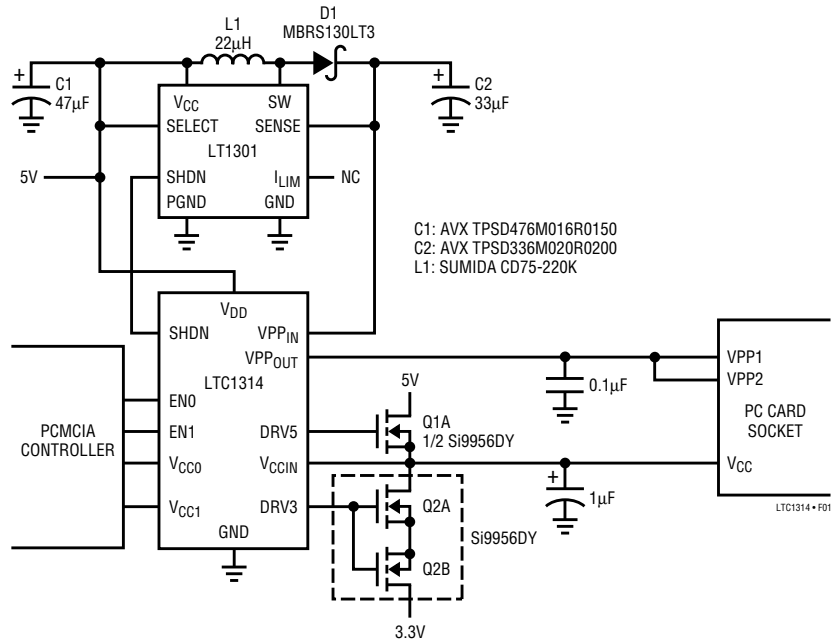


Figure 1. LTC1314 Switch Matrix with the LT1301 Boost Regulator

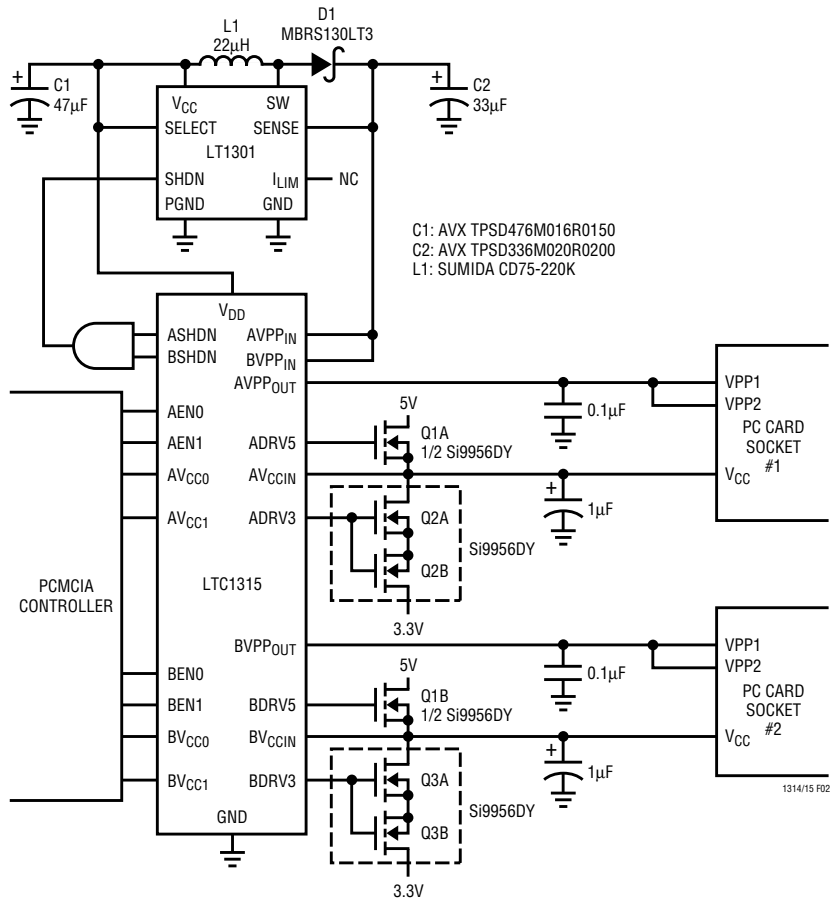


Figure 2. Typical Two-Socket Application Using the LTC1315 and the LT1301

## APPLICATIONS INFORMATION

the asymmetrical turn-on and turn-off of the MOSFETs. The LT1301 switching regulator is in shutdown mode and consumes only 10 $\mu$ A until the VPP pins require 12V.

The VPP switching is accomplished by a combination of the LTC1314/LTC1315 and LT1301. The LT1301 is in shutdown mode to conserve power until the VPP pins require 12V. When the VPP pins require 12V, the LT1301 is activated and the LTC1314/LTC1315's internal switches route the VPP<sub>IN</sub> pin to the VPP<sub>OUT</sub> pin. The LT1301 is capable of delivering 12V at 120mA maintaining high efficiency. The LTC1314/LTC1315's break-before-make and slope-controlled switching will ensure that the output voltage transition will be smooth, of moderate slope, and without overshoot. This is critical for flash memory products to prevent damaging parts from overshoot and ringing exceeding the 13.5V device limit.

### With Higher Voltage Supplies Available

Often systems have an available supply voltage greater than 12V. The LTC1314/LTC1315 can be used in conjunction with an LT1121 linear regulator to supply the PC card socket with all necessary voltages. Figures 3 and 4 show these circuits. The LTC1314/LTC1315 enable the LT1121 linear regulator only when 12V is required at the VPP pins. In all other modes the LT1121 is in shutdown mode and consumes only 16 $\mu$ A. The LT1121 also provides thermal shutdown and current limiting features to protect the socket, the card and the system regulator.

### Supply Bypassing

For best results, bypass V<sub>CCIN</sub> and VPP<sub>IN</sub> at their inputs with 1 $\mu$ F capacitors. VPP<sub>OUT</sub> should have a 0.01 $\mu$ F to 0.1 $\mu$ F capacitor for noise reduction and electrostatic discharge (ESD) damage prevention. Larger values of output capacitor will create large current spikes during transitions, requiring larger bypass capacitors on the V<sub>CCIN</sub> and VPP<sub>IN</sub> pins.

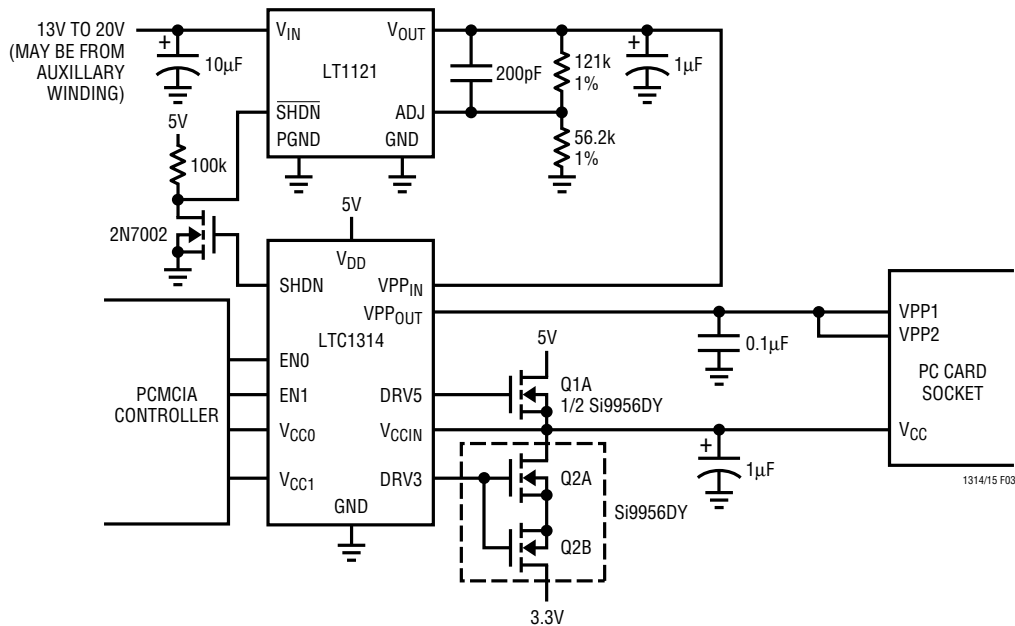


Figure 3. LTC1314 with the LT1121 Linear Regulator



# APPLICATIONS INFORMATION

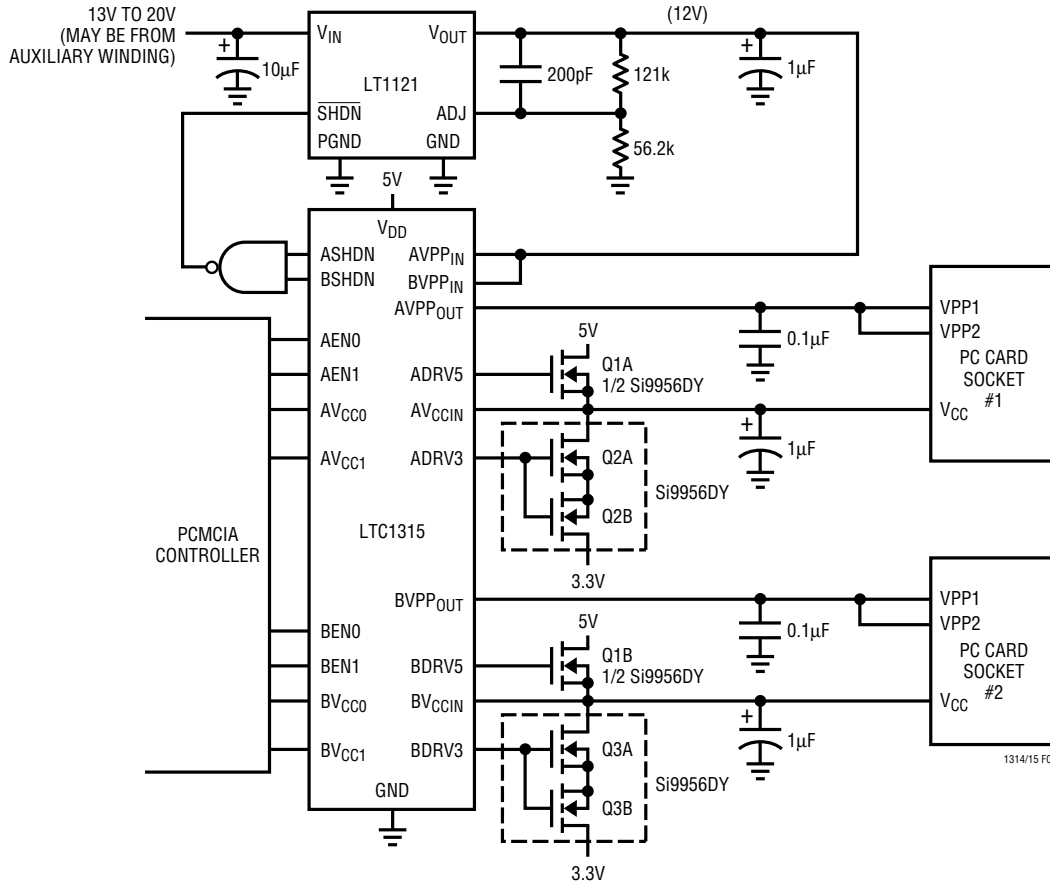
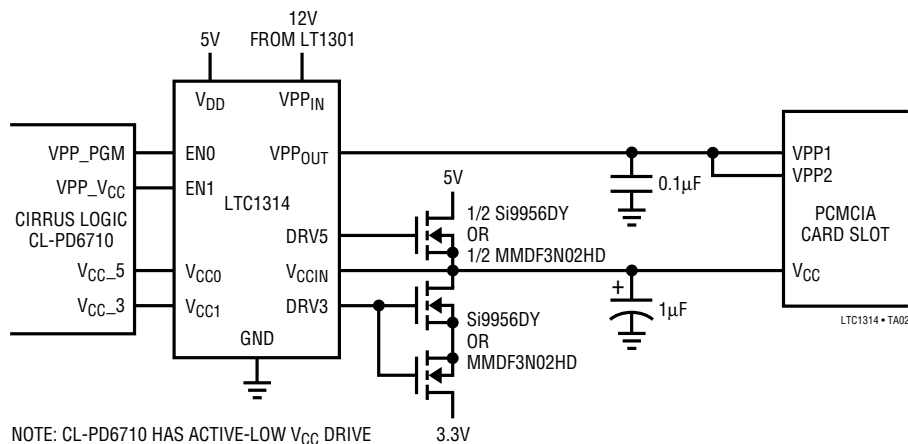


Figure 4. Typical Two-Socket Application Using the LTC1315 and the LT1121

# TYPICAL APPLICATIONS

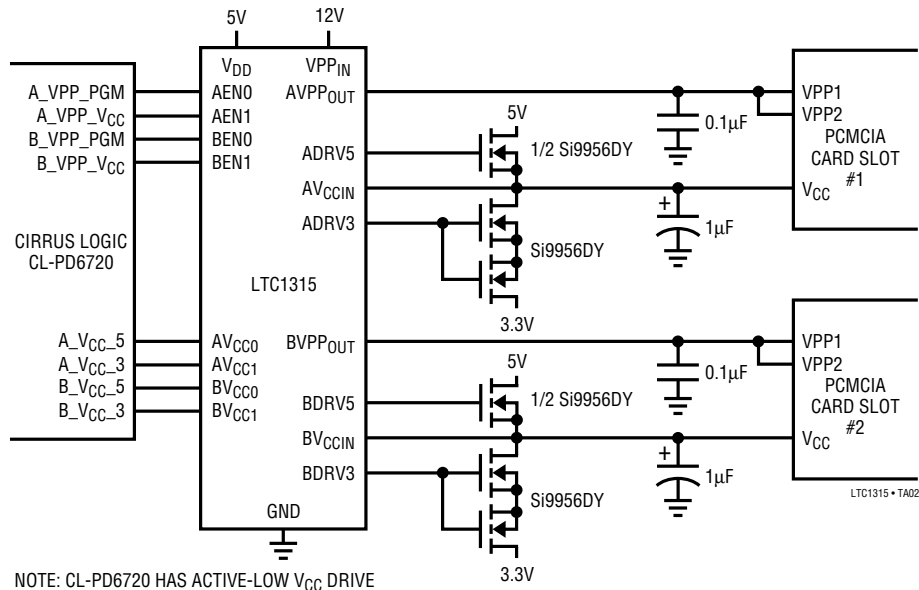
## Single Slot Interface to CL-PD6710



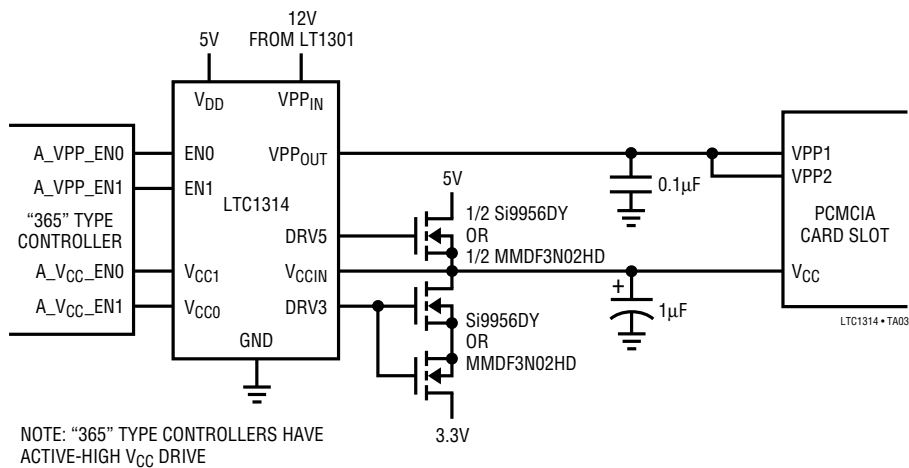
NOTE: CL-PD6710 HAS ACTIVE-LOW V<sub>CC</sub> DRIVE

**TYPICAL APPLICATIONS**

**Dual Slot Interface to CL-PD6720**

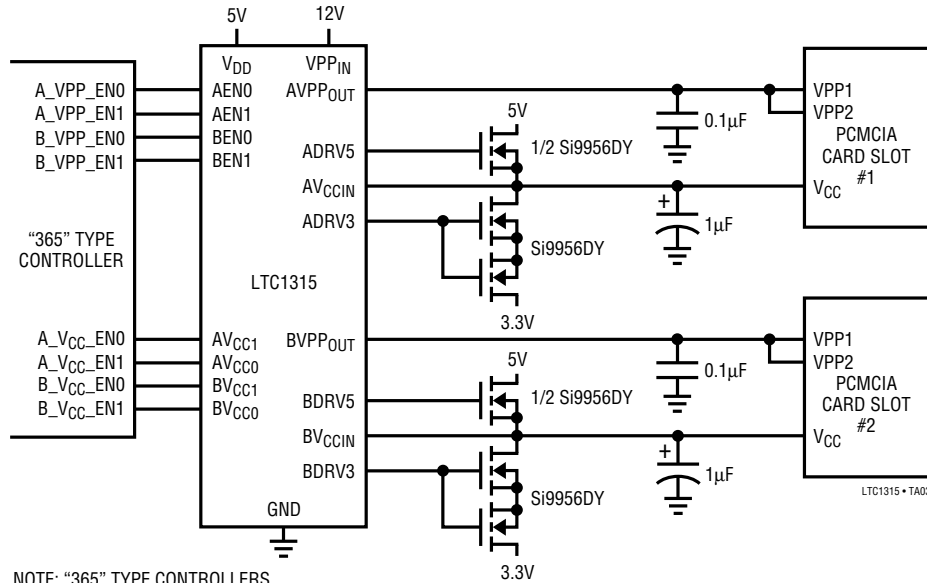


**Single Slot Interface to "365" Type Controller**



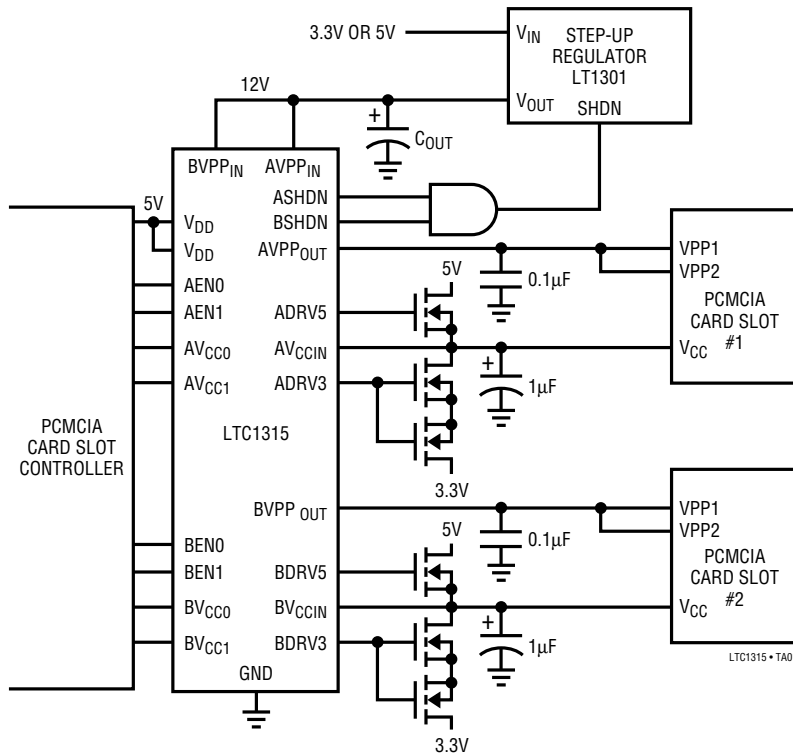
# TYPICAL APPLICATIONS

## Dual Slot Interface to "365" Type Controller



NOTE: "365" TYPE CONTROLLERS HAVE ACTIVE-HIGH V<sub>CC</sub> DRIVE

## Typical PCMCIA Dual Slot Driver



LTC1315 Truth Table

EN0	EN1	V <sub>CC0</sub>	V <sub>CC1</sub>	VPP <sub>OUT</sub>	DRV3	DRV5
0	0	X	X	GND	X	X
0	1	X	X	V <sub>CCIN</sub>	X	X
1	0	X	X	VPP <sub>IN</sub>	X	X
1	1	X	X	Hi-Z	X	X
X	X	1	0	X	1	0
X	X	0	1	X	0	1
X	X	0	0	X	0	0
X	X	1	1	X	0	0

X = DON'T CARE