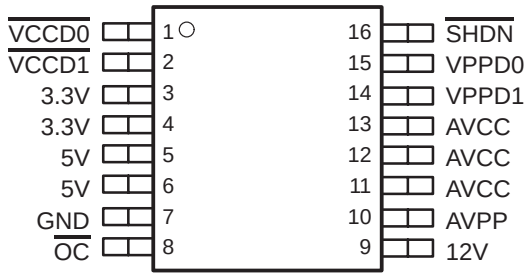
- **Fully Integrated V_{CC} and V_{pp} Switching for Single-Slot PC Card™ Interface**
- **Low $r_{DS(on)}$ (90-mΩ 5-V V_{CC} Switch and 3.3-V V_{CC} Switch)**
- **Compatible With Controllers From Cirrus, Ricoh, O_2Micro, Intel, and Texas Instruments**
- **3.3-V Low-Voltage Mode**
- **Meets PC Card Standards**
- **12-V Supply Can Be Disabled Except During 12-V Flash Programming**
- **Short-Circuit and Thermal Protection**
- **Space-Saving 16-Pin SSOP (DB)**
- **Compatible With 3.3-V, 5-V, and 12-V PC Cards**
- **Break-Before-Make Switching**

DB PACKAGE
(TOP VIEW)



description

The TPS2211 PC Card power-interface switch provides an integrated power-management solution for a single PC Card. All of the discrete power MOSFETs, a logic section, current limiting, and thermal protection for PC Card control are combined on a single integrated circuit, using the Texas Instruments LinBiCMOS™ process. The circuit allows the distribution of 3.3-V, 5-V, and/or 12-V card power, and is compatible with many PCMCIA controllers. The current-limiting feature eliminates the need for fuses, which reduces component count and improves reliability. Current-limit reporting can help the user isolate a system fault to the PC Card.

The TPS2211 features a 3.3-V low-voltage mode that allows for 3.3-V switching without the need for 5 V. Bias power can be derived from either the 3.3-V or 5-V inputs. This facilitates low-power system designs such as sleep mode and pager mode where only 3.3 V is available.

End equipment for the TPS2211 includes notebook computers, desktop computers, personal digital assistants (PDAs), digital cameras, and bar-code scanners.

AVAILABLE OPTIONS

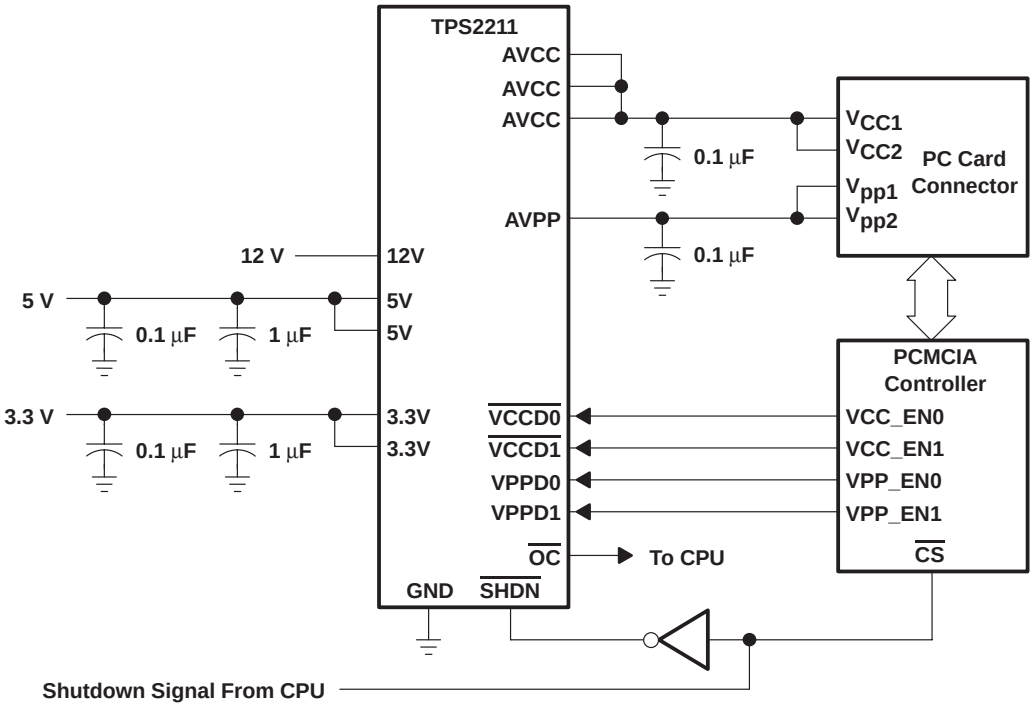
T_A	PACKAGED DEVICE	CHIP FORM (Y)
	SMALL OUTLINE (DB)	
–40°C to 85°C	TPS2211IDBLE	TPS2211Y

The DB package is only available left-end taped and reeled (indicated by the LE suffix on the device type, e.g. TPS2211IDBLE).

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PC Card is a trademark of PCMCIA (Personal Computer Memory Card International Association).
LinBiCMOS is a trademark of Texas Instruments Incorporated.

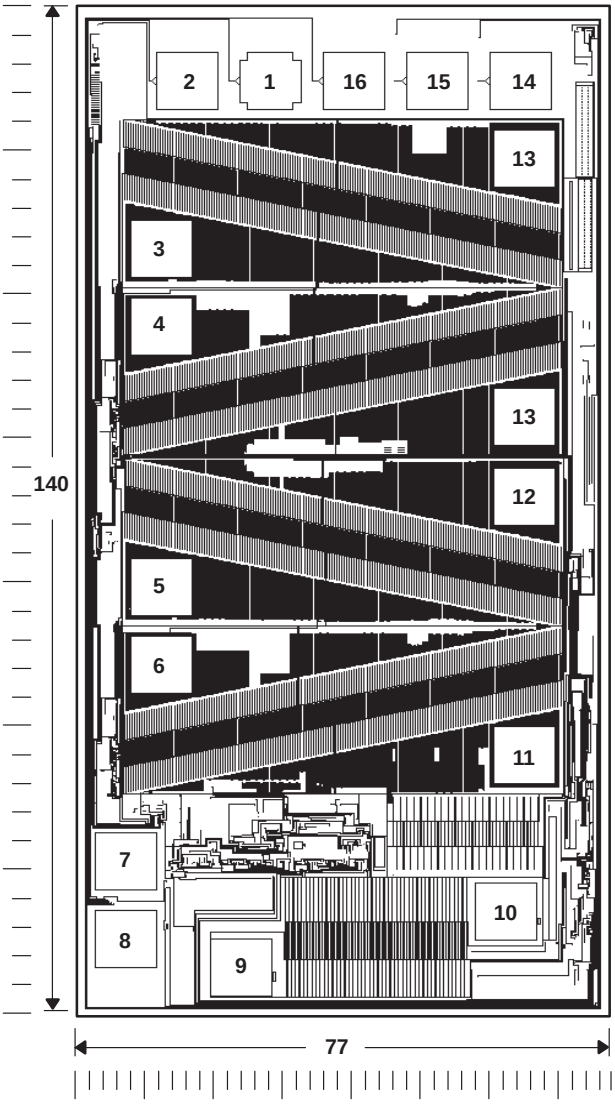
typical PC-card power-distribution application

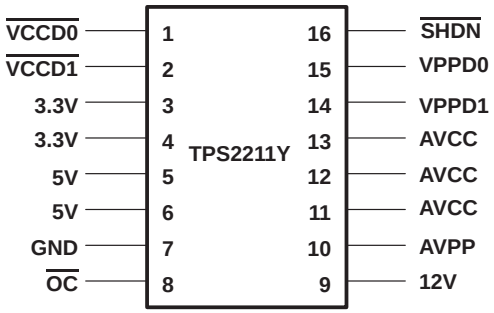


TPS2211Y chip information

This chip, when properly assembled, displays characteristics similar to those of the TPS2211. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. The chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

T_J max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
3.3V	3, 4	I	3.3-V V_{CC} input for card power and/or chip power if 5 V is not present
5V	5, 6	I	5-V V_{CC} input for card power and/or chip power
12V	9	I	12-V V_{pp} input card power
AVCC	11, 12, 13	O	Switched output that delivers 0 V, 3.3-V, 5-V, or high impedance to card
AVPP	10	O	Switched output that delivers 0 V 3.3-V, 5-V, 12-V, or high impedance to card
GND	7		Ground
$\overline{OC}$	8	O	Logic-level overcurrent reporting output that goes low when an overcurrent conditions exists
$\overline{SHDN}$	16	I	Logic input that shuts down the TPS2211 and sets all power outputs to high-impedance state
$\overline{VCCD0}$	1	I	Logic input that controls voltage of AVCC (see control-logic table)
$\overline{VCCD1}$	2	I	Logic input that controls voltage of AVCC (see control-logic table)
VPPD0	15	I	Logic input that controls voltage of AVPP (see control-logic table)
VPPD1	14	I	Logic input that controls voltage of AVPP (see control-logic table)

absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Input voltage range for card power: $V_{I(5V)}$ . . . . . –0.3 V to 7 V
$V_{I(3.3V)}$ . . . . . –0.3 V to 7 V
$V_{I(12V)}$ . . . . . –0.3 V to 14 V
Logic input voltage . . . . . –0.3 V to 7 V
Continuous total power dissipation . . . . . See Dissipation Rating Table
Output current (each card): $I_{O(VCC)}$ . . . . . internally limited
$I_{O(VPP)}$ . . . . . internally limited
Operating virtual junction temperature range, T_J . . . . . –40°C to 150°C
Operating free-air temperature range, T_A . . . . . –40°C to 85°C
Storage temperature range, T_{stg} . . . . . –55°C to 150°C
Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
DB	775 mW	6.2 mW/°C	496 mW	403 mW

These devices are mounted on an FR4 board with no special thermal considerations.

recommended operating conditions

		MIN	MAX	UNIT
Input voltage, V_I	$V_{I(5V)}$	0	5.25	V
	$V_{I(3.3V)}$	0	5.25	V
	$V_{I(12V)}$	0	13.5	V
Output Current	$I_{O(AVCC)}$		1	A
	$I_{O(AVPP)}$		150	mA
Operating virtual junction temperature, T_J		–40	125	°C

electrical characteristics, T_A = –40°C to 85°C (unless otherwise noted)

power switch

PARAMETER			TEST CONDITIONS†	TPS2211 MIN	TPS2211 TYP	TPS2211 MAX	UNIT
	Switch resistance	5 V to AVCC	$V_{I(5V)}$ = 5 V		50	90	mΩ
		3.3 V to AVCC	$V_{I(5V)}$ = 5 V, $V_{I(3.3V)}$ = 3.3 V		48	90	mΩ
		3.3 V to AVCC	$V_{I(5V)}$ = 0 V, $V_{I(3.3V)}$ = 3.3 V		48	90	mΩ
		5 V to AVPP	T_J=25°C			6	Ω
		3.3 V to AVPP	T_J=25°C			6	Ω
		12 V to AVPP	T_J=25°C			1	Ω
$V_{O(AVPP)}$	Clamp low voltage		I_{pp} at 10 mA			0.8	V
$V_{O(AVCC)}$	Clamp low voltage		I_{CC} at 10 mA			0.8	V
I_{lkg}	Leakage current	I_{PP} high-impedance state	T_A = 25°C		1	10	µA
			T_A= 85°C			50	µA
		I_{CC} high-impedance state	T_A = 25°C		1	10	µA
			T_A=85°C			50	µA
I_I	Input current	$V_{I(5V)}$ = 5 V	$V_{O(AVCC)}$ = 5 V, $V_{O(AVPP)}$ = 12 V		40	150	µA
		$V_{I(5V)}$ = 0 V, $V_{I(3.3V)}$ = 3.3 V	$V_{O(AVCC)}$ = 3.3 V, $V_{O(AVPP)}$ = 12 V		40	150	µA
		Shutdown mode	$V_{O(AVCC)}$ = $V_{O(AVPP)}$ = Hi-Z			1	µA
I_{OS}	Short-circuit output-current limit	$I_{O(AVCC)}$	T_J = 85°C, output powered into a short to GND	1		2.2	A
		$I_{O(AVPP)}$		120		400	mA

† Pulse-testing techniques maintain junction temperature close to ambient temperature; thermal effects must be taken into account separately.

logic section

PARAMETER	TEST CONDITIONS†	TPS2211 MIN	TPS2211 MAX	UNIT
Logic input current			1	µA
Logic input high level		2		V
Logic input low level			0.8	V
Logic output high level	$V_{I(5V)}$ = 5 V, I_O = 1 mA	$V_{I(5V)}$ – 0.4		V
	$V_{I(5V)}$ = 0 V, I_O = 1 mA, $V_{I(3.3V)}$ = 3.3 V	$V_{I(3.3V)}$ – 0.4		V
Logic output low level	I_O = 1 mA		0.4	V

† Pulse-testing techniques maintain junction temperature close to ambient temperature; thermal effects must be taken into account separately.

electrical characteristics, T_A = 25°C (unless otherwise noted)

power switch

PARAMETER			TEST CONDITIONS†	TPS2211Y MIN	TPS2211Y TYP	TPS2211Y MAX	UNIT
	Switch resistance	5 V to AVCC	$V_{I(5V)}$ = 5 V		50		mΩ
		3.3 V to AVCC	$V_{I(5V)}$ = 5 V, $V_{I(3.3V)}$ = 3.3 V		48		mΩ
		3.3 V to AVCC	$V_{I(5V)}$ = 0 V, $V_{I(3.3V)}$ = 3.3 V		48		mΩ
		5 V to AVPP	T_J=25°C		4.3		Ω
		3.3 V to AVPP	T_J=25°C		4.3		Ω
		12 V to AVPP	T_J=25°C		0.5		Ω
$V_{O(AVPP)}$	Clamp low voltage		I_{pp} at 10 mA		0.28		V
$V_{O(AVCC)}$	Clamp low voltage		I_{pp} at 10 mA		0.28		V
I_{lkg}	Leakage current	I_{pp} high-impedance state			1		µA
		I_{CC} high-impedance state			1		µA
I_I	Input current	V_I = 5 V	$V_{O(AVCC)}$ = 5 V, $V_{O(AVPP)}$ = 12 V		42		µA
		$V_{I(5V)}$ = 5 V, $V_{I(3.3V)}$ = 3.3 V	$V_{O(AVCC)}$ = 3.3 V, $V_{O(AVPP)}$ = 12 V		42		µA

† Pulse-testing techniques maintain junction temperature close to ambient temperature; thermal effects must be taken into account separately.

switching characteristics‡

PARAMETER		TEST CONDITIONS§		TPS2211, TPS2211Y MIN	TPS2211, TPS2211Y TYP	TPS2211, TPS2211Y MAX	UNIT
t_r	Rise times, output	$V_{O(AVCC)}$			2.8		ms
		$V_{O(AVPP)}$			6.4		ms
t_f	Fall times, output	$V_{O(AVCC)}$			4.5		ms
		$V_{O(AVPP)}$			12		ms
t_{pd}	Propagation delay (see Figure1)	$V_{I(VPPD0)}$ to $V_{O(AVPP)}$	t_{on}		6.8		ms
			t_{off}		18		ms
		$V_{I(\overline{VCCD1})}$ to $V_{O(AVCC)}$ (3.3V)	t_{on}		4		ms
			t_{off}		17		ms
		$V_{I(\overline{VCCD0})}$ to $V_{O(AVCC)}$ (5V)	t_{on}		6.6		ms
			t_{off}		17		ms

‡ Switching Characteristics are with C_L = 150 µF.
§ Refer to Parameter Measurement Information

PARAMETER MEASUREMENT INFORMATION

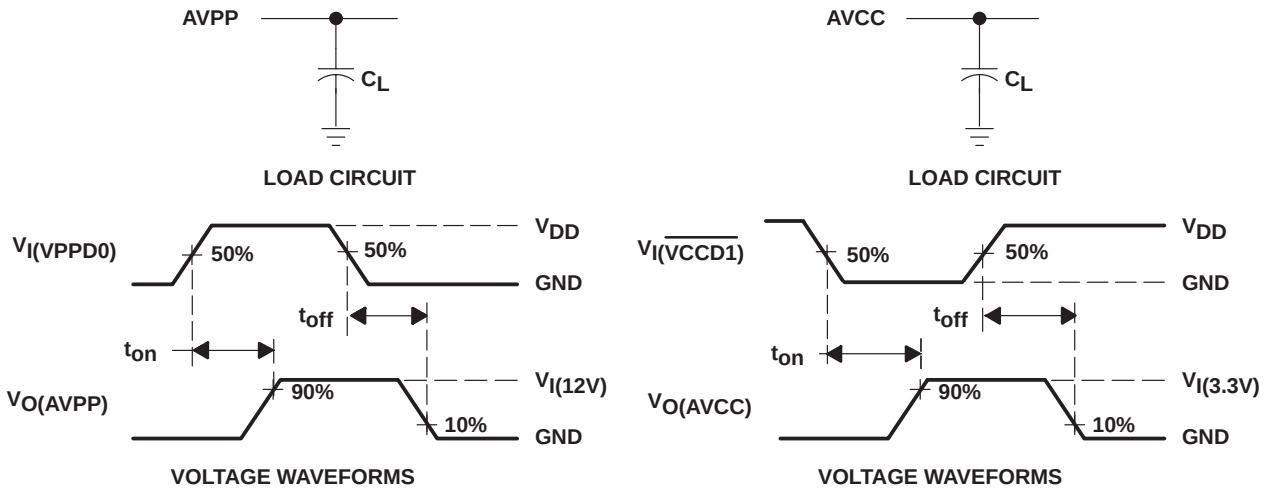


Figure 1. Test Circuits and Voltage Waveforms

Table of Timing Diagrams

	FIGURE
AVCC Propagation Delay and Rise Time With 1-µF Load, 3.3-V Switch	2
AVCC Propagation Delay and Fall Time With 1-µF Load, 3.3-V Switch	3
AVCC Propagation Delay and Rise Time With 150-µF Load, 3.3-V Switch	4
AVCC Propagation Delay and Fall Time With 150-µF Load, 3.3-V Switch	5
AVCC Propagation Delay and Rise Time With 1-µF Load, 5-V Switch	6
AVCC Propagation Delay and Fall Time With 1-µF Load, 5-V Switch	7
AVCC Propagation Delay and Rise Time With 150-µF Load, 5-V Switch	8
AVCC Propagation Delay and Fall Time With 150-µF Load, 5-V Switch	9
AVPP Propagation Delay and Rise Time With 1-µF Load, 12-V Switch	10
AVPP Propagation Delay and Fall Time With 1-µF Load, 12-V Switch	11
AVPP Propagation Delay and Rise Time With 150-µF Load, 12-V Switch	12
AVPP Propagation Delay and Fall Time With 150-µF Load, 12-V Switch	13

PARAMETER MEASUREMENT INFORMATION

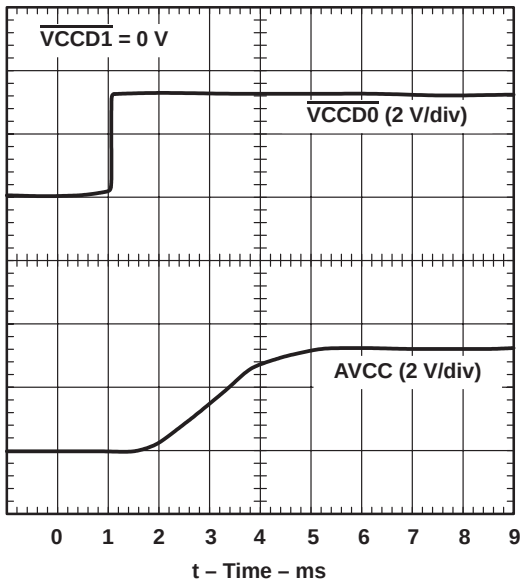


Figure 2. AVCC Propagation Delay and Rise Time With 1-μF Load, 3.3-V Switch

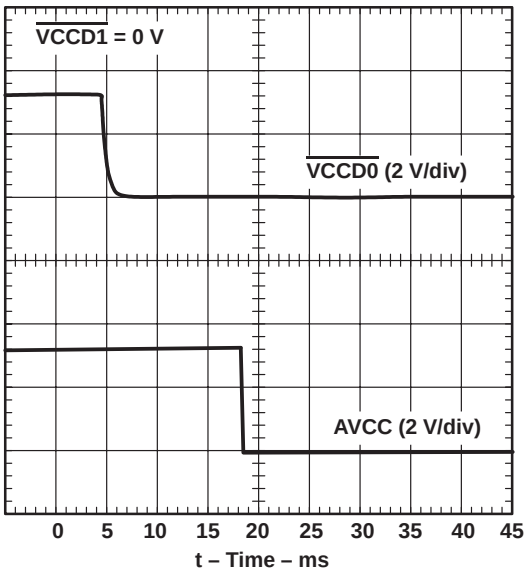


Figure 3. AVCC Propagation Delay and Fall Time With 1-μF Load, 3.3-V Switch

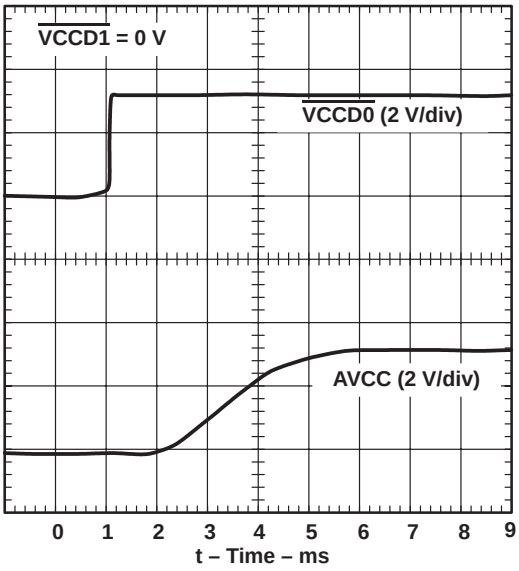


Figure 4. AVCC Propagation Delay and Rise Time With 150-μF Load, 3.3-V Switch

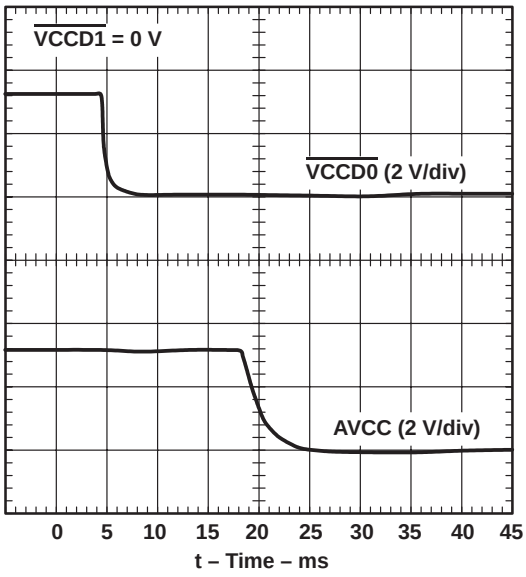


Figure 5. AVCC Propagation Delay and Fall Time With 150-μF Load, 3.3-V Switch

PARAMETER MEASUREMENT INFORMATION

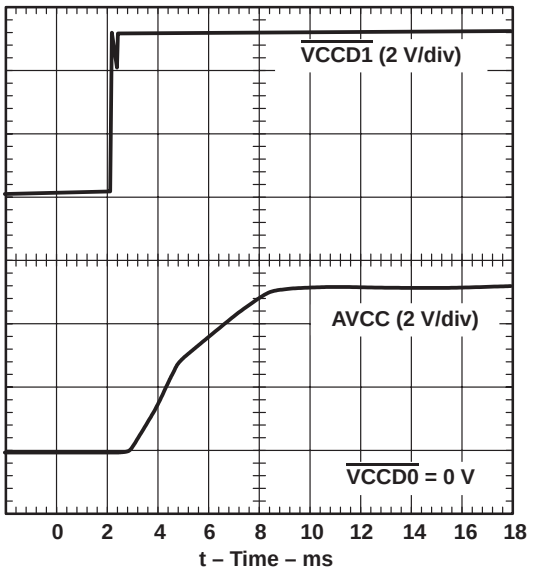


Figure 6. AVCC Propagation Delay and Rise Time With 1-μF Load, 5-V Switch

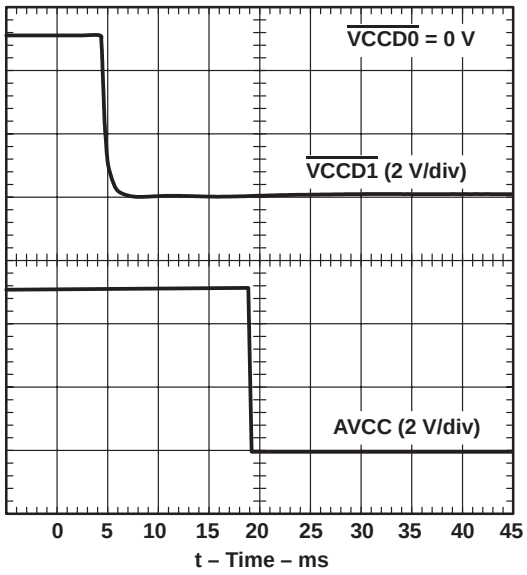


Figure 7. AVCC Propagation Delay and Fall Time With 1-μF Load, 5-V Switch

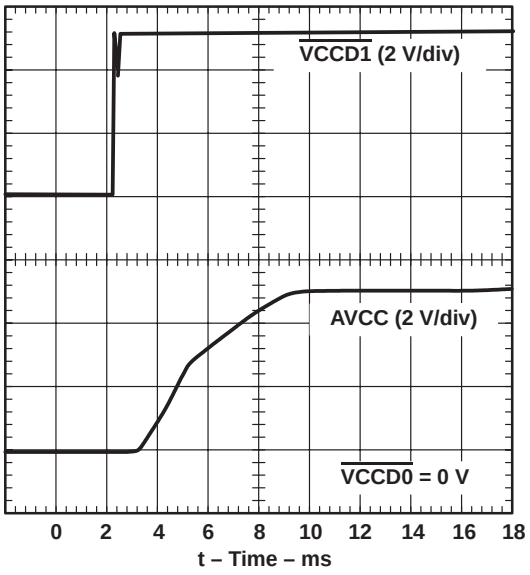


Figure 8. AVCC Propagation Delay and Rise Time With 150-μF Load, 5-V Switch

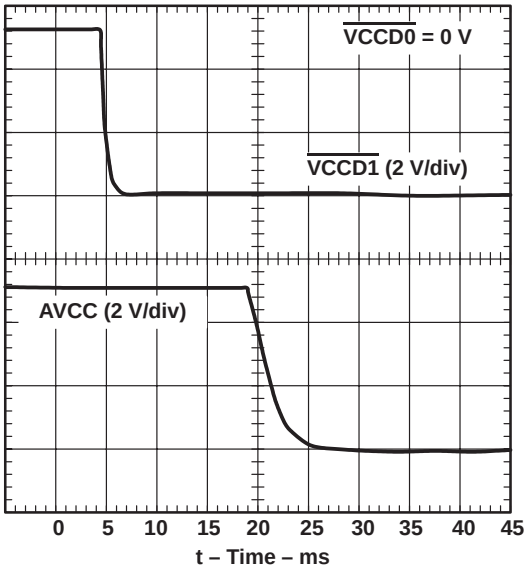


Figure 9. AVCC Propagation Delay and Fall Time With 150-μF Load, 5-V Switch

PARAMETER MEASUREMENT INFORMATION

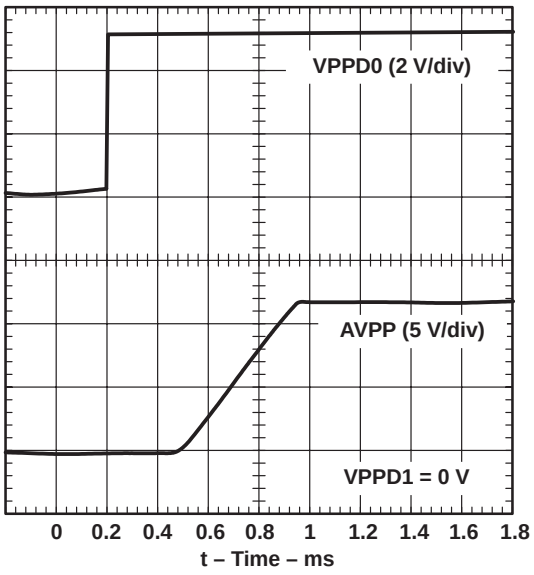


Figure 10. AVPP Propagation Delay and Rise Time With 1-μF Load, 12-V Switch

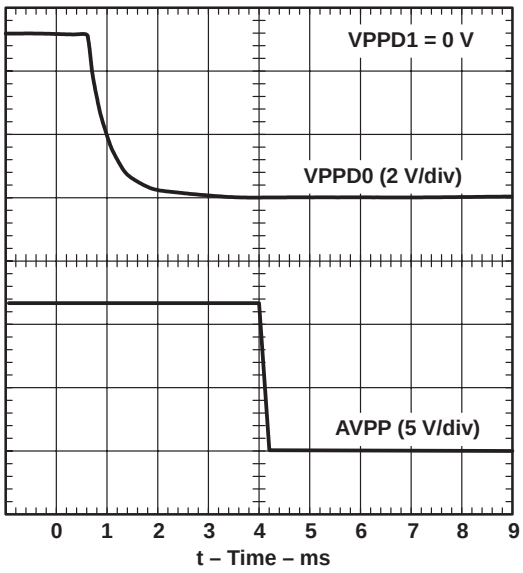


Figure 11. AVPP Propagation Delay and Fall Time With 1-μF Load, 12-V Switch

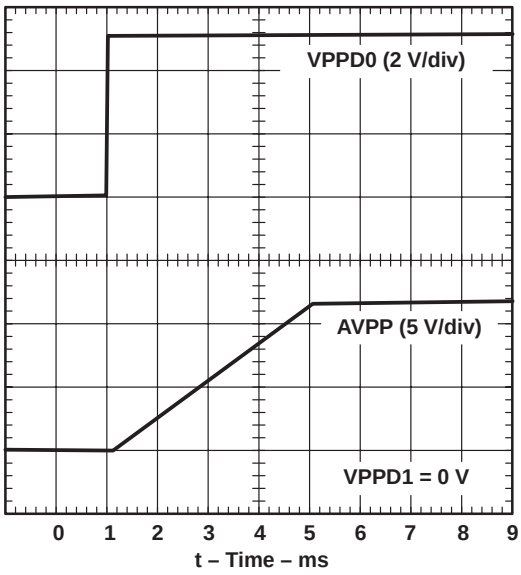


Figure 12. AVPP Propagation Delay and Rise Time With 150-μF Load, 12-V Switch

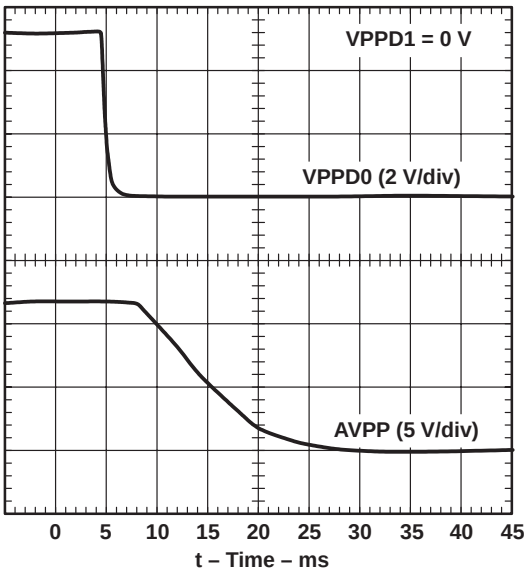


Figure 13. AVPP Propagation Delay and Fall Time With 150-μF Load, 12-V Switch

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
$I_{CC(5V)}$	Supply current	vs Junction Temperature	14
$I_{CC(3.3V)}$	Supply current	vs Junction Temperature	15
$r_{DS(on)}$	Static drain-source on-state resistance, 5-V switch	vs Junction Temperature	16
$r_{DS(on)}$	Static drain-source on-state resistance, 3.3-V switch	vs Junction Temperature	17
$r_{DS(on)}$	Static drain-source on-state resistance, 12-V switch	vs Junction Temperature	18
$V_{O(AVCC)}$	Output voltage, 5-V switch	vs Output current	19
$V_{O(AVCC)}$	Output voltage, 3.3-V switch	vs Output current	20
$V_{O(AVPP)}$	Output voltage, 12-V switch	vs Output current	21
$I_{OS(AVCC)}$	Short-circuit current, 5-V switch	vs Junction Temperature	22
$I_{OS(AVCC)}$	Short-circuit current, 3.3-V switch	vs Junction Temperature	23
$I_{OS(AVPP)}$	Short-circuit current, 12-V switch	vs Junction Temperature	24

TYPICAL CHARACTERISTICS

SUPPLY CURRENT vs JUNCTION TEMPERATURE

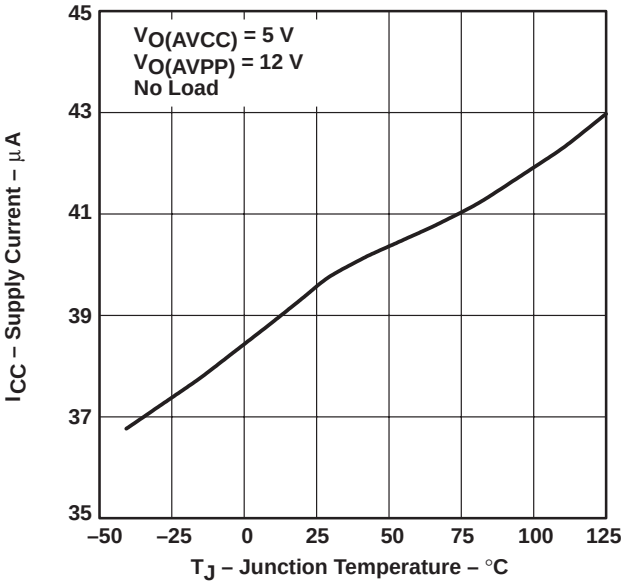


Figure 14

SUPPLY CURRENT vs JUNCTION TEMPERATURE

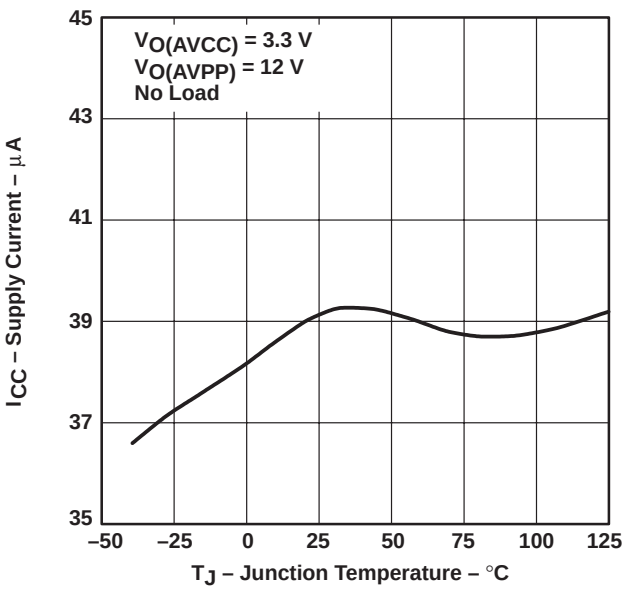


Figure 15

5-V SWITCH STATIC DRAIN-SOURCE ON-STATE RESISTANCE vs JUNCTION TEMPERATURE

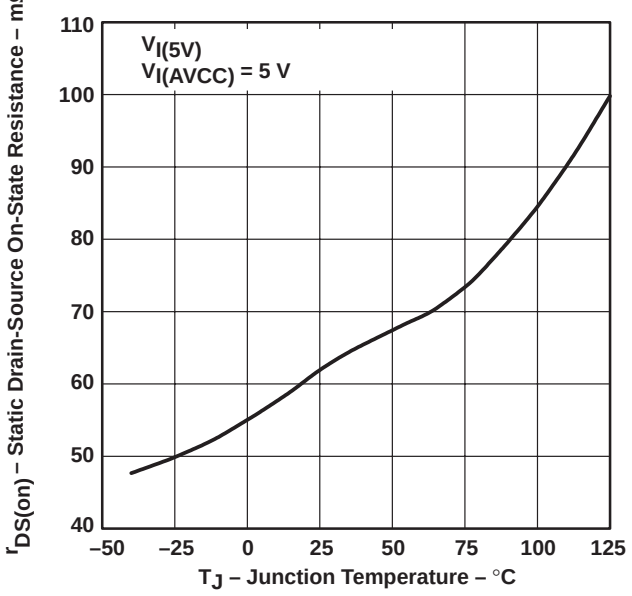


Figure 16

3.3-V SWITCH STATIC DRAIN-SOURCE ON-STATE RESISTANCE vs JUNCTION TEMPERATURE

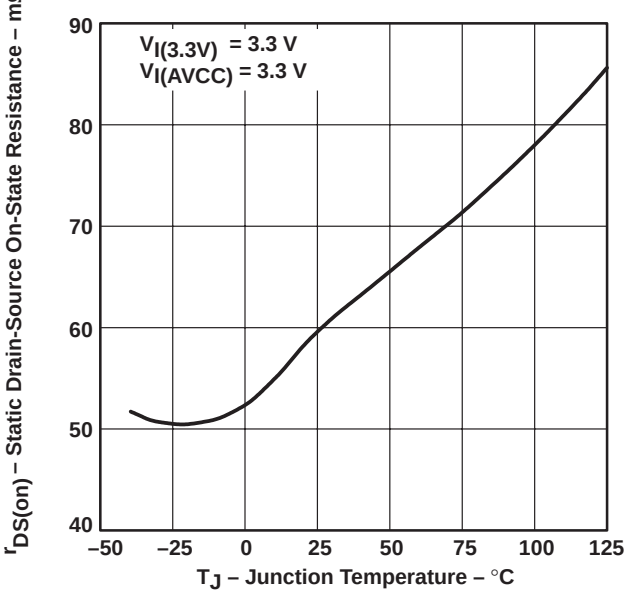


Figure 17

TYPICAL CHARACTERISTICS

12-V SWITCH
STATIC DRAIN-SOURCE ON-STATE RESISTANCE
vs
JUNCTION TEMPERATURE

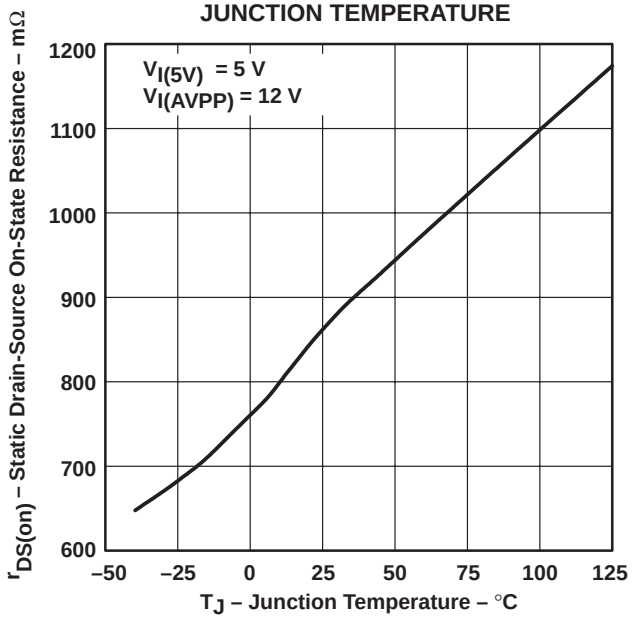


Figure 18

5-V SWITCH
OUTPUT VOLTAGE
vs
OUTPUT CURRENT

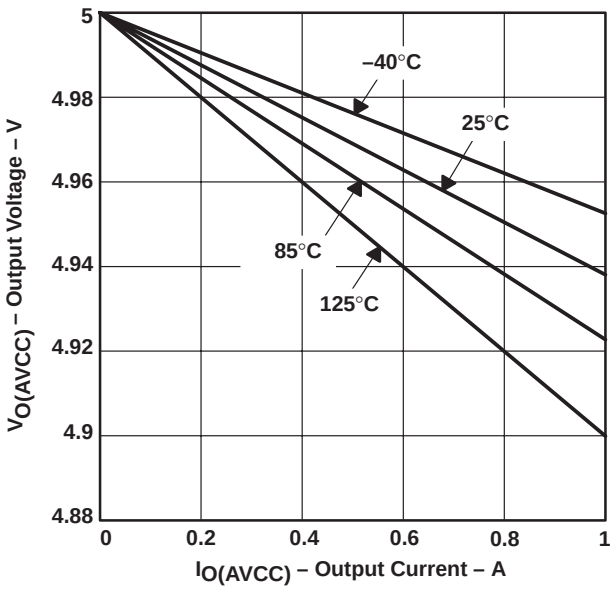


Figure 19

3.3-V SWITCH
OUTPUT VOLTAGE
vs
OUTPUT CURRENT

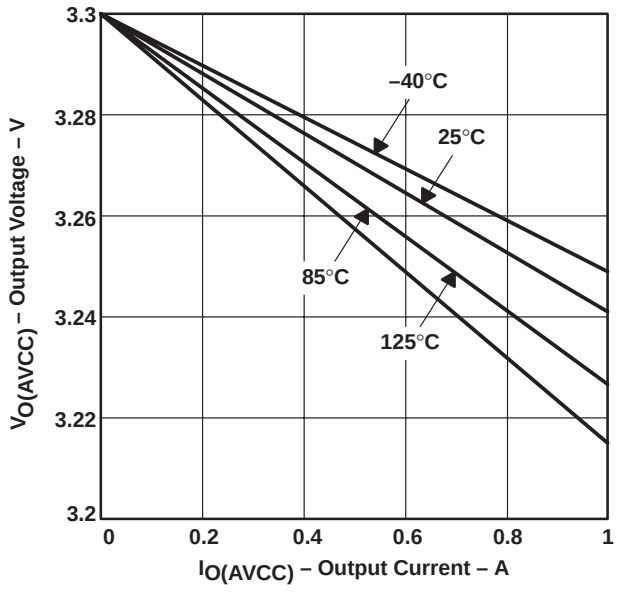


Figure 20

12-V SWITCH
OUTPUT VOLTAGE
vs
OUTPUT CURRENT

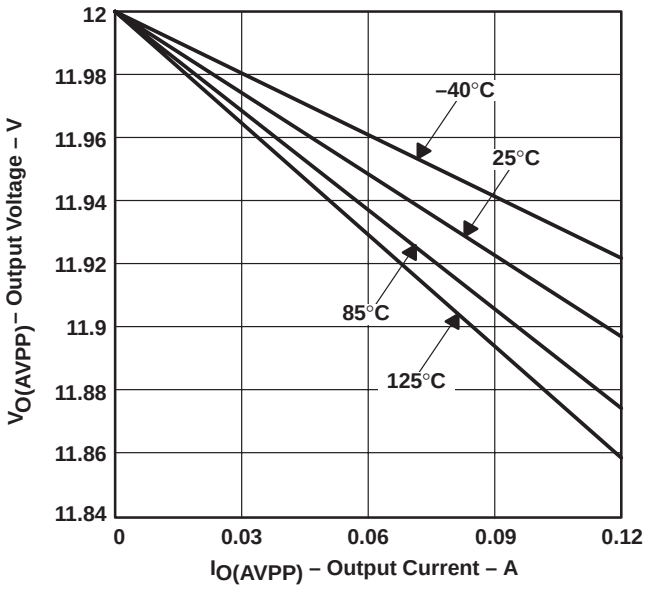


Figure 21

TYPICAL CHARACTERISTICS

5-V SWITCH
SHORT-CIRCUIT CURRENT
vs
JUNCTION TEMPERATURE

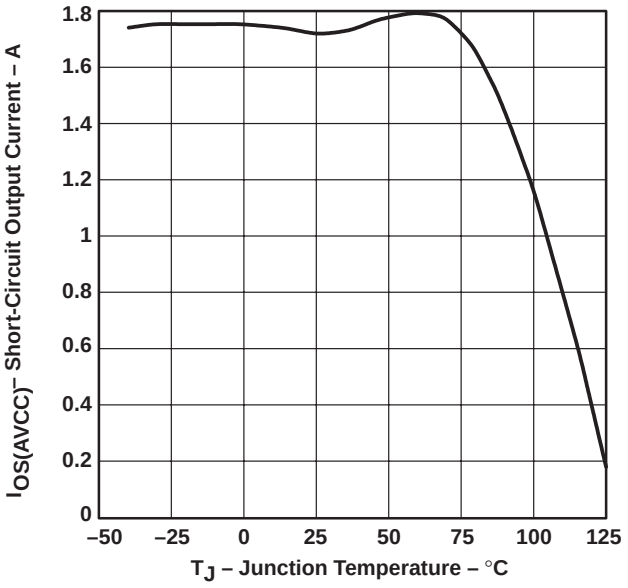


Figure 22

3.3-V SWITCH
SHORT-CIRCUIT CURRENT
vs
JUNCTION TEMPERATURE

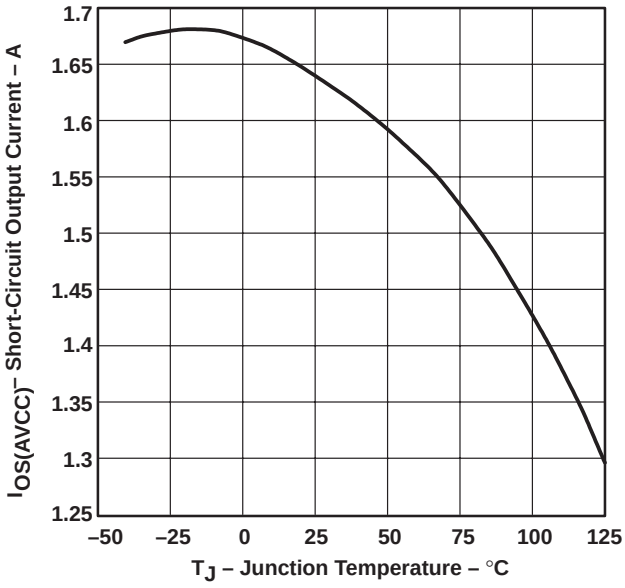


Figure 23

12-V SWITCH
SHORT-CIRCUIT CURRENT
vs
JUNCTION TEMPERATURE

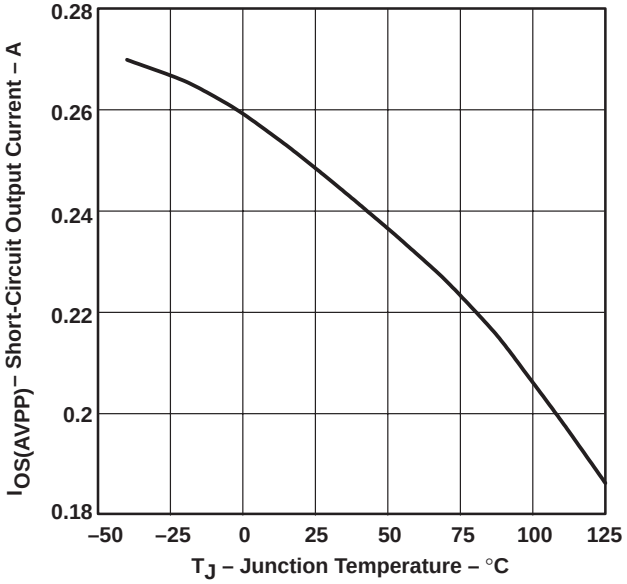


Figure 24

APPLICATION INFORMATION

overview

PC Cards were initially introduced as a means to add EEPROM (flash memory) to portable computers with limited on-board memory. The idea of add-in cards quickly took hold; modems, wireless LANs, GPS systems, multimedia, and hard-disk versions were soon available. As the number of PC Card applications grew, the engineering community quickly recognized the need for a standard to ensure compatibility across platforms. To this end, the PCMCIA (Personal Computer Memory Card International Association) was established, comprised of members from leading computer, software, PC Card, and semiconductor manufacturers. One key goal was to realize the “plug and play” concept, i.e. cards and hosts from different vendors should be compatible.

PC Card power specification

System compatibility also means power compatibility. The most current set of specifications (PC Card Standard) set forth by the PCMCIA committee states that power is to be transferred between the host and the card through eight of the 68 terminals of the PC Card connectors. This power interface consists of two V_{CC}, two V_{pp}, and four ground terminals. Multiple V_{CC} and ground terminals minimize connector-terminal and line resistance. The two V_{pp} terminals were originally specified as separate signals but are commonly tied together in the host to form a single node to minimize voltage losses. Card primary power is supplied through the V_{CC} terminals; flash-memory programming and erase voltage is supplied through the V_{pp} terminals.

designing for voltage regulation

The current PCMCIA specification for output voltage regulation of the 5-V output is 5% (250 mV). In a typical PC power-system design, the power supply will have an output voltage regulation ($V_{PS(reg)}$) of 2% (100 mV). Also, a voltage drop from the power supply to the PC Card will result from resistive losses (V_{PCB}) in the PCB traces and the PCMCIA connector. A typical design would limit the total of these resistive losses to less than 1% (50 mV) of the output voltage. Therefore the allowable voltage drop (V_{DS}) for the TPS2211 is the PCMCIA voltage regulation less the power supply regulation and less the PCB and connector resistive drops:

$$V_{DS} = V_{O(reg)} - V_{PS(reg)} - V_{PCB}$$

Typically, this would leave 100 mV for the allowable voltage drop across the TPS2211. The voltage drop is the output current multiplied by the switch resistance of the TPS2211. Therefore, the maximum output current that can be delivered to the PC Card in regulation is the allowable voltage drop across the TPS2211 divided by the output switch resistance.

$$I_O max = \frac{V_{DS}}{r_{DS(on)}}$$

The AVCC outputs deliver 1 A continuous at 5 V and 3.3 V within regulation over the operating temperature range. Using the same equations, the PCMCIA specification for output voltage regulation of the 3.3 V output is 300 mV. Using the voltage drop percentages for power supply regulation (2%) and PCB resistive loss (1%), the allowable voltage drop for the 3.3 V switch is 200 mV. The 12-V outputs (AVPP) of the TPS2211 can deliver 150 mA continuously.

APPLICATION INFORMATION

overcurrent and overtemperature protection

PC Cards are inherently subject to damage from mishandling. Host systems require protection against short-circuited cards that could lead to power supply or PCB trace damage. Even systems sufficiently robust to withstand a short circuit would still undergo rapid battery discharge into the damaged PC Card, resulting in a sudden loss of system power. Most hosts include fuses for protection. The reliability of fused systems is poor and requires troubleshooting and repair, usually by the manufacturer, when fuses are blown.

The TPS2211 uses sense FETs to check for overcurrent conditions in each of the AVCC and AVPP outputs. Unlike sense resistors or polyfuses, these FETs do not add to the series resistance of the switch; therefore voltage and power losses are reduced. Overcurrent sensing is applied to each output separately. When an overcurrent condition is detected, only the power output affected is limited; all other power outputs continue to function normally. The $\overline{OC}$ indicator, normally a logic high, is a logic low when an overcurrent condition is detected providing for initiation of system diagnostics and/or sending a warning message to the user.

During power up, the TPS2211 controls the rise time of the AVCC and AVPP outputs and limits the current into a faulty card or connector. If a short circuit is applied after power is established (e.g., hot insertion of a bad card), current is initially limited only by the impedance between the short and the power supply. In extreme cases, as much as 10 A to 15 A may flow into the short before the current limiting of the TPS2211 engages. If the AVCC or AVPP outputs are driven below ground, the TPS2211 may latch nondestructively in an off state. Cycling power will reestablish normal operation.

Overcurrent limiting for the AVCC outputs is designed to activate if powered up into a short in the range of 1 A to 2.2 A, typically at about 1.6 A. The AVPP outputs limit from 120 mA to 400 mA, typically around 280 mA. The protection circuitry acts by linearly limiting the current passing through the switch rather than initiating a full shutdown of the supply. Shutdown occurs only during thermal limiting.

Thermal limiting prevents destruction of the IC from overheating if the package power dissipation ratings are exceeded. Thermal limiting disables power output until the device has cooled.

12-V supply not required

Most PC Card switches use the externally supplied 12 V to power gate drive and other chip functions, which requires that power be present at all times. The TPS2211 offers considerable power savings by using an internal charge pump to generate the required higher voltages from the 5-V input. Therefore, the external 12-V supply can be disabled except when needed for flash-memory functions, thereby extending battery lifetime. Do not ground the 12-V switch inputs when the 12-V input is not used. Additional power savings are realized by the TPS2211 during a software shutdown in which quiescent current drops to a maximum of 1 μA.

3.3-V low-voltage mode

The TPS2211 will operate in a 3.3-V low-voltage mode when 3.3 V is the only available input voltage ($V_{I(5V)}$ = 0). This allows host and PC Cards to be operated in low-power 3.3-volts-only modes such as sleep or pager modes. Note that in these operation modes, the TPS2211 will derive its bias current from the 3.3-V input pin and only 3.3 V can be delivered to the PC Card.

APPLICATION INFORMATION

voltage transitioning requirement

PC Cards are migrating from 5 V to 3.3 V to minimize power consumption, optimize board space, and increase logic speeds. The TPS2211 meets all combinations of power delivery as currently defined in the PCMCIA standard. The latest protocol accommodates mixed 3.3-V/5-V systems by first powering the card with 5 V, then polling it to determine its 3.3-V compatibility. The PCMCIA specification requires that the capacitors on 3.3-V compatible cards be discharged to below 0.8 V before applying 3.3-V power. This functions as a power reset and ensures that sensitive 3.3-V circuitry is not subjected to any residual 5-V charge. The TPS2211 offers a selectable V_{CC} and V_{pp} ground state, in accordance with PCMCIA 3.3-V/5-V switching specifications.

output ground switches

PC Card specification requires that V_{CC} be discharged within 100 ms. PC Card resistance can not be relied on to provide a discharge path for voltages stored on PC Card capacitance because of possible high-impedance isolation by power-management schemes.

power supply considerations

The TPS2211 has multiple pins for each of its 3.3-V and 5-V power inputs and for the switched AVCC outputs. Any individual pin can conduct the rated input or output current. Unless all pins are connected in parallel, the series resistance is significantly higher than that specified, resulting in increased voltage drops and lost power. It is recommended that all input and output power pins be paralleled for optimum operation.

To increase the noise immunity of the TPS2211, the power supply inputs should be bypassed with a 1-µF electrolytic or tantalum capacitor paralleled by a 0.047-µF to 0.1-µF ceramic capacitor. It is strongly recommended that the switched outputs be bypassed with a 0.1-µF, or larger, ceramic capacitor; doing so improves the immunity of the TPS2211 to electrostatic discharge (ESD). Care should be taken to minimize the inductance of PCB traces between the TPS2211 and the load. High switching currents can produce large negative voltage transients, which forward biases substrate diodes, resulting in unpredictable performance. Similarly, no pin should be taken below –0.3 V.

calculating junction temperature

The switch resistance, $r_{DS(on)}$, is dependent on the junction temperature, T_J, of the die and the current through the switch. To calculate T_J, first find $r_{DS(on)}$ from Figures 16 through 18 using an initial temperature estimate about 50°C above ambient. Then calculate the power dissipation for each switch, using the formula:

$$P_D = r_{DS(on)} \times I^2$$

Next, sum the power dissipation and calculate the junction temperature:

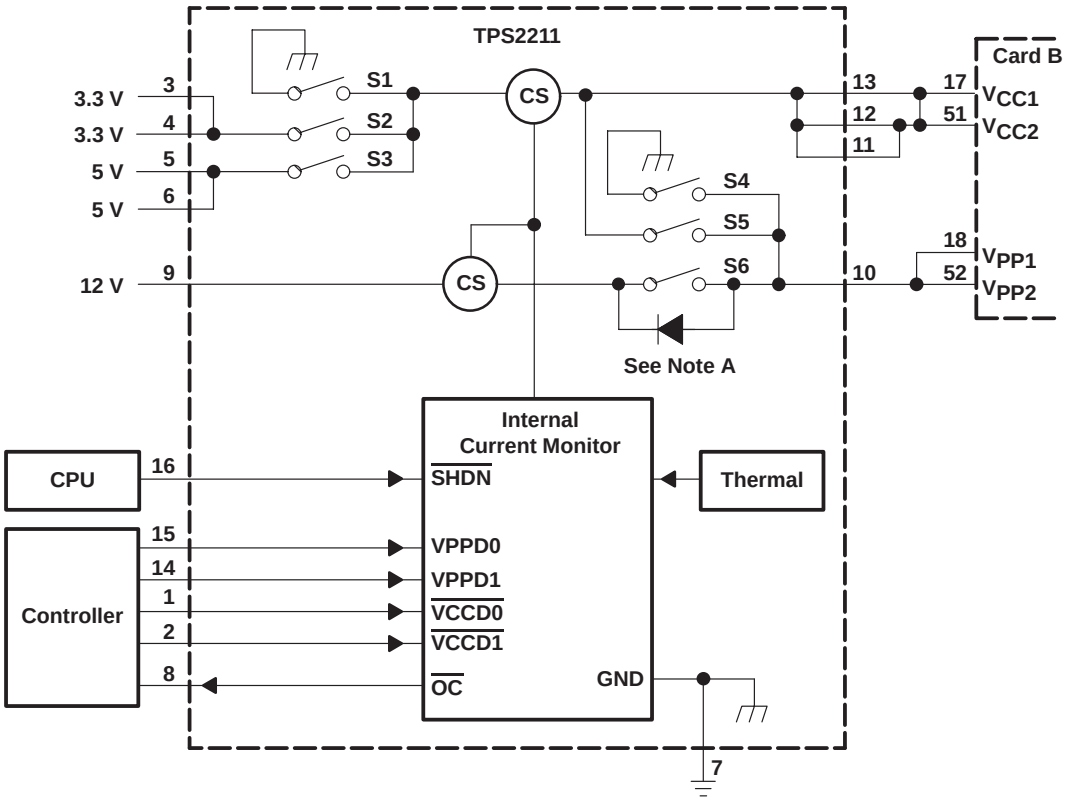
$$T_J = \left(\sum P_D \times R_{\theta JA}\right) + T_A,\ R_{\theta JA} = 108°C/W$$

Compare the calculated junction temperature with the initial temperature estimate. If the temperatures are not within a few degrees of each other, recalculate using the calculated temperature as the initial estimate.

APPLICATION INFORMATION

ESD protection

All TPS2211 inputs and outputs incorporate ESD-protection circuitry designed to withstand a 2-kV human-body-model discharge as defined in MIL-STD-883C, Method 3015. The AVCC and AVPP outputs can be exposed to potentially higher discharges from the external environment through the PC Card connector. Bypassing the outputs with 0.1-μF capacitors protects the devices from discharges up to 10 kV.



NOTE A: MOSFET switch S6 has a back-gate diode from the source to the drain. Unused switch inputs should never be grounded.

Figure 25. Internal Switching Matrix, TPS2211 control logic

APPLICATION INFORMATION

TPS2211 control logic

AVPP

CONTROL SIGNALS			INTERNAL SWITCH SETTINGS			OUTPUT
$\overline{\text{SHDN}}$	VPPD0	VPPD1	S4	S5	S6	AVPP
1	0	0	CLOSED	OPEN	OPEN	0 V
1	0	1	OPEN	CLOSED	OPEN	AVCC†
1	1	0	OPEN	OPEN	CLOSED	VPP (12 V)
1	1	1	OPEN	OPEN	OPEN	Hi-Z
0	X	X	OPEN	OPEN	OPEN	Hi-Z

† Output depends on AVCC

AVCC

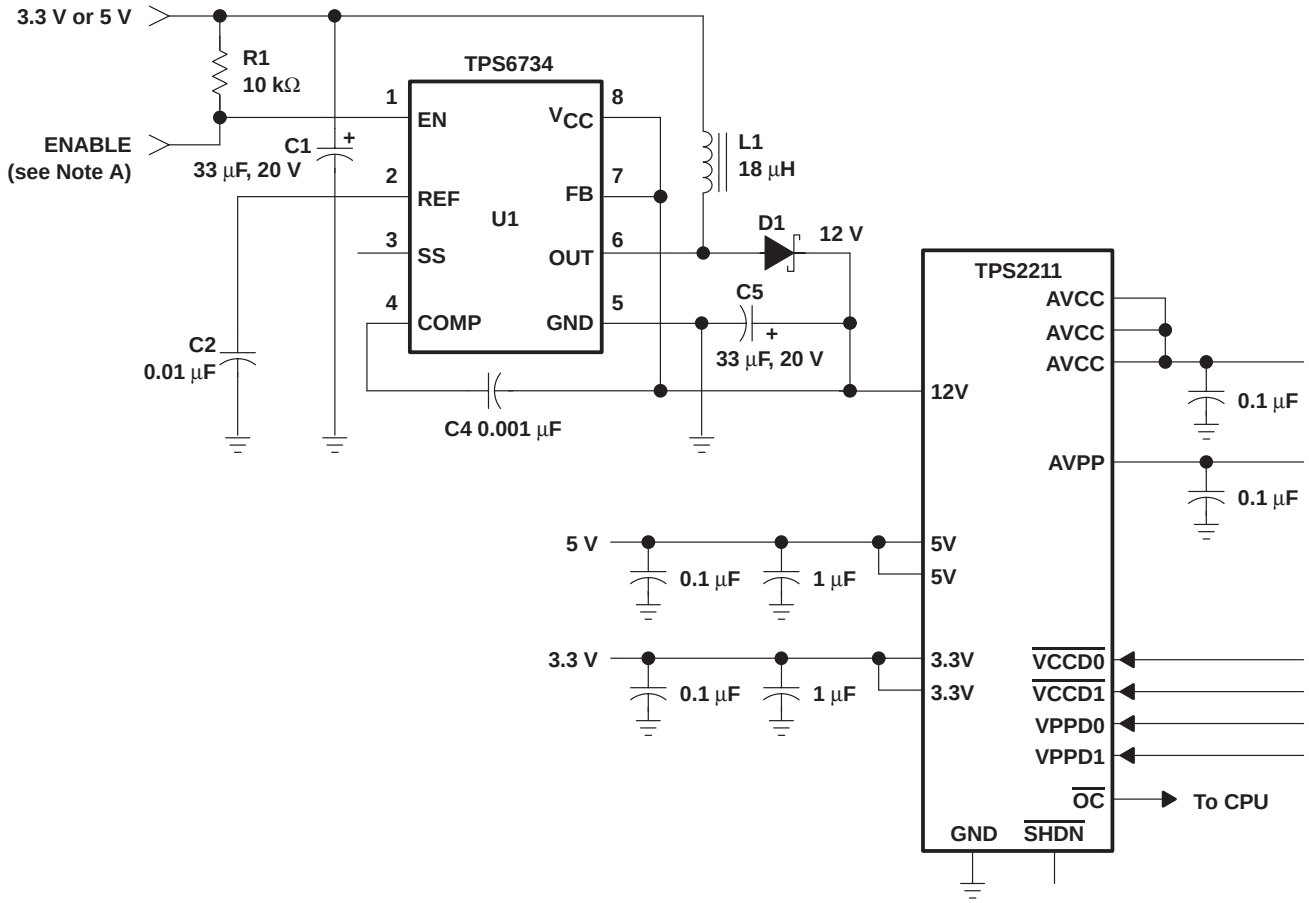
CONTROL SIGNALS			INTERNAL SWITCH SETTINGS			OUTPUT
$\overline{\text{SHDN}}$	$\overline{\text{VCCD1}}$	$\overline{\text{VCCD0}}$	S1	S2	S3	AVCC
1	0	0	CLOSED	OPEN	OPEN	0 V
1	0	1	OPEN	CLOSED	OPEN	3.3 V
1	1	0	OPEN	OPEN	CLOSED	5 V
1	1	1	CLOSED	OPEN	OPEN	0 V
0	X	X	OPEN	OPEN	OPEN	Hi-Z

APPLICATION INFORMATION

12-V flash memory supply

The TPS6734 is a fixed 12-V output boost converter capable of delivering 120 mA from inputs as low as 2.7 V. The device is pin-for-pin compatible with the MAX734 regulator and offers the following advantages: lower supply current, wider operating input-voltage range, and higher output currents. As shown in Figure 1, the only external components required are: an inductor, a Schottky rectifier, an output filter capacitor, an input filter capacitor, and a small capacitor for loop compensation. The entire converter occupies less than 0.7 in^2 of PCB space when implemented with surface-mount components. An enable input is provided to shut the converter down and reduce the supply current to 3 μA when 12 V is not needed.

The TPS6734 is a 170-kHz current-mode PWM (pulse-width modulation) controller with an n-channel MOSFET power switch. Gate drive for the switch is derived from the 12-V output after start-up to minimize the die area needed to realize the 0.7-Ω MOSFET and improve efficiency at input voltages below 5 V. Soft start is accomplished with the addition of one small capacitor. A 1.22-V reference (pin 2) is brought out for external use. For additional information, see the TPS6734 data sheet (SLVS127).



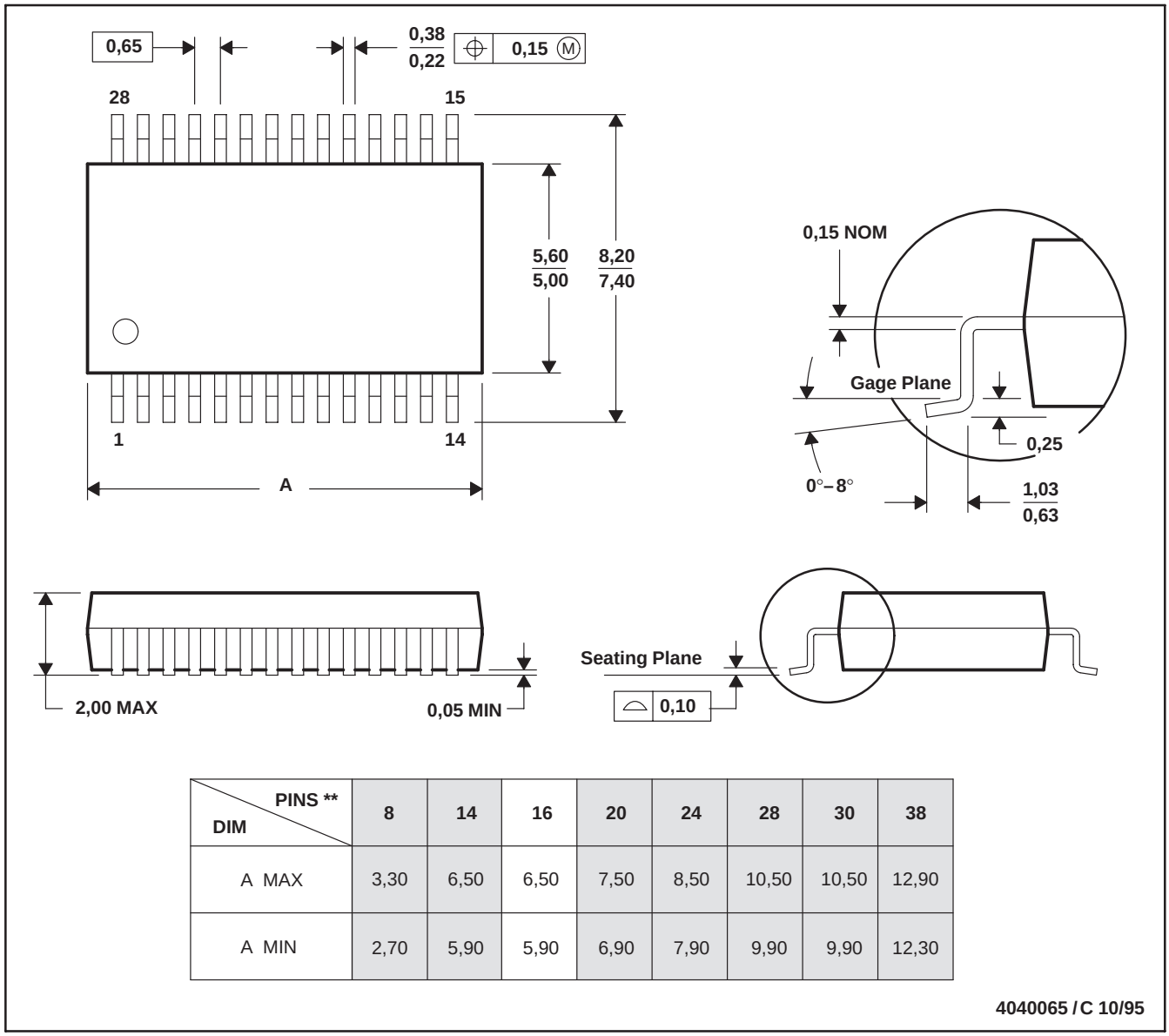
NOTE A: The enable terminal can be tied to a generall purpose I/O terminal on the PCMCIA controller or tied high.

Figure 26. TPS2211 with TPS6734 12-V, 120-mA Supply

MECHANICAL DATA

DB (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

28 PIN SHOWN



DIM \ PINS **	8	14	16	20	24	28	30	38
A MAX	3,30	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	2,70	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 / C 10/95

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-150

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