19-1376; Rev 1; 12/98

MAXIM

3V to 5V Regulating Charge Pumps for SIM Cards

General Description

The MAX1686 provides power for dual-voltage subscriber ID module (SIM) cards in portable applications such as GSM cellular phones. Designed to reside in the portable unit (cellular phone handset), the 1MHz charge pump converts a 2.7V to 4.2V input to regulated 5V output. The MAX1686H has a nominal output voltage of 5.0V, while the MAX1686 is set to 4.75V to reduce SIM-card current drain. The charge pump has only 45µA quiescent supply current, which reduces to 3µA when a 3V-capable SIM card is being powered and the charge pump is disabled. An internal input/output shorting switch provides power for 3V SIM cards.

The MAX1686/MAX1686H require only three external capacitors around their space-saving, thin (1mm) 8-pin µMAX packages.

Applications

GSM Cellular Phones

PCS Phones

Portable POS Terminals

Personal Communicators

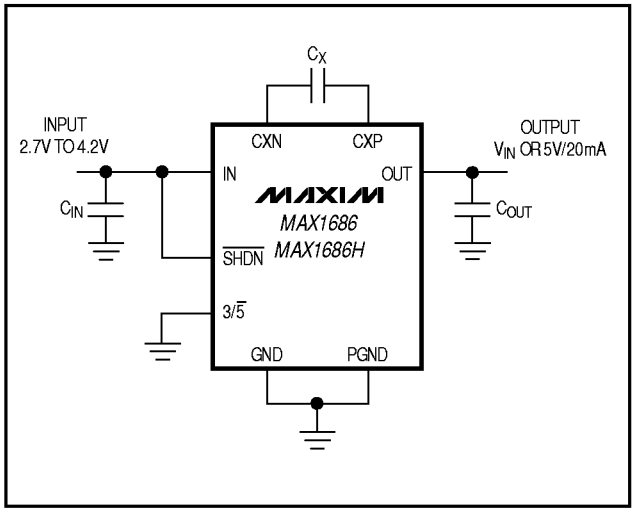
Features

- **2.7V to 4.2V Input Range**
- **12mA min Charge-Pump Output Current**
- **45µA Quiescent Supply Current**
- **0.1µA Supply Current in Shutdown Mode**
- **5.0V Regulated Charge-Pump Output (MAX1686H)**
  4.75V Regulated Charge-Pump Output (MAX1686)
- **Input-Output Shorting Switch for 3V Cards**
- **Small External Components**
  (Uses a 0.047µF, 0.1µF, and a 2.2µF Capacitor)
- **Output Driven to Ground in Shutdown Mode**
- **Super-Small 8-Pin µMAX Package**
- **Soft-Start and Short-Circuit Protection**

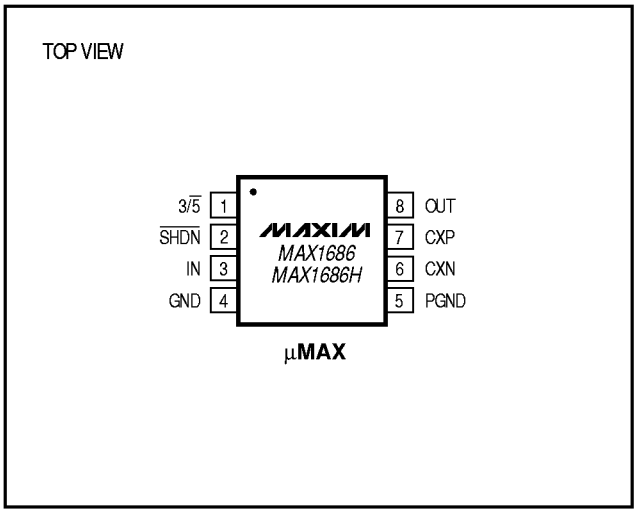
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX1686EUA	-40°C to +85°C	8 µMAX
MAX1686HEUA	-40°C to +85°C	8 µMAX

Typical Operating Circuit



Pin Configuration



3V to 5V Regulating Charge Pumps for SIM Cards

ABSOLUTE MAXIMUM RATINGS

IN, OUT, $\overline{SHDN}$, 3/$\overline{5}$ to GND.....-0.3V to +6V
CXP to GND.....-0.3V to (V_{OUT} + 0.3V)
CXN to GND .....-0.3V to (V_{IN} + 0.3V)
PGND to GND .....-0.3V to + 0.3V
OUT Short Circuit to GND .....Continuous
IN-to-OUT Current.....50mA

Continuous Power Dissipation (T_A = +70°C)
8-Pin µMAX (derate 4.1mW/°C above +70°C) 330mW
Operating Temperature Range
MAX1686EUA/MAX1686HEUA.....-40°C to +85°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +165°C
Lead Temperature (soldering, 10sec) .....+300°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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = $V_{\overline{SHDN}}$ = 3.3V, 3/$\overline{5}$ = GND, C_X = 0.22µF, C_{OUT} = 10µF (see *Applications Information* section to use smaller capacitors), T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

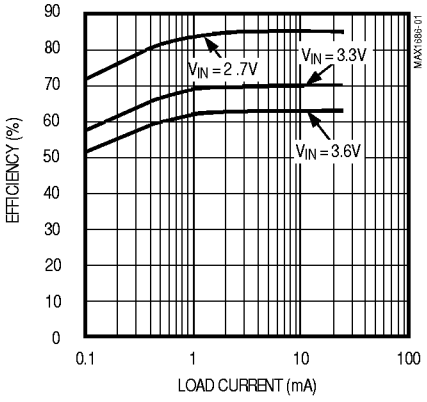
PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range			2.7		4.2	V
Input Undervoltage-Lockout Threshold Voltage			0.8	1.2	1.6	V
Quiescent Supply Current	Charge pump enabled, no load, 3/$\overline{5}$ = GND	T_A = +25°C		45	100	µA
		T_A = -40°C to +85°C			150	
	Charge pump disabled, no load, 3/$\overline{5}$ = IN			3	10	
Shutdown Supply Current	V_{IN} = 3.6V, $\overline{SHDN}$ = GND			0.1	5	µA
OUT Output Voltage	V_{IN} = 2.7V to 4.2V, load = 0 to 12mA	MAX1686	4.55	4.75	5.25	V
		MAX1686H	4.75	5.00	5.25	
	3/$\overline{5}$ = IN			V_{IN}		
IN-to-OUT Switch On-Resistance	$V_{3/\overline{5}}$ = V_{IN} = 3.0V			2.5	5	Ω
OUT Discharge Switch On-Resistance	3/$\overline{5}$ = GND or IN, $\overline{SHDN}$ = GND			80	200	Ω
OUT Short-Circuit Current	3/$\overline{5}$ = GND or IN		20	100	200	mA
Logic Input Low Voltage	$\overline{SHDN}$, 3/$\overline{5}$			0.5 · V_{IN}	0.3 · V_{IN}	V
Logic Input High Voltage	$\overline{SHDN}$, 3/$\overline{5}$		0.7 · V_{IN}	0.5 · V_{IN}		V
Logic Input Leakage Current	$\overline{SHDN}$, 3/$\overline{5}$ = GND or IN			0.1	1	µA
Charge-Pump Frequency	T_A = +25°C		800	1000	1200	kHz
	T_A = -40°C to +85°C		700		1300	

Note 1: Electrical specifications are measured by pulse testing and are guaranteed for a junction temperature within the operating temperature range, unless otherwise noted. Limits are 100% production tested at T_A = +25°C. Limits over the entire operating temperature range are guaranteed through correlation using Statistical Quality Control (SQC) methods and are not production tested.

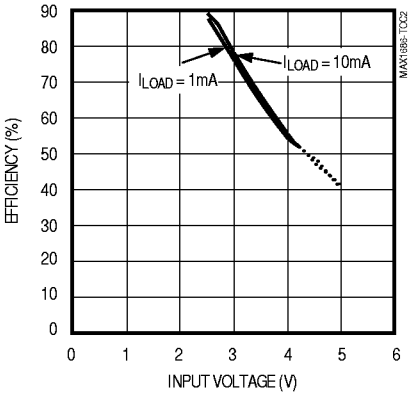
Typical Operating Characteristics

(See *Typical Operating Circuit*, C_{IN} = 0.47µF, C_X = 0.22µF, C_{OUT} = 10µF, V_{IN} = 3.3V, T_A = +25°C, unless otherwise noted.)

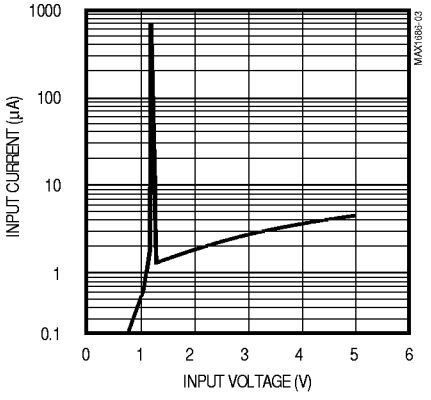
EFFICIENCY vs. LOAD CURRENT
(5V MODE)



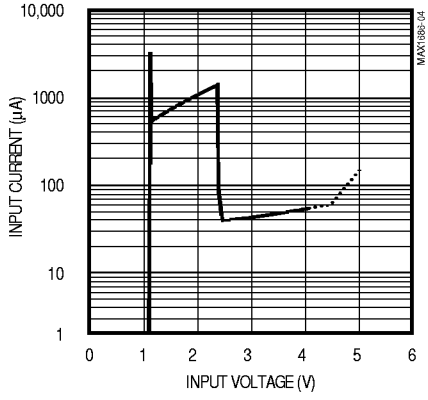
EFFICIENCY vs. INPUT VOLTAGE
(5V MODE)



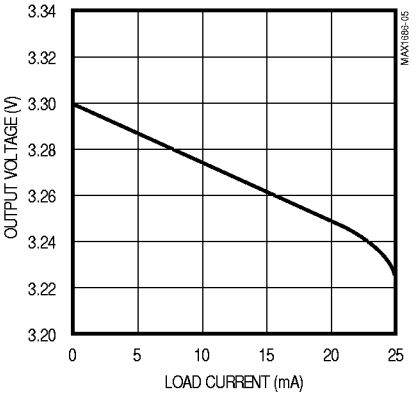
NO-LOAD INPUT CURRENT
vs. INPUT VOLTAGE (3V MODE)



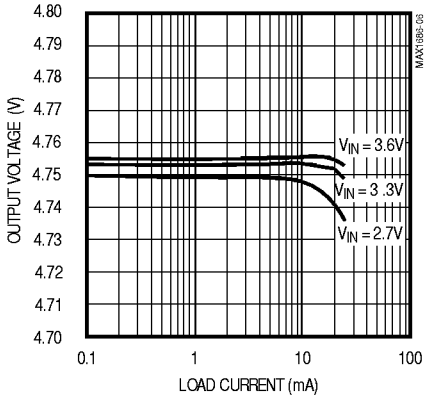
NO-LOAD INPUT CURRENT
vs. INPUT VOLTAGE (5V MODE)



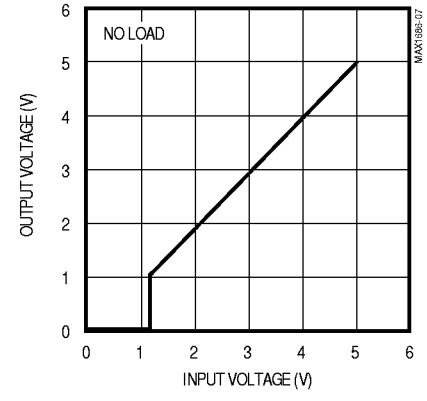
OUTPUT VOLTAGE
vs. LOAD CURRENT (3V MODE)



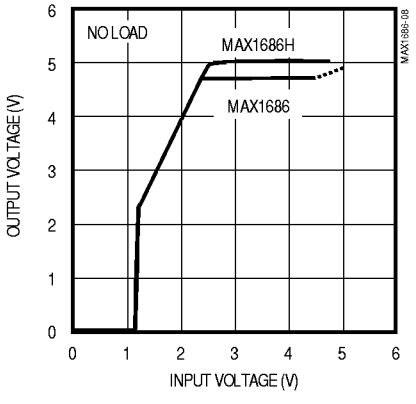
MAX1686 OUTPUT VOLTAGE
vs. LOAD CURRENT (5V MODE)



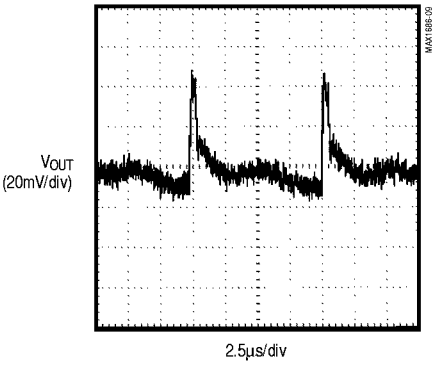
OUTPUT VOLTAGE
vs. INPUT VOLTAGE (3V MODE)



OUTPUT VOLTAGE
vs. INPUT VOLTAGE (5V MODE)



OUTPUT WAVEFORM
(I_{LOAD} = 10mA)



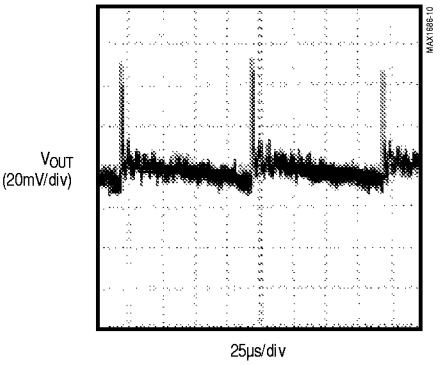
5V MODE, AC COUPLED,
C_{OUT} = 10µF || 0.1µF

3V to 5V Regulating Charge Pumps for SIM Cards

Typical Operating Characteristics (continued)

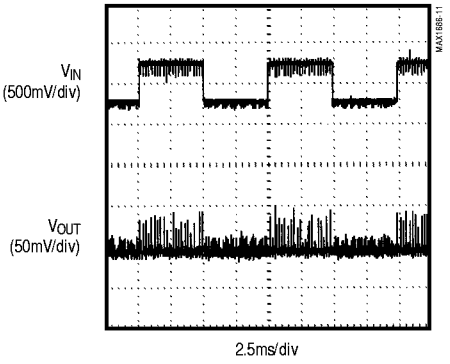
(See *Typical Operating Circuit*, C_{IN} = 0.47µF, C_X = 0.22µF, C_{OUT} = 10µF, V_{IN} = 3.3V, T_A = +25°C, unless otherwise noted.)

OUTPUT WAVEFORM
(I_{LOAD} = 1mA)



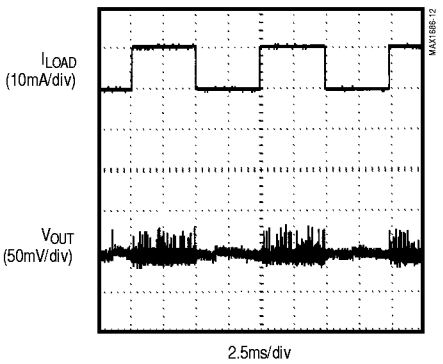
5V MODE, AC COUPLED,
C_{OUT} = 10µF || 0.1µF

LINE-TRANSIENT RESPONSE



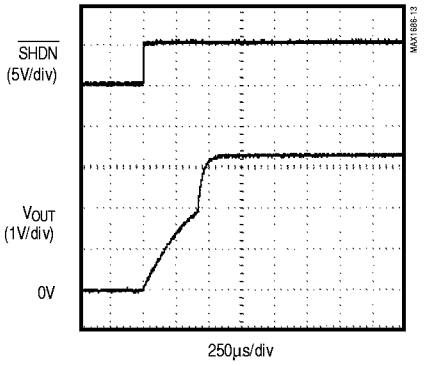
V_{IN} = 2.8V to 3.3V, I_{LOAD} = 10mA, 5V MODE,
AC COUPLED

LOAD-TRANSIENT RESPONSE

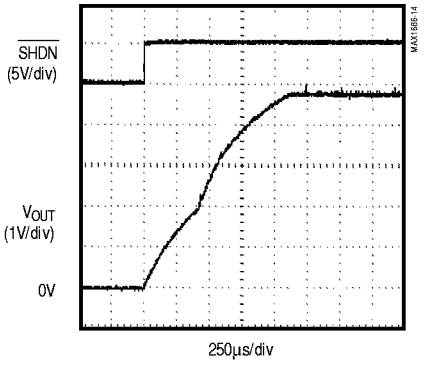


I_{LOAD} = 0 TO 10mA, 5V MODE, AC COUPLED

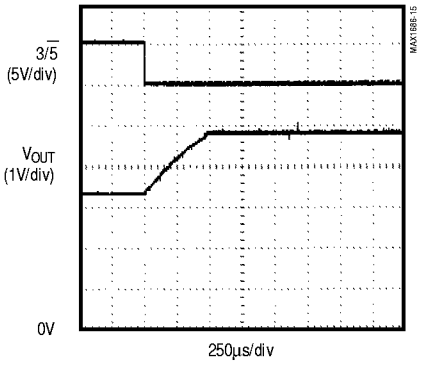
START-UP WAVEFORM
(3V MODE, R_L = 500Ω)



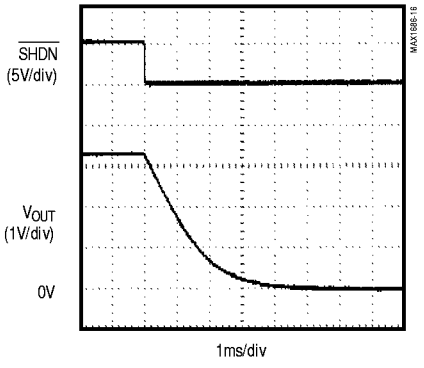
START-UP WAVEFORM
(5V MODE, R_L = 500Ω)



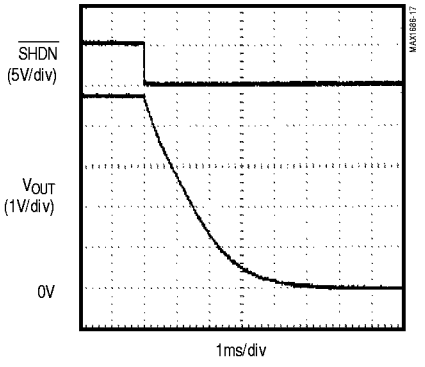
3V MODE TO 5V MODE
WAVEFORM (R_L = 500Ω)

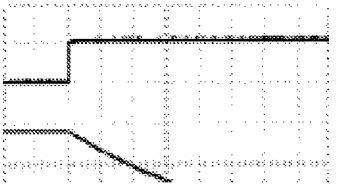


SHUTDOWN WAVEFORM
(3V MODE, NO LOAD)



SHUTDOWN WAVEFORM
(5V MODE, NO LOAD)





R_L = 500Ω