MCP1603

2.0 MHz, 500 mA Synchronous Buck Regulator

Features

- Over 90% Typical Efficiency
- Output Current Up To 500 mA
- Low Quiescent Current = 45 µA, typical
- Low Shutdown Current = 0.1 µA, typical
- Adjustable Output Voltage:
  - 0.8V to 4.5V
- Fixed Output Voltage:
  - 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V
- 2.0 MHz Fixed-Frequency PWM (Heavy Load)
- Automatic PWM to PFM Mode Transition
- 100% Duty Cycle Operation
- Internally Compensated
- Undervoltage Lockout (UVLO)
- Overtemperature Protection
- Space Saving Packages:
  - 5-Lead TSOT
  - 8-Lead 2X3 DFN

Applications

- Cellular Telephones
- Portable Computers
- Organizers / PDAs
- USB Powered Devices
- Digital Cameras
- Portable Equipment
- +5V or +3.3V Distributed Systems

General Description

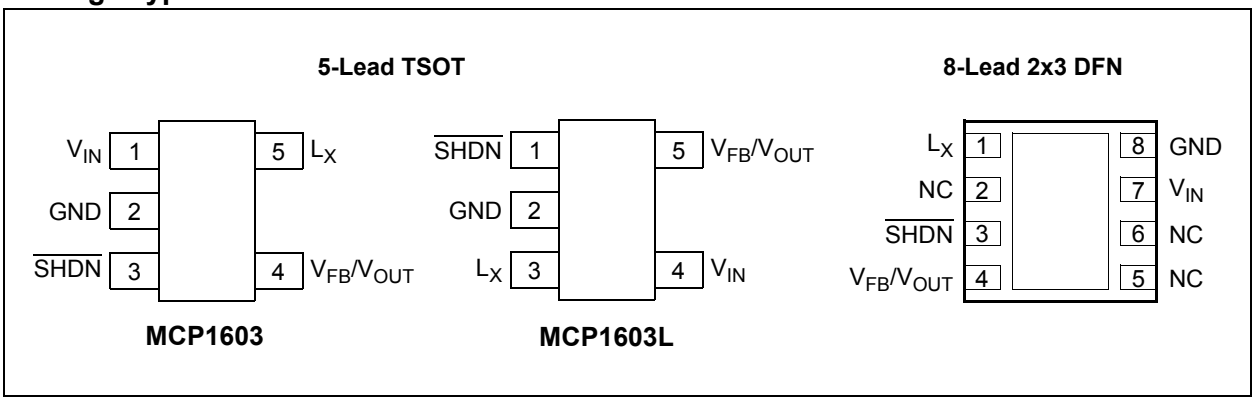
The MCP1603 is a high efficient, fully integrated 500 mA synchronous buck regulator whose 2.7V to 5.5V input voltage range makes it ideally suited for applications powered from 1-cell Li-Ion or 2-cell/3-cell NiMH/NiCd batteries.

At heavy loads, the MCP1603 operates in the 2.0 MHz fixed frequency PWM mode which provides a low noise, low output ripple, small-size solution. When the load is reduced to light levels, the MCP1603 automatically changes operation to a PFM mode to minimize quiescent current draw from the battery. No intervention is necessary for a smooth transition from one mode to another. These two modes of operation allow the MCP1603 to achieve the highest efficiency over the entire operating current range.

The MCP1603 is available with either an adjustable or fixed output voltage. The available fixed output voltage options are 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V. When a fixed option is used, only three additional small external components are needed to form a complete solution. Couple this with the low profile, small-foot print packages and the entire system solution is achieved with minimal size.

Additional protection features include: UVLO, overtemperature, and overcurrent protection.

Package Types



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V_{IN} - GND.....+6.0V
All Other I/O .....(GND - 0.3V) to (V_{IN} + 0.3V)
L_X to GND ..... -0.3V to (V_{IN} + 0.3V)
Output Short Circuit Current.....Continuous
Power Dissipation **(Note 5)**.....Internally Limited
Storage Temperature.....-65°C to +150°C
Ambient Temp. with Power Applied.....-40°C to +85°C
Operating Junction Temperature.....-40°C to +125°C
ESD Protection On All Pins:
HBM.....4 kV
MM.....300V

† **Notice:** Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{IN} = $\overline{SHDN}$ = 3.6V, C_{OUT} = C_{IN} = 4.7 µF, L = 4.7 µH, V_{OUT}(ADJ) = 1.8V, I_{OUT} = 100 mA, T_A = +25°C. **Boldface** specifications apply over the T_A range of -40°C to +85°C.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input Characteristics						
Input Voltage	V_{IN}	**2.7**	—	**5.5**	V	**Note 1**
Maximum Output Current	I_{OUT}	**500**	—	—	mA	**Note 1**
Shutdown Current	$I_{IN\_\overline{SHDN}}$	—	0.1	1	µA	$\overline{SHDN}$ = GND
Quiescent Current	I_Q	—	45	**60**	µA	$\overline{SHDN}$ = V_{IN}, I_{OUT} = 0 mA
Shutdown/UVLO/Thermal Shutdown Characteristics						
$\overline{SHDN}$, Logic Input Voltage Low	V_{IL}	—	—	**15**	%V_{IN}	V_{IN} = 2.7V to 5.5V
$\overline{SHDN}$, Logic Input Voltage High	V_{IH}	**45**	—	—	%V_{IN}	V_{IN} = 2.7V to 5.5V
$\overline{SHDN}$, Input Leakage Current	$I_{L\_\overline{SHDN}}$	**-1.0**	±0.1	**1.0**	µA	V_{IN} = 2.7V to 5.5V
Undervoltage Lockout	UVLO	**2.12**	2.28	**2.43**	V	V_{IN} Falling
Undervoltage Lockout Hysteresis	$UVLO_{HYS}$	—	140	—	mV	
Thermal Shutdown	T_{SHD}	—	150	—	°C	**Note 4**, **Note 5**
Thermal Shutdown Hysteresis	$T_{SHD-HYS}$	—	10	—	°C	**Note 4**, **Note 5**

Note 1: The minimum V_{IN} has to meet two conditions: $V_{IN} \geq 2.7V$ and $V_{IN} \geq V_{OUT}$ + 0.5V.

2: Reference Feedback Voltage Tolerance applies to adjustable output voltage setting.

3: V_R is the output voltage setting.

4: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable temperature and the thermal resistance from junction to air (i.e. T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown.

5: The internal MOSFET switches have an integral diode from the L_X pin to the V_{IN} pin, and from the L_X pin to the GND pin. In cases where these diodes are forward-biased, the package power dissipation limits must be adhered to. Thermal protection is not able to limit the junction temperature for these cases.

6: The current limit threshold is a cycle-by-cycle peak current limit.

DC CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = $\overline{SHDN}$ = 3.6V, C_{OUT} = C_{IN} = 4.7 µF, L = 4.7 µH, V_{OUT}(ADJ) = 1.8V, I_{OUT} = 100 mA, T_A = +25°C. **Boldface** specifications apply over the T_A range of -40°C to +85°C.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Output Characteristics						
Adjustable Output Voltage Range	V_{OUT}	**0.8**	—	**4.5**	V	**Note 2**
Reference Feedback Voltage	V_{FB}	—	0.8	—	V	
Reference Feedback Voltage Tolerance		-3.0	—	+3.0	%	T_A = -40°C to +25°C
		-2.5	—	+2.5	%	T_A = +25°C to +85°C
Feedback Input Bias Current	I_{VFB}	—	0.1	—	nA	
Output Voltage Tolerance Fixed	V_{OUT}	-3.0%	V_R	+3.0%	%	T_A = -40°C to +25°C, **Note 3**
	V_{OUT}	-2.5	V_R	+2.5	%	T_A = +25°C to +85°C, **Note 3**
Line Regulation	$V_{LINE-REG}$	—	0.3	—	%/V	V_{IN} = V_R + 1V to 5.5V, I_{OUT} = 100 mA
Load Regulation	$V_{LOAD-REG}$	—	0.35	—	%	V_{IN} = V_R +1.5V, I_{LOAD} = 100 mA to 500 mA
Internal Oscillator Frequency	F_{OSC}	**1.5**	2.0	**2.8**	MHz	
Start Up Time	T_{SS}	—	0.6	—	ms	T_R = 10% to 90%
R_{DSon} P-Channel	R_{DSon-P}	—	500	—	mΩ	I_P = 100 mA
R_{DSon} N-Channel	R_{DSon-N}	—	500	—	mΩ	I_N = 100 mA
L_X Pin Leakage Current	I_{LX}	**-1.0**	±0.1	**1.0**	µA	$\overline{SHDN}$ = 0V, V_{IN} = 5.5V, L_X = 0V, L_X = 5.5V
Positive Current Limit Threshold	$+I_{LX(MAX)}$	—	860	—	mA	**Note 6**

Note 1: The minimum V_{IN} has to meet two conditions: $V_{IN} \geq 2.7V$ and $V_{IN} \geq V_{OUT}$ + 0.5V.

2: Reference Feedback Voltage Tolerance applies to adjustable output voltage setting.

3: V_R is the output voltage setting.

4: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable temperature and the thermal resistance from junction to air (i.e. T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown.

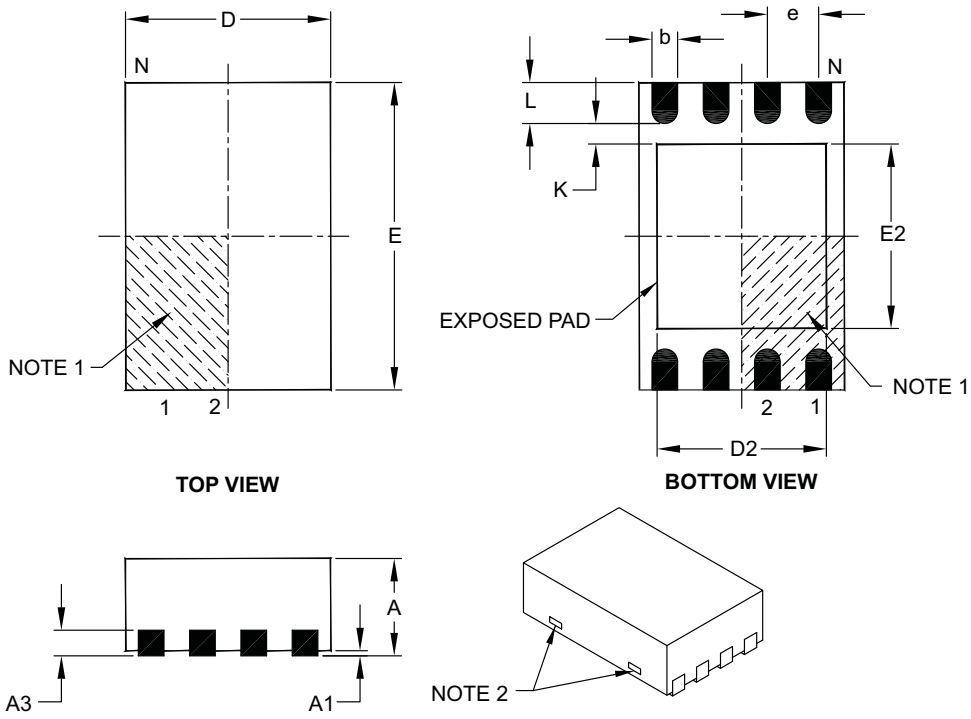
5: The internal MOSFET switches have an integral diode from the L_X pin to the V_{IN} pin, and from the L_X pin to the GND pin. In cases where these diodes are forward-biased, the package power dissipation limits must be adhered to. Thermal protection is not able to limit the junction temperature for these cases.

6: The current limit threshold is a cycle-by-cycle peak current limit.

TEMPERATURE SPECIFICATIONS

Electrical Specifications: Unless otherwise indicated, all limits are specified for: V_{IN} + 2.7V to 5.5V						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Temperature Ranges						
Operating Junction Temperature Range	T_J	-40	—	+125	°C	Steady State
Storage Temperature Range	T_A	-65	—	+150	°C	
Maximum Junction Temperature	T_J	—	—	+150	°C	Transient
Package Thermal Resistances						
Thermal Resistance, 5L-TSOT	θ_{JA}	—	256	—	°C/W	Typical 4-layer Board with Internal Ground Plane
Thermal Resistance, 8L-2x3 DFN	θ_{JA}	—	84.5	—	°C/W	Typical 4-layer Board with Internal Ground Plane and 2-Vias in Thermal Pad

8-Lead Plastic Dual Flat, No Lead Package (MC) – 2x3x0.9 mm Body [DFN]



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.50 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.20 REF	
Overall Length	D		2.00 BSC	
Overall Width	E		3.00 BSC	
Exposed Pad Length	D2	1.30	–	1.75
Exposed Pad Width	E2	1.50	–	1.90
Contact Width	b	0.18	0.25	0.30
Contact Length	L	0.30	0.40	0.50
Contact-to-Exposed Pad	K	0.20	–	–

Notes:

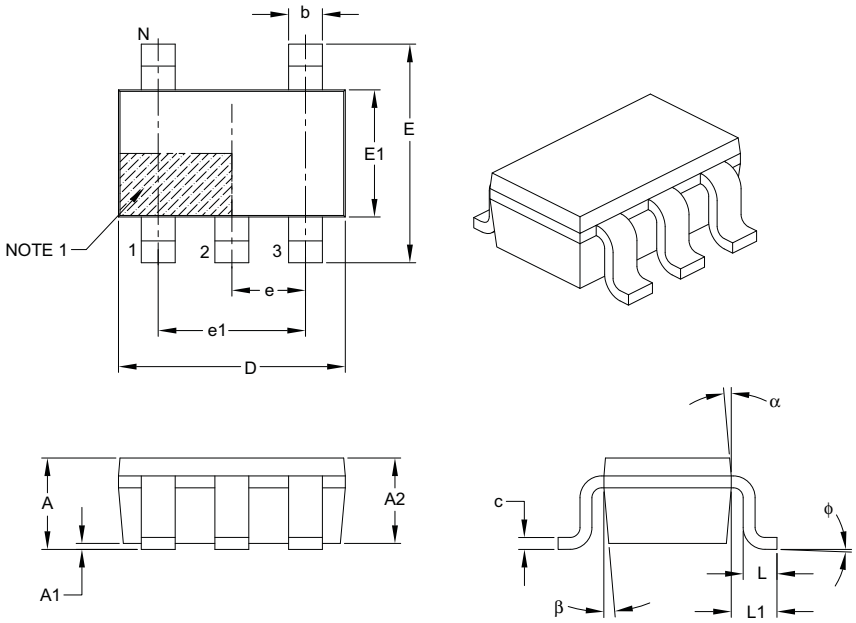
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package may have one or more exposed tie bars at ends.
3. Package is saw singulated.
4. Dimensioning and tolerancing per ASME Y14.5M.

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-123B

5-Lead Plastic Thin Small Outline Transistor (OS) [TSOT]



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Leads	N		5	
Lead Pitch	e		0.95 BSC	
Outside Lead Pitch	e1		1.90 BSC	
Overall Height	A	–	–	1.10
Molded Package Thickness	A2	0.70	0.90	1.00
Standoff	A1	0.00	–	0.10
Overall Width	E		2.80 BSC	
Molded Package Width	E1		1.60 BSC	
Overall Length	D		2.90 BSC	
Foot Length	L	0.30	0.45	0.60
Footprint	L1		0.60 REF	
Foot Angle	ϕ	0°	4°	8°
Lead Thickness	c	0.08	–	0.20
Lead Width	b	0.30	–	0.50
Mold Draft Angle Top	α	4°	10°	12°
Mold Draft Angle Bottom	β	4°	10°	12°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-128B

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X	X	XXX	X	/	XX
Device	TSOT Config.	Tape and Reel	Voltage Option	Temp.		Package

Device:	MCP1603: 2.0 MHz, 500 mA Buck Regulator
TSOT Pin Config. Designator *	Blank = Standard pinout L = Alternate pinout * Refer to Package Types for an explanation regarding the function of the device pins.
Tape and Reel:	T = Tape and Reel Blank = Tube
Voltage Option:	ADJ = Adjustable 120 = 1.20V “Standard” 150 = 1.50V “Standard” 180 = 1.80V “Standard” 250 = 2.50V “Standard” 330 = 3.30V “Standard”
Temperature:	I = -40°C to +85°C
Package Type:	MC = Plastic Dual-Flat No-Lead Package (MC), 8-Lead OS = Plastic Thin Small Outline Transistor (OS), 5-Lead

Examples:

8-Lead DFN:

a) MCP1603-120I/MC: 1.20V Buck Reg., 8LD-DFN pkg.

b) MCP1603-150I/MC: 1.50V Buck Reg., 8LD-DFN pkg.

c) MCP1603-180I/MC: 1.80V Buck Reg., 8LD-DFN pkg.

d) MCP1603-250I/MC: 2.50V Buck Reg., 8LD-DFN pkg.

e) MCP1603-330I/MC: 3.30V Buck Reg., 8LD-DFN pkg.

5-Lead TSOT:

a) MCP1603T-120I/OS: 1.20V Buck Reg., 5LD-TSOT pkg.

b) MCP1603T-180I/OS: 1.80V Buck Reg., 5LD-TSOT pkg.

c) MCP1603T-250I/OS: 2.50V Buck Reg., 5LD-TSOT pkg.

d) MCP1603T-330I/OS: 3.30V Buck Reg., 5LD-TSOT pkg.

e) MCP1603T-ADJI/OS: Adj. Buck Reg., 5LD-TSOT pkg.

f) MCP1603LT-250I/OS: 2.50V Buck Reg., 5LD-TSOT pkg.

g) MCP1603LT-ADJI/OS: Adj. Buck Reg., 5LD-TSOT pkg.