

## 2.0 MHz, 500 mA Synchronous Buck Regulator

### Features

- Over 90% Typical Efficiency
- Output Current Up To 500 mA
- Low Quiescent Current = 45  $\mu$ A, typical
- Low Shutdown Current = 0.1  $\mu$ A, 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

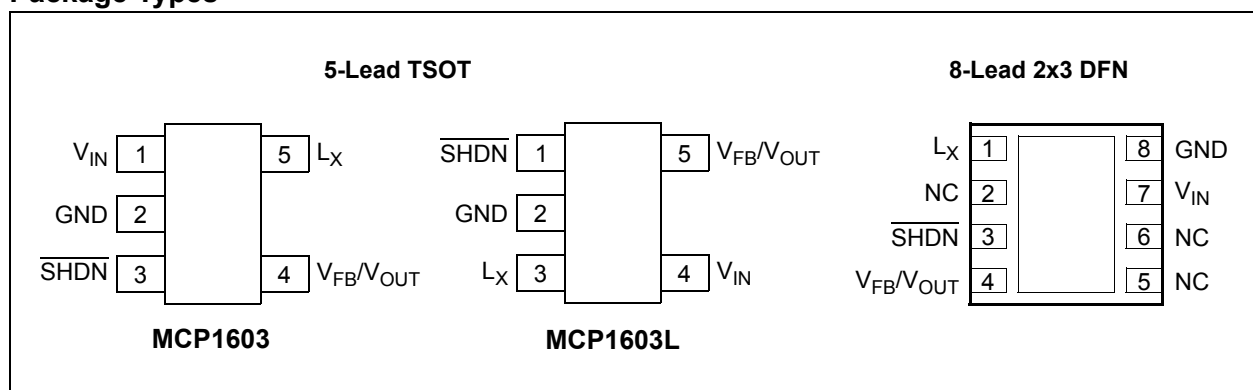
The MCP1603 is a high efficient, fully integrated 500 mA synchronous buck regulator whose 2.7V to 5.5V input voltage range makes it ideally suited for applications powered from 1-cell Li-Ion or 2-cell/3-cell NiMH/NiCd batteries.

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



# MCP1603

## 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 ( <b>Note 5</b> ) .....	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,  $V_{IN} = \overline{SHDN} = 3.6V$ ,  $C_{OUT} = C_{IN} = 4.7 \mu F$ ,  $L = 4.7 \mu H$ ,  $V_{OUT(ADJ)} = 1.8V$ ,  $I_{OUT} = 100 mA$ ,  $T_A = +25^\circ C$ . **Boldface** specifications apply over the  $T_A$  range of -40°C to +85°C.

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

- 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.  $T_A$ ,  $T_J$ ,  $\theta_{JA}$ ). 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)

<b>Electrical Characteristics:</b> Unless otherwise indicated, $V_{IN} = \overline{\text{SHDN}} = 3.6\text{V}$ , $C_{OUT} = C_{IN} = 4.7\ \mu\text{F}$ , $L = 4.7\ \mu\text{H}$ , $V_{OUT}(\text{ADJ}) = 1.8\text{V}$ , $I_{OUT} = 100\ \text{mA}$ , $T_A = +25^\circ\text{C}$ . <b>Boldface</b> specifications apply over the $T_A$ range of $-40^\circ\text{C}$ to $+85^\circ\text{C}$ .						
Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Output Characteristics</b>						
Adjustable Output Voltage Range	$V_{OUT}$	<b>0.8</b>	—	<b>4.5</b>	V	<b>Note 2</b>
Reference Feedback Voltage	$V_{FB}$	—	0.8	—	V	
Reference Feedback Voltage Tolerance		-3.0	—	+3.0	%	$T_A = -40^\circ\text{C}$ to $+25^\circ\text{C}$
		-2.5	—	+2.5	%	$T_A = +25^\circ\text{C}$ to $+85^\circ\text{C}$
Feedback Input Bias Current	$I_{VFB}$	—	0.1	—	nA	
Output Voltage Tolerance Fixed	$V_{OUT}$	-3.0%	$V_R$	+3.0%	%	$T_A = -40^\circ\text{C}$ to $+25^\circ\text{C}$ , <b>Note 3</b>
	$V_{OUT}$	-2.5	$V_R$	+2.5	%	$T_A = +25^\circ\text{C}$ to $+85^\circ\text{C}$ , <b>Note 3</b>
Line Regulation	$V_{LINE-REG}$	—	0.3	—	%/V	$V_{IN} = V_R + 1\text{V}$ to $5.5\text{V}$ , $I_{OUT} = 100\ \text{mA}$
Load Regulation	$V_{LOAD-REG}$	—	0.35	—	%	$V_{IN} = V_R + 1.5\text{V}$ , $I_{LOAD} = 100\ \text{mA}$ to $500\ \text{mA}$
Internal Oscillator Frequency	$F_{OSC}$	<b>1.5</b>	2.0	<b>2.8</b>	MHz	
Start Up Time	$T_{SS}$	—	0.6	—	ms	$T_R = 10\%$ to $90\%$
$R_{DSon}$ P-Channel	$R_{DSon-P}$	—	500	—	$\text{m}\Omega$	$I_P = 100\ \text{mA}$
$R_{DSon}$ N-Channel	$R_{DSon-N}$	—	500	—	$\text{m}\Omega$	$I_N = 100\ \text{mA}$
$L_X$ Pin Leakage Current	$I_{LX}$	<b>-1.0</b>	$\pm 0.1$	<b>1.0</b>	$\mu\text{A}$	$\overline{\text{SHDN}} = 0\text{V}$ , $V_{IN} = 5.5\text{V}$ , $L_X = 0\text{V}$ , $L_X = 5.5\text{V}$
Positive Current Limit Threshold	$+I_{LX(\text{MAX})}$	—	860	—	mA	<b>Note 6</b>

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

**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.  $T_A$ ,  $T_J$ ,  $\theta_{JA}$ ). 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.

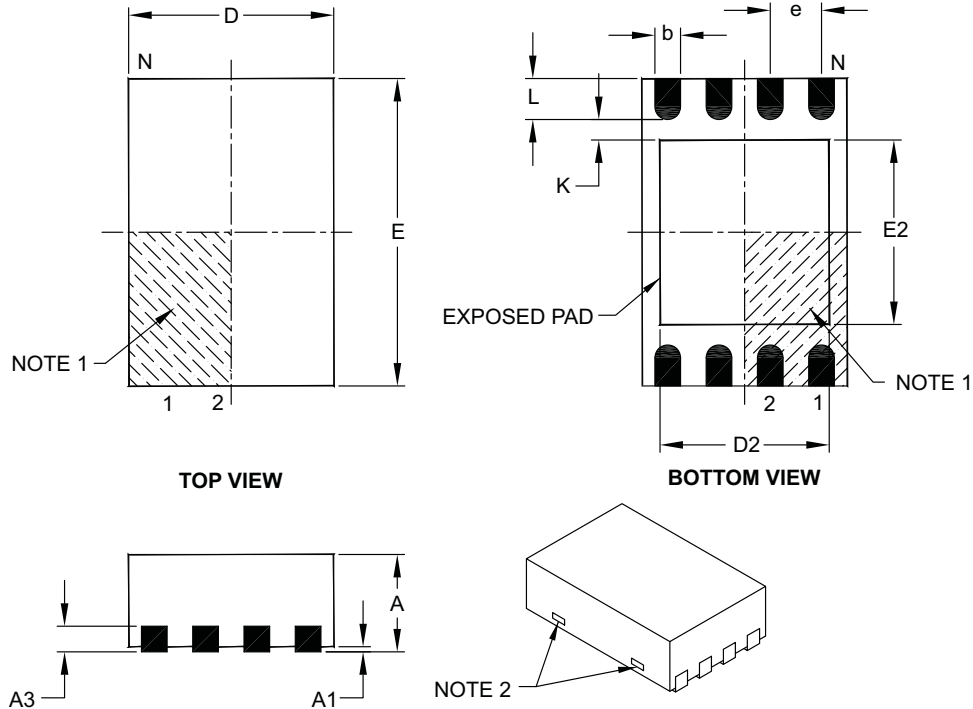
**6:** The current limit threshold is a cycle-by-cycle peak current limit.

# MCP1603

## 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
<b>Temperature Ranges</b>						
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
<b>Package Thermal Resistances</b>						
Thermal Resistance, 5L-TSOT	$\theta_{JA}$	—	256	—	°C/W	Typical 4-layer Board with Internal Ground Plane
Thermal Resistance, 8L-2x3 DFN	$\theta_{JA}$	—	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]



Dimension Limits	Units	MILLIMETERS		
		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:

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

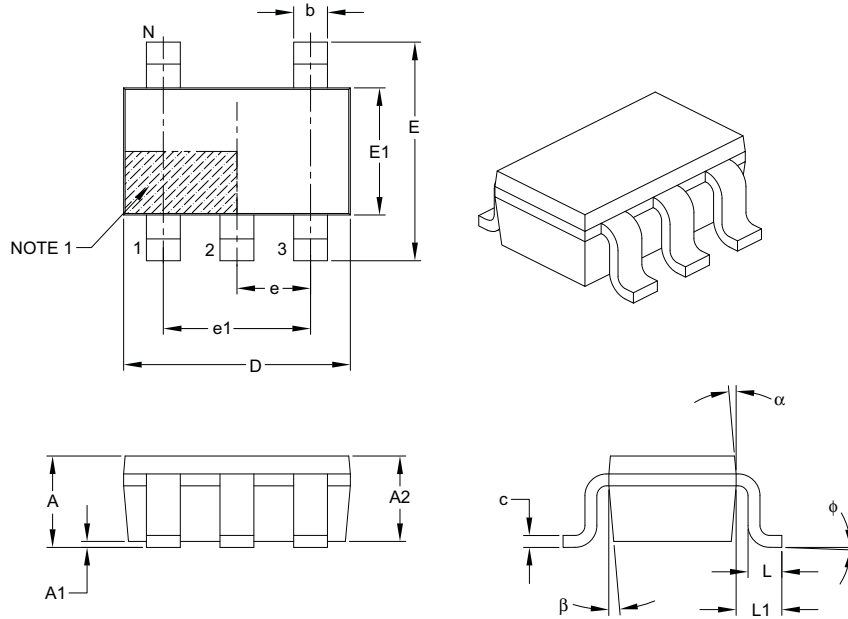
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-123B

# MCP1603

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



Dimension Limits	Units	MILLIMETERS		
		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	$\phi$	0°	4°	8°
Lead Thickness	c	0.08	—	0.20
Lead Width	b	0.30	—	0.50
Mold Draft Angle Top	$\alpha$	4°	10°	12°
Mold Draft Angle Bottom	$\beta$	4°	10°	12°

### Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
- 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.

<u>PART NO.</u>	X	X	XXX	X	/	XX
Device	TSOT Config.	Tape and Reel	Voltage Option	Temp.	Package	
<p>Device: MCP1603: 2.0 MHz, 500 mA Buck Regulator</p> <p>TSOT Pin Config. Designator * Blank = Standard pinout L = Alternate pinout * Refer to Package Types for an explanation regarding the function of the device pins.</p> <p>Tape and Reel: T = Tape and Reel Blank = Tube</p> <p>Voltage Option: ADJ = Adjustable 120 = 1.20V "Standard" 150 = 1.50V "Standard" 180 = 1.80V "Standard" 250 = 2.50V "Standard" 330 = 3.30V "Standard"</p> <p>Temperature: I = -40°C to +85°C</p> <p>Package Type: MC = Plastic Dual-Flat No-Lead Package (MC), 8-Lead OS = Plastic Thin Small Outline Transistor (OS), 5-Lead</p>	<p><b>Examples:</b></p> <p><b>8-Lead DFN:</b></p> <p>a) MCP1603-120I/MC: 1.20V Buck Reg., 8LD-DFN pkg.</p> <p>b) MCP1603-150I/MC: 1.50V Buck Reg., 8LD-DFN pkg.</p> <p>c) MCP1603-180I/MC: 1.80V Buck Reg., 8LD-DFN pkg.</p> <p>d) MCP1603-250I/MC: 2.50V Buck Reg., 8LD-DFN pkg.</p> <p>e) MCP1603-330I/MC: 3.30V Buck Reg., 8LD-DFN pkg.</p> <p><b>5-Lead TSOT:</b></p> <p>a) MCP1603T-120I/OS: 1.20V Buck Reg., 5LD-TSOT pkg.</p> <p>b) MCP1603T-180I/OS: 1.80V Buck Reg., 5LD-TSOT pkg.</p> <p>c) MCP1603T-250I/OS: 2.50V Buck Reg., 5LD-TSOT pkg.</p> <p>d) MCP1603T-330I/OS: 3.30V Buck Reg., 5LD-TSOT pkg.</p> <p>e) MCP1603T-ADJI/OS: Adj. Buck Reg., 5LD-TSOT pkg.</p> <p>f) MCP1603LT-250I/OS: 2.50V Buck Reg., 5LD-TSOT pkg.</p> <p>g) MCP1603LT-ADJI/OS: Adj. Buck Reg., 5LD-TSOT pkg.</p>					