

500 mA Synchronous BUCK Regulator

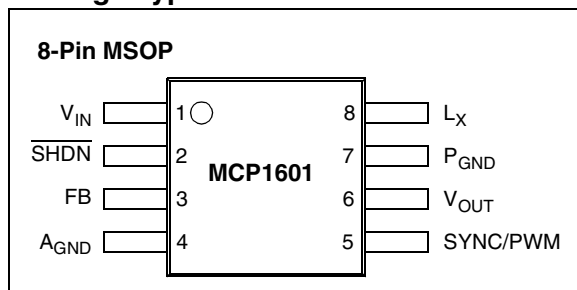
Features

- Input Range of 2.7V to 5.5V
- 3 Operating Modes: PWM, PFM and LDO
- Integrated BUCK and Synchronous Switches
- Ceramic or Electrolytic Input/Output Filtering Capacitors
- 750 kHz Fixed Switching Frequency
- Oscillator Synchronization to 1 MHz PWM Mode
- Auto-Switching from PWM/PFM Operation
- 100% Duty Cycle Capable for Low Input Voltage
- 500 mA Continuous Output Current Capability
- Integrated Under-Voltage Lock-Out Protection
- Integrated Over-Temperature Protection
- Integrated Soft Start Circuitry
- Low Output Voltage Capability to 0.9V
- Temperature Range: -40°C to +85°C
- Small 8-Pin MSOP Package

Applications

- Low Power Handheld CPUs and DSPs
- Cellular Phones
- Organizers and PDAs
- Digital Cameras
- +5V or +3.3V Distributed Voltages
- USB Powered Devices

Package Type



Description

The MCP1601 is a fully integrated synchronous BUCK (step down) DC/DC converter for battery powered systems. With an input operating range of 2.7V to 5.5V, the MCP1601 is ideal for applications being powered by one single cell Li-Ion, 2 to 3 cell NiMH, NiCd or alkaline sources. Output voltages can range from 0.9V to V_{IN} to accommodate a wide range of applications. Efficiency can exceed 92% while operating at 750 kHz with load current capability up to 500 mA. The MCP1601 is used to minimize space, cost and wasted energy.

The PWM mode switching frequency is internally set to a fixed 750 kHz allowing the use of low profile, surface mount inductors and ceramic capacitors while maintaining a typical efficiency of 92%.

The MCP1601 is capable of three distinct operating modes: PWM, PFM and Low Drop Out.

When operating in PWM (pulse width modulation) mode, the DC/DC converter switches at a single high frequency determined by either the internal 750 kHz oscillator or external synchronization frequency.

For applications that operate at very light to no load for extended periods of time, the MCP1601 is capable of operating in PFM (pulse frequency modulation mode) to reduce the number of switching cycles/sec and consume less energy.

The third mode of operation (LDO mode) occurs when the input voltage approaches the output voltage and the BUCK duty cycle approaches 100%. The MCP1601 will enter a low drop out mode and the high-side P-Channel BUCK switch will saturate, providing the output with the maximum voltage possible.

The MCP1601 has integrated over-current protection, over-temperature protection and UVLO (Under Voltage Lockout) to provide for a fail safe solution with no external components.

The MCP1601 is available in the 8-pin MSOP package, with an operating temperature range of -40°C to +85°C.

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

$V_{IN} - A_{GND}$	6.0V
SHDN, FB, SYNC/PWM, V_{OUT} ($A_{GND}-0.3V$) to ($V_{IN}+0.3V$)	
L_X to P_{GND}	-0.3V to ($V_{IN}+0.3V$)
P_{GND} to A_{GND}	-0.3V to +0.3V
Output Short Circuit Current.....	continuous
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.....	≥ 4 kV

† **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 listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

PIN FUNCTION TABLE

NAME	FUNCTION
V_{IN}	Input Source Voltage
SHDN	Device Shutdown Pin
FB	Output Voltage Feedback Input
A_{GND}	Analog Ground
V_{OUT}	Sensed Output Voltage
SYNC/PWM	Synchronous Clock input or PWM/PFM select
P_{GND}	Power Ground
L_X	Output Inductor Node

ELECTRICAL SPECIFICATIONS

Electrical Specifications: Unless otherwise indicated, $V_{IN}=4.2V$, $V_{OUT}=1.8V$, $I_{LOAD} = 10\text{ mA}$, $T_A=-40^\circ\text{C}$ to $+85^\circ\text{C}$.						
Parameters	Sym	Min	Typ	Max	Units	Conditions
Power Input Requirements						
Voltage	V_{IN}	2.7	—	5.5	V	$I_{LOAD} = 0\text{ mA}$ to 500 mA
Shutdown Current	$I(V_{IN})$	—	0.05	1.0	μA	Shutdown Mode ($\overline{\text{SHDN}} = \text{GND}$)
PFM Mode Current	$I(V_{IN})$	—	119	180	μA	SYNC/PWM = GND, PFM Mode ($I_{LOAD} = 0\text{ mA}$)
Oscillator Section						
Internal Oscillator Frequency	F_{OSC}	650	750	850	kHz	SYNC/PWM = V_{IN}
External Oscillator Capture Range	F_{SYNC}	850	—	1000	kHz	$F_{SYNC} > F_{OSC}$
External Oscillator Duty Cycle	$F_{SYN-FALL}$	10	—	90	%	$F_{SYNC} = 1\text{ MHz}$
Internal Power Switches						
R_{DSon} P-CHANNEL	R_{DSon-P}	—	500	—	mΩ	$I_P=100\text{ mA}$, $T_A=+25^\circ\text{C}$, $V_{IN}=4.2V$
R_{DSon} N-CHANNEL	R_{DSon-N}	—	500	—	mΩ	$I_N=100\text{ mA}$, $T_A=+25^\circ\text{C}$, $V_{IN}=4.2V$
Dropout Voltage	$V_{DROPOUT}$	—	250	—	mV	$V_{OUT} = 2.7V$, $I_{LOAD} = 300\text{ mA}$, $T_A=+25^\circ\text{C}$, $V_{DROPOUT}=97\%V_{OUT}$
Pin Leakage Current	I_{LX}	-1.0	—	1.0	μA	$\overline{\text{SHDN}} = 0V$, $V_{IN} = 5.5V$, $L_X = 0V$, $L_X = 5.5V$
Output PWM Mode						
Peak Current Limit	$I_{PEAK-PWM}$	—	1.0	—	A	PWM Mode, SYNC/PWM = V_{IN} , $T_A = +25^\circ\text{C}$
Output Voltage						
Output Voltage Range	V_{OUT}	0.9	—	V_{IN}	V	
Reference Feedback Voltage	V_{FB}	0.78	0.8	0.82	V	
Feedback Input Bias Current	I_{VFB}	—	0.1	—	nA	
Line Regulation	$V_{LINE-REG}$	—	0.1	—	%/V	$V_{IN}=2.7V$ to 5.5V, $I_{LOAD}=10\text{ mA}$
Load Regulation	$V_{LOAD-REG}$	—	1.5	—	%	$V_{IN} = 3.6V$, $I_{LOAD} = 0\text{ mA}$ to 300 mA
Start-Up Time	T_{START}	—	0.5	—	ms	PWM Mode, SYNC/PWM= V_{IN}

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ELECTRICAL SPECIFICATIONS (CONTINUED)

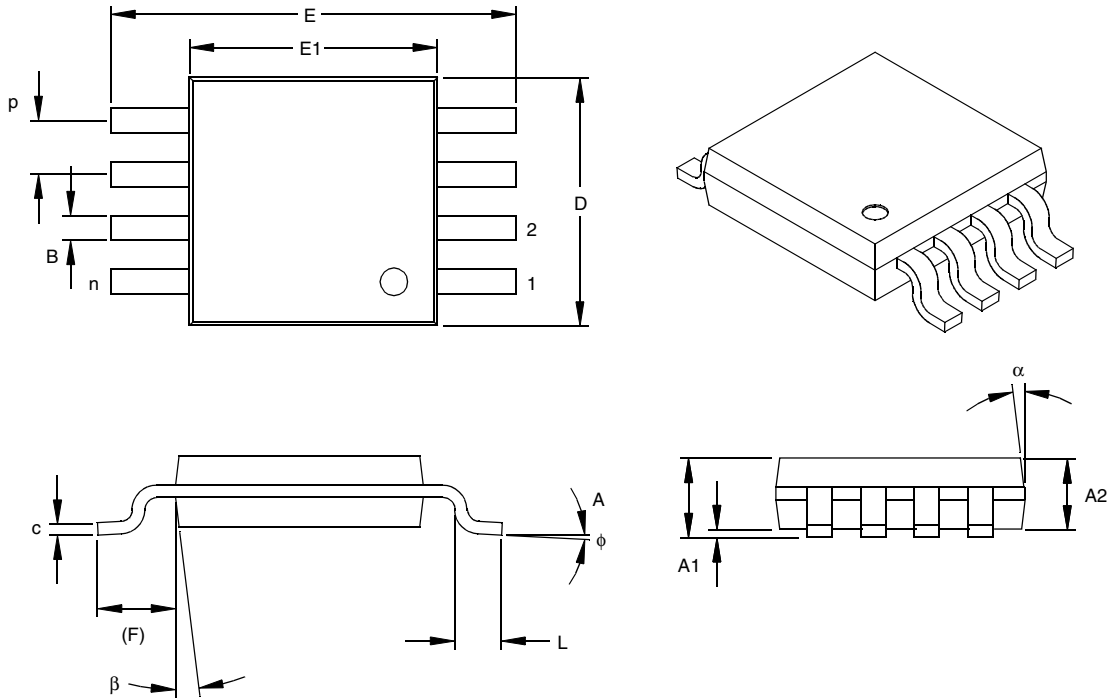
Electrical Specifications: Unless otherwise indicated, $V_{IN}=4.2V$, $V_{OUT}=1.8V$, $I_{LOAD} = 10\text{ mA}$, $T_A=-40^{\circ}C$ to $+85^{\circ}C$.						
Parameters	Sym	Min	Typ	Max	Units	Conditions
Protection Features						
Average Short Circuit Current		—	890	—	mA	$R_{LOAD} < 1\text{ ohm}$
Under-Voltage Lockout	UVLO	2.4	—	2.7	V	For V_{IN} decreasing
Under-Voltage Lockout Hysteresis	UVLO _{HYS}	—	190	—	mV	
Thermal Shutdown	T _{SHD}	—	160	—	°C	
Thermal Shutdown Hysteresis	T _{SHD-HYS}	—	10	—	°C	
Interface Signals (SHDN, SYNC/PWM)						
Logic Low Input	$V_{IN-HIGH}$	—	—	15	% of V_{IN}	
Logic High Input	$V_{IN-HIGH}$	45	—	—	% of V_{IN}	
Input Leakage Current	I_{IN-LK}	—	—	0.1	μA	

TEMPERATURE SPECIFICATIONS

Electrical Specifications: Unless otherwise noted, all parameters apply at $V_{DD} = 2.7V$ to $5.5V$						
Parameters	Symbol	Min	Typ	Max	Units	Conditions
Temperature Ranges						
Specified Temperature Range	T_A	-40	—	+85	°C	
Operating Junction Temperature Range	T_J	-40	—	+125	°C	
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 8 Pin MSOP	θ_{JA}	—	208	—	°C/W	Single-Layer SEMI G42-88 Board, Natural Convection

MCP1601

8-Lead Plastic Micro Small Outline Package (MS) (MSOP)



Units		INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8				8
Pitch	p	.026			0.65		
Overall Height	A			.044			1.18
Molded Package Thickness	A2	.030	.034	.038	0.76	0.86	0.97
Standoff §	A1	.002		.006	0.05		0.15
Overall Width	E	.184	.193	.200	4.67	4.90	5.08
Molded Package Width	E1	.114	.118	.122	2.90	3.00	3.10
Overall Length	D	.114	.118	.122	2.90	3.00	3.10
Foot Length	L	.016	.022	.028	0.40	0.55	0.70
Footprint (Reference)	F	.035	.037	.039	0.90	0.95	1.00
Foot Angle	φ	0		6	0		6
Lead Thickness	c	.004	.006	.008	0.10	0.15	0.20
Lead Width	B	.010	.012	.016	0.25	0.30	0.40
Mold Draft Angle Top	α		7			7	
Mold Draft Angle Bottom	β		7			7	

*Controlling Parameter
 § Significant Characteristic

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

Drawing No. C04-111

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	/XX
Device	Temperature Range	Package
Device:	MCP1601: 500 mA Synchronous BUCK Regulator MCP1601T: 500 mA Synchronous BUCK Regulator Tape and Reel	
Temperature Range:	I = -40°C to +85°C	
Package:	MS = Plastic Micro Small Outline (MSOP), 8-lead	

Examples:

- a) MCP1601-I/MS: 8LD MSOP package.
- b) MCP1601T-I/MS: Tape and Reel, 8LD MSOP package.