MOTOROLA

MC33468

Variable Frequency Micropower Step-up DC-DC Converter

The MC33468 is a micropower step–up switching voltage regulator, specifically designed for handheld and pager applications, to provide a regulated output voltage using a minimum of external parts. This device features a quiescent bias current of 3.0 μA typical.

The MC33468 features a highly accurate voltage reference, an error amplifier, an oscillator, a variable frequency modulation (VFM) controller, a drive pin (EXT) for an external transistor, and feedback resistors.

The Vout pin is fixed at 2V in the IC. The output of the converter with an inductor, a diode, a capacitor, a drive transistor, and feed–back resistors can have an output of 30V.

MC33468 Features:

- Low Quiescent Bias Current of 3.0 μA
- High Output Voltage Accuracy of ±2.5%
- Low Startup Voltage of 0.8 V at No Load
- Output Voltage Set With External Resistors
- Operating Temperature Range: –40°C to +85°C
- Surface Mount Package

VARIABLE FREQUENCY MICROPOWER DC–to–DC CONVERTER

SEMICONDUCTOR TECHNICAL DATA

N SUFFIX
PLASTIC PACKAGE
CASE 1212
(SOT–23–5)

ORDERING INFORMATION

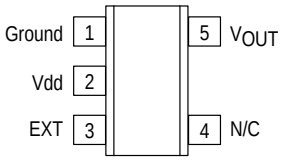
Device	Output Voltage	Marking	Reel Size	Tape Width	Quantity
MC33468SN–20ATR	2.0	0KXX*	7”	8 mm	3000

* “XX” denotes the lot number.

PIN DESCRIPTION

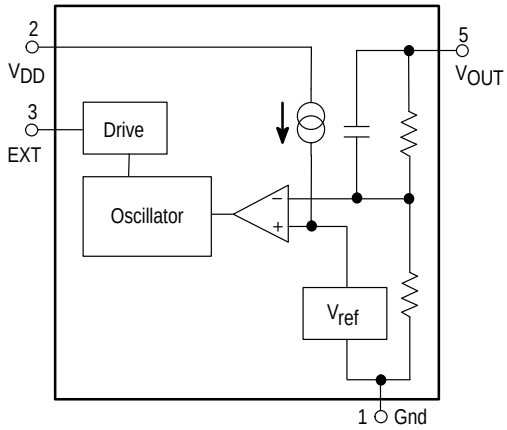
Pin No.	Symbol	Description
1	GND	Ground
2	V_{DD}	Input
3	EXT	External Transistor Drive
4	NC	No Connection
5	V_{OUT}	Voltage Output Pin (Fixed at 2V)

PIN CONNECTIONS



(Top View)

Representative Block Diagram



MAXIMUM RATINGS (T_C = 25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltage (Transient)	V_{DD}	12	V
Power Supply Voltage (Operating)	V_{DD}	10	V
External Pin Voltage	V_{EXT}	–0.3 to V_{DD} + 0.3	V
EXT Pin Source/Sink Current	I_{EXT}	50/50	mA
Power Dissipation and Thermal Characteristics N Suffix, Plastic Package Case 1212 (SOT–23–5) Maximum Power Dissipation @ T_A = 250°C Thermal Resistance, Junction–to–Air	 P_D $R_{\theta JA}$	 150 667	 mW °C/W
Operating Junction Temperature	T_J	125	°C
Operating Ambient Temperature	T_A	–40 to +85	°C
Storage Temperature Range	T_{stg}	–55 to +125	°C

ELECTRICAL CHARACTERISTICS (V_{DD} = 1.9 V, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit	Note[1]
OSCILLATOR						
Frequency	f_{osc}	–	180	–	kHz	B
Oscillator Minimum Supply Voltage (I_O = 0 mA)	V_{DD}	–	0.7	0.8	V	B
Oscillator Duty Cycle	D	65	75	–	%	B
EXT OUTPUT						
ON State Source Current (V_{EXT} = GND)	I_{source}	1.5	–	–	mA	C
OFF State Sink Current (V_{EXT} = 1.9 V)	I_{sink}	1.5	–	–	mA	D
TOTAL DEVICE						
Output Voltage	V_{OUT}	1.950	2.000	2.050	V	
Quiescent Bias Current (V_{OUT} = 1.9 V, I_O = 0 mA)	I_Q	–	15	25	µA	A
Quiescent Bias Current (V_{OUT} = 2.1 V, I_O = 0 mA)	I_Q	–	3.0	5.0	µA	A
Internal Resistor (V_{OUT} to GND)	R_{Vout}	2.0	–	–	MΩ	
Output Voltage Temperature Coefficient I_{OUT} = 10 mA, –40°C ≤ T_A ≤ 85°C	$\frac{\Delta V_{OUT}}{\Delta T_A}$	–	±50	–	ppm/oc	E

1. Indicates test circuits shown on next page.

Figure 1. Output Voltage versus Output Current

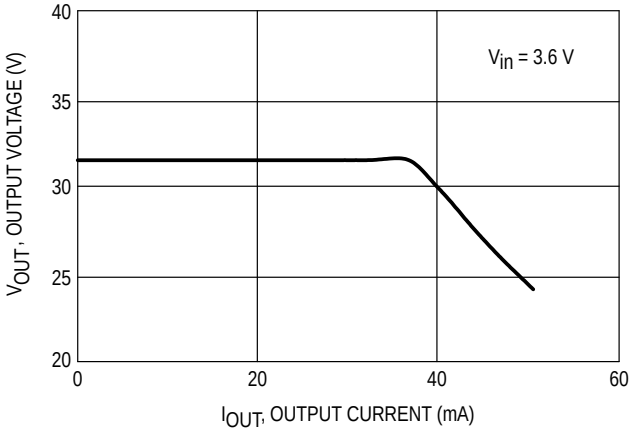
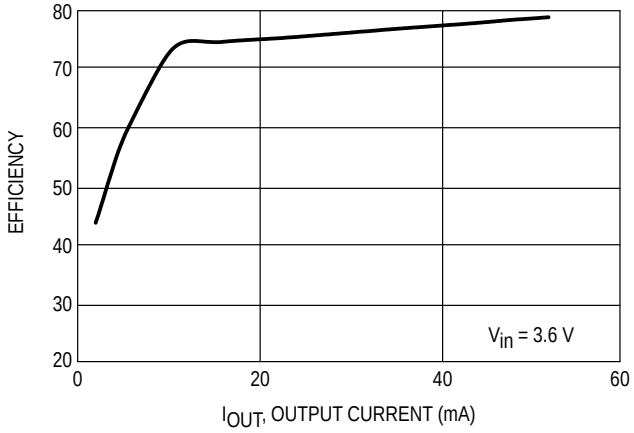


Figure 2. Efficiency versus Output Current



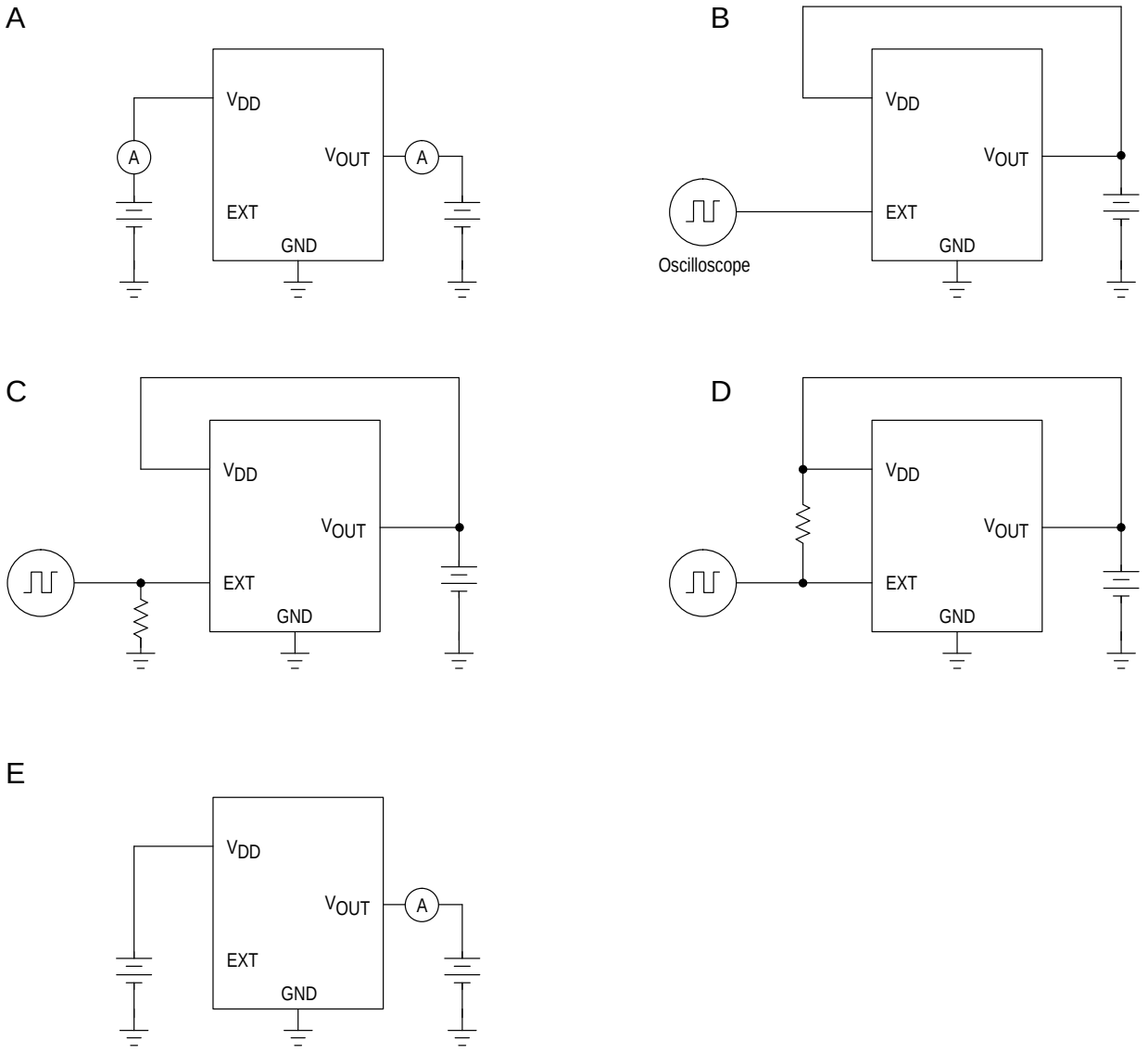


Figure 3. Test Circuit Schematics

DEFINITIONS

Quiescent Bias Current – Current which is used to operate the switching regulator chip and is not delivered to the load.

Leakage Current – Current drawn through a transistor junction, under a specified collector voltage, when the transistor is off.

FUNCTIONAL DESCRIPTION

Introduction

The MC33468 is a monolithic power switching regulator optimized for dc–to–dc converter applications where power drain must be minimized. The MC33468 uses Variable Frequency Modulation to step up the input DC voltage to a higher accurate output voltage. Potential applications include low power consumer products and battery powered portable products. Typical application circuits are shown in Figure 4.

Operating Description

The MC33468 converter operates as a fixed on–time, variable off–time voltage mode ripple regulator. Operation is intended to be in the discontinuous mode, where the inductor current ramps up to a peak value which is greater than or equal to twice the value of the dc input current during the on–time of the transistor switch. During the off–time of the transistor switch, the inductor current ramps down to zero and remains at zero until another switching cycle begins.

Since the V_{DD} pin is connected to the input no external startup circuit is needed.

Oscillator

The oscillator frequency, is internally programmed to 180 kHz. The duty ratio of the oscillator is designed for a constant value of 0.75 nominal. Hence the nominal on–time of the power switch is:

$$t_{on} = \frac{D}{f_{osc}} = \frac{0.75}{(180\ kHz)} = 4.16\ \mu s$$

Feedback Comparator

The output voltage is sensed and fed to a high speed comparator noninverting input through an internal resistive divider. The comparator inverting input is connected to an internally trimmed reference.

With a voltage mode ripple converter operating under normal conditions, output switch conduction is initiated and terminated by the oscillator, off–time is controlled by the high speed voltage feedback comparator.

Figure 4. Typical 2.0 V Application with BJT

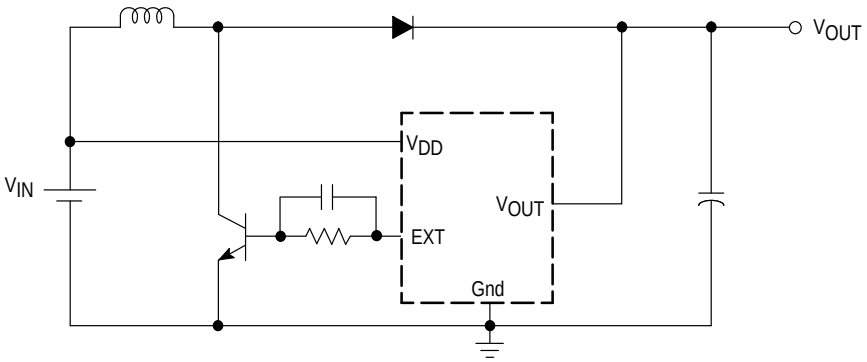


Figure 5. Design Equations for Step–Up

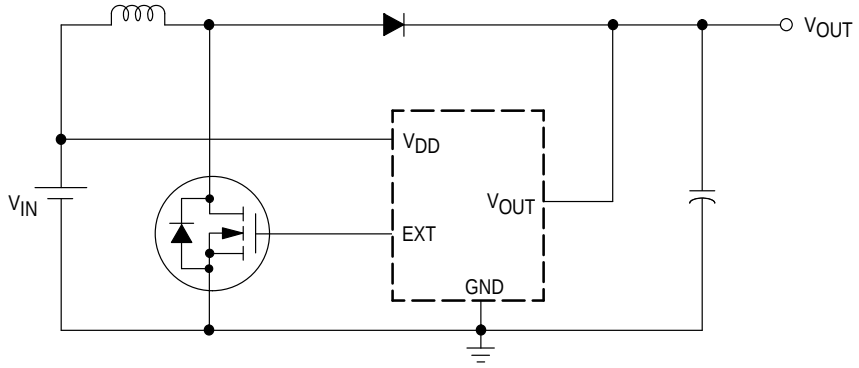
Calculation	Equation
t_{on}	$\frac{D}{f_{osc}}$
L	$< \frac{(n)(V_{in})^2(t_{on})}{P_O}$
$I_{L(avg)}$	I_{in}
$I_{L(pk)}$	$\frac{(V_{in} - V_{sat})(t_{on})}{L}$
$V_{ripple(pp)}$	$\approx \frac{(t_{on})(I_O)}{(C_O)}$

The following converter design characteristics must be chosen:

V_{in} – Nominal Operating dc input voltage
V_O – Desired dc output voltage
I_O – Desired dc output current
$V_{ripple(pp)}$ – Desired peak–to–peak output ripple voltage. For best performance the ripple voltage should be kept to a low value since it directly affects regulation. Capacitor C_O should have a low equivalent series resistance (ESR).

NOTE: 1. V_{sat} – Saturation voltage of the switching transistor.
n – Estimated circuit efficiency.

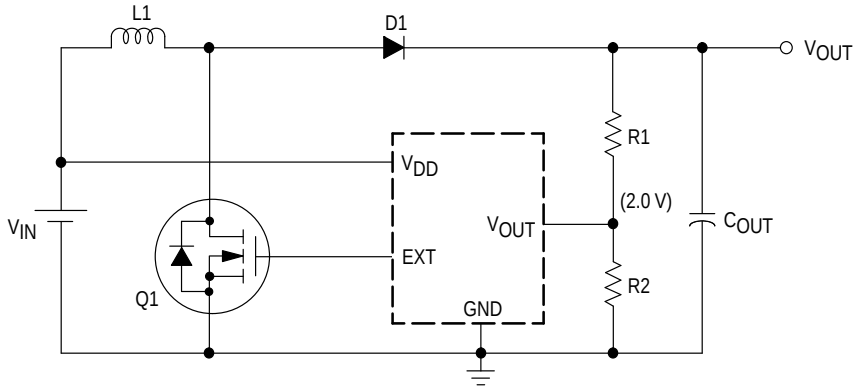
Figure 6. Typical 2.0 V Application with MOSFET



If input voltage is high enough, higher efficiency may be obtained by using a MOSFET as the switch transistor, in which no gate resistor or capacitor is needed.

MOSFET and BJT voltage rating (V_{DS} and V_{CE}) should be high enough to allow for spikes in voltage.

Figure 7. Typical Application for Output Voltages Over 2.0 V



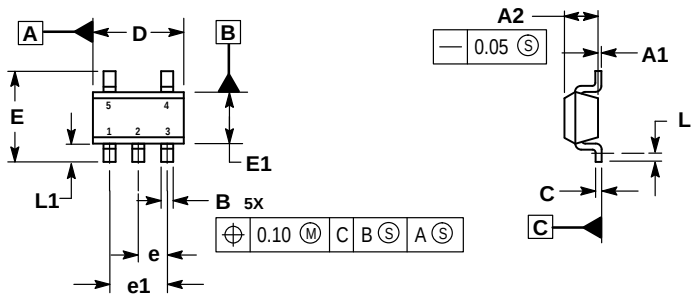
Inductor (L1)	CD54 (15 μH)
Diode (D1)	MBRD540T1
Capacitor (C_{OUT})	47 μF (Tantalum type)
Transistor (Q1)	MMFT3055VL
Resistor (R1)	150 kΩ
Resistor (R2)	10 kΩ

When choosing the output capacitor, ensure that the capacitor voltage is higher than V_{out}. Select an inductor with low DC resistance and high saturation. A Schottky diode is recommended for a lower voltage drop and faster switching.

Use external resistors that are much smaller resistance than the resistance internal to the I_C (minimum of 2 MΩ). When R1 is much less than the internal resistance, the error is minimized.

OUTLINE DIMENSIONS

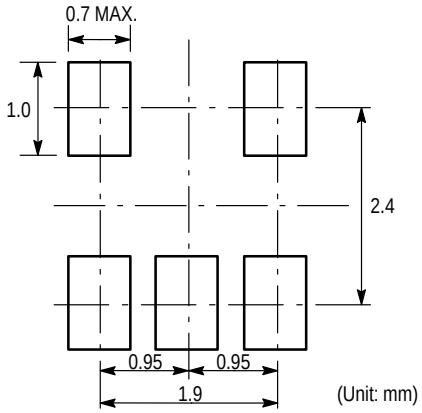
N SUFFIX
PLASTIC PACKAGE
CASE 1212–01
(SOT–23)
ISSUE O



NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM C IS A SEATING PLANE.

	MILLIMETERS	
DIM	MIN	MAX
A1	0.00	0.10
A2	1.00	1.30
B	0.30	0.50
C	0.10	0.25
D	2.80	3.00
E	2.50	3.10
E1	1.50	1.80
e	0.95 BSC	
e1	1.90 BSC	
L	0.20	—
L1	0.45	0.75

Recommended Footprint for Surface Mount Applications



SOT–23–5

NOTES

How to reach us:

USA / EUROPE / Locations Not Listed: Motorola Literature Distribution;
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JAPAN: Motorola Japan Ltd.; SPD, Strategic Planning Office, 141,
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2, Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.
852–26629298

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