TelCom
Semiconductor, Inc.

PRELIMINARY INFORMATION

TC18 Series

PFM STEP-UP SWITCHING REGULATORS

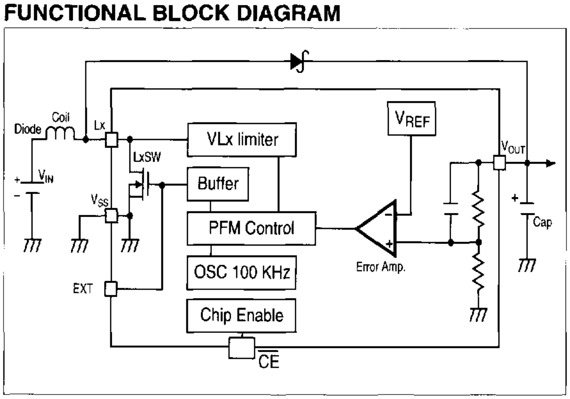
FEATURES

- Only 3 external components required .... Coil, diode, capacitor
- Ultra low operating current .... 4 - 6µA, Typ.
- Wide Choice of V_{OUT} .... 2.5V to 7.5V in 0.1V Steps
- High-accuracy output voltage .... ±2.5% Max.
- Low noise
- Low voltage operation .... 0.9V Max. (Output current 1mA)
- High efficiency .... 80% Typ.
- Compact packages .... SOT-89-3 and SOT-89-5
- Larger current can be obtained by connecting an external power transistor

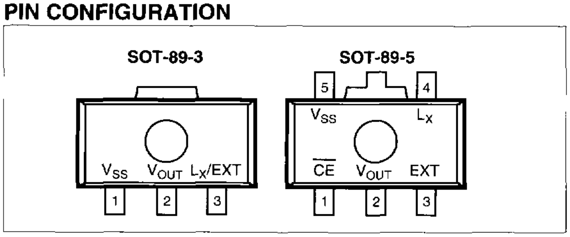
APPLICATIONS

- Constant voltage supply for battery-operated products
- Constant voltage supply for cameras, electronic and portable communication products
- Constant voltage source for devices that require a higher voltage than battery voltages

FUNCTIONAL BLOCK DIAGRAM



PIN CONFIGURATION



GENERAL DESCRIPTION

The TC18 Series are PFM-control, low operating current, step-up switching regulator ICs. Their unique design keeps the required external components to a minimum. PFM control can allow even less operating current than PWM control.

The TC181BXX IC comprises an oscillator, PFM control circuit, control transistor (Lx switch), reference voltage, differential amplifier circuit, voltage sensing resistor and an Lx switch protective circuit, and requires only three externally connected components (a coil, diode and capacitor). The internal switch allows output currents of 60 to 80 mA.

The TC182BXX IC utilizes the same chip as the TC181BXX device, but a transistor drive terminal (EXT) appears in place of the Lx terminal. This permits connection of a small external power transistor with a low ON resistance to control much larger currents. This device is ideal for applications which require outputs up to several hundred milliamps.

The TC183BXX version allows either connection and includes an internal chip enable circuit so that is possible to set the standby supply current to 0.5 µA max.

The TC18 Series is ideal for use with battery-operated devices, and combines high-efficiency operation with low noise and ultra-low current consumption.

3

ORDERING INFORMATION

PART CODE TC18 XX XX XX X XX XXX

Switch Selection:
1B: Internal (see Fig. 1)
2B: External (see Fig. 2)
3B: Internal & External, plus $\overline{CE}$

Output Voltage:
Ex: 30 = 3.0V; 50 = 5.0V

Extra Feature Code: Fixed: 00

Temperature: E: – 40°C to +85°C

Package Type and Pin Count:
MB: SOT-89-3, MT: SOT-89-5

Taping Direction:
723: Left Taping, 713: Right Taping

TC18 Series

ABSOLUTE MAXIMUM RATINGS:

Parameter	Symbol	Limit	Unit
Output Voltage	V_{OUT}	12	V
Lx Voltage	VLx	12	V
EXT Pin Voltage	V_{EXT}	– 0.3 to (V_{OUT} + 0.3)	V
Lx Output Current	ILx	250	mA
EXT Pin Current	I_{EXT}	±50	mA
Power Dissipation	Pd	500	mW
Operating Temperature	T_A	– 40 to +85	°C
Storage Temperature	T_{stg}	– 65 to +150	°C
CE Pin Voltage	V_{CE}	– 0.3 to (V_{OUT} + 0.3)	V

PIN DESCRIPTION

Pin No			Name	Description
XX1	XX2	XX3		
1	1	5	V_{SS}	Ground
2	2	2	V_{OUT}	Voltage Output
3	–	4	Lx	Switching Pin
–	3	3	EXT	Transistor Drive Pin (CMOS)
–	–	1	$\overline{CE}$	Chip Enable Pin (Active LOW)

ELECTRICAL CHARACTERISTICS:

TC181B30: V_{OUT} = 3V, V_{IN} = 2V, V_{SS} = 0V, I_{OUT} = 10mA, T_A = 25°C, unless otherwise specified. (See Fig. 1)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		2.925	3.000	3.075	V
V_{IN}	Max. Input Voltage				8	V
V_{ST}	Starting Voltage	I_{OUT} = 1mA, V_{IN}: 0 → 2V		0.8	0.9	V
V_{hdl}	Holding Voltage	I_{OUT} = 1mA, V_{IN}: 2 → 0V	0.7			V
$I_{IN}1$	Input Current 1	at V_{IN} pin, No Load		4	8	μA
$I_{IN}2$	Input Current 2	at V_{IN} pin, V_{IN} = 3.5V		2	5	μA
ILx	Lx Switching Current	VLx = 0.4V	60			mA
ILxL	Leakage Current of Lx pin	VLx = 6V, V_{IN} = 3.5V			0.5	μA
f_{osc}	Oscillator Frequency		80	100	120	kHz
maxdty	Oscillator Duty Cycle	on (VLx "Low")	65	75	85	%
η	Efficiency		70	80		%
V_{LXlim}	VLx Pin Voltage Limit[1]	Lx Switch on	0.65	0.8	1.0	V

TC181B50: V_{OUT} = 5V, V_{IN} = 3V, V_{SS} = 0V, I_{OUT} = 10mA, T_A = 25°C, unless otherwise specified. (See Fig. 1)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		4.875	5.000	5.125	V
V_{IN}	Max. Input Voltage				8	V
V_{ST}	Starting Voltage	I_{OUT} = 1mA, V_{IN}: 0 → 3V		0.8	0.9	V
V_{hdl}	Holding Voltage	I_{OUT} = 1mA, V_{IN}: 3 → 0V	0.7			V
$I_{IN}1$	Input Current 1	at V_{IN} pin, No Load		6	12	μA
$I_{IN}2$	Input Current 2	at V_{IN} pin, V_{IN} = 5.5V		2	5	μA
ILx	Lx Switching Current	VLx = 0.4V	80			mA
ILxL	Leakage Current of Lx pin	VLx = 6V, V_{IN} = 5.5V			0.5	μA
f_{osc}	Oscillator Frequency		80	100	120	kHz
maxdty	Oscillator Duty Cycle	on (VLx "Low")	65	75	85	%
η	Efficiency		70	80		%
V_{LXlim}	VLx Pin Voltage Limit[1]	Lx Switch on	0.65	0.8	1.0	V

3

ELECTRICAL CHARACTERISTICS (continued):

TC182B30: V_{OUT} = 3V, V_{IN} = 2V, V_{SS} = 0V, I_{OUT} = 10mA, T_A = 25°C, unless otherwise specified. (See Fig. 2)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		2.925	3.000	3.075	V
V_{IN}	Max. Input Voltage				8	V
V_{ST}	Starting Voltage	EXT no Load, V_{OUT}: 0 → 2V		0.7	0.8	V
Idd1	Operating Current 1	EXT no Load, V_{OUT} = 2.9V		30	50	μA
Idd2	Operating Current 2	EXT no Load, V_{OUT} = 3.5V		2	5	μA
I_{EXT}H	EXT "H" Output Current	V_{EXT} = V_{OUT} = – 0.4V	– 1.5			mA
I_{EXT}L	EXT "Low" Output Current	V_{EXT} = 0.4V	1.5			mA
f_{osc}	Oscillator Frequency		80	100	120	kHz
maxdty	Oscillator Duty Cycle	V_{EXT} "High"	65	75	85	%

TC182B50: V_{OUT} = 5V, V_{IN} = 3V, V_{SS} = 0V, I_{OUT} = 10mA, T_A = 25°C, unless otherwise specified. (See Fig. 2)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		4.875	5.000	5.125	V
V_{IN}	Max. Input Voltage				8	V
V_{ST}	Starting Voltage	EXT no Load, V_{OUT}: 0 → 3V		0.7	0.8	V
Idd1	Operating Current 1	EXT no Load, V_{OUT} = 4.8V		60	90	μA
Idd2	Operating Current 2	EXT no Load, V_{OUT} = 5.5V		2	5	μA
I_{EXT}H	EXT "H" Output Current	V_{EXT} = V_{OUT} = - 0.4V	– 2			mA
I_{EXT}L	EXT "L" Output Current	V_{EXT} = 0.4V	2			mA
f_{osc}	Oscillator Frequency		80	100	120	kHz
maxdty	Oscillator Duty Cycle	V_{EXT} "High"	65	75	85	%

CIRCUIT EXAMPLES

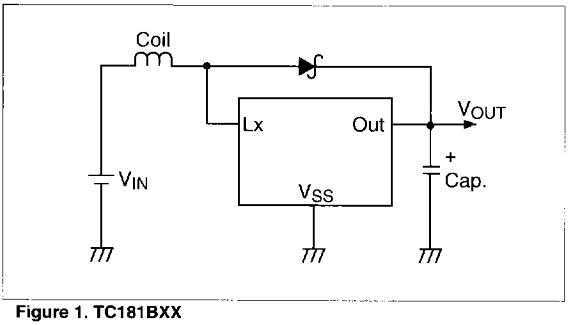


Figure 1. TC181BXX

Parts
- Coil: 82 μH (Sumida Electric Company Ltd. CM-5)
- Diode: MA721 (Matsushita Electronics Corp. Schottky)
- Capacitor: 22μF (Tantalum)

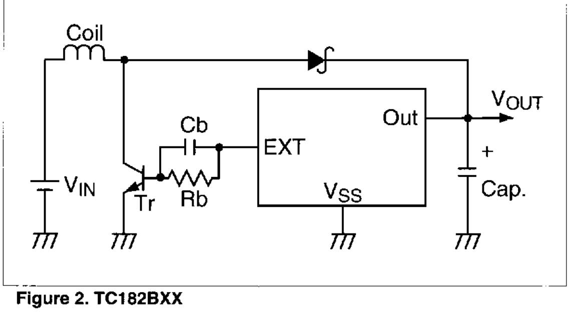


Figure 2. TC182BXX

Parts
- Coil: 28μH (Toroidal Core)
- Diode: HRP22 (Hitachi, Schottky)
- Capacitor: 100μF (Tantalum)
- Transistor: 2SD1628G
- Rb: 300Ω
- Cb: 0.01μF

ELECTRICAL CHARACTERISTICS (continued):

TC183B30: V_{OUT} = 2V, V_{IN} = 3V, V_{SS} = 0V, I_{OUT} = 10mA, T_A = 25°C, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		2.295	3.0	3.075	V
V_{IN}	Input Voltage				8	V
V_{ST}	Starting Voltage	I_{OUT} = 1mA, V_{IN}: 0 → 3V		0.8	0.9	V
V_{hold}	Holding Voltage	I_{OUT} = 1mA, V_{IN}: 3 → 0V	0.7			V
η	Efficiency		70	80		%
I_{IN1}	Supply Current 1	At V_{IN} Pin, No Load		4	8	μA
I_{IN2}	Supply Current 2	At V_{IN} Pin, V_{IN} = 3.5V		2	5	μA
ILx	Lx Switching Current	VLx = 0.4V	60			mA
ILxL	Leakage Current of Lx pin	VLx = 6V, V_{IN} = 3.5V			0.5	μA
$I_{EXT}H$	EXT "H" Output Current	V_{EXT} = V_{OUT} – 0.4V	– 1.5			mA
$I_{EXT}L$	EXT "L" Output Current	V_{EXT} = 0.4V	1.5			mA
V_{CEH1}	$\overline{CE}$ Input Voltage "H"1	V_{OUT} ≥ 1.5V	VOUT - 0.4			V
VCEL1	$\overline{CE}$ Input Voltage "L"1	V_{OUT} ≥ 1.5V			0.4	V
V_{CEH2}	$\overline{CE}$ Input Voltage "H"2	0.8V ≤ V_{OUT} ≤ 1.5V	VOUT - 0.1			V
V_{CEL2}	$\overline{CE}$ Input Voltage "L"2	0.8V ≤ V_{OUT} ≤ 1.5V			0.1	V
I_{CEH}	$\overline{CE}$ Input Current "H"	$\overline{CE}$ = 3V	– 0.5		0.5	μA
I_{CEL}	$\overline{CE}$ Input Current "L"	$\overline{CE}$ = 3V	– 0.5		0.5	μA
f_{osc}	Oscillator Frequency		80	100	120	kHz
Maxdty	Oscillator Duty Cycle	on (V_{LX} "Low")	65	75	85	%
V_{LXlim}	VLx Pin Voltage Limit[1]	Lx Switch on	0.65	0.8	1.0	V

NOTICE

Observe the following precautions when using this IC:

- Place external components as close as possible to the IC to reduce wiring. In particular, wire the capacitor connected to the V_{OUT} pin using the shortest route possible.

- Ensure sufficient grounding. The V_{SS} pin receives a large current due to switching. High impedance in the V_{SS} routing causes the internal potential of the IC to fluctuate with the switching current, resulting in unstable operation.

- Use capacitors with good high frequency response, such as tantalum capacitors or electrolytic aluminum and ceramic capacitors. The capacitance must be 10μF or more. It is recommended that the capacitors be able to withstand at least three times the specified output voltage, because the coil may cause a high spikelike voltage when the Lx transistor is turned off.

- Select a coil with a low resistance, adequate current carrying capacity and resistance to magnetic saturation. The ILx may exceed its absolute maximum rated value during a maximum load when the coil inductance value is too low. Be sure to select the proper inductance value.

- Use Schottky diodes with fast switching speed. Ensure that they have adequate current-carrying capacity.

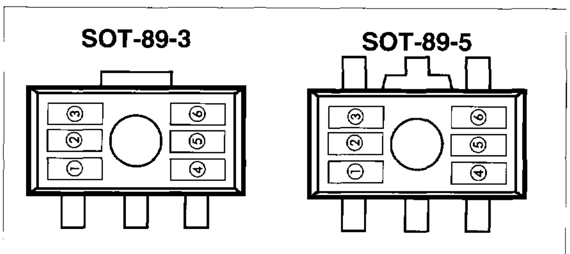
ELECTRICAL CHARACTERISTICS (continued):

TC183B50: V_{OUT} = 5V, V_{IN} = 3V, V_{SS} = 0V, I_{OUT} = 10mA, T_A = 25°C, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		4.875	5.000	5.125	V
V_{IN}	Input Voltage				8	V
V_{ST}	Starting Voltage	I_{OUT} = 1mA, V_{IN}: 0 → 3V		0.8	0.9	V
V_{hold}	Holding Voltage	I_{OUT} = 1mA, V_{IN}: 3 → 0V	0.7			V
η	Efficiency		70	85		%
I_{IN1}	Supply Current 1	At V_{IN} Pin, No Load		6	12	µA
I_{IN2}	Supply Current 2	At V_{IN} Pin, V_{IN} = 5.5V		2	5	µA
ILx	Lx Switching Current	VLx = 0.4V	80			mA
ILxL	Leakage Current of Lx pin	VLx = 6V, V_{IN} = 5.5V			0.5	µA
$I_{EXT}H$	EXT "H" Output Current	V_{EXT} = V_{OUT} – 0.4V	– 2.0			mA
$I_{EXT}L$	EXT "L" Output Current	V_{EXT} = 0.4V	2.0			mA
V_{CEH1}	$\overline{CE}$ Input Voltage "H"1	V_{OUT} ≥ 1.5V	VOUT - 0.4			V
V_{CEL1}	$\overline{CE}$ Input Voltage "L"1	V_{OUT} ≥ 1.5V			0.4	V
V_{CEH2}	$\overline{CE}$ Input Voltage "H"2	0.8V ≤ V_{OUT} < 1.5V	VOUT - 0.1			V
V_{CEL2}	$\overline{CE}$ Input Voltage "L"2	0.8V ≤ V_{OUT} < 1.5V			0.1	V
I_{CEH}	$\overline{CE}$ Input Current "H"	$\overline{CE}$ = 5V	– 0.5		0.5	µA
I_{CEL}	$\overline{CE}$ Input Current "L"	$\overline{CE}$ = 5V	– 0.5		0.5	µA
f_{osc}	Oscillator Frequency		80	100	120	kHz
Maxdty	Oscillator Duty Cycle	on (V_{LX} "Low")	65	75	85	%
V_{LXlim}	VLx Pin Voltage Limit[1]	Lx Switch on	0.65	0.8	1.0	V

Note 1: The ILx increases steadily after the Lx switch is set to ON due to use of an external coil. The accompanying VLx also increases. When the VLx reaches the V_{LXlim}, the Lx switch is set to OFF by the protective circuit.

MARKING



a and b represents first digit and decimal place of V_{OUT}. For example:

Mark a	Mark b	V_{OUT} Voltage
2	7	2.7V

c represents driver type

Mark c	Type		
1	1	TC18XX1	Internal Switch (SOT-89-3 only)
2	2	TC18XX2	External Switch (SOT-89-3 only)
3	3	TC18XX3	Int./Ext. Switch, plus $\overline{CE}$ (SOT-89-5 only)

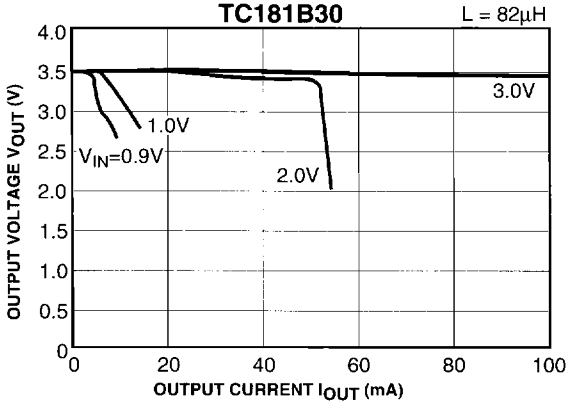
d and e represent assembly lot number

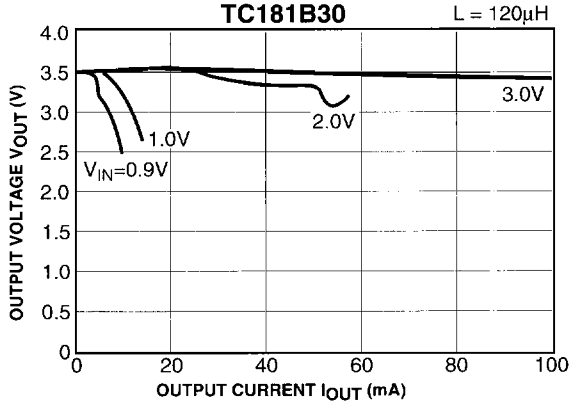
f represents oscillator frequency

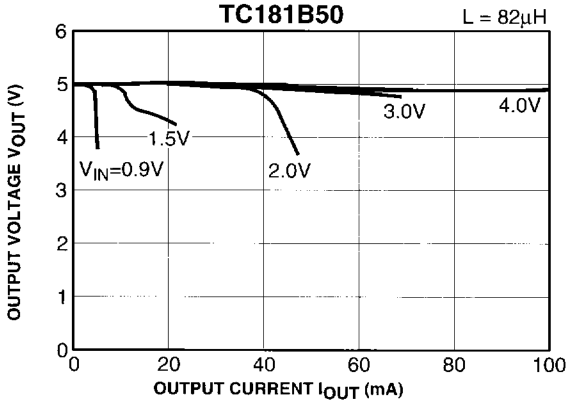
Mark f	Type	
B	B	100kHz

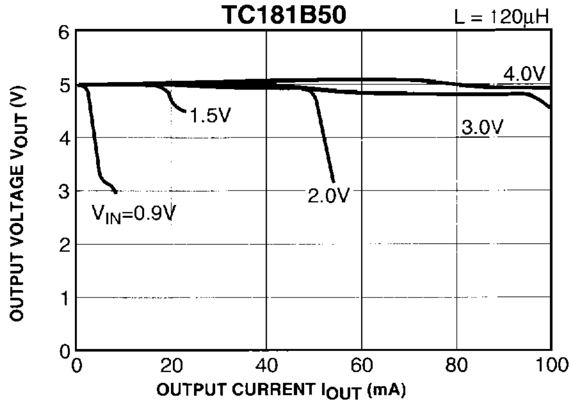
TYPICAL CHARACTERISTICS

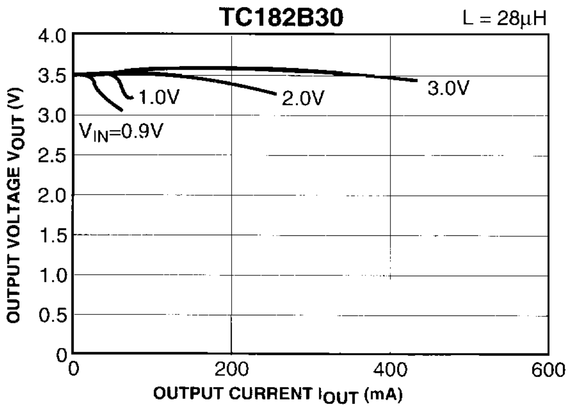
1) Output Voltage vs. Output Current (T_A = 25°C)

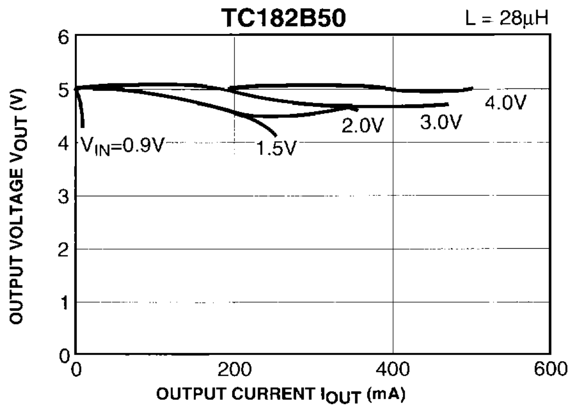






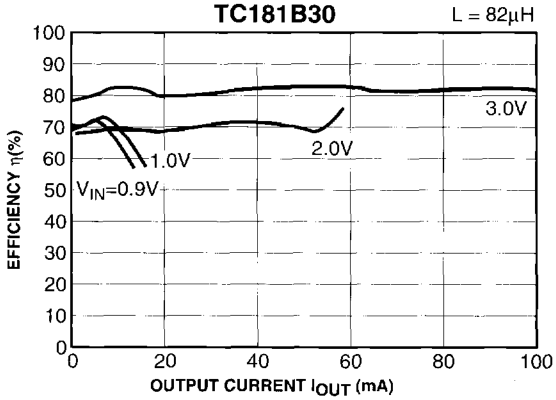


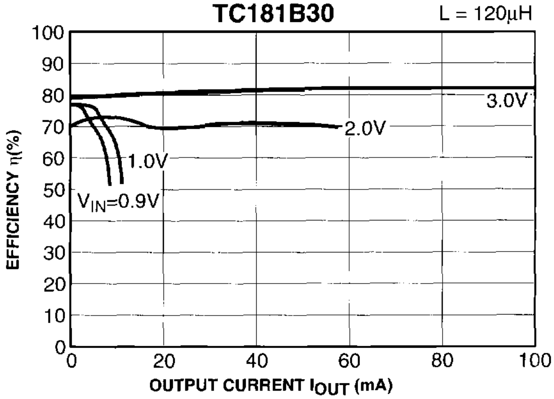


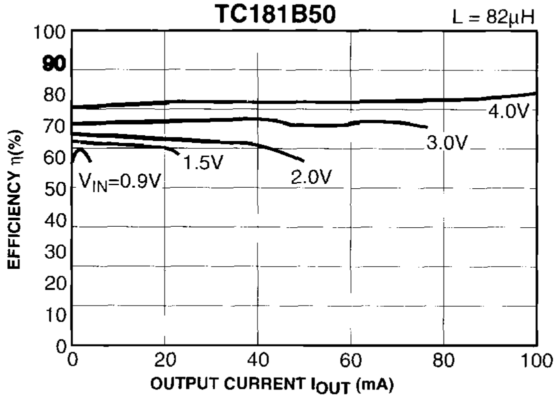


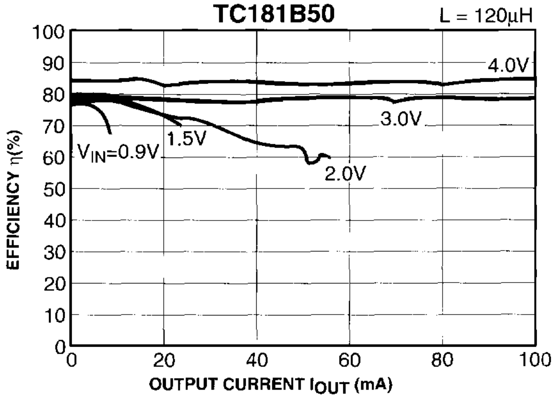
TYPICAL CHARACTERISTICS (continued):

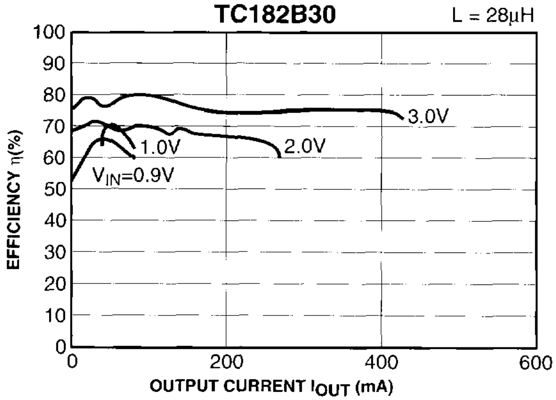
2) Efficiency vs. Output Current (T_A = 25°C)

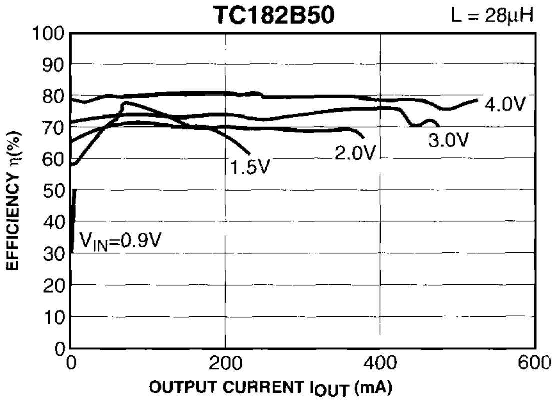










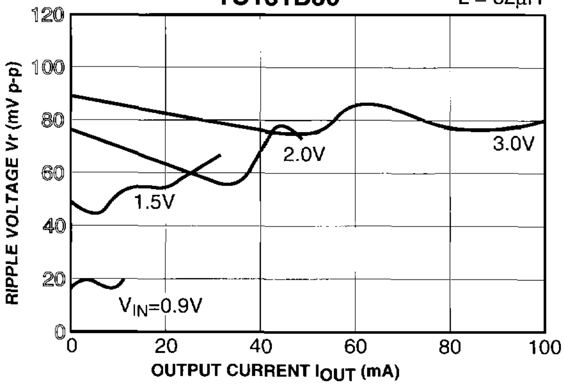


TC18 Series

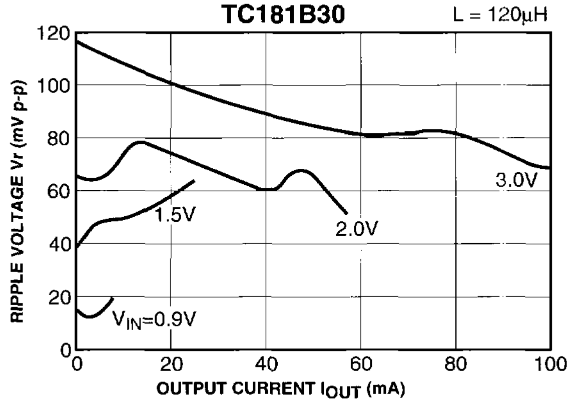
TYPICAL CHARACTERISTICS (continued):

3) Output Ripple Voltage vs. Output Current (T_A = 25°C)

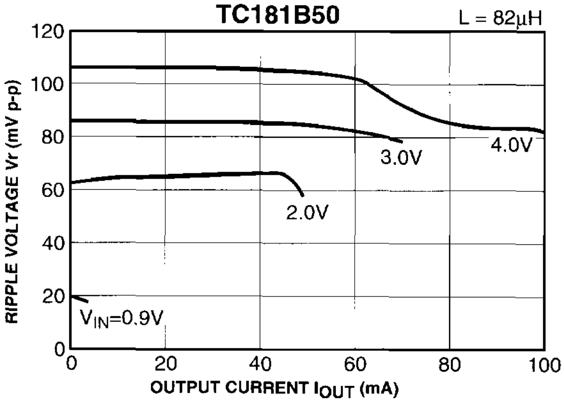
TC181B30 L = 82µH



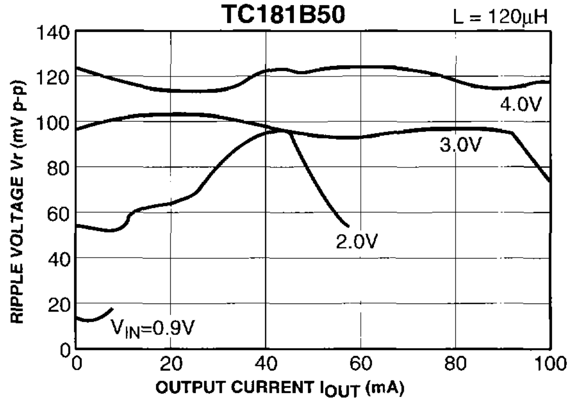
TC181B30 L = 120µH



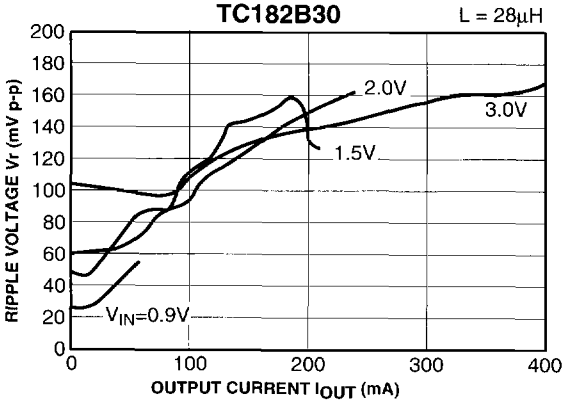
TC181B50 L = 82µH



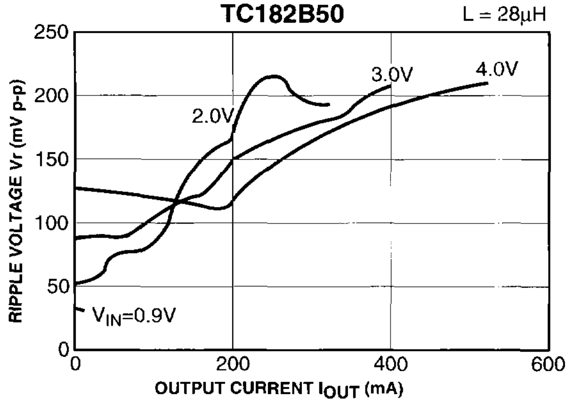
TC181B50 L = 120µH



TC182B30 L = 28µH

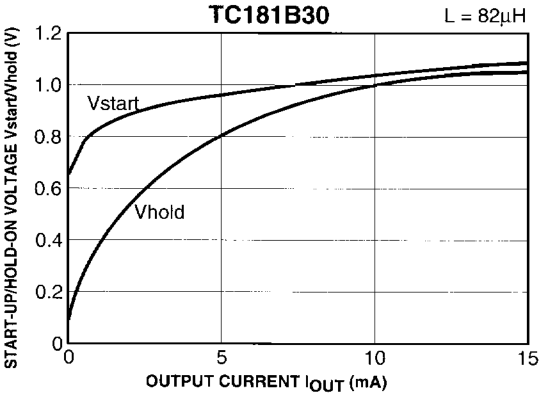


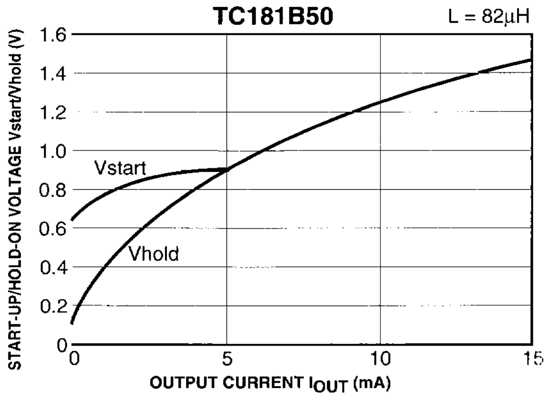
TC182B50 L = 28µH



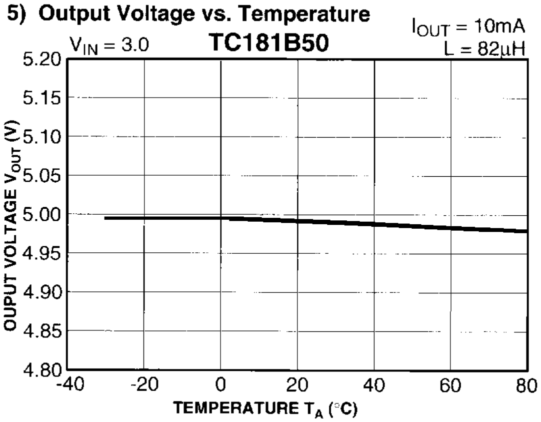
TYPICAL CHARACTERISTICS (continued):

4) Start-up/Hold-ON Voltage vs. Output Current (T_A = 25°C) Vstart: Increasing V_{IN} from 0V, Vhold: Decreasing V_{IN} from 2.0V

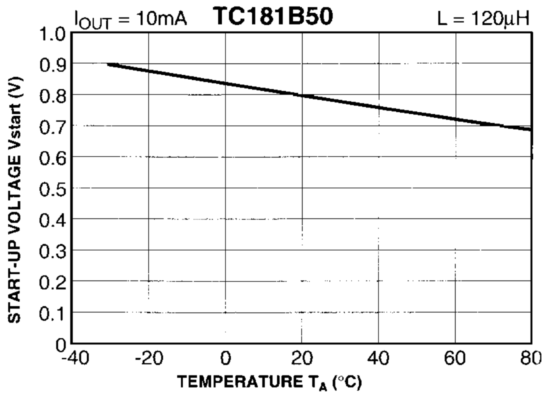




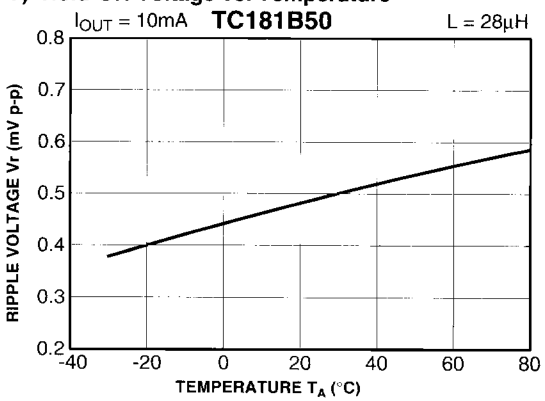
5) Output Voltage vs. Temperature



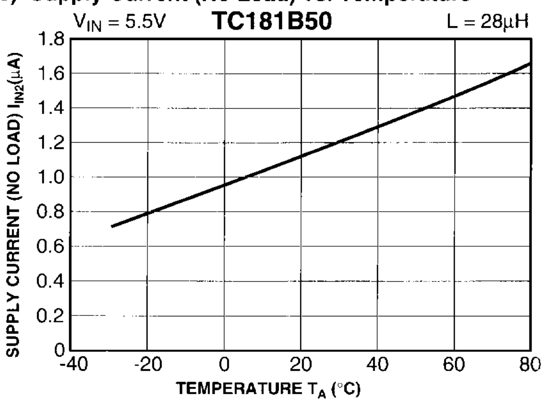
6) Start-up Voltage vs. Temperature



7) Hold-ON Voltage vs. Temperature

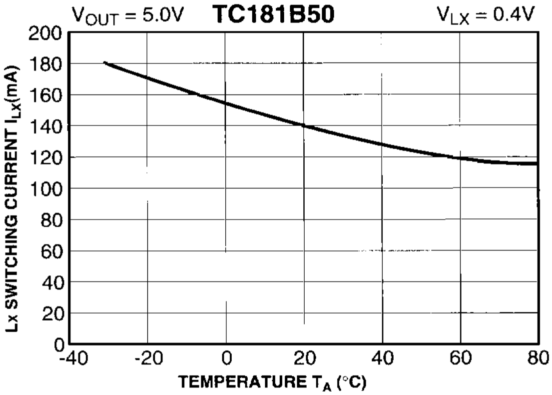


8) Supply Current (No Load) vs. Temperature

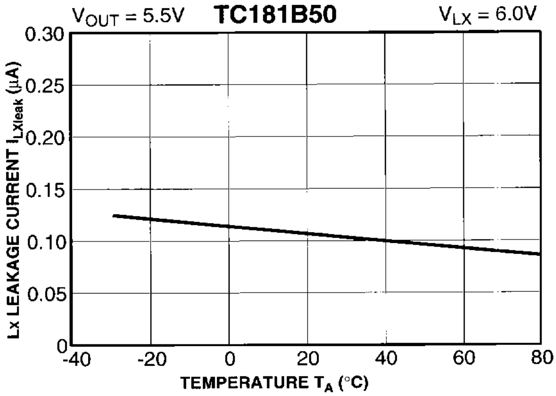


TYPICAL CHARACTERISTICS (continued):

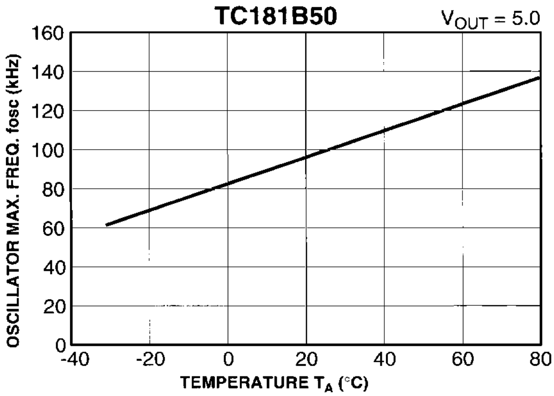
9) Switching Current vs. Temperature



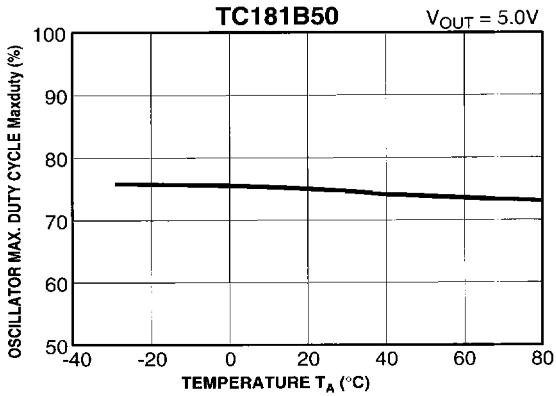
10) Lx Leakage Current vs. Temperature



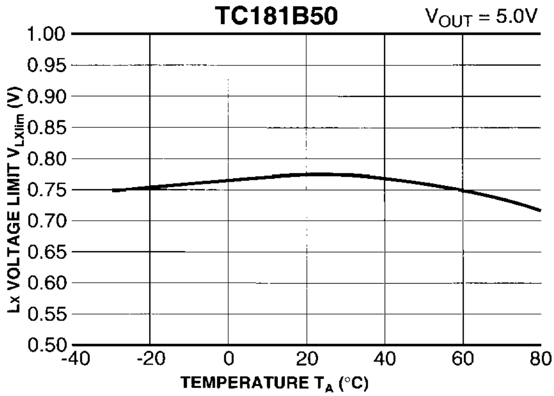
11) Oscillator Maximum Frequency vs. Temperature



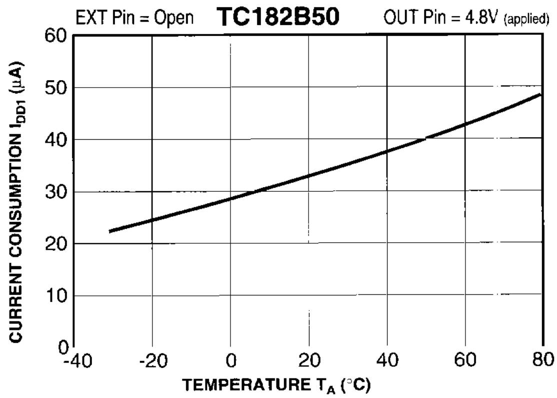
12) Oscillator Maximum Duty Cycle vs. Temperature



13) Lx Voltage Limit vs. Temperature

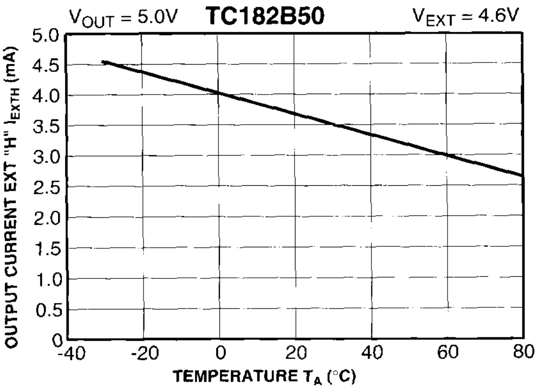


14) Consumption Current vs. Temperature

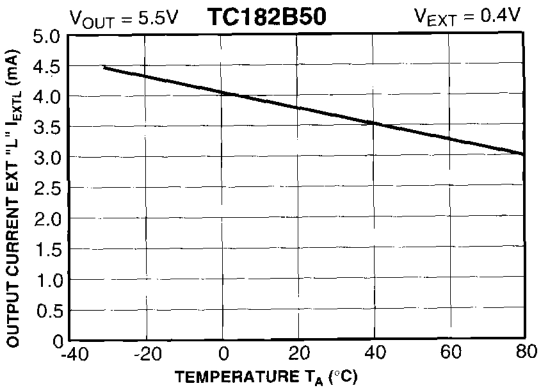


TYPICAL CHARACTERISTICS (continued):

15) EXT "High" Output Current vs. Temperature



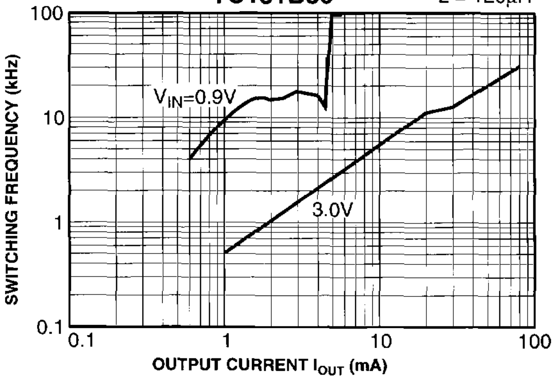
16) EXT "Low" Output Current vs. Temperature



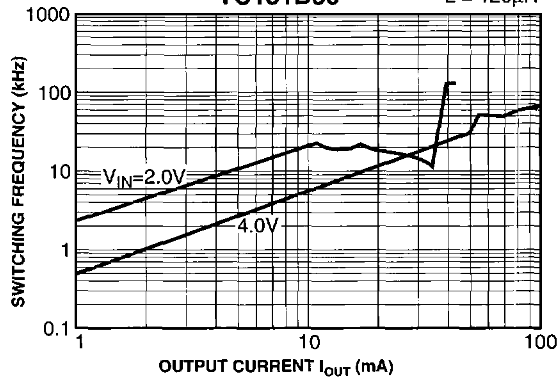
TYPICAL CHARACTERISTICS (continued):

17) Switching Frequency vs. Output Current

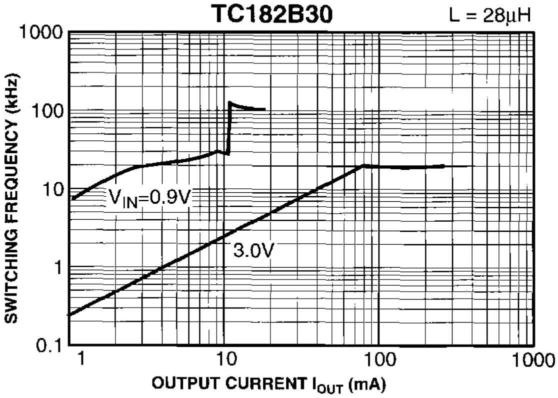
TC181B30 L = 120µH



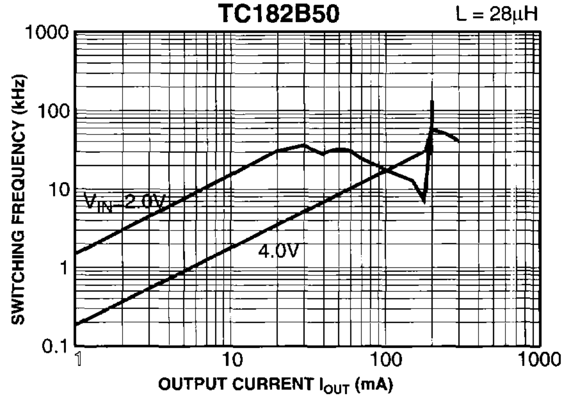
TC181B50 L = 120µH



TC182B30 L = 28µH



TC182B50 L = 28µH



Output Voltage Ripple