TelCom
Semiconductor, Inc.

TC17 Series

PWM STEP-UP SWITCHING REGULATOR

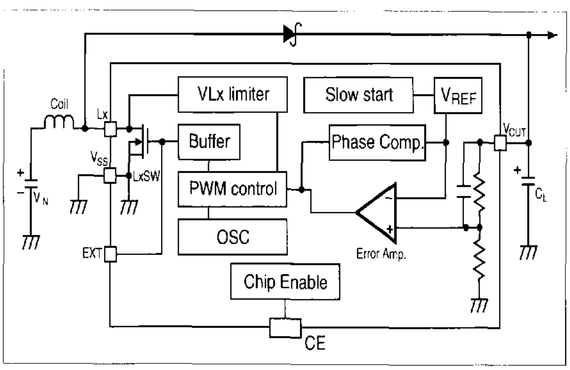
FEATURES

- Only 3 external components required .... Coil, diode, capacitor
- Low operating current .... Typ. 30µA
- Low ripple and noise
- Low voltage operation .... 0.9V Max. (Output current 1mA)
- Wide Choice of V_{OUT} .... 2.7V to 7.5V in 0.1V Steps
- High accuracy output voltage .... ± 2.5% Max.
- High efficiency .... 85% Typ.
- Soft start circuit .... 500µs Min.
- Compact packages ....SOT-89-3 and SOT-89-5
- Larger current can be obtained by connecting an external power transistor

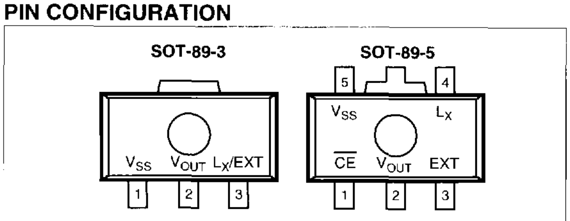
APPLICATIONS

- Constant voltage source for battery-operated products
- Constant voltage source 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 TC17 Series ICs are PWM control step-up switching regulators. Their unique design keeps external components to a minimum.

The TC171AXX IC consists of an oscillator circuit, PWM control circuit, control transistor (Lx switch), reference voltage source, error amplifier circuit, phase correction circuit, voltage detection resistor, soft start circuit, and Lx switch protection circuit. The internal switch allows output currents of 60 to 80 mA

The TC172BXX ICs are similar to the XX1A series, but have an external transistor drive pin (EXT) instead of an Lx pin. This permits connection of a small external power transistor with a low ON resistance to control much larger currents. The TC172BXX ICs are suitable for applications that require output currents up to several hundred milliamps.

The TC173BXX IC allows either connection and also includes a chip enable circuit so that it is possible to set the standby supply current at 0.5 µA max.

A newly developed PWM control circuit allows the TC17 Series ICs to attain the lowest supply current (no load), equal to that of many PFM step-up converters. When V_{IN} exceeds V_{OUT} (plus diode and coil drops), the oscillator circuit stops, reducing current drain to 2µA.

The TC17 Series ICs are recommended for applications which require a low ripple PWM DC/DC converter, but cannot adopt conventional circuits because of their large supply currents.

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ORDERING INFORMATION

PART CODE   TC17 XX XX XX X XX XXX

Switch Selection:
1A: 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

ABSOLUTE MAXIMUM RATINGS: V_{SS} = 0.0V

Parameter	Symbol	Limit	Unit
Output Voltage	V_{OUT}	12	V
Lx Voltage[1]	VLx	12	V
EXT Pin Voltage[2]	V_{EXT}	– 0.3 to (V_{OUT} + 0.3)	V
$\overline{CE}$ Pin Voltage[3]	V_{CE}	– 0.3 to (V_{OUT} + 0.3)	V
Lx Output Current[1]	I_{LX}	250	mA
EXT Pin Current[2]	I_{EXT}	±50	mA
Power Dissipation	P_D	500	mW
Operating Temperature	T_{opr}	– 40 to +85	°C
Storage Temperature	T_{stg}	– 65 to +150	°C

NOTES: 1 Applicable for 1AXX & 3BXX
2 Applicable for 2BXX & 3BXX
3 Applicable for 3BXX

PIN DESCRIPTION

Pin No			Name	Description
1AXX	2BXX	3BXX		
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:

TC171A30: 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_{IN}	Input Voltage				8	V
V_{ST}	Starting Voltage	I_{OUT} = 1mA, V_{IN}: 0 → 2V		0.8	0.9	V
V_{hold}	Holding Voltage	I_{OUT} = 1mA, V_{IN}: 2 → 0V	0.7			V
Idd1	Supply Current 1	at V_{OUT} pin		15	25	µA
Idd2	Supply Current 2	at V_{OUT} pin, V_{IN} = 3.5V		2	5	µA
V_{OUT}	Output Voltage		2.925	3.000	3.075	V
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}	Oscillating Frequency		40	50	60	kHz
maxdty	Max. Oscillator Duty Cycle	on (VLx "Low")	70	80	90	%
η	Efficiency		70	85		%
tst	Soft Start Time[1]	Time for V_{OUT} = 0 → 5V	0.5	2.0		ms
V_{Lxlim}	VLx Pin Voltage Limit[2]	Lx Switch on	0.65	0.8	1.0	V

ELECTRICAL CHARACTERISTICS (continued):

TC171A50: 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_{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
Idd1	Supply Current 1	at V_{OUT} pin		30	45	µA
Idd2	Supply Current 2	at V_{OUT} pin, V_{IN} = 5.5V		2	5	µA
V_{OUT}	Output Voltage		4.875	5.000	5.125	V
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}	Oscillating Frequency		40	50	60	kHz
maxdty	Max. Oscillator Duty Cycle	on (VLx "Low")	70	80	90	%
η	Efficiency		70	85		%
tst	Soft Start Time[1]	Time for V_{OUT} = 0 → 5V	0.5	2.0		ms
V_{Lxlim}	VLx Pin Voltage Limit[2]	Lx Switch on	0.65	0.8	1.0	V

TC172B30: 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_{IN}	Input Voltage				8	V
V_{ST}	Starting Voltage	EXT no Load, V_{OUT}: 0 → 2V		0.7	0.8	V
Idd1	Supply Current 1	EXT no Load, V_{OUT} = 2.9V		30	50	µA
Idd2	Supply Current 2	EXT no Load, V_{OUT} = 3.5V		2	5	µA
V_{OUT}	Output Voltage		2.925	3.000	3.075	V
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
f_{osc}	Oscillating Frequency		80	100	120	kHz
maxdty	Max. Oscillator Duty Cycle	V_{EXT} "High"	70	80	90	%
tst	Soft Start Time[1]	V_{OUT} = 0 → 3V	0.5	2.0		ms

TC172B50: 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_{IN}	Input Voltage				8	V
V_{ST}	Starting Voltage	EXT no Load, V_{OUT}: 0 → 3V		0.7	0.8	V
Idd1	Supply Current 1	EXT no Load, V_{OUT} = 4.8V		60	90	µA
Idd2	Supply Current 2	EXT no Load, V_{OUT} = 5.5V		2	5	µA
V_{OUT}	Output Voltage		4.875	5.000	5.125	V
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}	Oscillating Frequency		80	100	120	kHz
maxdty	Max. Oscillator Duty Cycle	V_{EXT} "High"	70	80	90	%
tst	Soft Start Time[1]	V_{OUT} = 0 → 5V	0.5	2.0		ms

ELECTRICAL CHARACTERISTICS (continued):

TC173B30: V_{OUT} = 3.0V, V_{IN} = 2V, 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		2.925	3.0	3.075	V
V_{IN}	Input Voltage				8	V
V_{ST}	Starting Voltage	I_{OUT} = 1mA, V_{IN}: 0 → 2V		0.8	0.9	V
V_{hold}	Holding Voltage	I_{OUT} = 1mA, V_{IN}: 2 → 0V	0.7			V
η	Efficiency		70	85		%
Idd1	Supply Current 1	at V_{OUT} pin		30	50	µA
Idd2	Supply Current 2	at V_{OUT} 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	$V_{OUT} \geq 1.5V$	$V_{OUT} - 0.4$			V
V_{CEL1}	$\overline{CE}$ Input Voltage "L"1	$V_{OUT} \geq 1.5V$			0.4	V
V_{CEH2}	$\overline{CE}$ Input Voltage "H"2	$0.8V \leq V_{OUT} \leq 1.5V$	$V_{OUT} - 0.1$			V
V_{CEL2}	$\overline{CE}$ Input Voltage "L"2	$0.8V \leq V_{OUT} \leq 1.5V$			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"	$\overline{CE}$ = 0V	– 0.5		0.5	µA
f_{osc}	Oscillating Frequency		80	100	120	kHz
maxdty	Max. Oscillator Duty Cycle	on (VLx "Low")	70	80	90	%
t_{start}	Soft Start Time[1]	V_{OUT} = 0→ 3V	0.5	2.0		ms
V_{Lxlim}	Lx Pin Voltage Limit[2]	Lx Switch on	0.65	0.8	1.0	V

ELECTRICAL CHARACTERISTICS (continued):

TC173B50: V_{OUT} = 5.0V, 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	5.0	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		%
Idd1	Supply Current 1	at V_{OUT} pin		60	90	μA
Idd2	Supply Current 2	at V_{OUT} 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	V_{OUT} − 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	V_{OUT} − 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"	CE = 5V	−0.5		0.5	μA
I_{CEL}	$\overline{CE}$ Input Current "L"	CE = 0V	−0.5		0.5	μA
f_{osc}	Oscillating Frequency		80	100	120	kHz
maxdty	Max. Oscillator Duty Cycle	on (VLx "Low")	70	80	90	%
t_{start}	Soft Start Time[1]	V_{OUT} = 0 → 5V	0.5	2.0		ms
V_{Lxlim}	VLx Pin Voltage Limit[2]	Lx Switch on	0.65	0.8	1.0	V

Note 1: The soft start circuit follows the sequence below:
When V_{IN} is applied → V_{REF} is kept at 0V for about 200μs → During this period, error amplifier output is brought to "H" → V_{REF} rises and then the error amplifier output gradually decreases to the appropriate value due to the internal phase compensation circuit. Accordingly, the output gradually increases.

Note 2: ILx gradually rises after the Lx switch is turned on, and VLx rises accordingly. If the voltage reaches Lxlim, the Lx switch protection circuit turns off the Lx switch.

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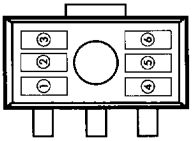
NOTICE

To use these ICs, note the following points:

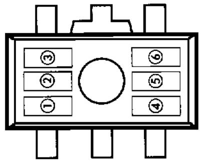
- Place external components as close as possible to the IC to reduce wiring. In particular, wire the capacitor connected to the V_{OUT} pin using the shortest route possible.
- Ensure sufficient grounding. The V_{SS} pin receives large currents due to switching. High impedance in the V_{SS} routing causes 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 + ceramic capacitors. The capacity must be 10μF or more. It is recommended that the rated voltage of the capacitors be at least three times the specified output voltage, because the coil may cause a high spike-like voltage when the Lx transistor is turned off.
- Select coils that have a small DC resistance and are not magnetically-saturated easily. If the coil inductance is too small, ILx may exceed the absolute maximum rating under maximum load. Select the proper inductance value.
- Use Schottky diodes with fast switching speed, and adequate current-carrying capability.

MARKING

SOT-89-3



SOT-89-5



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	TC171AXX	Internal Switch (SOT-89-3-only)
2	2	TC172BXX	External Switch (SOT-89-3-only)
3	3	TC173BXX	Int./Ext. Switch, plus $\overline{CE}$ (SOT-89-5-only)

d and e represent assembly lot number

f represents oscillator frequency

Mark f	Type	
A	A	50kHz
B	B	100kHz

TEST CIRCUITS

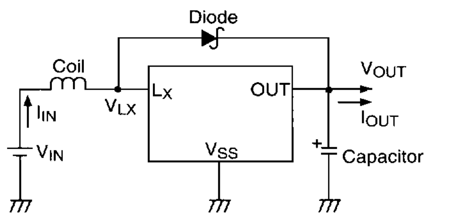


Figure 1. TC171AXX

Parts	Capacitor	22µF (Tantalum)
	Coil	120 µH, 270 µH (Sumida Electric Company Ltd., CM-5)
	Diode	MA721 (Matsushita Electronics Corp., Schottky)

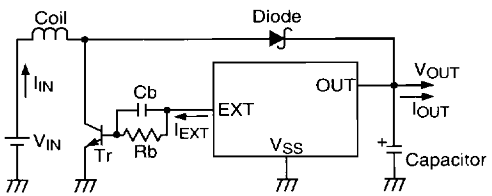


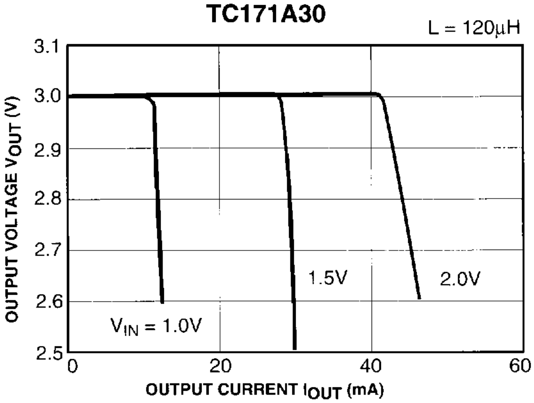
Figure 2. TC172BXX

Parts	Capacitor	100µF (Aluminum Electrolytic)// 22µF (Tantalum)
	Coil	28µH (Sumida Electric Company Ltd., CM-5)
	Diode	MA721 (Matsushita Electronics Corp., Schottky)
	Transistor	2SD1628G
	Rb	300Ω
	Cb	0.01µF

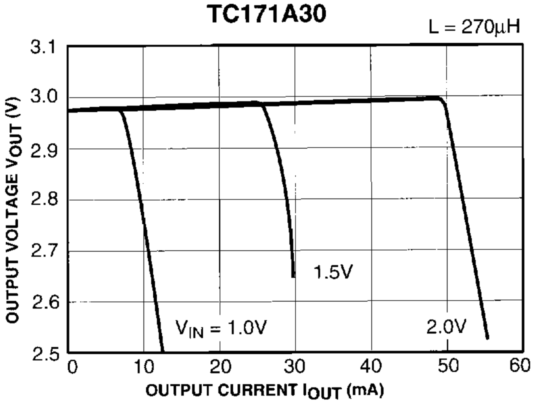
TYPICAL CHARACTERISTICS

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

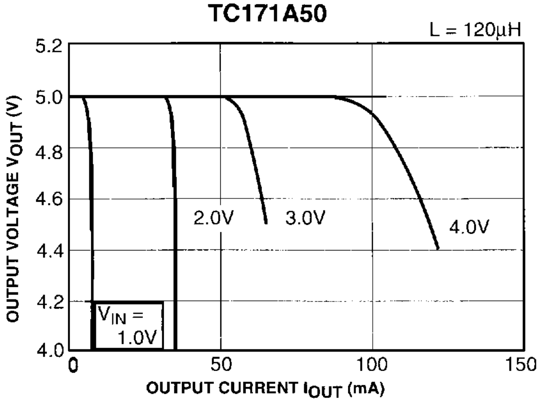
TC171A30



TC171A30



TC171A50



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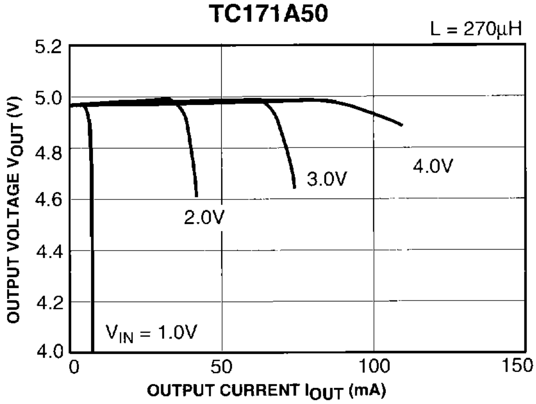

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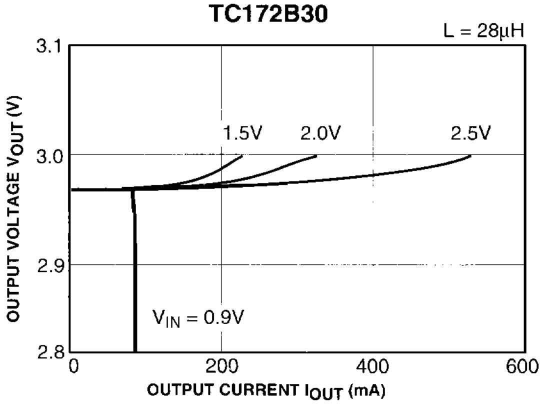

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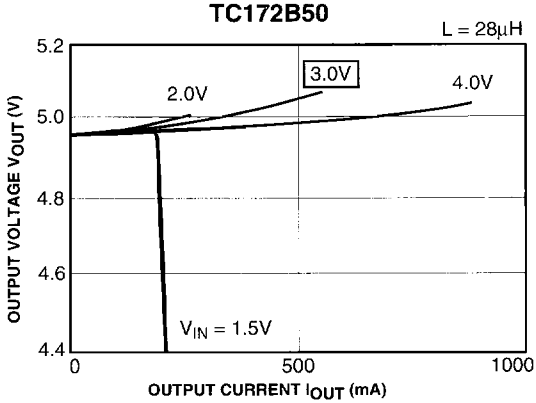
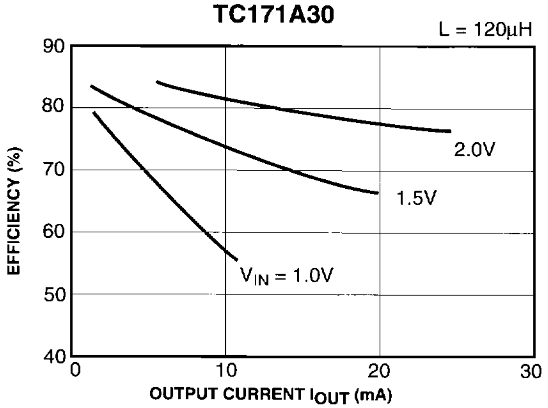
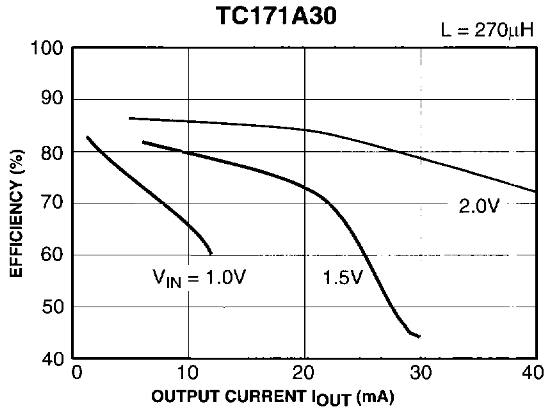
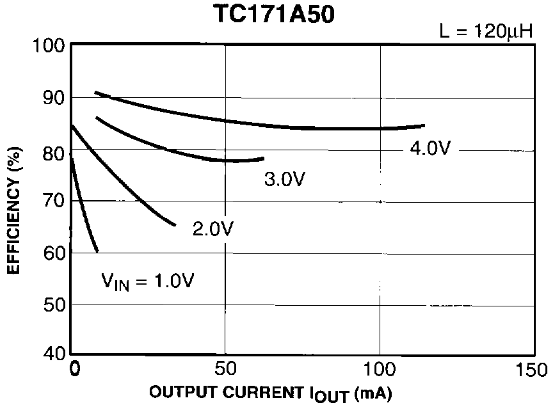


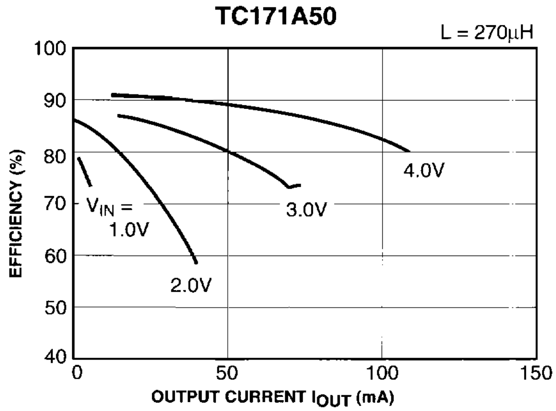
TYPICAL CHARACTERISTICS

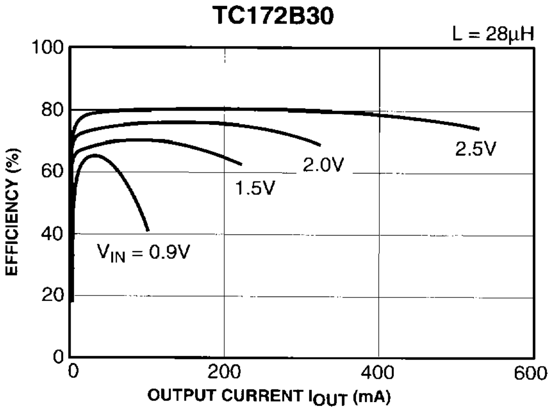
2) Efficiency vs. Output Current (T_A = 25°C)

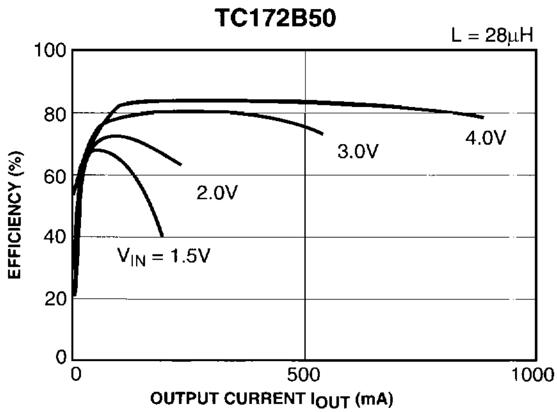






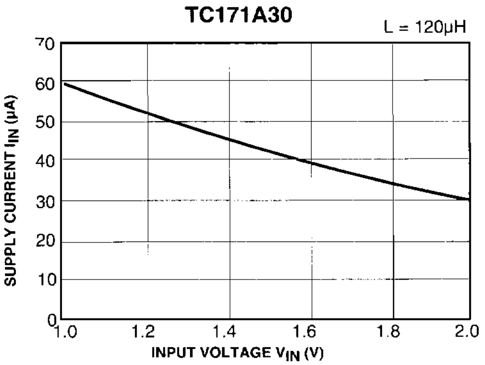


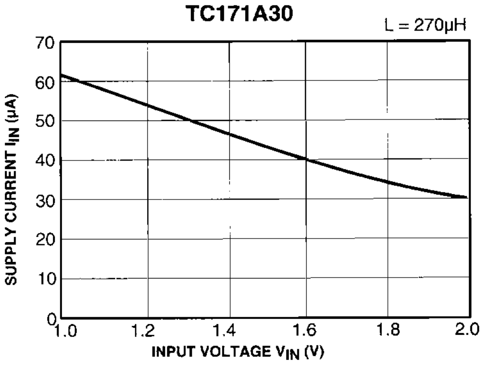


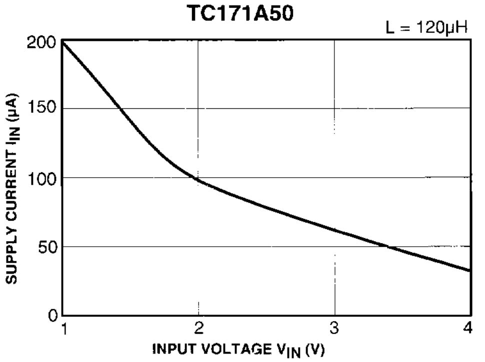


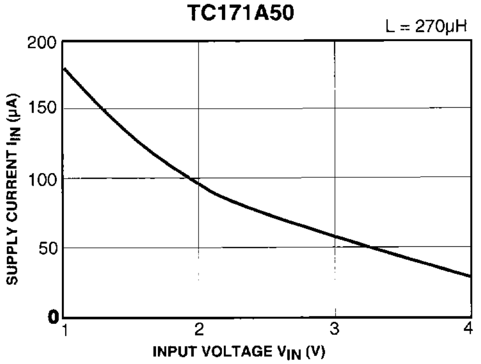
TYPICAL CHARACTERISTICS

3) Supply Current (No Load) vs. Input Voltage (T_A = 25°C)





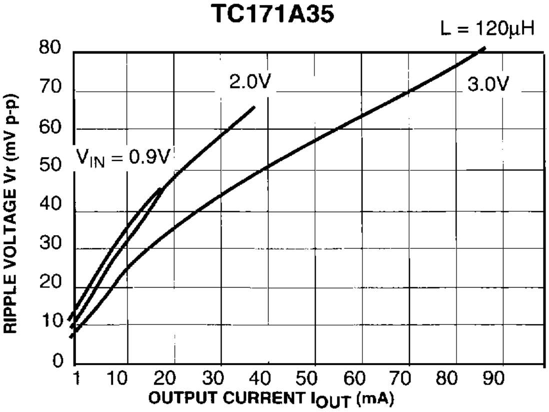




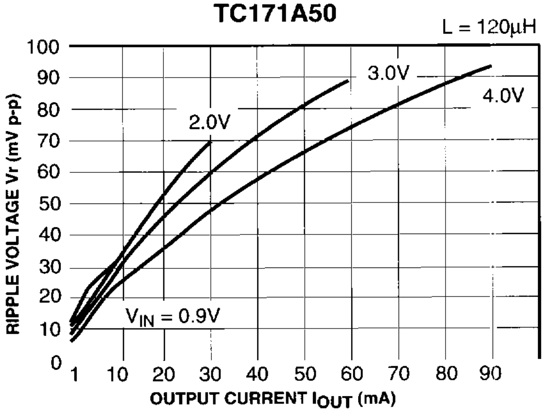
TYPICAL CHARACTERISTICS

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

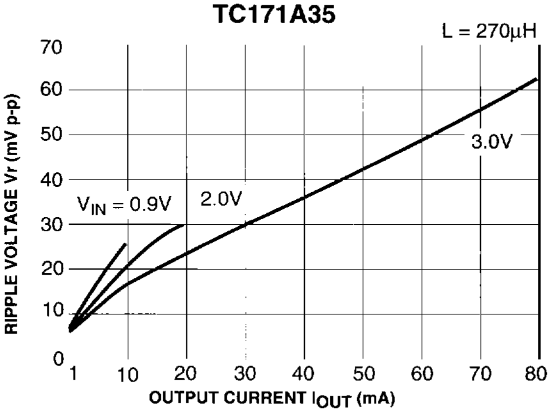
TC171A35



TC171A50



TC171A35



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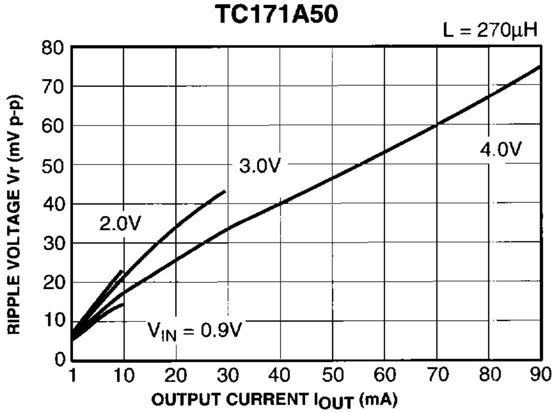
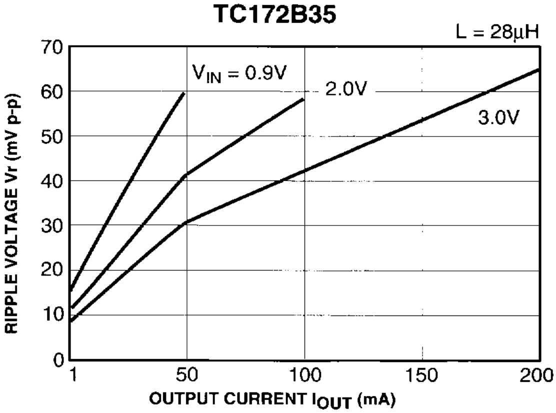
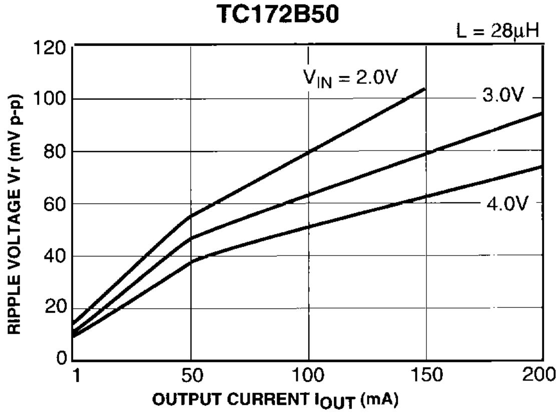


TC172B35

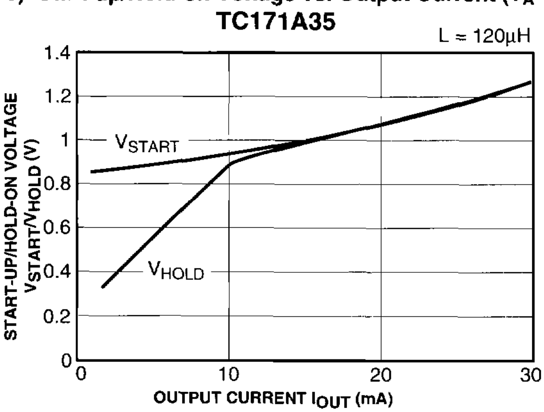


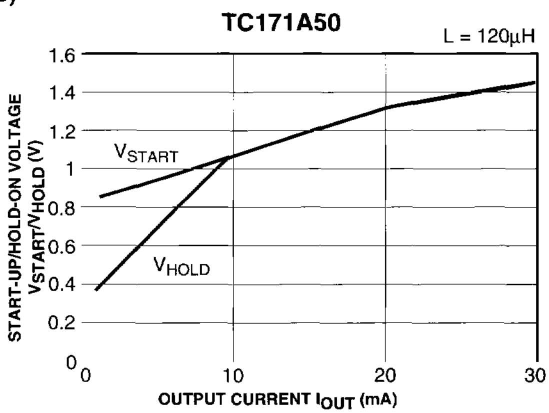
TC172B50

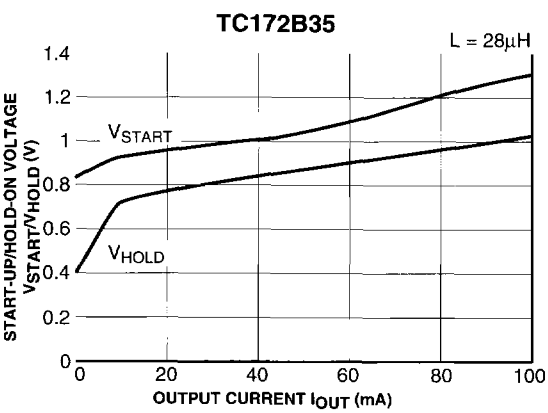


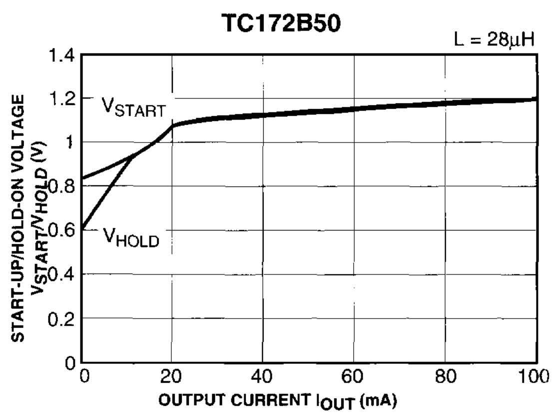
TYPICAL CHARACTERISTICS

5) Start-up/Hold-on Voltage vs. Output Current (T_A = 25°C)









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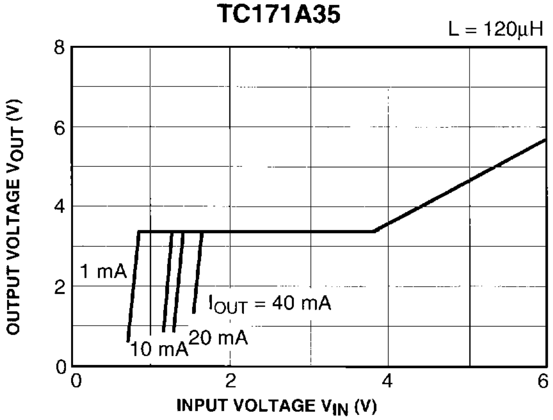
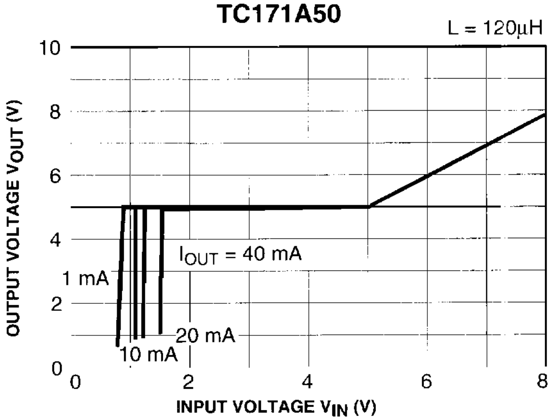
TYPICAL CHARACTERISTICS

6) Output Voltage vs. Input Voltage ($T_A = 25°C$)

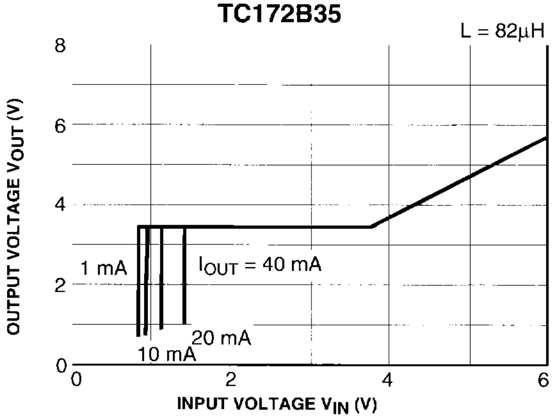
TC171A35



TC171A50



TC172B35



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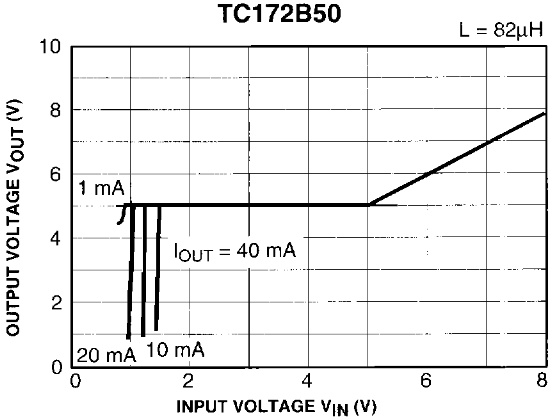
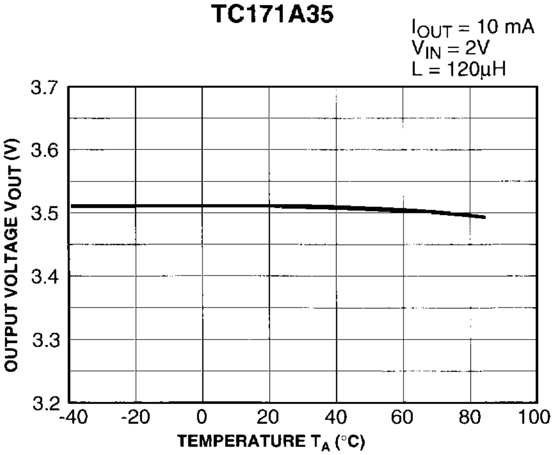


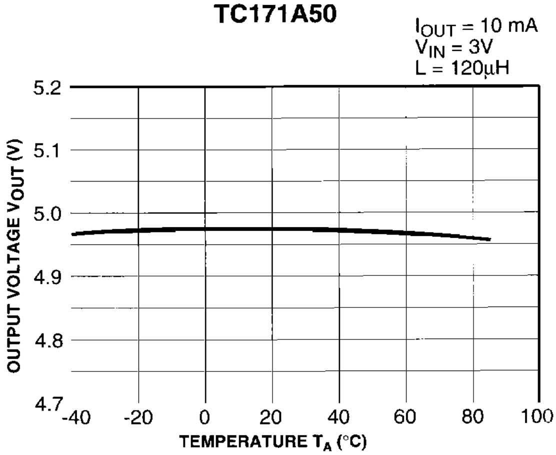
TYPICAL CHARACTERISTICS

7) Output Voltage vs. Temperature (T_A = 25°C)

TC171A35



TC171A50



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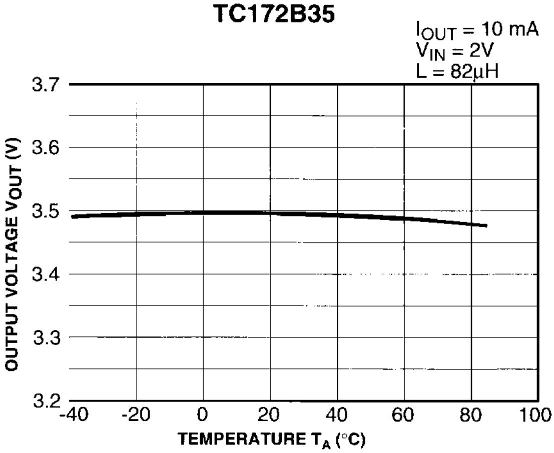

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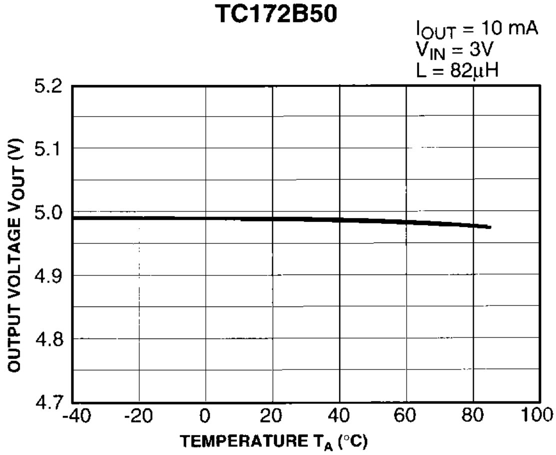
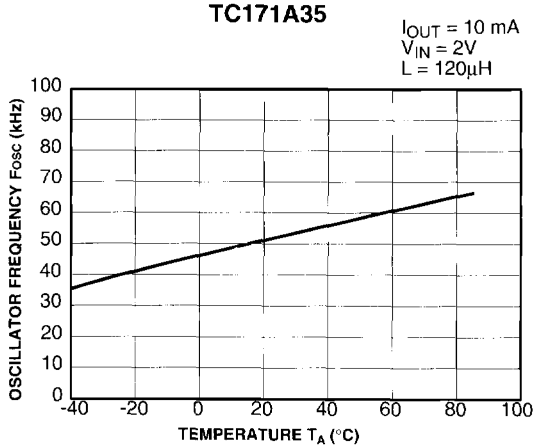


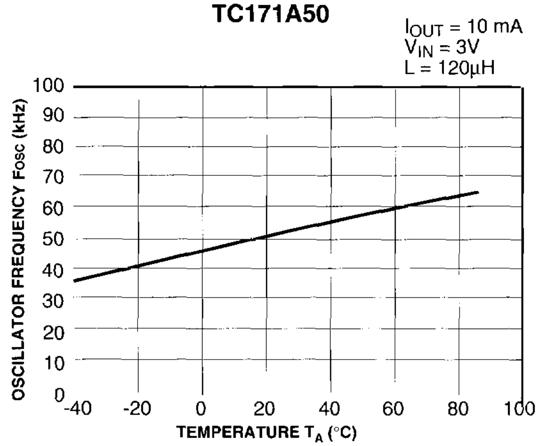
TYPICAL CHARACTERISTICS

8) Oscillator Frequency vs. Temperature (T_A = 25°C)

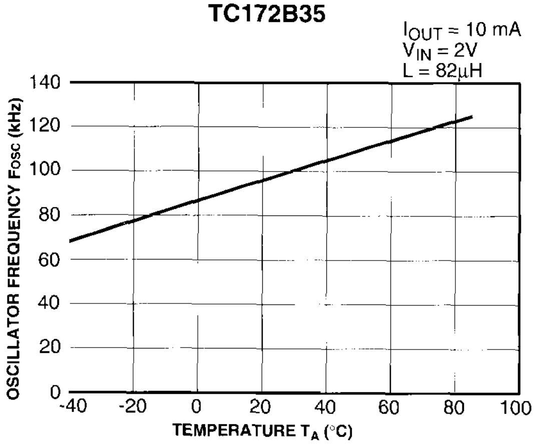
TC171A35



TC171A50



TC172B35



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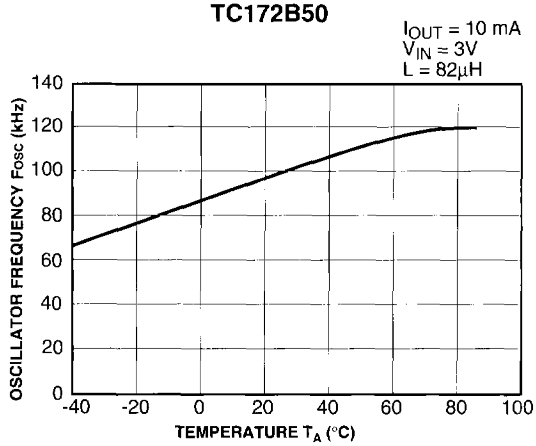
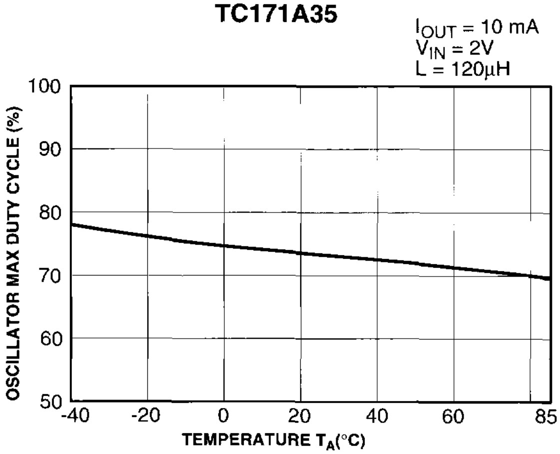


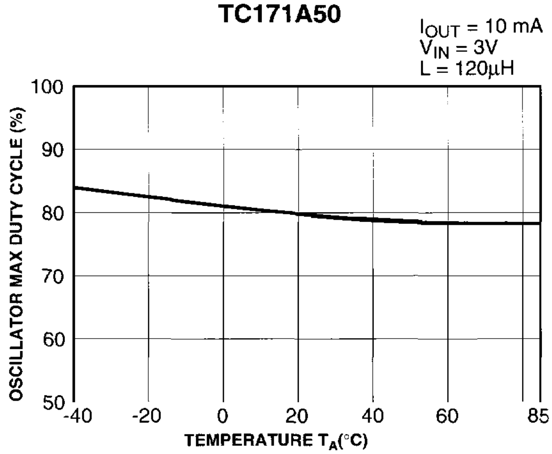
TYPICAL CHARACTERISTICS

9) Oscillator Max Duty Cycle vs. Temperature (T_A = 25°C)

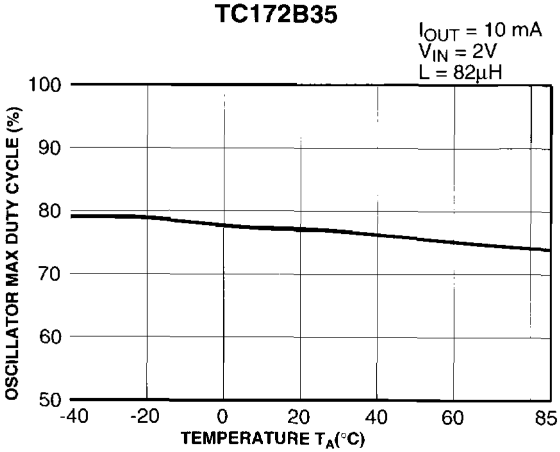
TC171A35



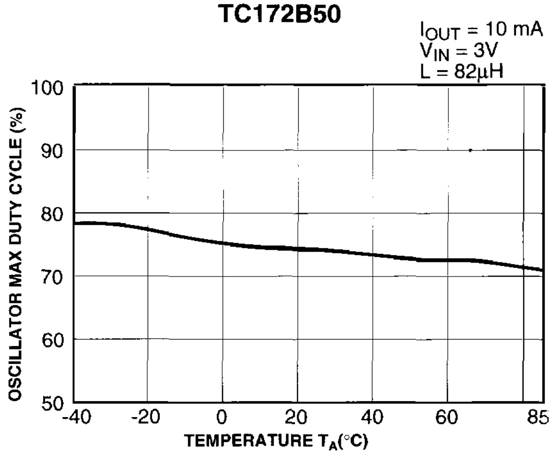
TC171A50



TC172B35



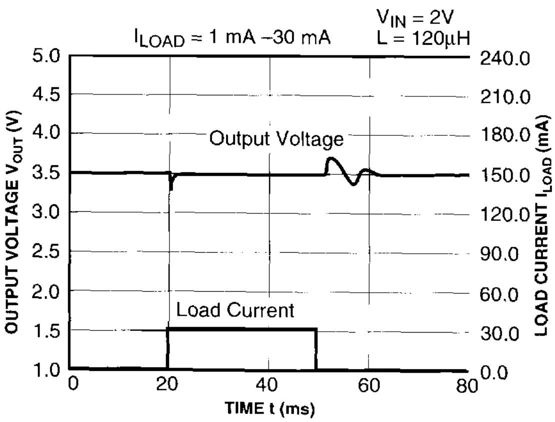
TC172B50



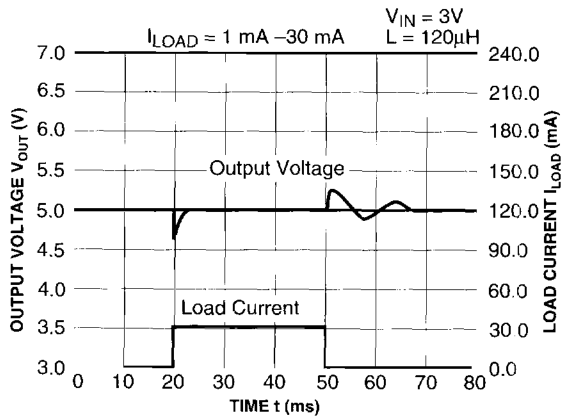
TYPICAL CHARACTERISTICS

10) Load Transient Response (T_A = 25°C)

TC171A35



TC171A50



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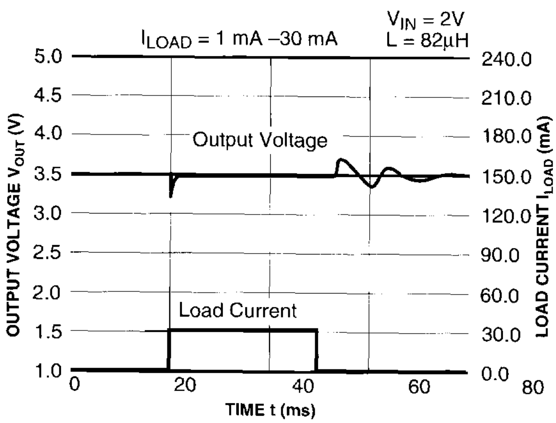

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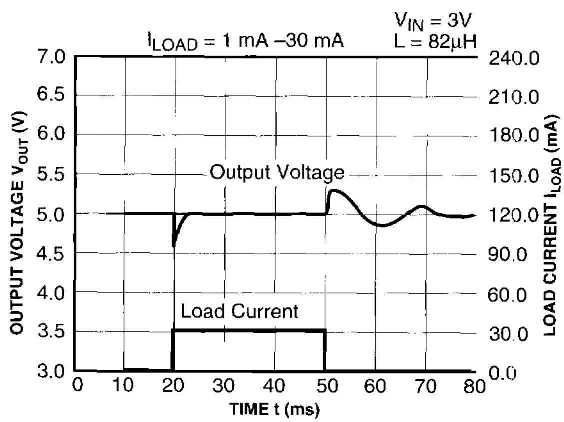

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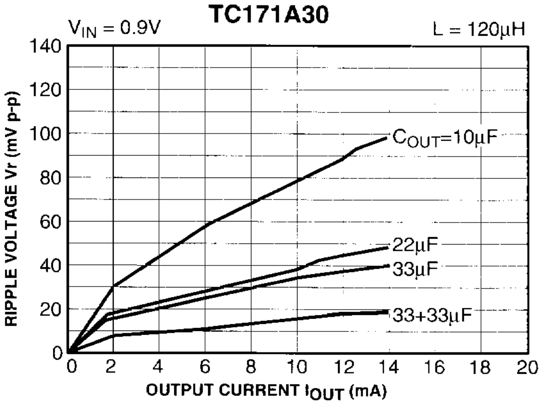
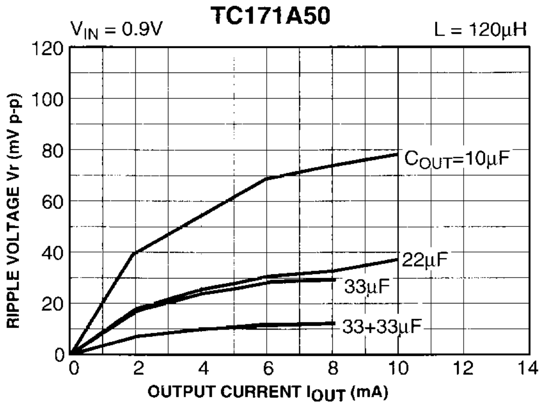
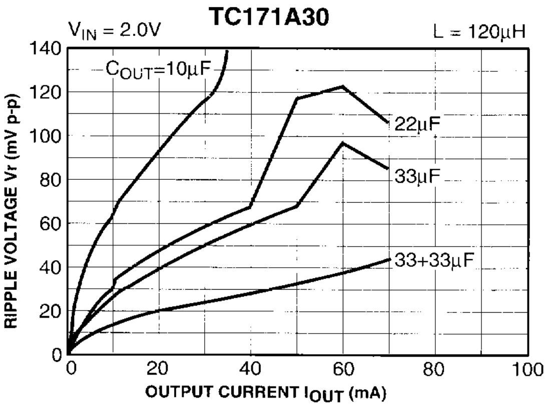
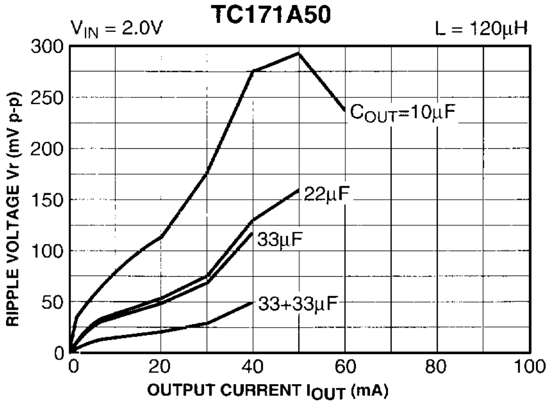
TYPICAL CHARACTERISTICS

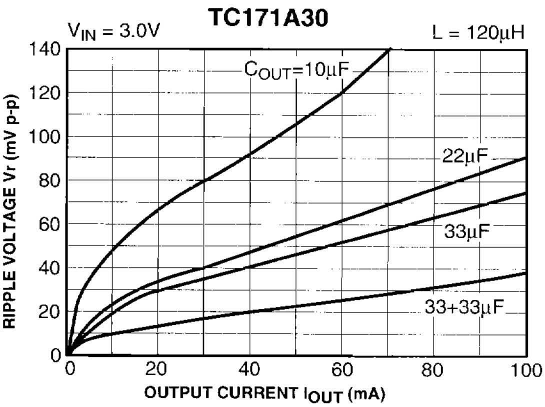
11) Ripple Voltage vs. Output Current (T_A = 25°C)

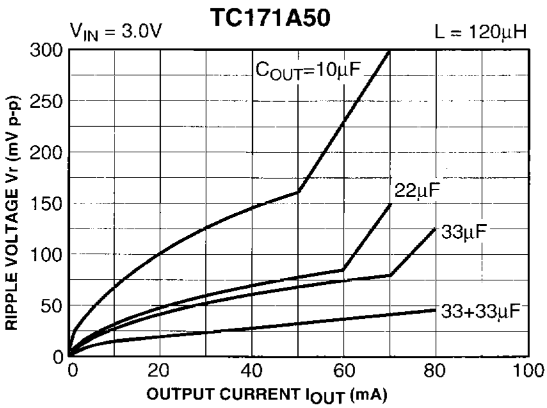








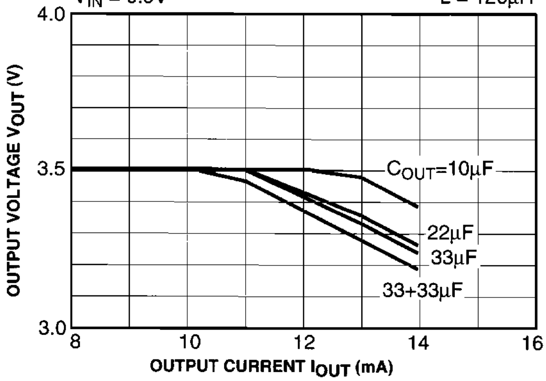




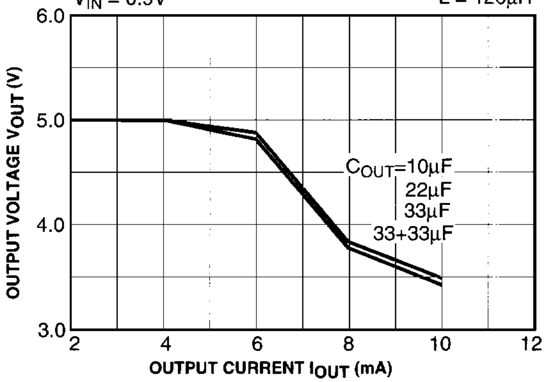
TYPICAL CHARACTERISTICS

12) Output Voltage vs. Output Current

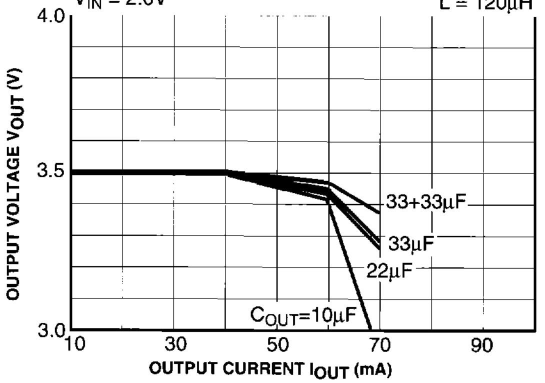
V_{IN} = 0.9V **TC171A30** L = 120µH



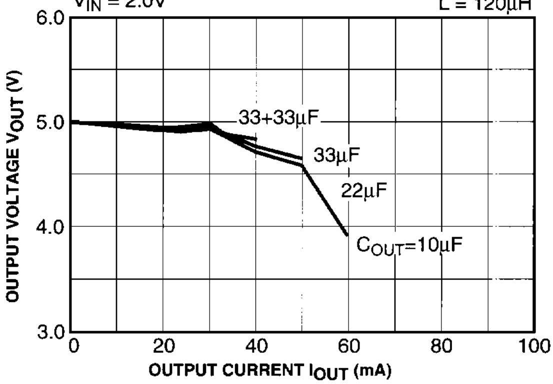
V_{IN} = 0.9V **TC171A50** L = 120µH



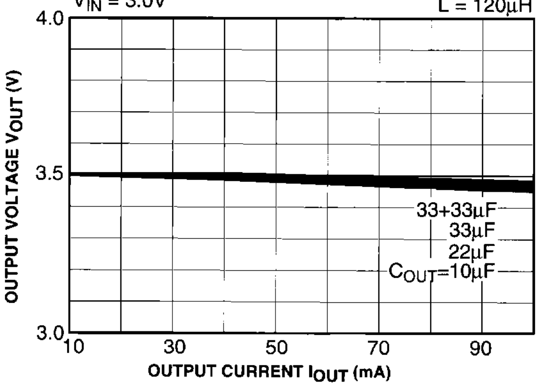
V_{IN} = 2.0V **TC171A30** L = 120µH



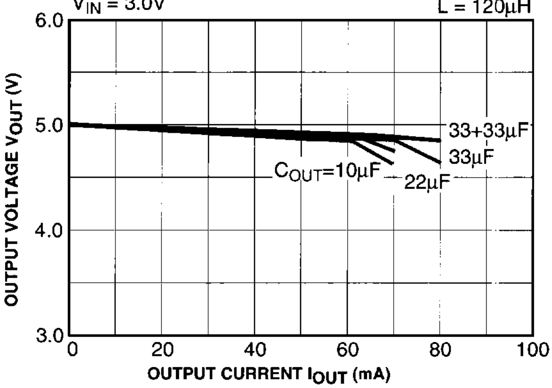
V_{IN} = 2.0V **TC171A50** L = 120µH



V_{IN} = 3.0V **TC171A30** L = 120µH

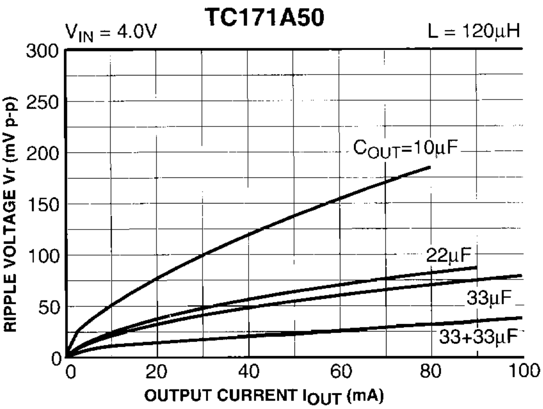


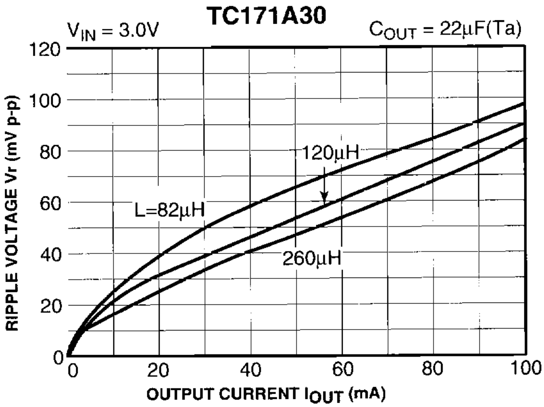
V_{IN} = 3.0V **TC171A50** L = 120µH

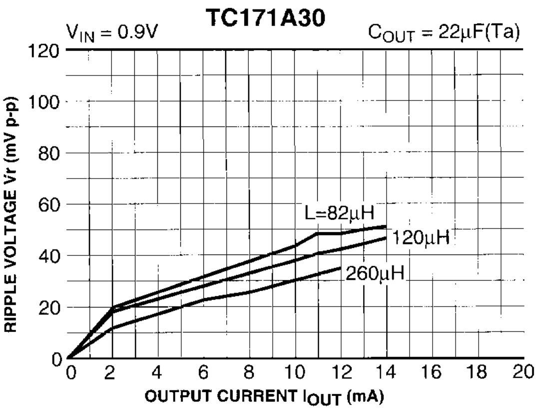


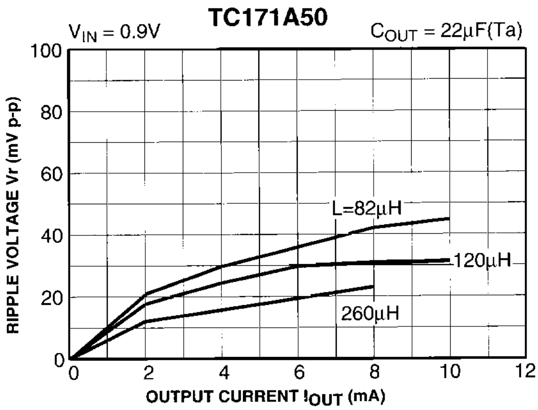
TYPICAL CHARACTERISTICS

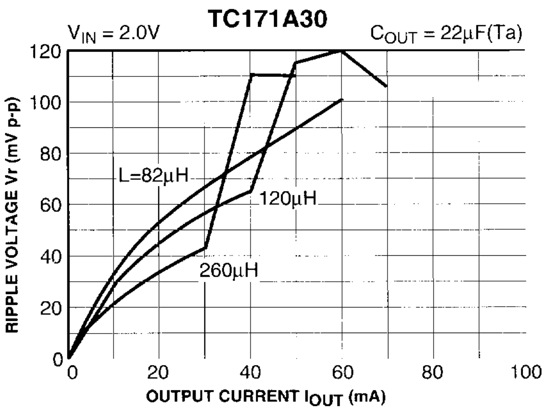
13) Ripple Voltage vs. Output Current

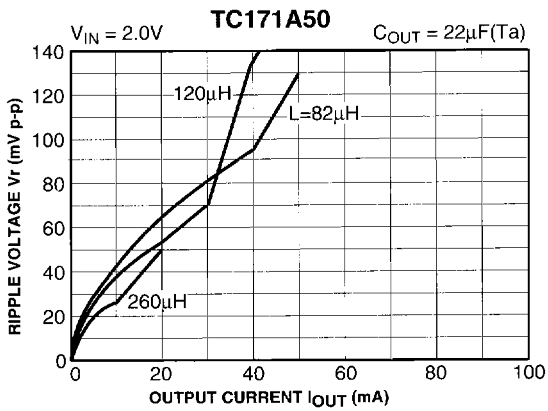






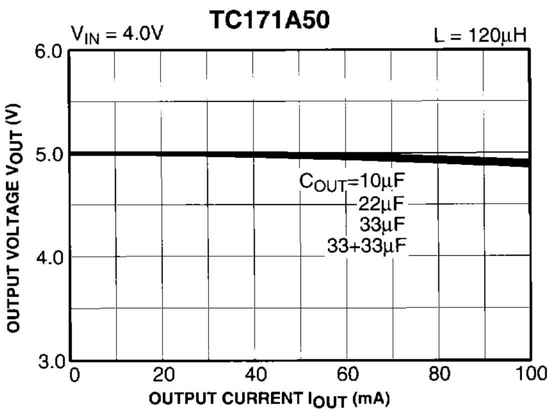


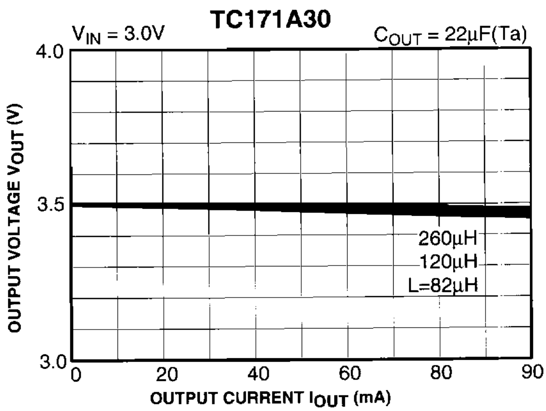


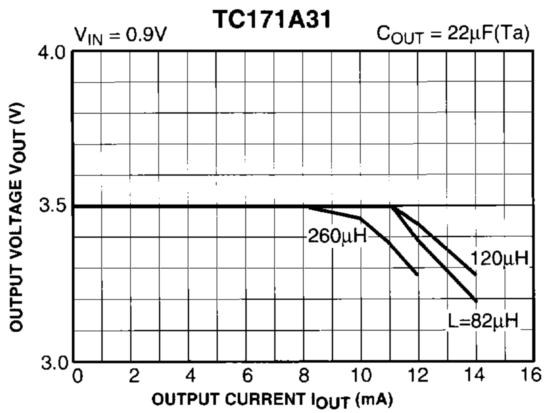


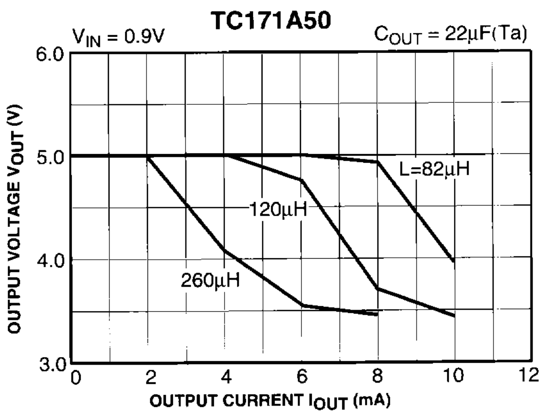
TYPICAL CHARACTERISTICS

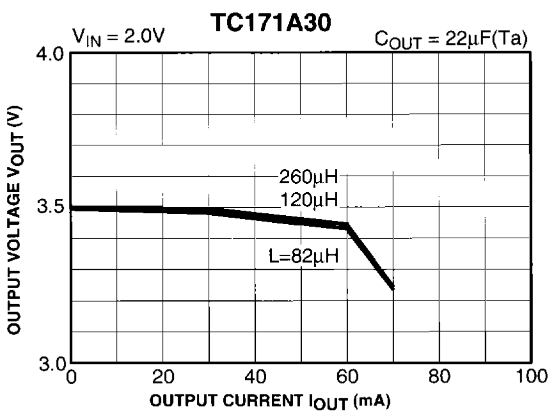
14) Output Voltage vs. Output Current

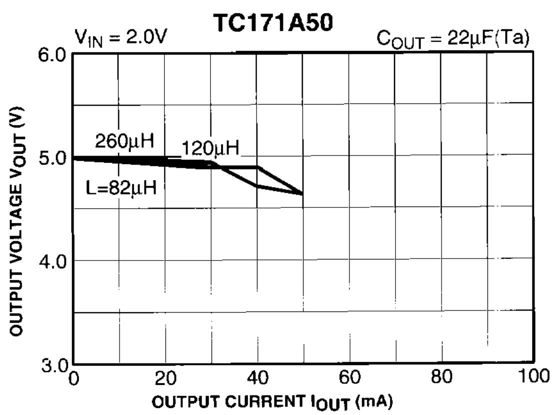












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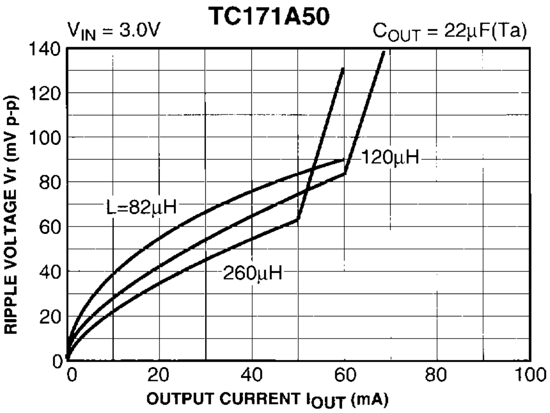
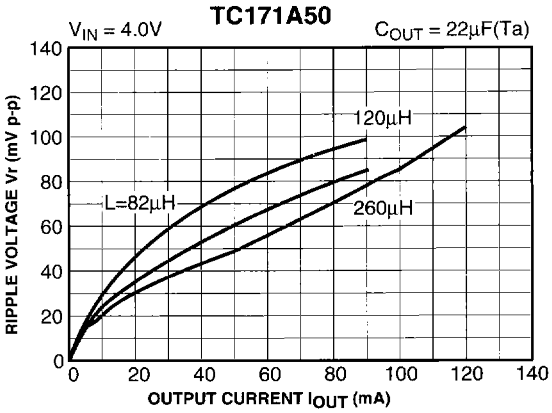
TYPICAL CHARACTERISTICS

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





16) Output Voltage vs. Output Current