DUAL LOW DROPOUT VOLTAGE REGULATOR

FEATURES

- **2 Channel LDO in one Package**
- **Outputs can be set by External Resistors**
- **High Precision Output Voltage (± 2.0 % or ± 60 mV)**
- **Independent Active High On/Off Control for each LDO**
- **Very Low Dropout Voltage (V_{DROP}A = 90 mV at 100 mA, V_{DROP}B = 80 mV at 50 mA)**
- **Stable with Ceramic Capacitors**
- **Excellent Ripple Rejection Ratio (84 dB @ 400 Hz)**
- **1 µA at Shutdown**
- **Peak Output Current is 370 mA**
- **SOT23L-8 Package**
- **Wide Operating Voltage Range (1.8 V ~ 14.5 V)**
- **Reverse Bias and Overcurrent Protection**
- **Built-in Thermal Shutdown**

APPLICATIONS

- **Battery Powered Systems**
- **Measurement Systems**
- **Mobile Communications Systems**
- **Cellular Phones**
- **Cordless Phones**
- **PDAs**
- **Toy Motor Drivers**

DESCRIPTION

The TK740xx is a Dual Ultra Low-Drop-Out regulator with a built-in electronic switch. The A-Side delivers up to 200 mA output current and the B-Side delivers up to 120 mA output current over the full temperature range. The internal switch can be controlled by TTL or CMOS logic levels. The device is in the "on" state when the control pin is pulled to a logic high level. External capacitors can be connected between the F_{BA} and V_{OUTA} and F_{BB} and V_{OUTB} pins to lower the output noise level.

Internal PNP pass transistors are used to achieve a low dropout voltage of 90 mV (typ.) at 100 mA load current side A and 80 mV (typ.) at 50 mA load current side B. The TK740xx has very low quiescent current. 45 µA at no load and 0.4 mA with a 50 mA load. The internal thermal shut down circuitry limits the junction temperature to 150 °C. The load current is internally monitored and the device will shut down in the presence of a short circuit or overcurrent condition at the output.

The TK740xx circuit features very high stability. An output capacitor of 0.22 µF provides stable operation for $V_{OUT} \geq 2.0$ V. Any type of capacitor can be used; however, the larger this capacitor is, the better the overall characteristics are. The ripple rejection ratio is 84 dB at 400 Hz, and 80 dB at 1 kHz.

The TK740xx is available in the SOT23L-8 surface mount package.

ORDERING INFORMATION

TK740 □CL-□□□□

- Package Code
- Temp. Code
- Tape/Reel Code
- A Side Voltage Code
- B Side Voltage Code

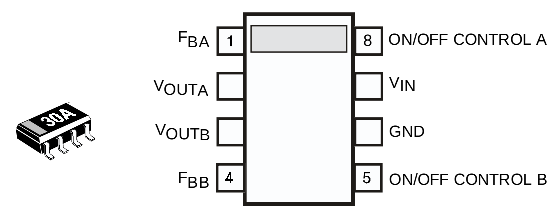
VOLTAGE CODES:
Refer to Table 1

PACKAGE CODE:
S: SOT23L-8

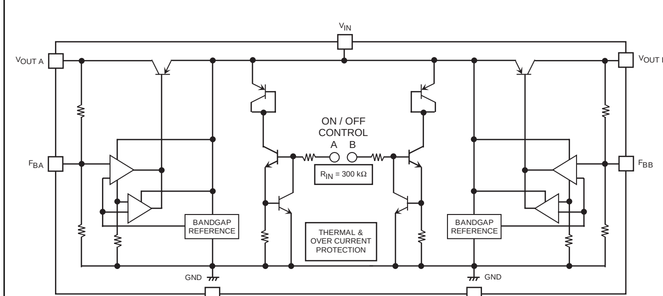
TAPE/REEL CODE:
L: Tape Left
Reel Size = 1300 pcs.

TEMP. CODE:
C: -30 to 80°C
I: -40 to 85°C

TK740xxL



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS - C RANK

Supply Voltage .... -0.4 to16 V
Power Dissipation .... 600 mW
Reverse Bias Voltage .... -0.4 to 10 V
Operating Voltage Range .... 1.8 to 14.5 V
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +80 °C
Noise Bypass Pin Voltage .... -0.4 to 5 V
Control Pin Voltage .... -0.4 to V_{OP} V
Short Circuit Current (A Side) .... 430 mA
Short Circuit Current (B Side) .... 330 mA

TK740xx ELECTRICAL CHARACTERISTICS - C RANK

Test conditions: T_A = 25 °C, $V_{IN} = V_{OUT(TYP)}$ + 1 V, I_{OUT} = 1 mA

SYMBOL		PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
COMMON	V_{OUT}	Output Voltage	I_{OUT} = 5 mA	See Table 1			
COMMON	Line Reg	Line Regulation	Δ V = 5 V ($V_{IN} = V_{OUT(TYP)}$ + 1V to $V_{OUT(TYP)}$ + 6 V) I_{OUT} = 5 mA V_{IN} = 18 V		0.0	5.0	mV
COMMON	I_Q	Quiescent Current	I_{OUT} = 0 mA Excluding I_{CONT}		45	75	μA
COMMON	I_{STBY}	Standby Current	V_{CC} = 10 V OFF Mode		0.0	0.1	μA
COMMON	V_{FB}	Feedback Term. Voltage		1.11	1.19	1.29	V
COMMON	$\Delta V_{OUT}/\Delta T_A$	Temperature Coefficient	I_{OUT} = 5 mA		70		ppm / °C
COMMON	CONTROL TERMINAL SPECIFICATION (Note 3)						
COMMON	I_{CONT}	Control Current	V_{OUT} = 1.8 V, ON Mode		1.8	5	μA
COMMON	V_{CONT}	Control Voltage	Output ON	1.8			V
COMMON	V_{CONT}	Control Voltage	Output OFF			0.8	V
SIDE A	Load Reg	Load Regulation (Note 1)	I_{OUT} = 5 mA to 100 mA		14	30	mV
SIDE A	Load Reg	Load Regulation (Note 1)	I_{OUT} = 5 mA to 200 mA		33	37	mV
SIDE A	V_{DROP}	Dropout Voltage	I_{OUT} = 100 mA		90	150	mV
SIDE A	V_{DROP}	Dropout Voltage	I_{OUT} = 150 mA		125	180	mV
SIDE A	V_{DROP}	Dropout Voltage	I_{OUT} = 200 mA		160	250	mV
SIDE A	$I_{OUT(MAX)}$	Maximum Output Current	$V_{OUT} = V_{OUT(TYP)}$ x 0.9 (Note 2)	290	380		mA
SIDE B	Load Reg	Load Regulation (Note 1)	I_{OUT} = 5 mA to 100 mA		17	40	mV
SIDE B	V_{DROP}	Dropout Voltage	I_{OUT} = 50 mA		80	125	mV
SIDE B	V_{DROP}	Dropout Voltage	I_{OUT} = 100 mA		135	220	mV
SIDE B	$I_{OUT(MAX)}$	Maximum Output Current	$V_{OUT} = V_{OUT(TYP)}$ x 0.9 (Note 2)	190	280		mA

TK740xx ELECTRICAL CHARACTERISTICS - C RANK (CONT.)

Test conditions: T_A = 25 °C, $V_{IN} = V_{OUT(TYP)}$ + 1 V, I_{OUT} = 1 mA

SYMBOL		PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
	RR	Ripple Rejection	f = 400 Hz, CL = 1.0 μF, C_N = 0.01 μF, V_{NOISE} = 200 mV_{RMS}, $V_{IN} = V_{OUT(TYP)}$ + 1.5 V, I_{OUT} = 10 mA		84		dB
			f = 1 kHz, CL = 1.0 μF, C_N = 0.01 μF, V_{NOISE} = 200 mV_{RMS}, $V_{IN} = V_{OUT(TYP)}$ + 1.5 V, I_{OUT} = 10 mA		80		dB

Note 1: This value depends on the output voltage. This is a reference value for a 3V output device. The details of each device are described in the individual specifications.

Note 2: The output current is limited by the power dissipation of the total of both sides.

Note 3: Pull down resistor for control terminal is not built in.

General Note: Parameters with only typical values are just reference. (Not guaranteed)

General Note: Limits are guaranteed by production testing or correction techniques using Statistical Quality Control (SQC) methods. Unless otherwise noted. $V_{IN} = V_{OUT(TYP)}$ + 1V; I_{OUT}= 1 mA (Tj = 25°C) The operation of -30° to 80°C is guaranteed in the design by a usual inspection.

General Note: Exceeding the “Absolute Maximum Rating” may damage the device.

ABSOLUTE MAXIMUM RATINGS - I RANK

Supply Voltage .... -0.4 to16 V
Power Dissipation .... 600 mW
Reverse Bias Voltage .... -0.4 to 10 V
Operating Voltage Range .... 2.1 to 14 V
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -40 to +85 °C
Noise Bypass Pin Voltage .... -0.4 to 5 V
Control Pin Voltage .... -0.4 to V_{OP} V
Short Circuit Current (A Side) .... 430 mA
Short Circuit Current (B Side) .... 330 mA

TK740xx ELECTRICAL CHARACTERISTICS - I RANK

Test conditions: T_A = 25 °C, Bold typeface applies over the -40°C to 85°C Ambient Temperature Range. Operational Voltage Range is (2.1 V ≤ V_{OP} ≤ 14 V). Unless otherwise noted. $V_{IN} = V_{OUT(TYP)}$ + 1 V, I_{OUT} = 1 mA

SYMBOL		PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
COMMON	V_{OUT}	Output Voltage	I_{OUT} = 5 mA	See Table 2			
COMMON	Line Reg	Line Regulation	Δ V = 5 V ($V_{IN} = V_{OUT(TYP)}$ + 1V to $V_{OUT(TYP)}$ + 6 V) I_{OUT} = 5 mA V_{IN} = 18 V		0.0	5.0 **7.0**	mV
COMMON	I_Q	Quiescent Current	I_{OUT} = 0 mA Excluding I_{CONT}		45	75 **95**	µA
COMMON	I_{STBY}	Standby Current	V_{CC} = 10 V OFF Mode		0.0	0.1 **3**	µA
COMMON	V_{FB}	Feedback Term. Voltage		1.11	**1.19**	**1.30**	V
COMMON	$\Delta V_{OUT}/\Delta T_A$	Temperature Coefficient	I_{OUT} = 5 mA		70		ppm / °C
COMMON	Control Terminal Specification (Note 3)						
COMMON	I_{CONT}	Control Current	V_{OUT} = 1.8 V ON Mode		1.8	5 7	µA
COMMON	V_{CONT}	Control Voltage	Output ON	1.8 **2.0**			V
COMMON	V_{CONT}	Control Voltage	Output OFF			0.8 **0.6**	V
SIDE A	Load Reg	Load Regulation (Note 1)	I_{OUT} = 5 mA to 100 mA		14	30 **39**	mV
SIDE A	Load Reg	Load Regulation (Note 1)	I_{OUT} = 5 mA to 200 mA		33	70 **90**	mV
SIDE A	V_{DROP}	Dropout Voltage	I_{OUT} = 100 mA		90	150 **180**	mV
SIDE A	V_{DROP}	Dropout Voltage	I_{OUT} = 150 mA		125	180 **230**	mV
SIDE A	V_{DROP}	Dropout Voltage	I_{OUT} = 200 mA		160	250 **300**	mV
SIDE A	$I_{OUT(MAX)}$	Maximum Output Current	$V_{OUT} = V_{OUT(TYP)}$ x 0.9 (Note 2)	290 **250**	380		mA

TK740xx ELECTRICAL CHARACTERISTICS (I RANK) (CONT.)

Test conditions: T_A = 25 °C, Bold typeface applies over the -40°C to 85°C Ambient Temperature Range. Operational Voltage Range is (2.1 V ≤ V_{OP} ≤ 14 V). Unless otherwise noted. $V_{IN} = V_{OUT(TYP)}$ + 1 V, I_{OUT} = 1 mA

	SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
SIDE B	Load Reg	Load Regulation (Note 1)	I_{OUT} = 5 mA to 100 mA		17	40 **50**	mV
SIDE B	V_{DROP}	Dropout Voltage	I_{OUT} = 50 mA		80	125 **175**	mV
SIDE B	V_{DROP}	Dropout Voltage	I_{OUT} = 100 mA		135	220 **280**	mV
SIDE B	$I_{OUT(MAX)}$	Maximum Output Current	$V_{OUT} = V_{OUT(TYP)}$ x 0.9 (Note 2)	190 **150**	380		mA
	RR	Ripple Rejection	f = 400 Hz, CL = 1.0 μF, C_N = 0.01 μF, V_{NOISE} = 200 mV_{RMS}, $V_{IN} = V_{OUT(TYP)}$ + 1.5 V, I_{OUT} = 10 mA		84		dB
	RR	Ripple Rejection	f = 1 kHz, CL = 1.0 μF, C_N = 0.01 μF, V_{NOISE} = 200 mV_{RMS}, $V_{IN} = V_{OUT(TYP)}$ + 1.5 V, I_{OUT} = 10 mA		80		dB

Note 1: This value depends on the output voltage. This is a reference value for a 3V output device. The details of each device are described in the individual specifications.

Note 2: The output current is limited by the power dissipation of the total of both sides.

Note 3: Pull down resistor for control terminal is not built in.

General Note: Parameters with only typical values are just reference. (Not guaranteed)

General Note: Limits are guaranteed by production testing or correction techniques using Statistical Quality Control (SQC) methods. Unless otherwise noted. $V_{IN} = V_{OUT(TYP)}$ + 1V; I_{OUT}= 1 mA (Tj = 25°C) The operation of -40° to 85°C is guaranteed in the design by a usual inspection.

General Note: Exceeding the “Absolute Maximum Rating” may damage the device.

TK740xx ELECTRICAL CHARACTERISTICS TABLE 1

Test Conditions: $V_{IN} = V_{OUT(TYP)} + 1$ V, $I_{OUT} = 5$ mA, $T_A = 25$ °C, unless otherwise specified.

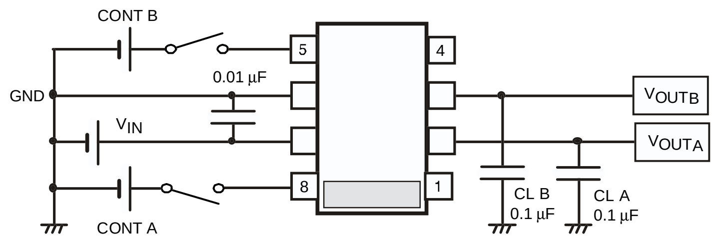
			Standard Temp. Range Spec. Room Temp (T_A = 25°C)		Extended Temp. Range. Spec. Full Temp (T_A = -40 to 85°C)	
Availability	**Output Voltage**	**Voltage Code**	**V_{OUT} Min**	**V_{OUT} Max**	**V_{OUT} Min**	**V_{OUT} Max**
	1.3 V	13	1.240 V	1.360V		
	1.4 V	14	1.340 V	1.460 V		
*	1.5 V	15	1.440 V	1.560 V		
	1.6 V	16	1.540 V	1.660 V		
	1.7 V	17	1.640 V	1.760 V		
*	1.8 V	18	1.740 V	1.860 V	1.720 V	1.880 V
*	1.9 V	19	1.840 V	1.960 V		
*	2.0 V	20	1.940 V	2.060 V	1.920 V	2.080 V
	2.1 V	21	2.040 V	2.160 V	2.020 V	2.180 V
*	2.2 V	22	2.140 V	2.260 V	2.120 V	2.280 V
	2.3 V	23	2.240 V	2.360 V	2.220 V	2.380 V
	2.4 V	24	2.340 V	2.460 V	2.320 V	2.480 V
*	2.5 V	25	2.440 V	2.560 V	2.420 V	2.580 V
	2.6 V	26	2.540 V	2.660 V	2.520 V	2.680 V
*	2.7 V	27	2.640 V	2.760 V	2.620 V	2.780 V
*	2.8 V	28	2.740 V	2.860 V	2.720 V	2.880 V
*	2.9 V	29	2.840 V	2.960 V	2.820 V	2.980 V
*	3.0 V	30	2.940 V	3.060 V	2.920 V	3.080 V
*	3.1 V	31	3.038 V	3.162 V	3.020 V	3.180 V
*	3.2 V	32	3.136 V	3.264 V	3.120 V	3.280 V

TK740xx ELECTRICAL CHARACTERISTICS TABLE 1 (CONT)

Test Conditions: $V_{IN} = V_{OUT(TYP)} + 1$ V, $I_{OUT} = 5$ mA, $T_A = 25$ °C, unless otherwise specified.

			Standard Temp. Range Spec. Room Temp (T_A = 25°C)		Extended Temp. Range. Spec. Full Temp (T_A = -40 to 85°C)	
Availability	Output Voltage	Voltage Code	V_{OUT} Min	V_{OUT} Max	V_{OUT} Min	V_{OUT} Max
*	3.3 V	33	3.234 V	3.366 V	3.220 V	3.380 V
	3.4 V	34	3.232 V	3.468 V	3.320 V	3.480 V
*	3.5 V	35	3.430 V	3.570	3.420 V	3.580 V
*	3.6 V	36	3.528 V	3.672 V	3.520 V	3.680 V
	3.7 V	37	3.626 V	3.774 V	3.620 V	3.780 V
*	3.8 V	38	3.724 V	3.876 V	3.720 V	3.880 V
	3.9 V	39	3.822 V	3.978 V	3.820 V	3.980 V
*	4.0 V	40	3.920 V	4.080 V	3.910 V	4.090 V
	4.1 V	41	4.018 V	4.182 V	4.009 V	4.191 V
	4.2 V	42	4.116 V	4.284 V	4.108 V	4.292 V
	4.3 V	43	4.214 V	4.386 V	4.197 V	4.393 V
	4.4 V	44	4.312 V	4.488 V	4.306 V	4.494 V
*	4.5 V	45	4.410 V	4.590 V	4.405 V	4.595 V
	4.6 V	46	4.508 V	4.692 V	4.504 V	4.696 V
*	4.7 V	47	4.606 V	4.794 V	4.606 V	4.797 V
	4.8 V	48	4.704 V	4.896 V	4.702 V	4.898 V
	4.9 V	49	4.802 V	4.998 V	4.801 V	4.999 V
*	5.0 V	50	4.900 V	5.100 V	4.900 V	5.100 V

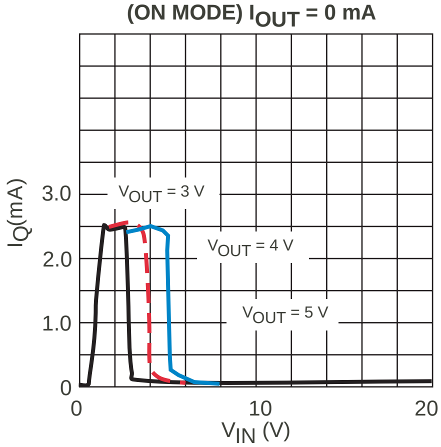
TEST CIRCUIT



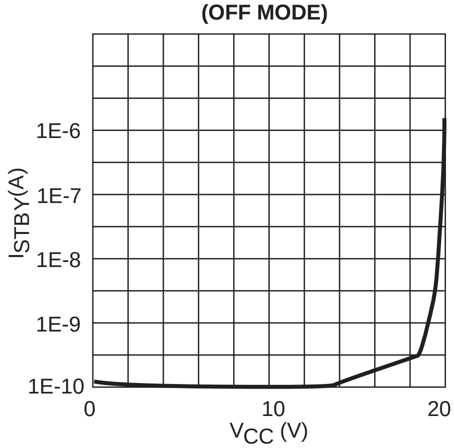
TYPICAL PERFORMANCE CHARACTERISTICS

A and B: COMMON CHARACTERISTICS

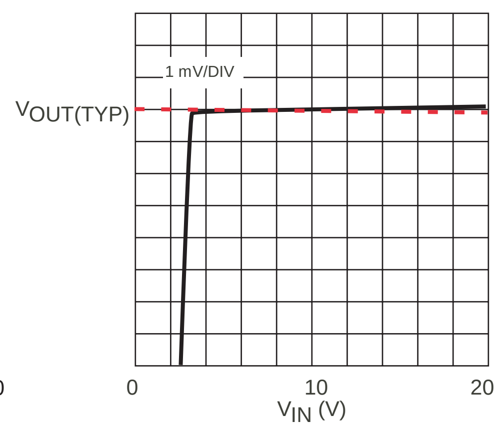
QUIESCENT CURRENT vs. V_{IN} (ON MODE) I_{OUT} = 0 mA



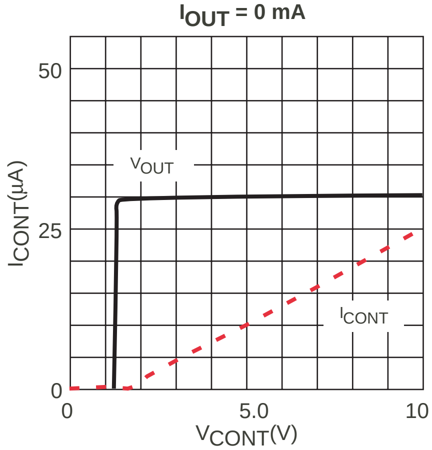
STANDBY CURRENT vs. V_{IN} (OFF MODE)



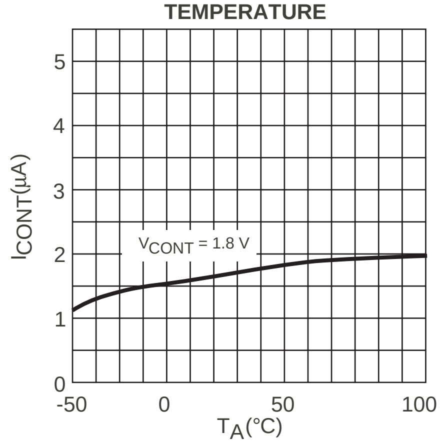
LINE REGULATION



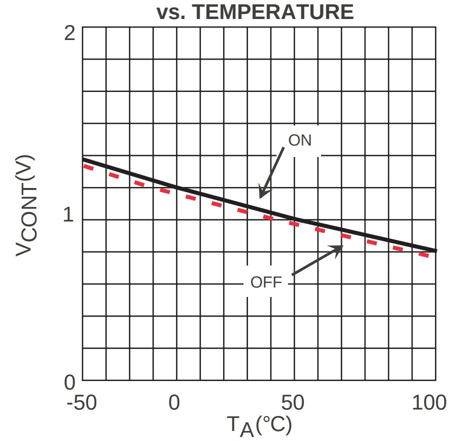
CONTROL CURRENT vs. CONTROL VOLTAGE I_{OUT} = 0 mA



CONTROL CURRENT vs. TEMPERATURE



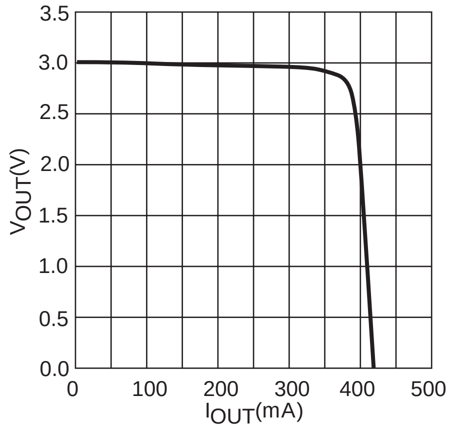
CONTROL VOLTAGE (V_{OUT}, ON/OFF POINT) vs. TEMPERATURE



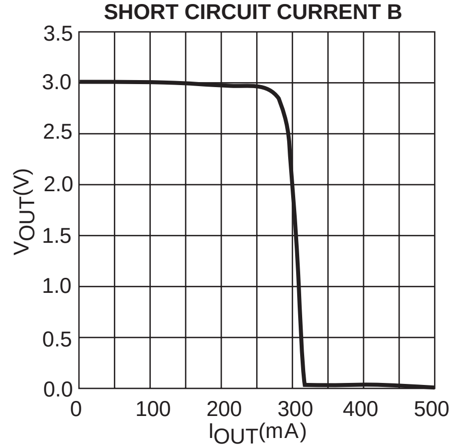
TYPICAL PERFORMANCE CHARACTERISTICS (CONT)

SIDE A	SIDE B

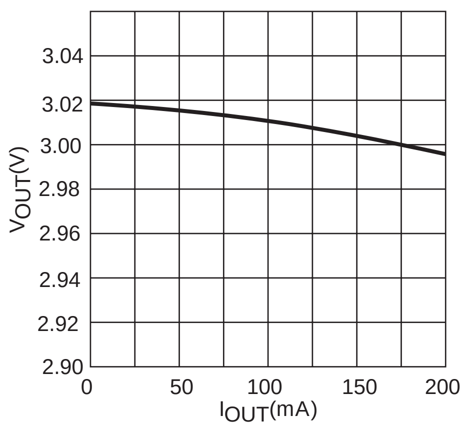
SHORT CIRCUIT CURRENT A



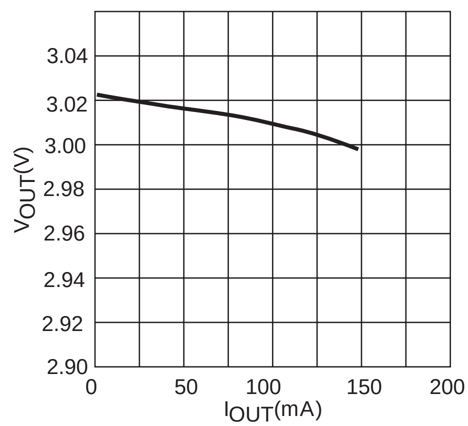
SHORT CIRCUIT CURRENT B



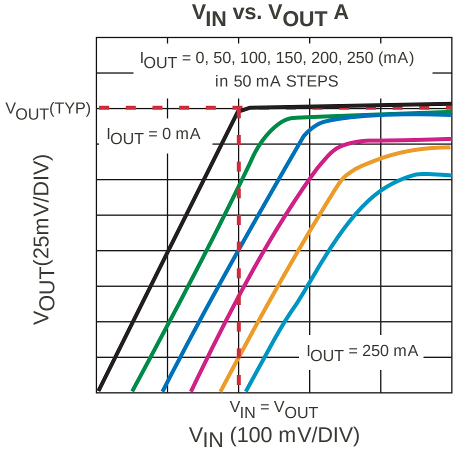
LOAD REGULATION A



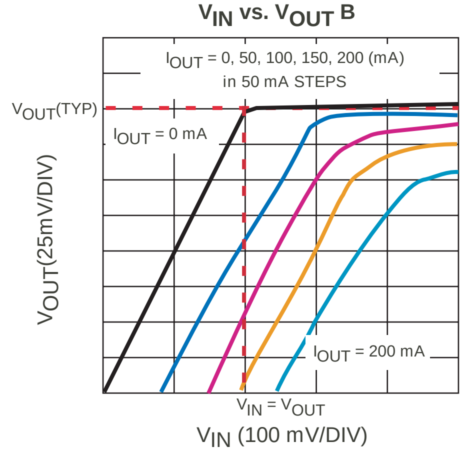
LOAD REGULATION B



V_{IN} vs. V_{OUT} A

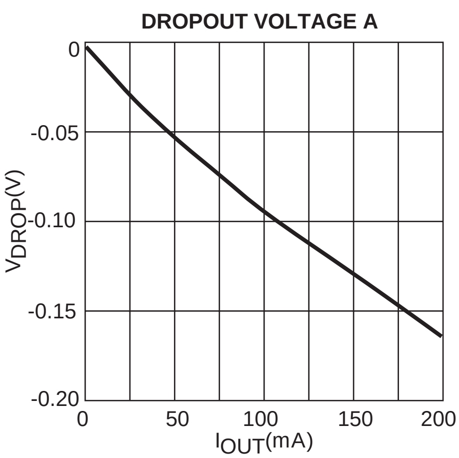


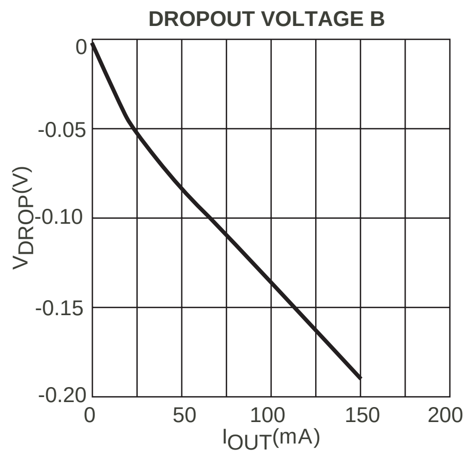
V_{IN} vs. V_{OUT} B

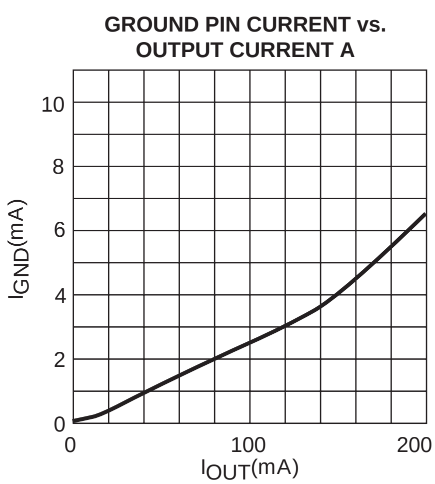


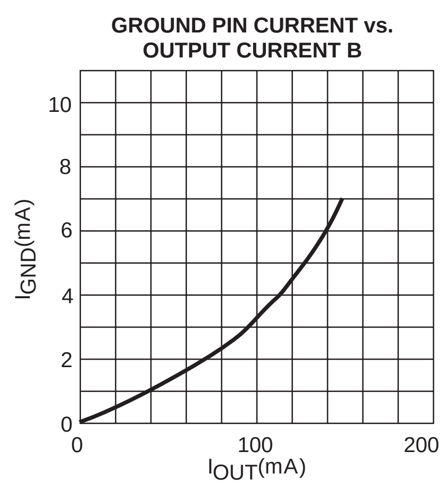
TYPICAL PERFORMANCE CHARACTERISTICS (CONT)

SIDE A	SIDE B







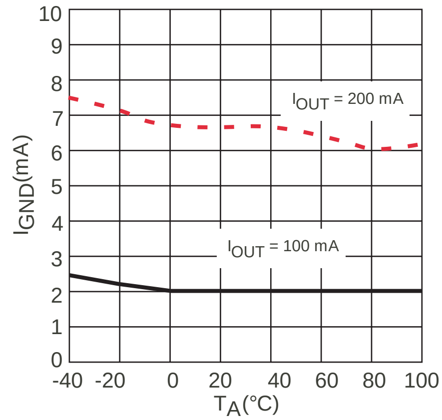


TYPICAL PERFORMANCE CHARACTERISTICS (CONT)

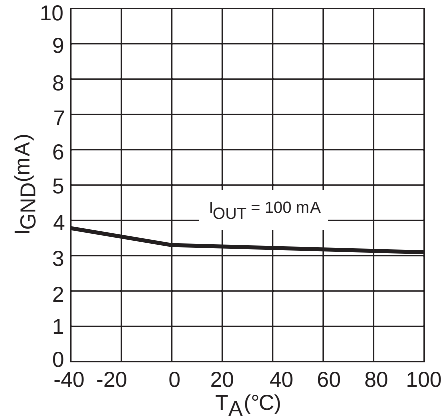
SIDE A	SIDE B

AMBIENT TEMPERATURE BEHAVIOR

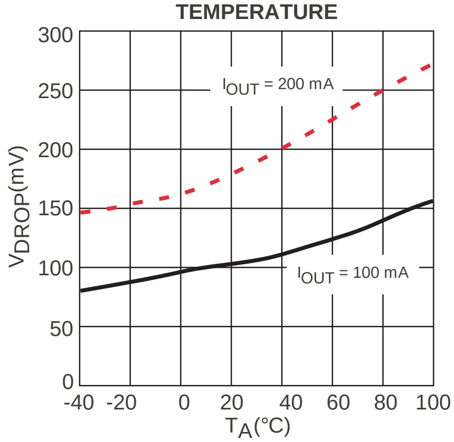
GROUND PIN CURRENT vs. TEMPERATURE (Side A)



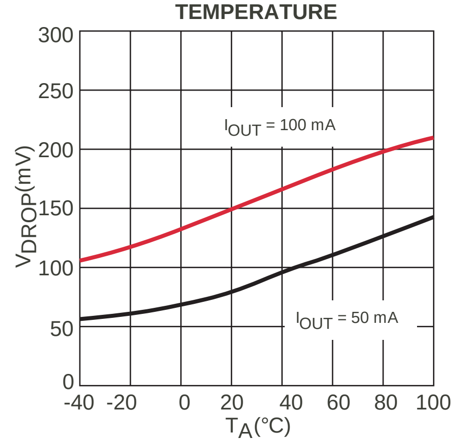
GROUND PIN CURRENT vs. TEMPERATURE (Side B)



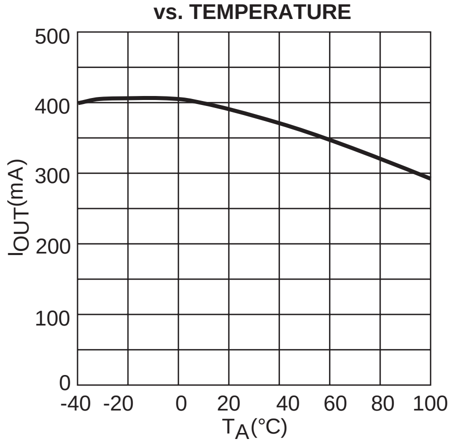
DROPOUT VOLTAGE vs. TEMPERATURE (Side A)



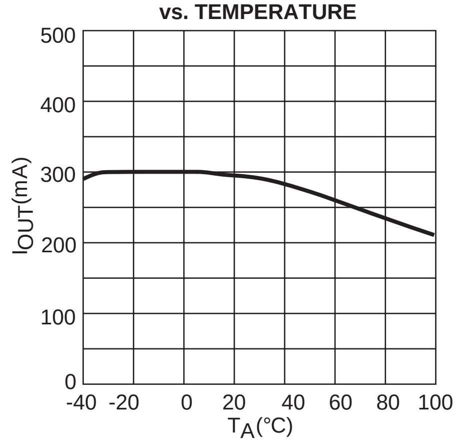
DROPOUT VOLTAGE vs. TEMPERATURE (Side B)



MAXIMUM OUTPUT CURRENT vs. TEMPERATURE (Side A)



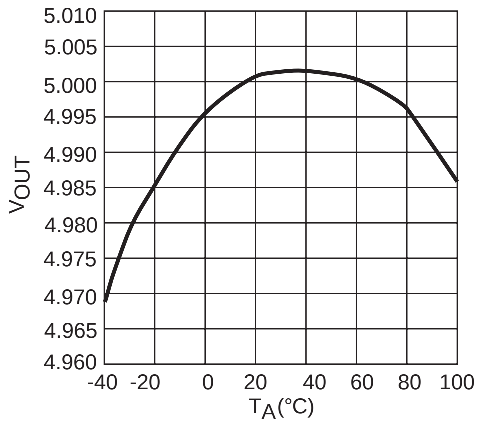
MAXIMUM OUTPUT CURRENT vs. TEMPERATURE (Side B)



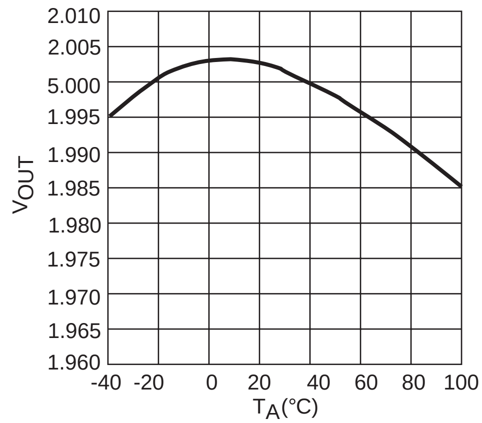
TYPICAL PERFORMANCE CHARACTERISTICS (CONT)

OUTPUT VOLTAGE TEMPERATURE BEHAVIOR

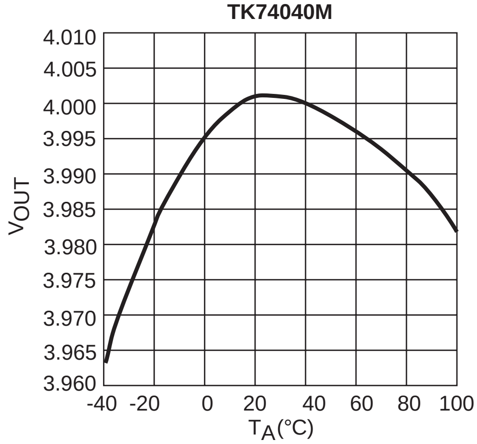
TK74050M



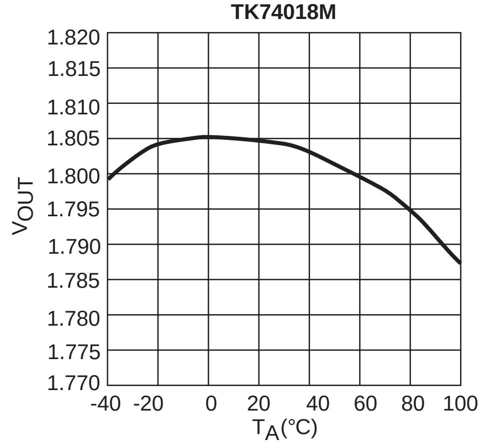
TK74020M



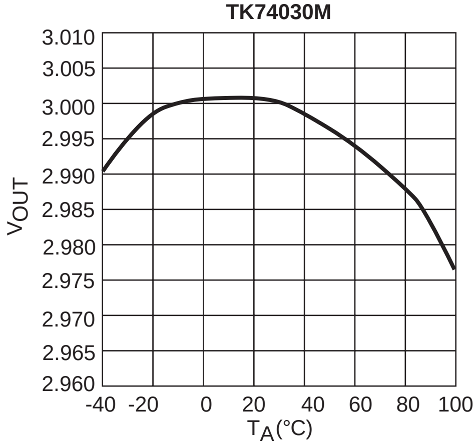
TK74040M



TK74018M



TK74030M



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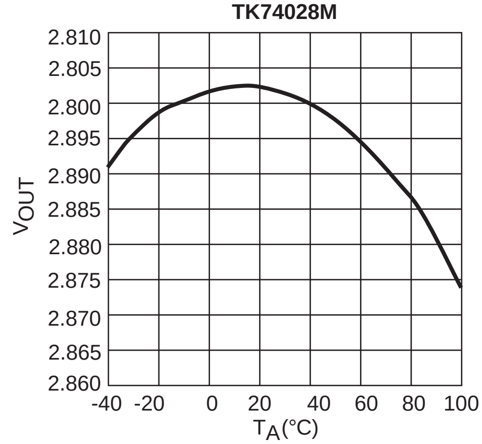
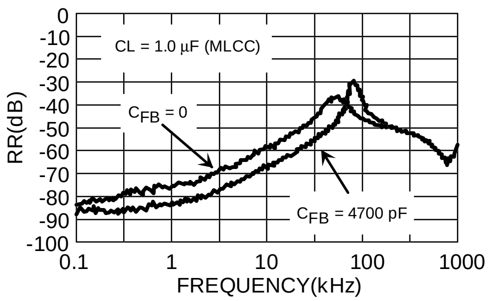
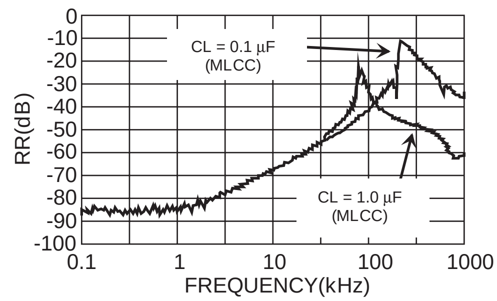
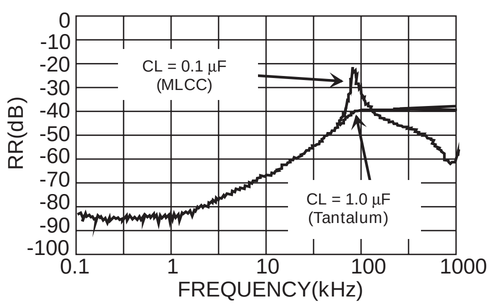


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

Ripple Rejection (Tk74030M)

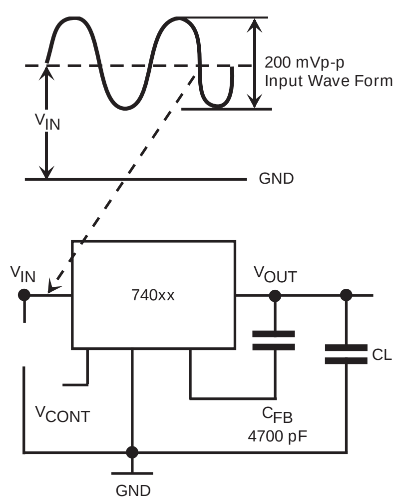






Conditions:
V_{IN} = 4.0 V
V_{RIPPLE} = 500 mVp-p
C_{IN} = 0 μF
I_{OUT} = 10 mA
C_{OUT} = 1.0 μF (MLCC)
C_{FB} = 4700 pF

With C_{FB}



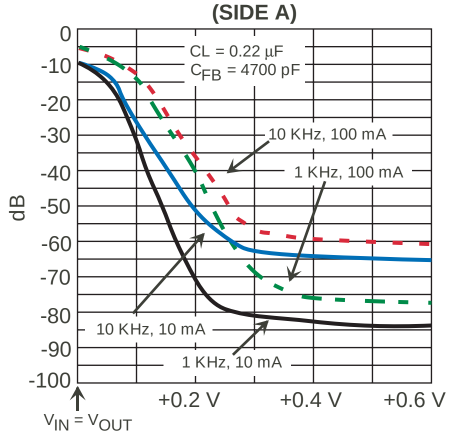
The Ripple Rejection characteristic improves by enlarging the capacitor on the output side. The characteristic of the high frequency area is decided by the characteristic of the output side capacitor.

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

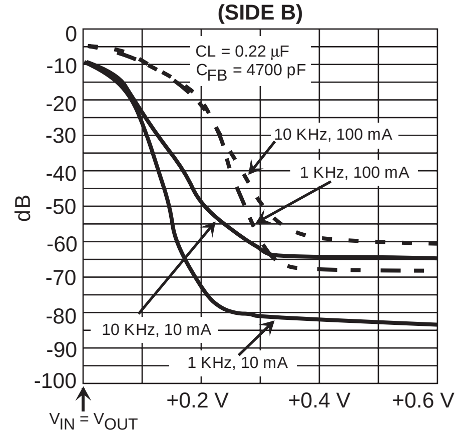
Ripple Rejection When I/O Voltage difference is few

When the difference between the input voltage and the output voltage decreases, the Ripple Rejection characteristic is different in Side A and Side B. The characteristic on the A side (where the power transistor is large) improves.

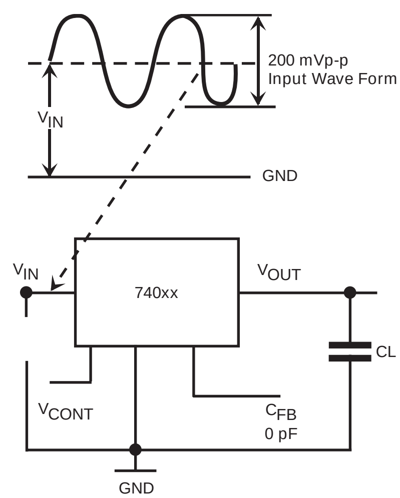
RIPPLE REJECTION vs. V_{IN} (SIDE A)



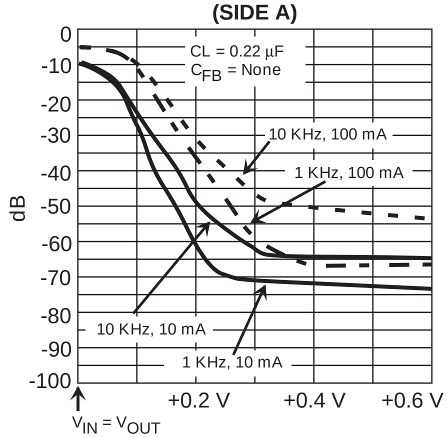
RIPPLE REJECTION vs. V_{IN} (SIDE B)



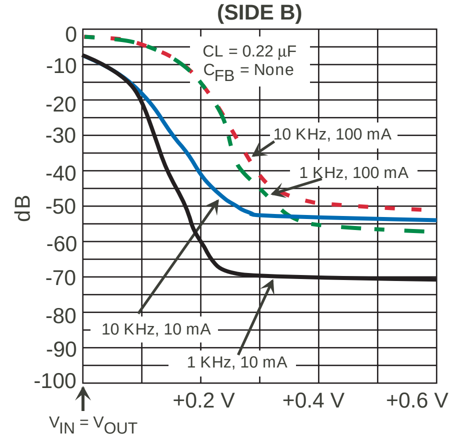
Without C_{FB}



RIPPLE REJECTION vs. V_{IN} (SIDE A)

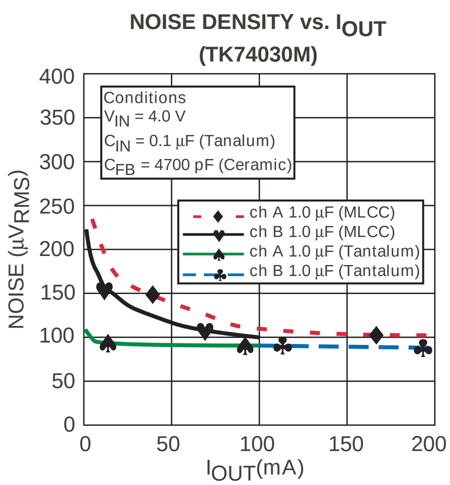


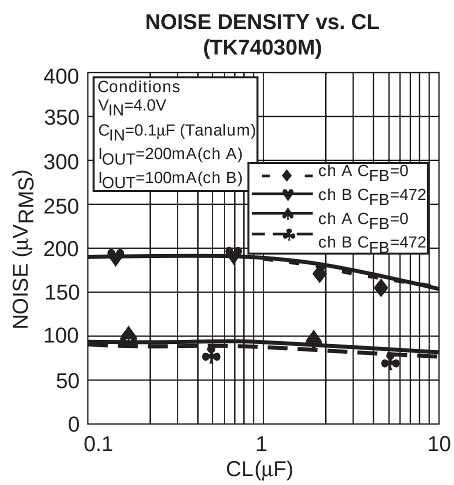
RIPPLE REJECTION vs. V_{IN} (SIDE B)



TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

OUTPUT NOISE





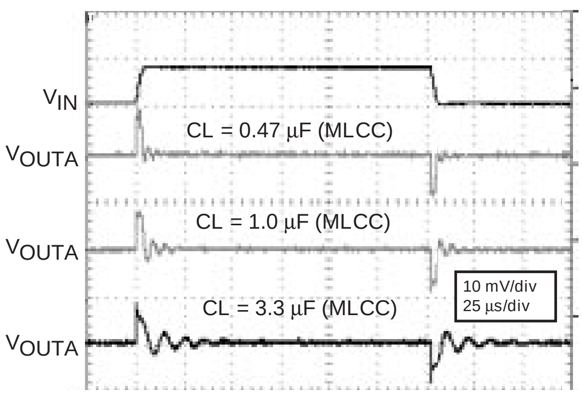
The noise in the low current region decreases when a tantalum capacitor is used. As for the output side capacitor, a tantalum capacitor of 0.1 μF is recommended. The characteristic of the capacitor greatly influences the amount of the noise.

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

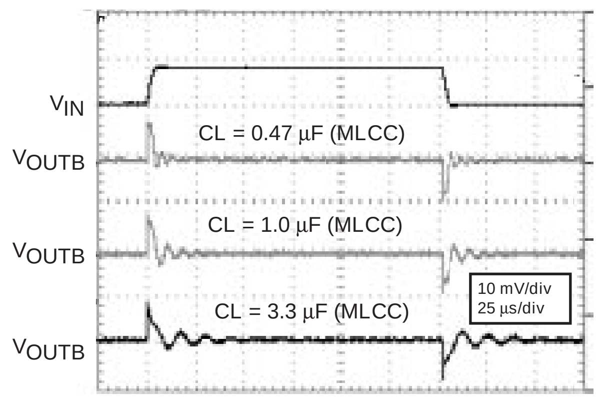
Line Transient

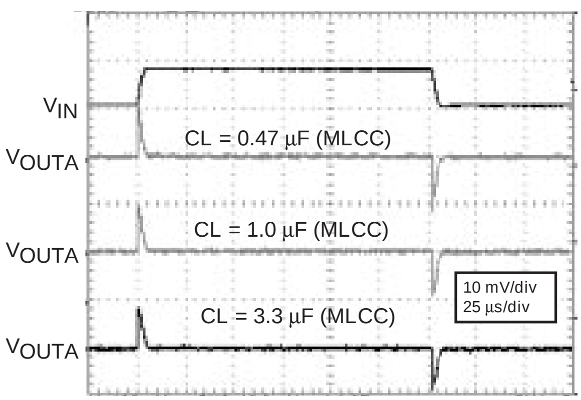
V_{IN} = 4 V to 5 V to 4 V, C_{IN} = 1.0 µF(MLCC), C_{FB} = 4700 pF

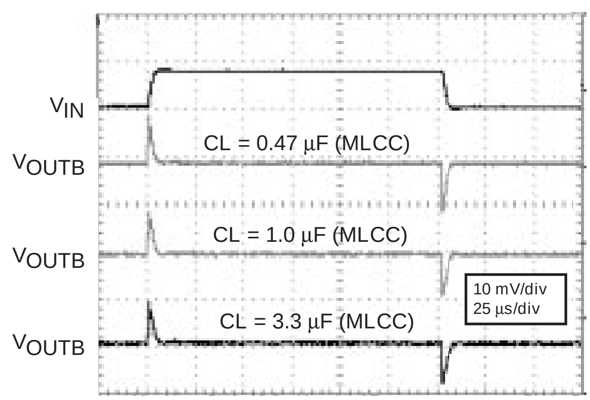
A Side (I_{OUT} = 100 mA)



B Side (I_{OUT} = 50 mA)







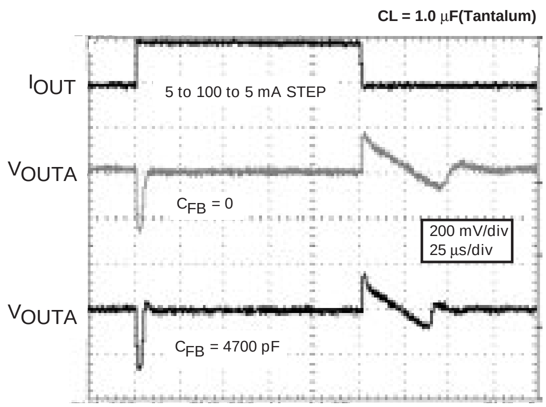
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

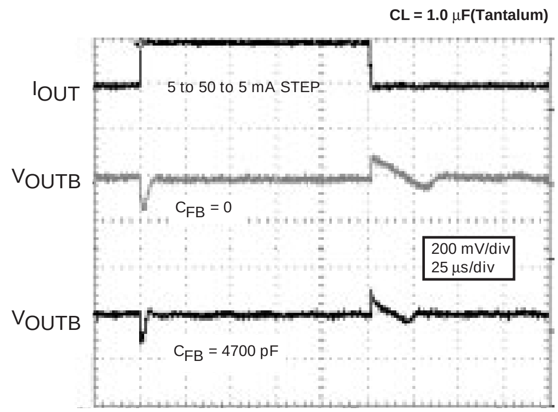
Load Transient

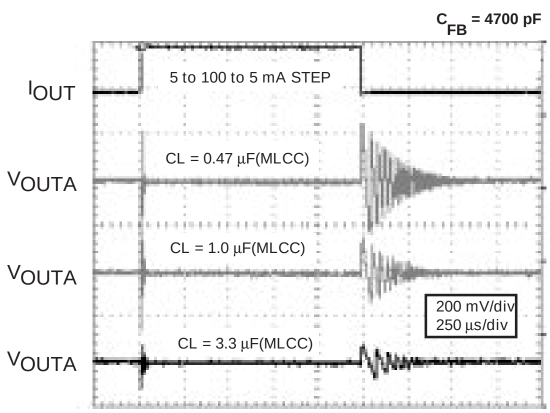
V_{IN} = 4 V, C_{IN} = 1.0 µF(MLCC)

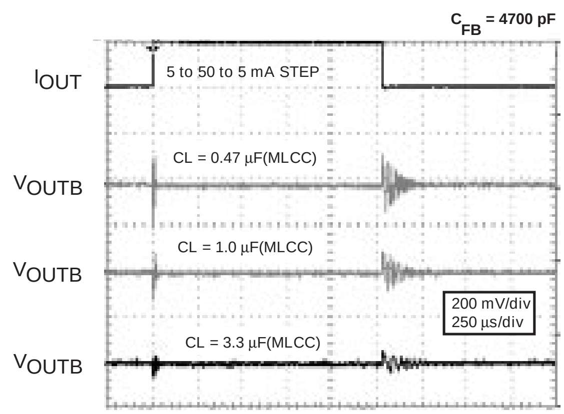
A Side (I_{OUT}) = 5 - 100 - 5 mA)

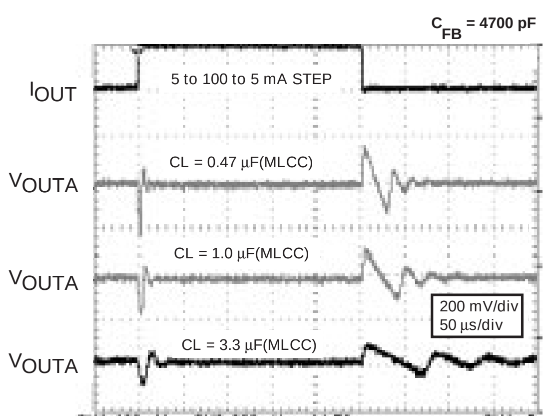
B Side (I_{OUT}) = 5 - 50 - 5 mA)

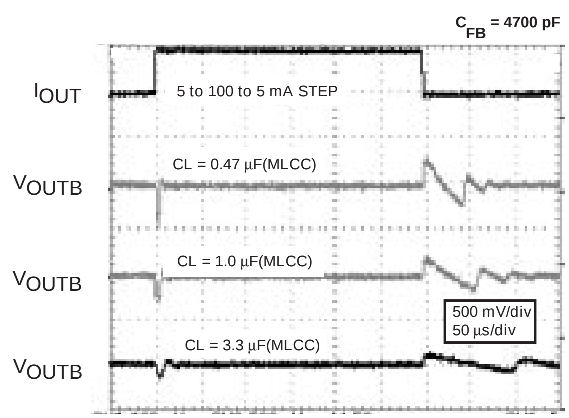










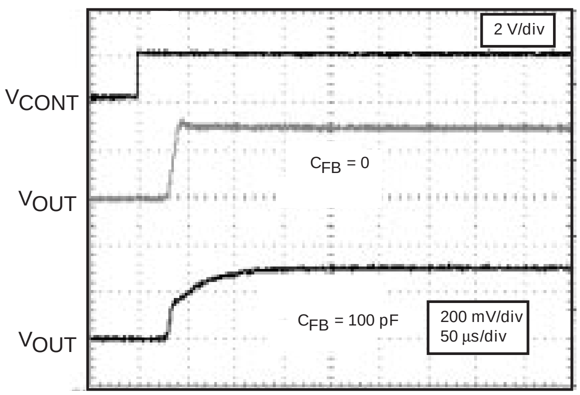


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

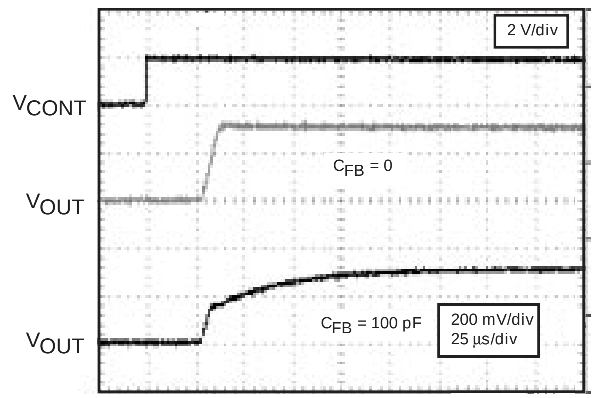
ON / OFF Transient

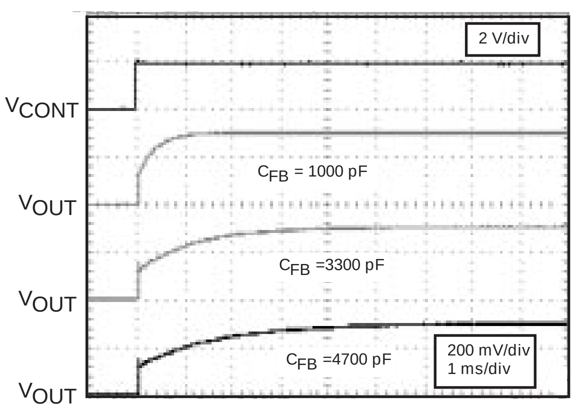
I_{OUT} = 10 mA, C_{IN} = 0.11 µF(MLCC), CL = 1.0 µF (MLCC)

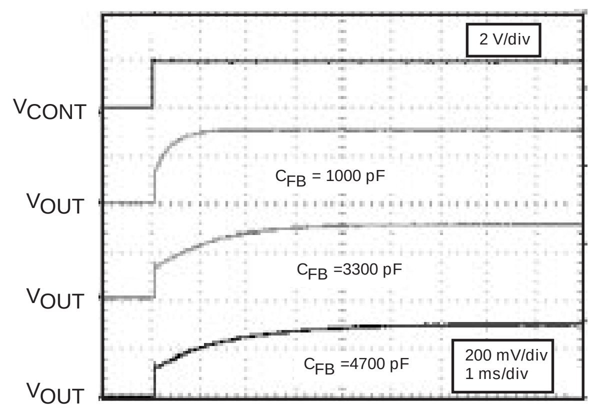
A Side

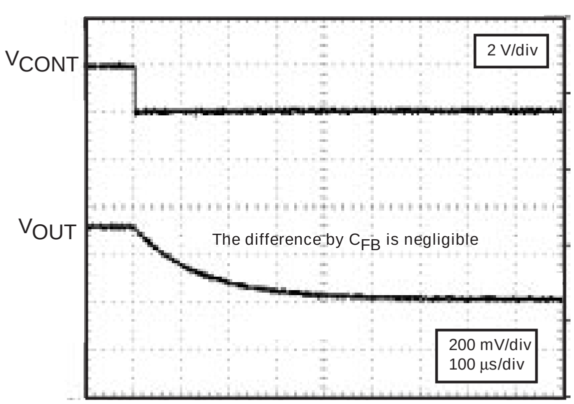


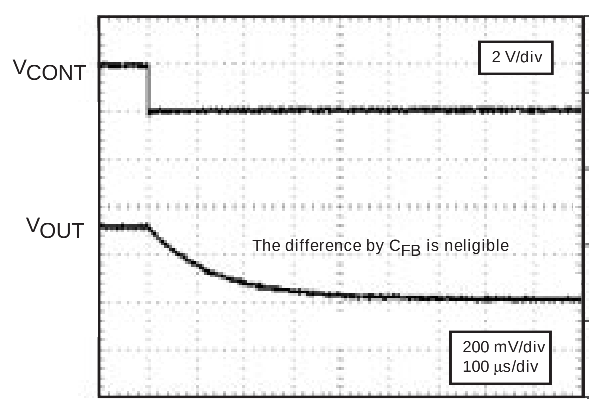
B Side











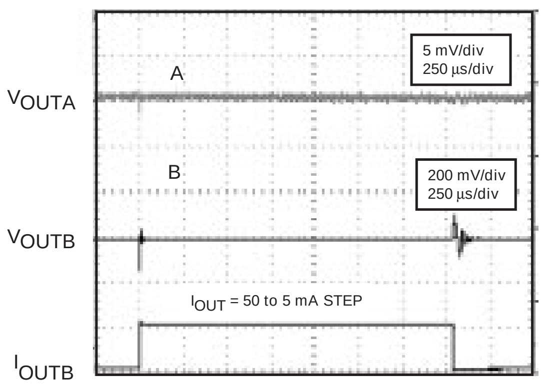
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

Cross Regulation

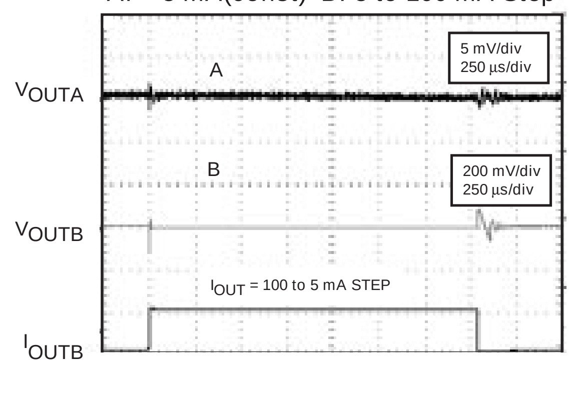
C_{IN} = 0.1 μF CL = 1.0 μF(MLCC) C_{FB} = None

The following graphs show the effect on both output voltages when rapidly changing the load current on only one side (A side or B side in 5-50 , 5-100, 5-200 mA steps). The current on the side where the load current is not allowed to change is 5 mA constant. The measurement sensitivity on the side without the current change is 5 mV/div: the side with the current change is 200 mV/DIV.

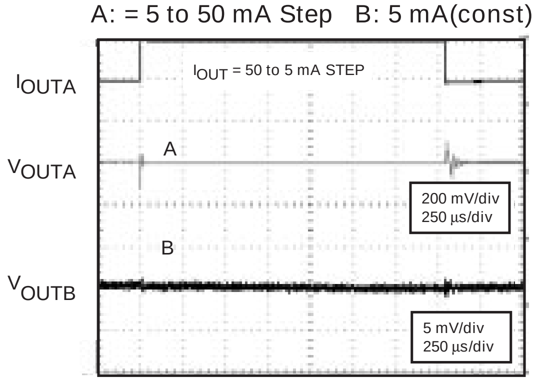
A: = 5 mA(const) B: 5 to 50 mA Step



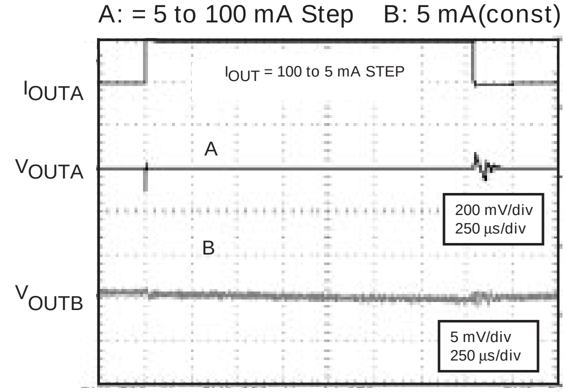
A: = 5 mA(const) B: 5 to 100 mA Step



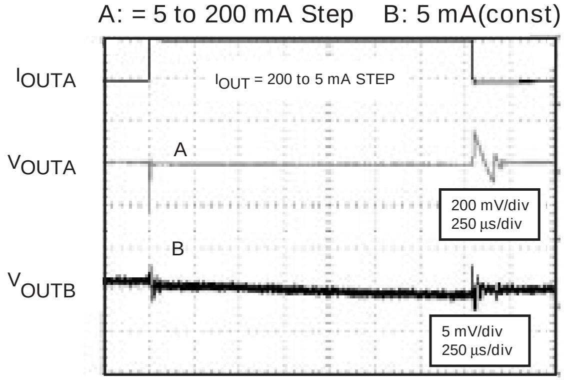
A: = 5 to 50 mA Step B: 5 mA(const)



A: = 5 to 100 mA Step B: 5 mA(const)



A: = 5 to 200 mA Step B: 5 mA(const)



DEFINITION AND EXPLANATION OF TECHNICAL TERMS

OUTPUT VOLTAGE (V_{OUT})

The output voltage is specified with V_{IN} = ($V_{OUT(TYP)}$ + 1 V) and I_{OUT} = 5 mA.

MAXIMUM OUTPUT CURRENT ($I_{OUT(MAX)}$)

The rated output current is specified under the condition where the output voltage drops to $V_{OUT(TYP)}$ x 0.9. The input voltage is set to $V_{OUT(TYP)}$ +1 V, and the current is pulsed to minimize temperature effect. The output current decreases during low voltage operation.

DROPOUT VOLTAGE (V_{DROP})

The dropout voltage is the difference between the input voltage and the output voltage at which point the regulator starts to fall out of regulation (this is the point when the output voltage decreases by 100 mV). Below this value, the output voltage will fall as the input voltage is reduced. It is dependent upon the load current and the junction temperature.

LINE REGULATION (Line Reg)

Line regulation is the ability of the regulator to maintain a constant output voltage as the input voltage changes. The line regulation is specified as the input voltage is changed from $V_{IN} = V_{OUT}$ + 1 V to $V_{IN} = V_{OUT}$ + 6 V. It is a pulsed measurement to minimize temperature effects.

LOAD REGULATION (Load Reg)

Load regulation is the ability of the regulator to maintain a constant output voltage as the load current changes. It is a pulsed measurement to minimize temperature effects with the input voltage set to $V_{IN} = V_{OUT}$ +1 V. The load regulation is specified under two output current step conditions of 5 mA to 100 mA and 5 mA to 200 mA.

QUIESCENT CURRENT (I_Q)

The quiescent current is the current which flows through the ground terminal under no load conditions (I_{OUT} = 0 mA).

GROUND PIN CURRENT(I_{GND})

The ground pin current is the current which flows through the GND terminal according to load current. It is measured by (input current-output current).

RIPPLE REJECTION RATIO (RR)

Ripple rejection is the ability of the regulator to attenuate the ripple content of the input voltage at the output. It is specified with 500 mV_{RMS}, 100 Hz and 1 MHz signal superimposed on the input voltage, where $V_{IN} = V_{OUT}$ + 1.5 V. The output decoupling capacitor is set to 1.0 µF, the C_{FB} capacitor is set to 4700 pF, and the load current is set to 10 mA. Ripple rejection is the ratio of the ripple content of the output vs. the input and is expressed in dB. Ripple rejection can be improved by increasing the C_{FB} capacitor (However, the on/off response time will increase).

STANDBY CURRENT (I_{STBY})

Standby current is the current into the regulator when the output is turned off by the control function. It is measured with an input voltage of 8 V.

OVER CURRENT SENSOR

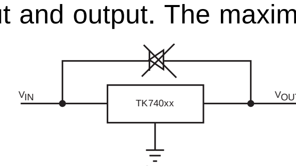
The overcurrent sensor protects the device when there is excessive output current. it also protects the device if the output is accidentally shorted to ground.

THERMAL SENSOR

The thermal sensor protects the device if the junction temperature exceeds the safe value (T_j = 150 °C). This temperature rise can be caused by extreme heat, excessive power dissipation caused by large output voltage drops, or excessive output current. The regulator will shut off when the temperature exceeds the safe value. As the junction temperature decreases, the regulator will begin to operate again. Under sustained fault conditions, the regulator output will oscillate as the device turns off then resets. Damage may occur to the device under extreme fault conditions.

REVERSE VOLTAGE PROTECTION

Reverse voltage protection prevents damage due to the output voltage being higher than the input voltage. This fault condition can occur when the output capacitor remains charged and the input is reduced to zero, or when an external voltage higher than the input voltage is applied to the output side. Toko's regulators do not need an inherent diode connected between the input and output. The maximum reverse bias boltage is 6 V.



DEFINITION AND EXPLANATION OF TECHNICAL TERMS (CONT.)

PACKAGE POWER DISSIPATION (P_D)

This is the power dissipation level at which the thermal sensor is activated. The IC contains an internal thermal sensor which monitors the junction temperature. When the junction temperature exceeds the monitor threshold of 150 °C, the IC is shut down. The junction temperature rises as the difference between the input power (V_{IN} x I_{IN}) and the output power (V_{OUT} x I_{OUT}) increases. The rate of temperature rise is greatly affected by the mounting pad configuration on the PCB, the board material, and the ambient temperature. When the IC mounting has good thermal conductivity, the junction temperature will be low even if the power dissipation is large. When mounted on the recommended mounting pad, the power dissipation of the SOT23L-8 is increased to 600 mW. For operation at ambient temperatures over 25 °C, the power dissipation of the SOT23L-8 device should be derated at 4.8 mW/ °C. To determine the power dissipation for shutdown when mounted, attach the device on the actual PCB and deliberately increase the output current (or raise the input voltage) until the thermal protection circuit is activated. Calculate the power dissipation of the device by subtracting the output power from the input power. These measurements should allow for the ambient temperature of the PCB. The value obtained from P_D /(150 °C - T_A) is the derating factor. The PCB mounting pad should provide maximum thermal conductivity in order to maintain low device temperatures. As a general rule, the lower the temperature, the better the reliability of the device. The thermal resistance when mounted is expressed as follows:

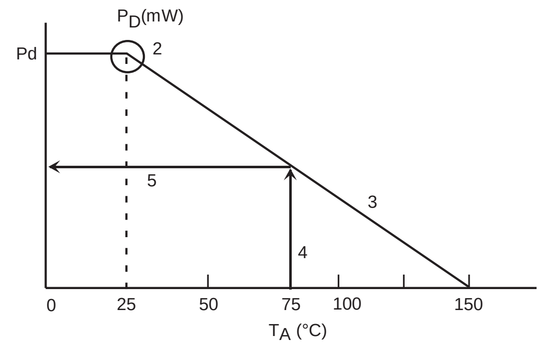
$$T_j = \theta_{jA} \times P_D + T_A$$

For Toko ICs, the internal limit for junction temperature is 150 °C. If the ambient temperature (T_A) is 25 °C, then:

$$150\ °C = \theta_{jA} \times P_D + 25\ °C$$
$$\theta_{jA} = 125\ °C / P_D$$
$$\theta_{jA} = 125\ °C / P_D\ (°C / mW)$$

P_D is the value when the thermal protection circuit is activated. A simple way to determine P_D is to calculate V_{IN} x I_{IN} when the output side is shorted. Input current gradually falls as temperature rises. You should use the value when thermal equilibrium is reached.

The range of usable currents can also be found from the graph below.



Procedure:

1) Find P_D
2) P_{D1} is taken to be P_D x (~0.8 - 0.9)
3) Plot P_{D1} against 25 °C
4) Connect P_{D1} to the point corresponding to the 150 °C with a straight line.
5) In design, take a vertical line from the maximum operating temperature (e.g., 75 °C) to the derating curve.
6) Read off the value of P_D against the point at which the vertical line intersects the derating curve. This is taken as the maximum power dissipation, D_{PD}.

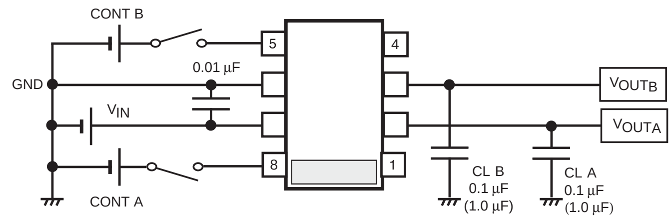
The maximum operating current is:

$$I_{OUT} = (D_{PD} / (V_{IN(MAX)} - V_{OUT})$$

APPLICATION INFORMATION

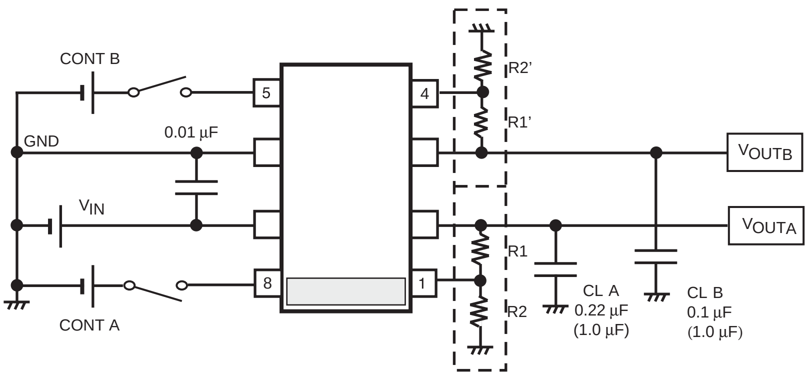
STANDARD APPLICATION

Typically, give the capacitor as large a value as practical in consideration of the temperature characteristic. The output noise and ripple noise decrease with a larger capacitance value. In addition, the response to the output side load change also improves.



OUTPUT VOLTAGE CHANGE

The output voltage on both sides can be set by using R1 and R2. The output voltage is deteremed by the ratio of R1 and R2. The error of the output voltage usually grows because of the tolerance of the external parts.



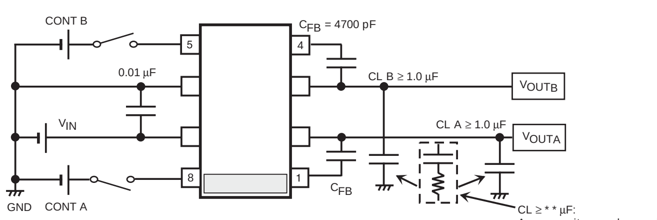
$V_{OUT} = (R1 \div R2 + 1) \times 1.19$

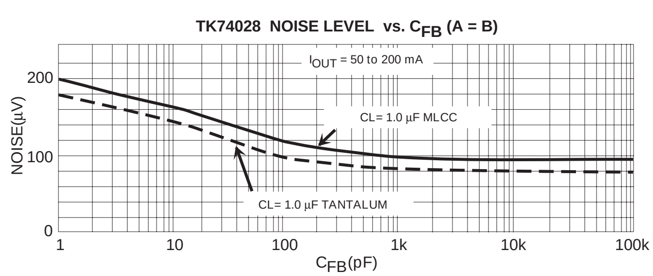
$22\ k \geq R2$

$R1(K\Omega) = (VOUT \div 1.19 - 1) \times R2$

NOISE REDUCTION (IMPROVEMENT OF RIPPLE REJECTION RATIO)

Please connect C_{FB} with the F_{BA} terminals (1 and 2) and F_{BB} terminals (3 and 4). It is possible to use C_{FB} only on the needed side. A tantalum capacitor is the best in this application. A small capacitance is sufficient (0.1 µF, 0.22 µF, etc.). When the ceramic capacitor is used, the noise grows in the low current region. If 1.0 Ω. ($R_S \geq 1$) is connected in series with the ceramic capacitor, the same characteristics as a tantalum capacitor can be obtained. Please adjust the output side capacitor to the value in which stable operation is done over all required temperature ranges. Damage will not be caused by enlarging this value. Increasing this value will decrease the ripple noise and improve the output load transient response. However, the risetime using the on/off control becomes slower. It is possible to use the noise reduction application with output voltage change application above.

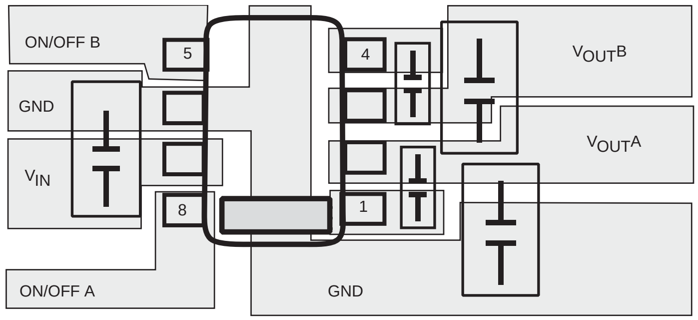




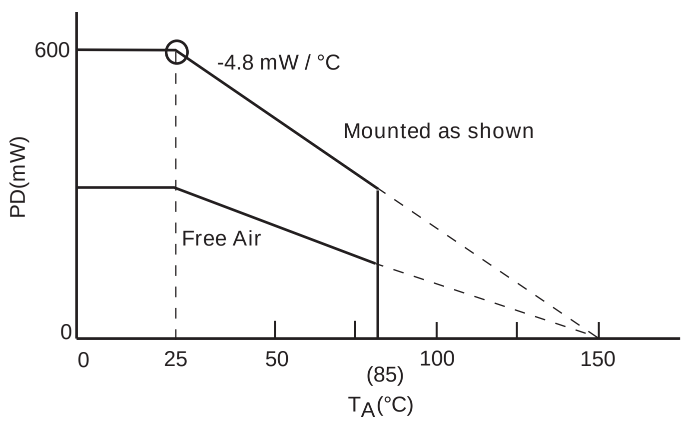
4700 pF is recommended for C_{FB}

APPLICATION INFORMATION (CONT.)

BOARD LAYOUT



SOT23L-8 BOARD LAYOUT



APPLICATION INFORMATION (CONT.)

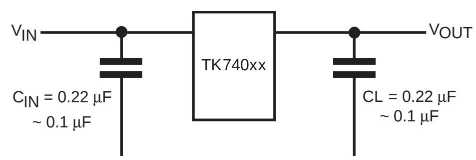
INPUT-OUTPUT CAPACITORS

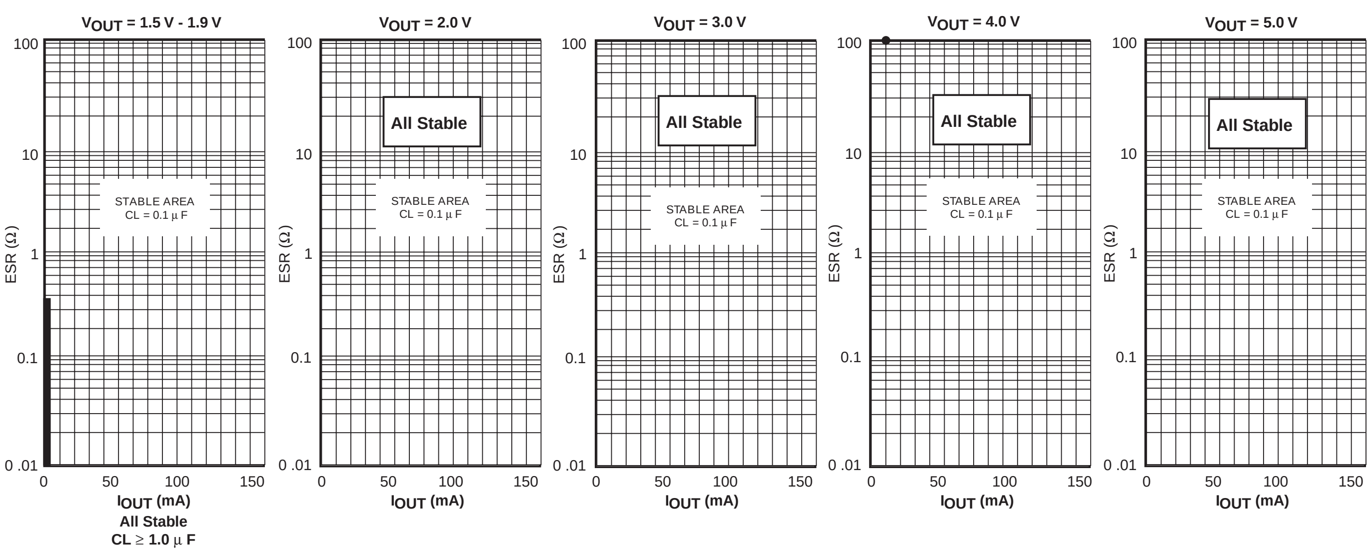
Linear regulators require input and output capacitors in order to maintain the regulator's loop stability. The equivalent series resistance (ESR) of the output capacitor must be in the stable operation area. However, it is recommended to use as large a value of capacitance as is practical. The output noise and the ripple noise decrease as the capacitance value increases. The IC is never damaged by enlarging the capacitance.

ESR values vary widely between ceramic and tantalum capacitors. However, tantalum capacitors are assumed to provide more ESR damping resistance, which provides greater circuit stability. This implies that a higher level of circuit stability can be obtained by using tantalum capacitors when compared to ceramic capacitors with similar values. The IC provides stable operation with an output side capacitor of 0.1 μF ($V_{OUT} \geq 1.8$ V). If the capacitor is 0.1 μF or more over its full range of temperature, either a ceramic capacitor or tantalum capacitor can be used without considering ESR ($V_{OUT} \geq 1.8$ V).

The recommended value of $C_L \geq 0.1\ \mu$F for $I_{OUT} \geq 0.5$ mA.
For load current ≤ 0.5 mA, increase the output capacitor to 1 μF.

The input capacitor is necessary when the battery is discharged, the power supply impedance increases, or the line distance to the power supply is long. This capacitor might be necessary on each individual IC even if two or more regulator ICs are used. It is not possible to determine this indiscriminately. Please confirm the stability while mounted.





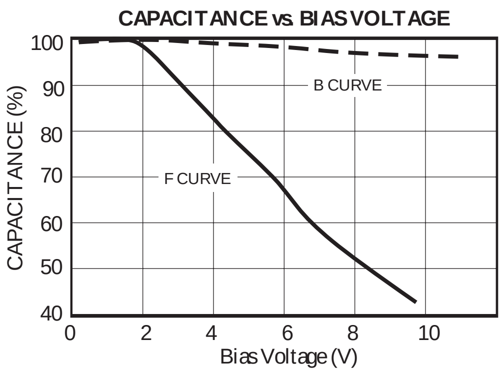
Please increase the output capacitor value when the load current is 0.5 mA or less. The stability of the regulator improves if a big output side capacitor is used (the stable operation area extends).

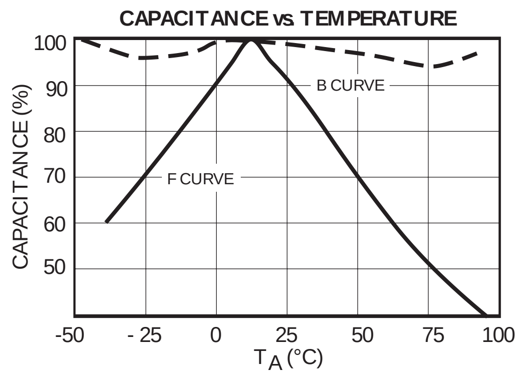
For evaluation KYOCERA CM05B104K10AB, CM05B224K10AB, CM105B104K16A, CM105B224K16A, CM21B225K10A
MURATA GRM36B104K10, GRM42B104K10, GRM39B104K25, GRM39B224K10, GRM39B105K6.3

APPLICATION INFORMATION (CONT.)

Bias Voltage and Temperature Characteristics of Ceramic Capacitors

Generally, a ceramic capacitor has both a temperature characteristic and a voltage characteristic. Please consider both characteristics when selecting the part. The B curves are the recommended characteristics.



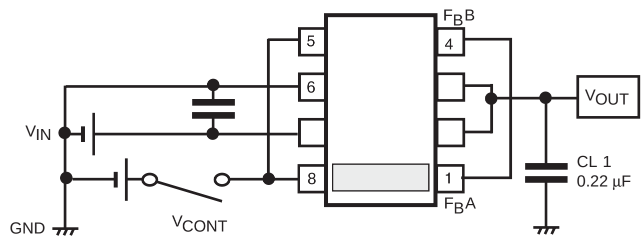


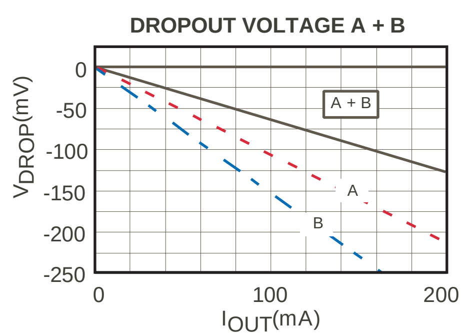
APPLICATION INFORMATION (CONT.)

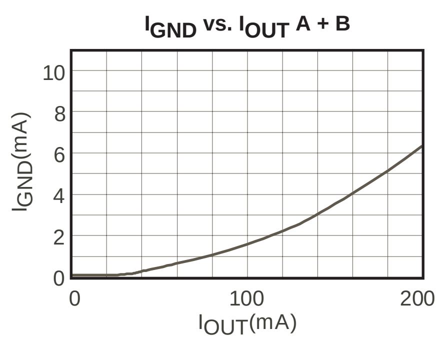
Super-Low I/O Voltage Difference and High Current LDO
Connect the following terminals; pin 5 and pin 8, pin 1 and pin 4, pin 2 and pin 3. V_{DROP} = 70 mV at 100 mA; 125 mV at 200 mA; 180 mV at 300 mA is typically obtained.

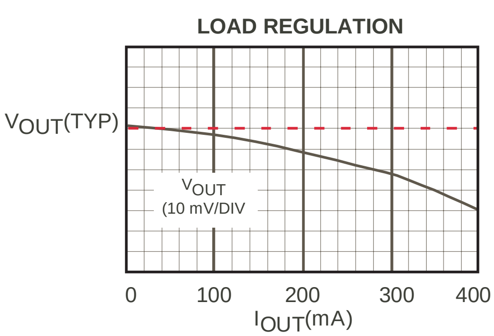
Attention when this application is adopted
The control current and the no load current double because the A and B circuits are connected in parallel. A very large current flows at the output during a short-circuit. Therefore, there is a possibility of damage by the current. Please note the short-circuit of the output side and GND. The current value that can regularly be delivered is 300-400 mA. The output current is limited by the permissible electric power loss of the package. The current cannot be delivered exceeding this. However, a large peak current can be delivered for the pulse load with little generation of heat. The permissible loss increases by improving heat radiation. Please make the copper pattern in the IC part installation as wide as possible.

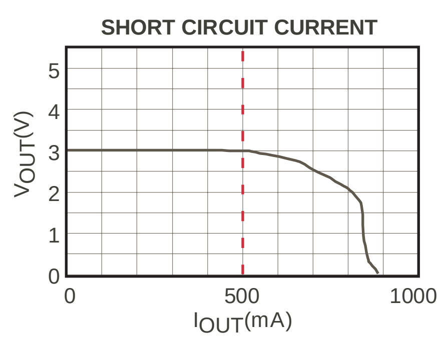
For instance, the permissible electric power loss increases greatly if the board thermal plan is bonded to the IC. The characteristic of this application is not guaranteed immediately because Toko does not test to this application. The characteristic of this application is almost obtained by guaranteeing the characteristic on the A side and the B side. The difference appears large; use care when designing.







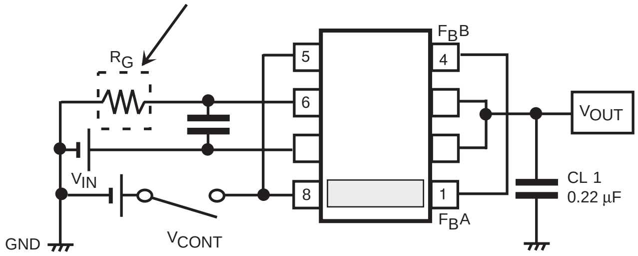


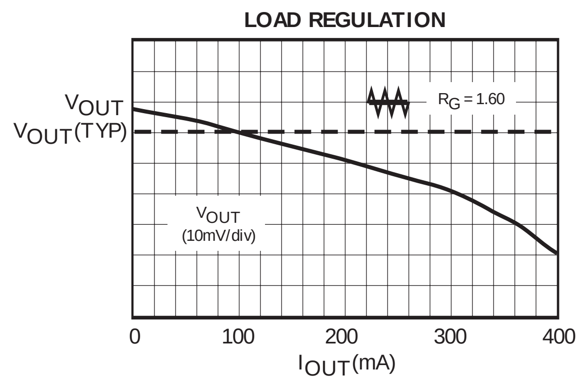


APPLICATION INFORMATION (CONT.)

Improvement of load regulation with high current application

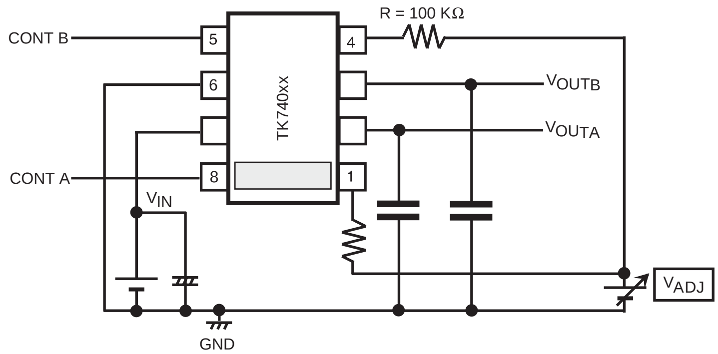
Please connect a resistor (Max = 1.2 - 1.6 Ω) between pin 6 of the TK740xx and GND.
The load regulation is greatly improved. Please increase the I/O capacitors.





APPLICATION INFORMATION (CONT.)

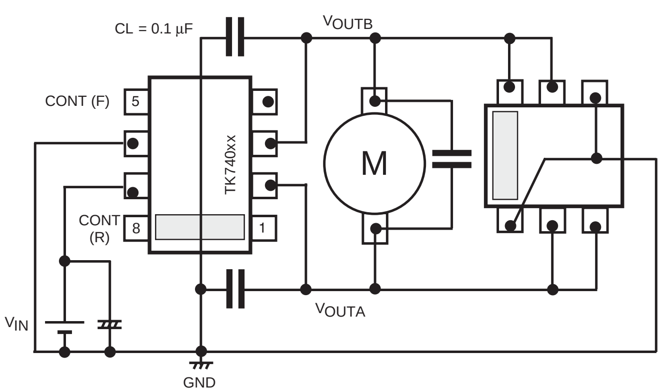
Variable output voltage. Output voltage controled by an external voltage (power supply, DAC, tec.).
When V_{ADJ} is raised more than 1.25V, the correspoinding output voltage falls. Because the two sides operate independently, one side only can be used, if desired.

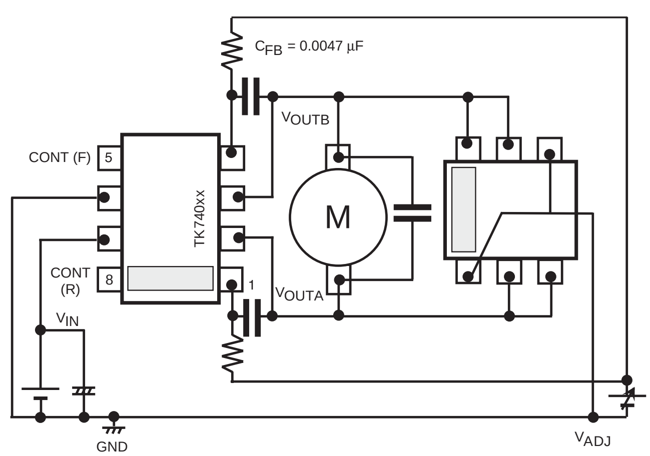


Forward or reverse: Motor drive circuit.
The direction of the direct current motor rotation changes with the direction of the current. A bridge circuit can be made with the TK740xx and an external transistor. Each element of the bridge circuit is controlled by an external signal. On/off control of the bridge elements is accomplished and the desired voltage polarity for the motor is selected. The speed changes in accordance with the amount of current (voltage) which flows through the motor. The TK740xx has both the switch function and the variable output voltage function. The motor rotation speed can be controlled by changing the output voltage. The speed and direction of the motor can be controlled by combining the two functions above. The I/O voltage difference of TK740xx is approximately 0.17 V at I_{OUT} = 150 mA. The current when the motor starts is 300 mA Max.

Constant speed (fixed voltage)
Even if the input voltage changes, the voltage impressed to the motor is constant.

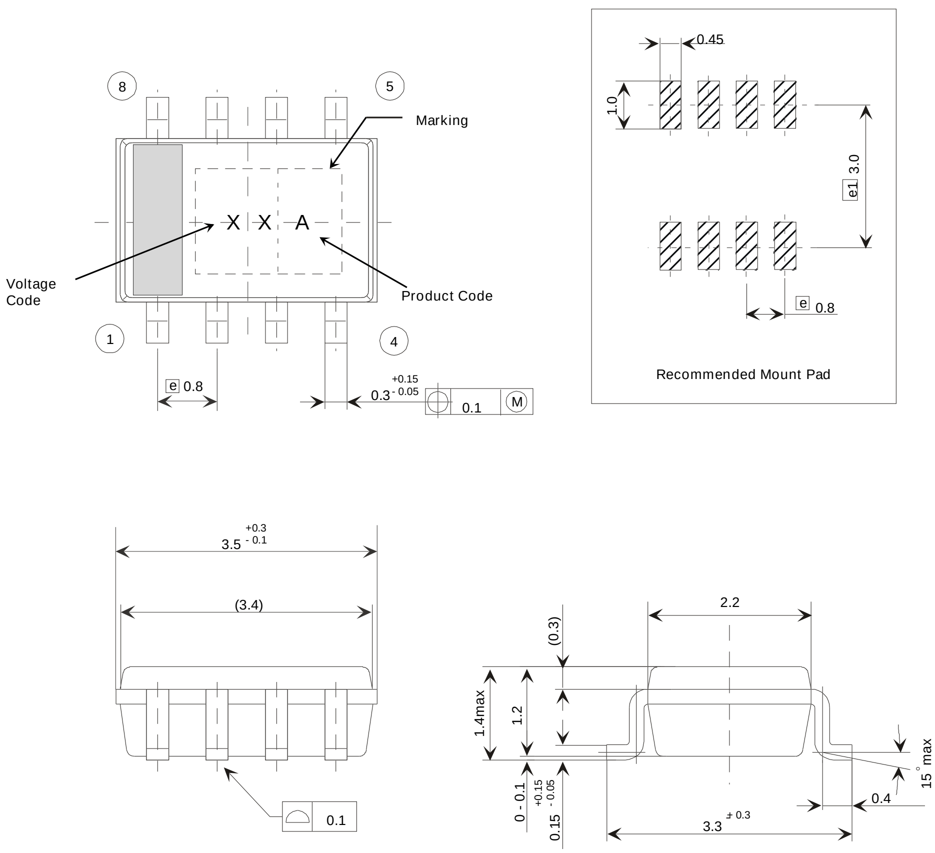
Variable speed (variable voltage)
When V_{ADJ} is raised more than 1.25 V, the output voltage falls.





PACKAGE OUTLINE

SOT23L-8



Dimensions are shown in millimeters
Tolerance: x.x = ± 0.2 mm (unless otherwise specified)

Marking Information

Product Code A

Part Number	Voltage Code
TK74013	13
TK74014	14
TK74015	15
TK74016	16
TK74017	17
TK74018	18
TK74019	19
TK74020	20
TK74021	21
TK74022	22
TK74023	23
TK74024	24
TK74025	25
TK74026	26
TK74027	27
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TK74041	41
TK74042	42
TK74043	43
TK74044	44
TK74045	45
TK74046	46
TK74047	47
TK74048	48
TK74049	49
TK74050	50

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