150kHz, 2A, PWM Step-Down DC/DC Converter

◆ DESCRIPTION

The MT150x series are monolithic IC designed for a step-down DC/DC converter, and own the ability of driving a 2A load without additional transistor. It saves board space.

The Internal compensation makes feedback control having good line and load regulation without external design. Regarding protected function, thermal shutdown is to prevent over temperature operating from damage, and current limit is against over current operating of the output switch. If current limit function occurs and V_{FB} is down below 0.5V, the switching frequency will be reduced.

The MT150x series operate at a switching frequency of 150KHz. Other features include a guaranteed +4% tolerance on output voltage under specified input voltage and output load conditions, and +15% on the oscillator frequency. The output version included fixed 3.3V, 5V, 12V, and an adjustable type. The chips are available in a standard 8-lead SOP-8 package.

◆ FEATURES

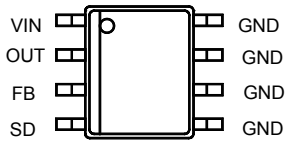
- Guaranteed 2A output current
- 3.3V, 5V, 12V and adjustable output versions
- Thermal shutdown and current limit protection
- Internal oscillator of 150kHz fixed frequency.
- Built-in TTL On/Off control

◆ APPLICATIONS

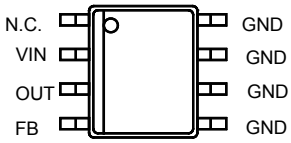
- One Channel switching regulators
- LCD Monitors
- High-efficiency step-down regulator

◆ PIN CONFIGURATIONS

SOP-8 (Top View)



MT1502-X.XM



MT1501-X.XM

◆ ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Maximum	Unit
Supply Voltage	V_{CC}	24	V
ON\OFF Pin Input Voltage	V_{SD}	-0.3 to +18	V
Feedback Pin Voltage	V_{FB}	-0.3 to +18	V
Output Voltage to Ground	V_{OUT}	-1	V
Power Dissipation	P_D	Internally limited	W
Thermal resistance junction to ambient SOP-8	θ_{JA}	70	°C/W
Operating junction temperature range	T_J	150	°C
Storage temperature range	T_{STG}	- 65 to 150	°C
Operating temperature	T_{OPR}	-40 to +125	°C

Note : Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

◆ ORDERING INFORMATION

Device	Package		V_{OUT} Volts	T_A (°C)
MT1501-X.X	M	SOP-8	X.X_ 3.3/ 5.0/ 12/ ADJ	0-70
MT1502-X.X				

◆ POWER DISSIPATION TABLE

Package	θ_{JA} (°C /W)	Df(mW/°C) $T_A \geq 25$°C	$T_A \leq 25$°C Power rating(mW)	T_A=70°C Power rating(mW)	T_A= 85°C Power rating (mW)
M	70	6.06	1785	1142	928

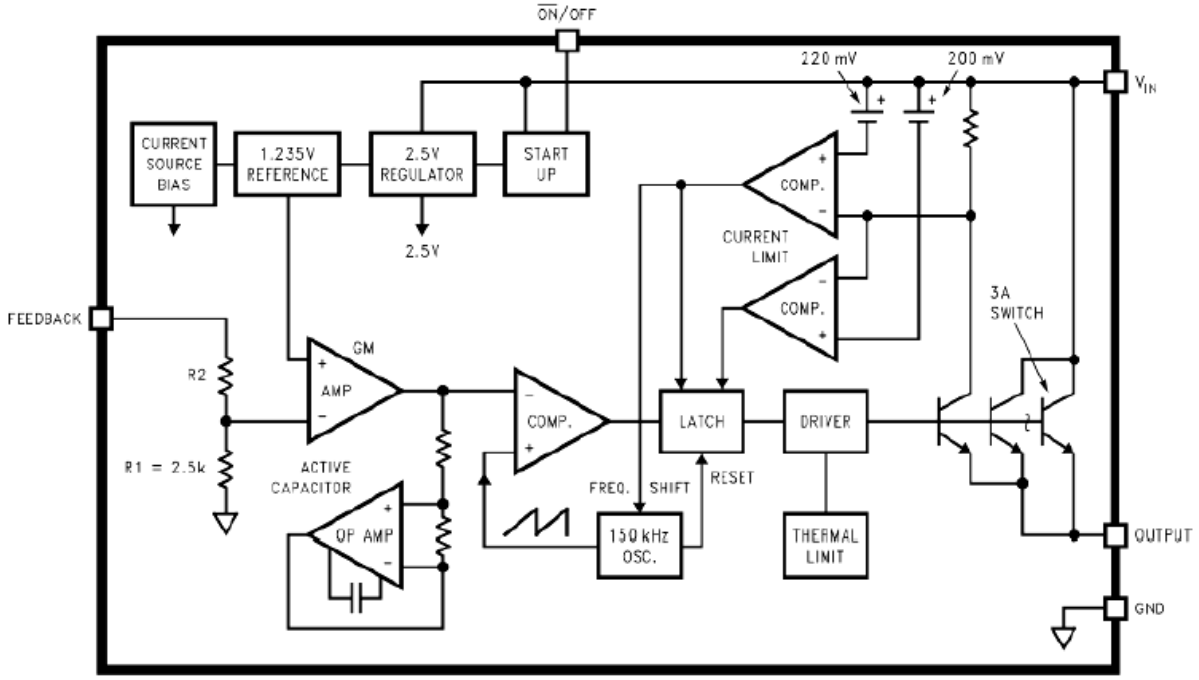
Note :

1. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
2. T_J: Junction Temperature Calculation:
   $T_J = T_A + (P_D \times \theta_{JA})$
   The θ_{JA} numbers are guidelines for the thermal performance of the device/PC-board system. All of the above assume no ambient airflow.
3. θ_{JA}: Thermal Resistance-Junction to Ambient, D_F : Derating factor, P_O: Power consumption.

◆ PIN DESCRIPTION

No.	MT1501 PIN Name	Function	No.	MT1502 PIN Name	Function
1	**N.C.**	NC	1	**VIN**	Supply Voltage
2	**VIN**	Supply Voltage	2	**OUTPUT**	Switch Pin. Connect inductor/diode
3	**OUTPUT**	Switch Pin. Connect Inductor/diode	3	**FB**	Feedback Pin.
4	**FB**	Feedback Pin.	4	**SHDN**	Shutdown Control Input. Active-Low into shutdown mode
5	**GND**	Ground Pin	5	**GND**	Ground Pin
6	**GND**	Ground Pin	6	**GND**	Ground Pin
7	**GND**	Ground Pin	7	**GND**	Ground Pin
8	**GND**	Ground Pin	8	**GND**	Ground Pin

◆ BLOCK DIAGRAM



◆ ELECTRICAL CHARACTERISTICS

T_J=25℃, V_{IN}=12V for 3.3V,5V, and Adjustable version and V_{IN}=18V for the 12V version, I_{LOAD} = 0.5A, unless Otherwise specified

Parameter		Symbol	Conditions	Min.	Typ.	Max.	Unit
Output Voltage	MT1501/2-3.3	V_{OUT}	5.5V<V_{IN}<22V, 0.2A<I_{LOAD}<2A	3.168	3.3	3.432	V
Efficiency		η	V_{IN}=12V,I_{LOAD}=2A	-	75	-	%
Output Voltage	MT1501/2-5.0	V_{OUT}	8V< V_{IN}<22V 0.2A<I_{LOAD}<2A	4.800	5.0	5.200	V
Efficiency		η	V_{IN}=12V,I_{LOAD}=2A	-	80	-	%
Output Voltage	MT1501/2-12	V_{OUT}	15V<V_{IN}<22V 0.2A<I_{LOAD}<2A	11.52	12	12.48	V
Efficiency		η	V_{IN}=16V,I_{LOAD}=2A	-	89	-	%
Feedback Voltage	MT1501/2-ADJ	V_{FB}	5V<V_{IN}<22V, 0.2A<I_{LOAD}<2A	1.193	1.230	1.267	V
Efficiency		η	V_{IN}=12V,I_{LOAD}=2A	-	74	-	%
Feedback bias Current		I_{FB}	V_{FB} = 1.3V (Adjustable Only)	-	-10	-50	nA
Oscillator Frequency		F_{OSC}	T_J=25 ℃	127	150	173	KHz
Oscillator Frequency OF Short Circuit Protect		F_{SCP}	When current limit occurred and V_{FB}<0.5V, T_A=25℃	5	15	25	KHz
Saturation Voltage		V_{SAT}	I_o = 2A, No outside circuit and V_{FB}=0V force driver on	-	1.4	1.6	V
Max. Duty Cycle (ON)		D_C	V_{FB} = 0V force driver on	-	100	-	%
Min. Duty Cycle (OFF)			V_{FB} = 12V force driver off	-	0	-	%
Current Limit		I_{LIMIT}	Peak current, No outside circuit and V_{FB}= 0V force driver on	3.6	4.5	5.5	A
Output Leakage Current		I_{LEAK}	Output Leakage Current No outside circuit V_{FB}=12V force driver off, V_{OUT}=0V	-	-	-200	μA
			V_{IN}=22V, V_{OUT}=-1V	-5	-	30	
Quiescent Current		I_Q	VFB = 12V force driver off	-	5	10	mA
Standby Quiescent Current		I_{STBY}	ON/OFF Pin=5V,V_{IN}=22V	-	70	156	μA

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
ON/OFF Pin Logic Input Threshold Voltage	V_{IL}	Low(Regulator ON)	-	1.3	0.6	V
	V_{IH}	High(Regulator OFF)	2.0		-	
ON/OFF Pin Logic Input Current	I_{IH}	V_{LOGIC}=2.5V(OFF)	-	-	-0.01	μA
	I_{IL}	V_{LOGIC}=0.5V(ON)	-	-0.1	-1	

NOTES

Thermal Considerations:

The SOP-8 package needs a heat sink under most conditions. The size of the heat sink depends on the input voltage, the output Voltage, the load current and ambient temperature. The MT150x junction temperature rises above ambient temperature for a 2A load and different input and output voltages. The data for these curves was taken with the MT150x(SOP-8 package) operating as a buck-switching regulator in an ambient temperature of 25℃ (still air). These temperature increments are all approximate and are affected by many factors.

Higher ambient temperatures require more heat sinker. For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (One exception is the output(switch) pin, which should not have large areas of copper.) Large areas of copper provide the best transfer of heat (lower thermal resistance) to the surrounding air, and moving air lowers the thermal resistance even further.

Package thermal resistance and junction temperature increments are affected by a lot of factors. Some of these factors include board size, shape, thickness, position, location, and even board temperature. Other factors are, trace width, total printed circuit copper area, copper thickness, single or double-sided, multi-layer board and the amount of solder on the board. The effectiveness of the PC board to dissipate heat also depends on the size, Furthermore, some of these components such as the catch diode will add heat to the PC board and the heat can vary as the input voltage changes. For the inductor, depending on the physical size, type or core material and the DC resistance, it could either act as a heat sink taking heat away from the board, or it could add heat to the board.

◆ APPLICATION DATA

Diode Selection Table

VR(V)	3A Diode		4~6A Diode	
	Surface Mount	Through Hole	Surface Mount	Through Hole
	Schottky	Schottky	Schottky	Schottky
20	SK32	1N5820 SR302 MBR320	--	1N5823 SR502 MBR520
30	SK33	1N5821 MBR330 31DQ03	50WQ03	1N5824 SR503 SB530
40	SK34 MBRS340	1N5822 SR304 MBR340 31DQ04	50WQ04	1N5825 SR504 SB540
50	SK35 MBRS360	SR305 MBR350 31DQ05 MUR320	50WQ05 50WF10	SB550 50SQ080 HER601 MUR620

◆ QUICK DESIGN COMPONENT SELECTION TABLE FOR ADJUSTABLE OUTPUT

Output Voltage (V)	Through Hole Output Capacitor			Surface Mount Output Capacitor		
	Panasonic HFQ Series (μF/V)	Nichicon PL Series (μF/V)	Feed forward Capacitor	Panasonic HFQ Series (μF/V)	Nichicon PL Series (μF/V)	Feed forward Capacitor
2	820/35	820/35	33nF	330/6.3	470/4	33nF
4	560/35	470/35	10nF	330/6.3	390/6.3	10nF
6	470/25	470/25	3.3nF	220/10	330/10	3.3nF
9	330/35	330/25	1.5nF	100/16	180/16	1.5nF
12	330/25	330/25	1nF	100/16	180/16	1nF
15	220/35	220/25	680pF	68/20	120/20	680pF
24	220/35	150/35	560pF	33/25	33/25	220pF

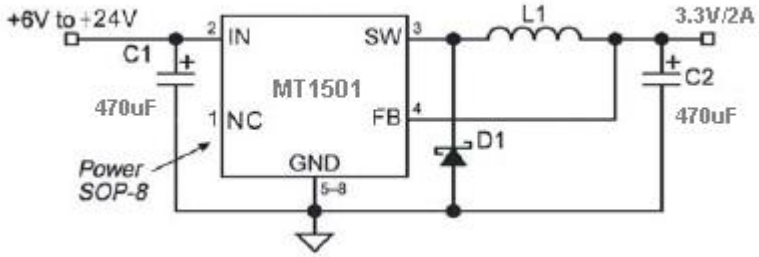
◆ QUICK DESIGN COMPONENT SELECTION TABLE FOR FIXED OUTPUT

Input/Output Condition			Inductor		Output Capacitor(μF/V)			
					Through Hole Electrolytic		Surface Mount Tantalum	
Output Voltage (V)	Load Current (V)	Max.Input Voltage (V)	Inductance (μH)	Current (A)	Nichicon PL Series	Panasonic HFQ Series	Sprague 595D Series	AVX TPS Series
5	3	8	22	3.5	560/25	560/25	330/10	220/10
		15	33	3.5	330/35	330/35	330/10	220/10
		25	47	3.5	270/35	330/35	330/10	220/10
	2	9	22	3.1	560/16	470/25	330/10	220/10
		15	68	3.1	180/35	180/35	270/10	100/10
		25	68	3.1	180/35	180/35	270/10	100/10
3.3	3	5	22	3.5	560/16	470/25	390/6.3	330/6.3
		12	22	3.5	560/25	560/35	390/6.3	330/6.3
		25	33	3.5	470/35	680/35	390/6.3	330/6.3
	2	6	22	3.1	470/35	470/25	390/6.3	330/6.3
		12	33	3.1	330/35	330/25	390/6.3	330/6.3
		25	47	3.1	270/50	330/25	330/10	220/10

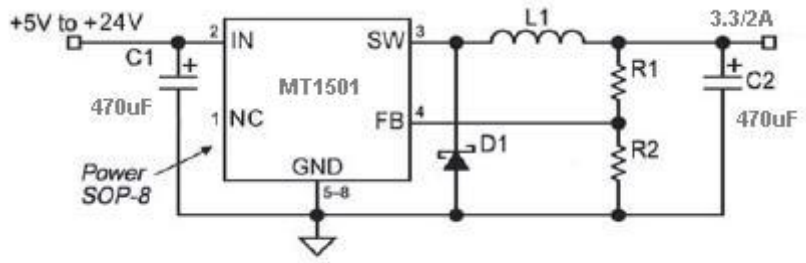
◆ TYPICAL APPLICATIONS

1. MT1501 Reference:

Fixed Voltage Version:



Adjustable Voltage Version:

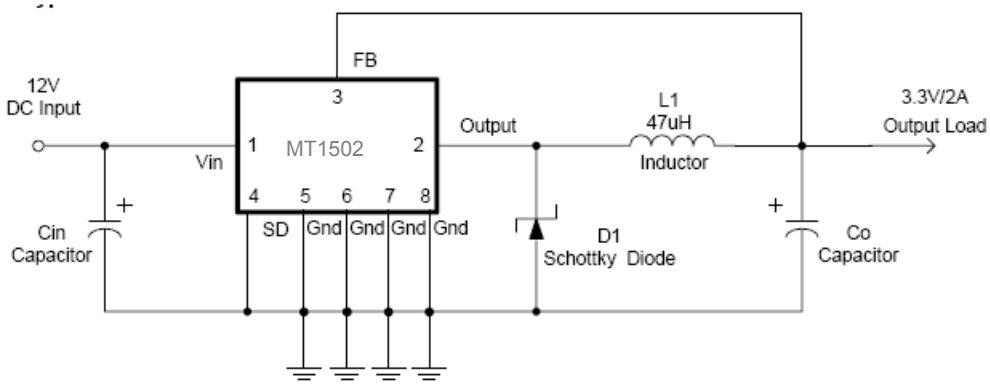


$$Vout = V_{FB} \times (1 + \frac{R1}{R2})$$

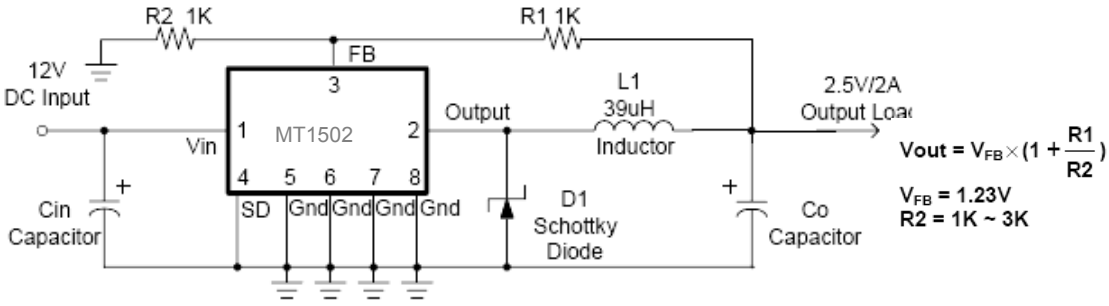
V_{FB} = 1.23V
R2 = 1K ~ 3K

2. MT1502 Reference:

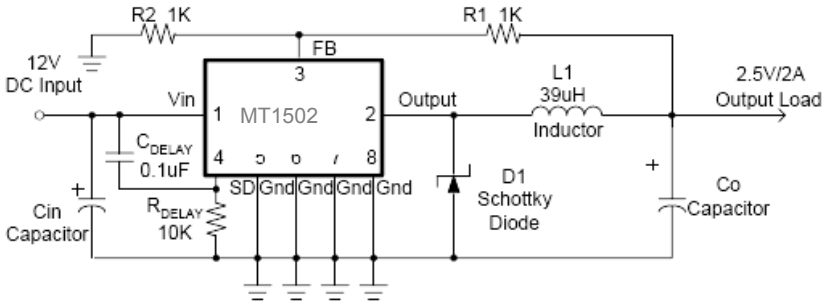
Fixed Voltage Version:



Adjustable Voltage Version:



Delay Start Circuit:



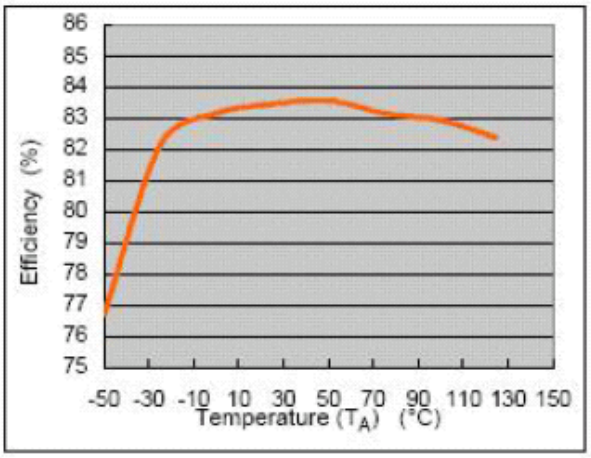
◆ APPLICATION NOTE

Maximum Power Dissipation Calculation:

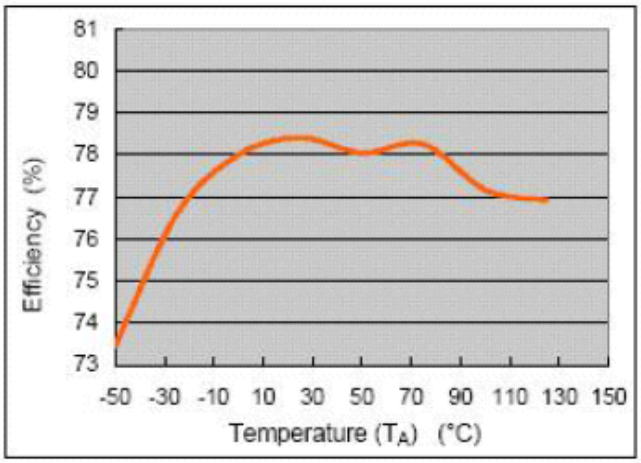
$$P_{D(max)} = [(V_{IN(max)} - V_{O(nom)})] \times I_{O(nom)} + V_{IN(max)} \times I_Q$$

Where: $V_{O(nom)}$: The nominal output voltage
$I_{O(nom)}$: The nominal output current, and
I_Q : The quiescent current the regulator consumes at $I_{O(MAX)}$
$V_{IN(max)}$: The maximum input voltage

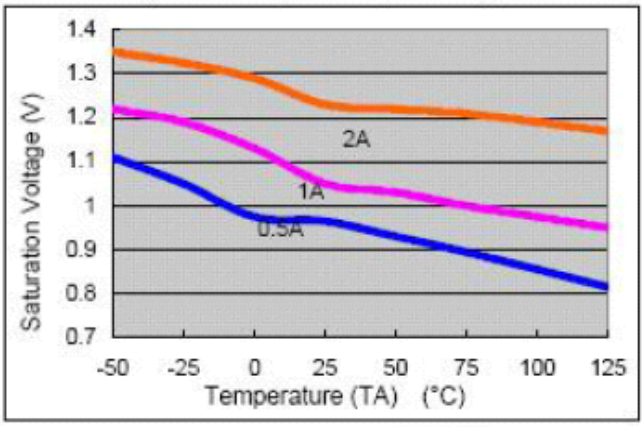
MT150X Efficiency vs. Temperature (Vin=12V, Vout=5V, Io=2A)



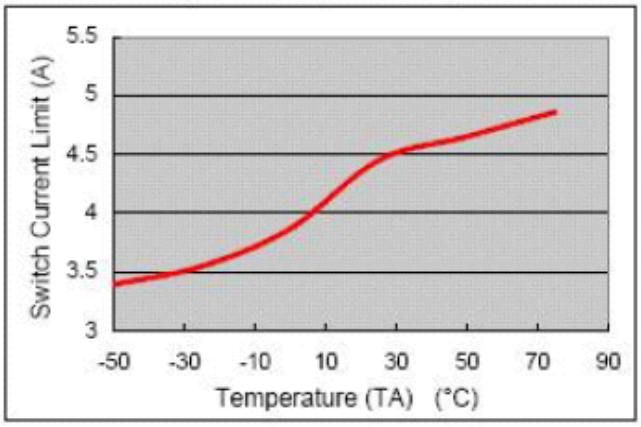
MT150X Efficiency vs. Temperature (Vin=12V, Vout=3.3V, Io=2A)



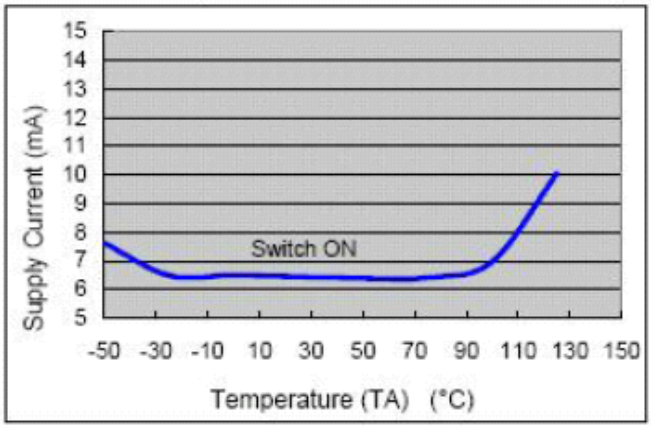
MT150X Saturation Voltage vs. Temperature (Vcc=12V, Vfb=0V, VSD=0)

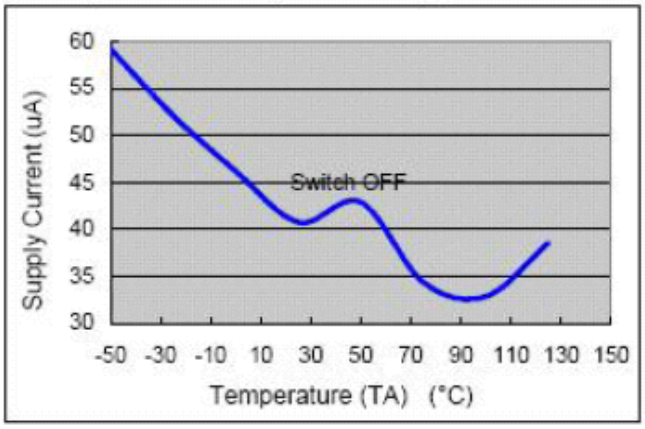


MT150X Switch Current Limit vs. Temperature (Vcc = 12V, Vfb = 0V)

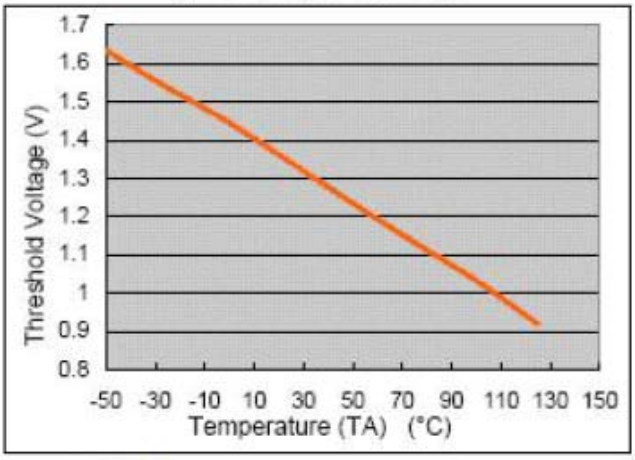


MT150X Supply Current vs. Temperature (Vcc=12V, No Load, Von/off =0V(Switch ON) ,Von/off =5V(Switch OFF))

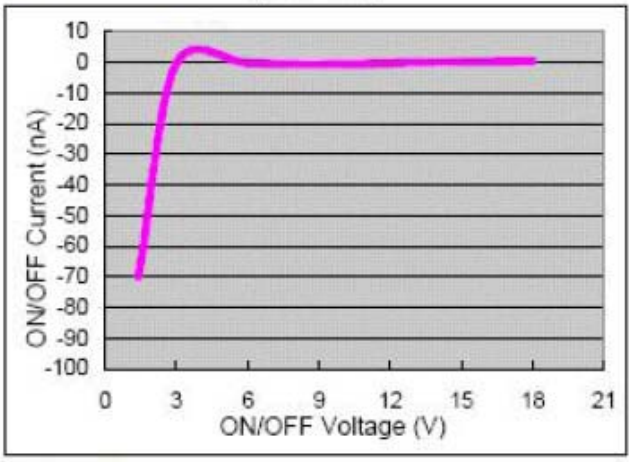




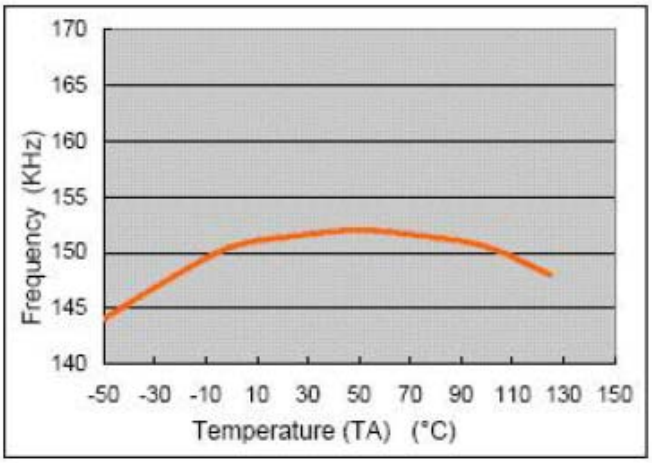
MT150X Threshold Voltage vs. Temperature
(Vcc=12V, Io=100mA)



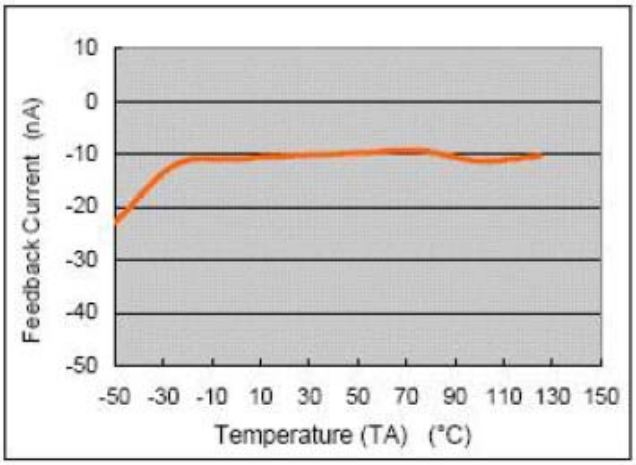
MT150X ON/OFF Current vs. ON/OFF Voltage
(Vin=12V)



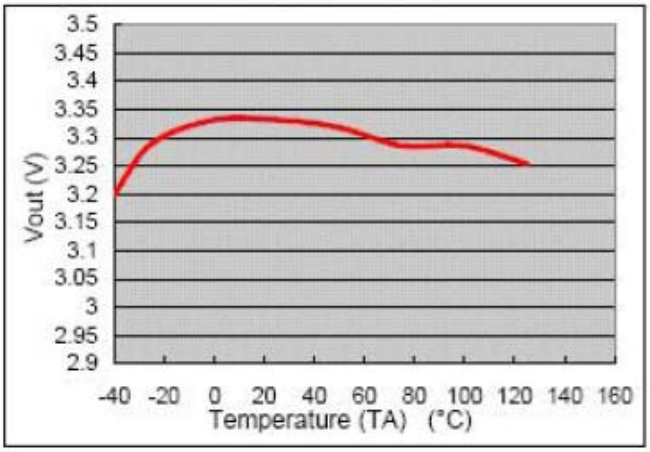
MT150X Frequency vs. Temperature
(Vcc=12V, Io=500mA, Vout=5V)



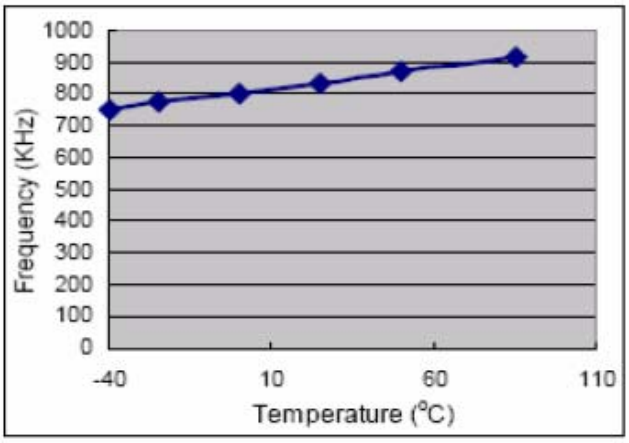
MT150X Feedback Current vs. Temperature
(Vcc=12V, Vout=5V, Vfb=1.3V)



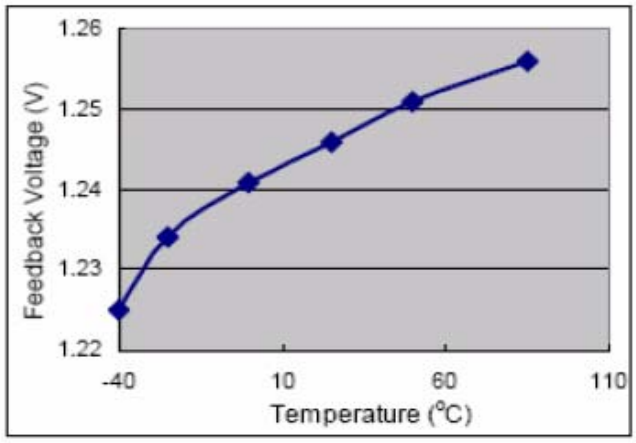
MT150X Output Voltage vs. Temperature
(Vin=12V, Io=2A)



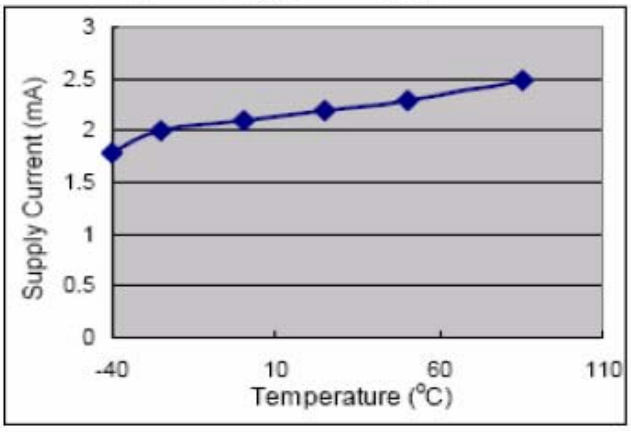
Frequency vs. Temperature
V_{in} = 5V; V_{out} = 15V



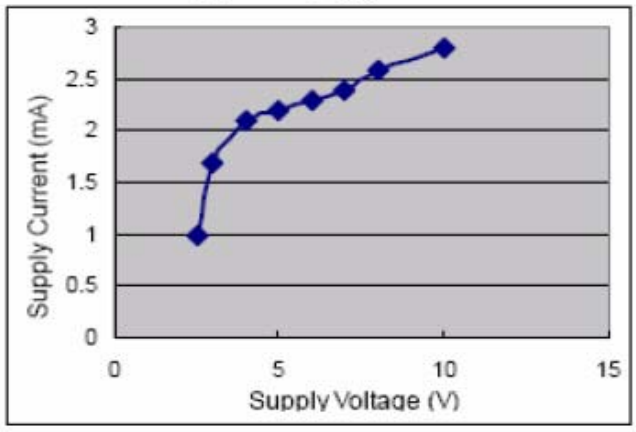
Feedback Voltage vs. Temperature
V_{in} = 5V; V_{out} = 15V



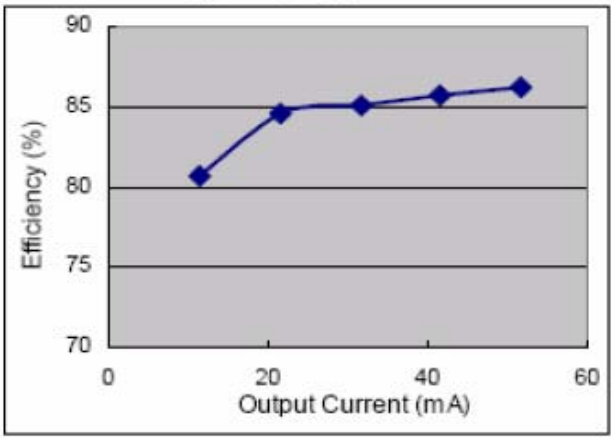
Supply Current vs. Temperature
V_{in} = 5V; V_{out} = 15V; I_{out} = 0A



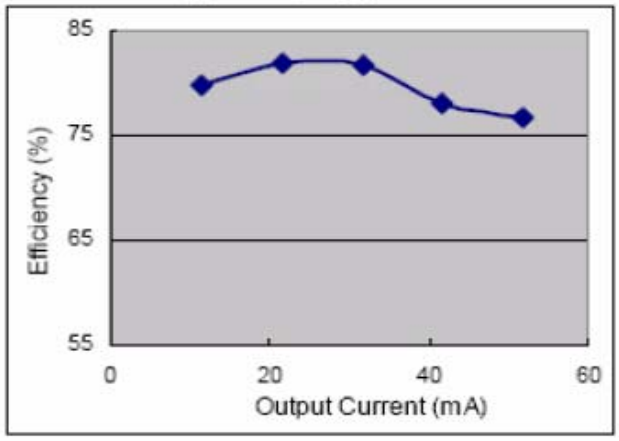
Supply Current vs. Supply Voltage
V_{out} = 15V; I_{out} = 0A



Efficiency vs. Output Current
V_{in} = 5V; V_{out} = 15V

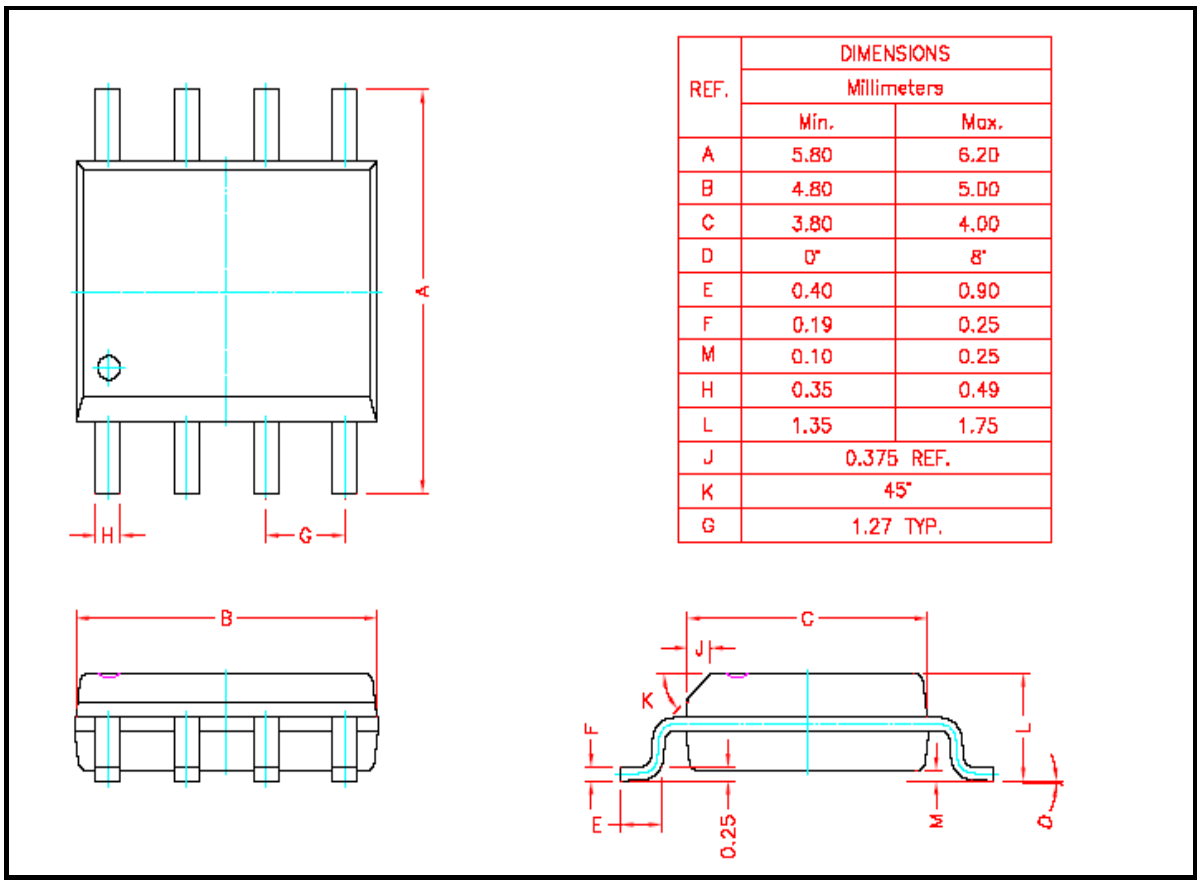


Efficiency vs. Output Current
V_{in} = 3.3V; V_{out} = 15V



◆ PHYSICAL DIMENSIONS:

8-Pin Plastic S.O.I.C. (M)



REF.	DIMENSIONS Millimeters	
	Min.	Max.
A	5.80	6.20
B	4.80	5.00
C	3.80	4.00
D	0°	8°
E	0.40	0.90
F	0.19	0.25
M	0.10	0.25
H	0.35	0.49
L	1.35	1.75
J	0.375 REF.	
K	45°	
G	1.27 TYP.	