500mA TinyPower^{TM} LDO

HT78Rxx

Revision: V1.10 Date: May 23, 2025

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Features

- Fixed output voltages: 1.5V, 3.0V, 3.3V, 3.5V, 5.0V
- High accuracy: ±2%
- Low voltage drop: 60mV (typ.), V_{OUT}=5.0V at 500mA
- Maximum input voltage: 20V
- Guaranteed output current: 500mA
- Low quiescent current: 3μA (typ.)
- Current limiting
- Over-temperature shutdown
- Package types: 3-pin SOT89 and 5-pin SOT23

Applications

- Portable electronics
- Wireless devices
- Cordless phones
- PC peripherals
- Battery powered devices
- Electronic scales

General Description

The HT78Rxx series of positive, linear regulators feature low quiescent current (3μA typ.) with low dropout voltage, making them ideal for battery applications. The space-saving 5-pin SOT23 package is attractive for "Pocket" and "Hand Held" applications. The devices are capable of supplying 500mA of output current continuously.

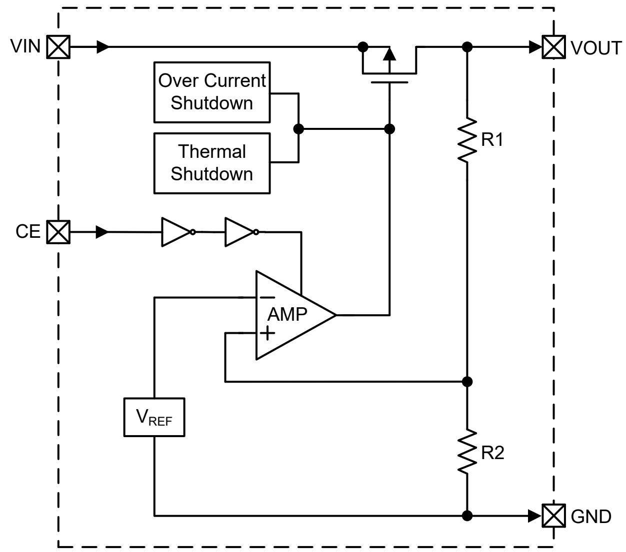
They are available with several fixed output voltages ranging from 1.5V to 5.0V. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain variable voltages and currents.

These rugged devices have Thermal Shutdown and Current Limiting to prevent device failure under the "Worst" of operating conditions.

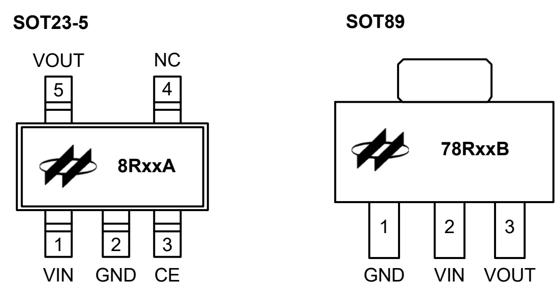
Selection Table

Part No.	Output Voltage	Package	Marking
HT78R15A	1.5	SOT23-5	8R15A
HT78R30A	3		8R30A
HT78R33A	3.3		8R33A
HT78R35A	3.5		8R35A
HT78R50A	5		8R50A
HT78R15B	1.5	SOT89	78R15B
HT78R30B	3		78R30B
HT78R33B	3.3		78R33B
HT78R35B	3.5		78R35B
HT78R50B	5		78R50B

Block Diagram



Pin Assignment



Pin Description

Pin No.		Pin Name	Pin Description
SOT89	SOT23-5		
—	3	CE	Chip enable pin, high enable
3	5	VOUT	Output pin
2	1	VIN	Input pin
1	2	GND	Ground pin
—	4	NC	No connection

Absolute Maximum Ratings

Parameter		Value	Unit
V_{IN}		-0.3 to 24	V
V_{CE}		-0.3 to 24	V
Operating Temperature Range, Ta		-40 to 105	°C
Maximum Junction Temperature, $T_{J(MAX)}$		150	°C
Storage Temperature Range		-60 to 150	°C
ESD Susceptibility	Human Body Model	±5000	V
	Machine Model	±200	V
Junction-to-Ambient Thermal Resistance, θ_{JA}	SOT89	200	°C/W
	SOT23-5	500	°C/W
Power Dissipation, P_D	SOT89	0.625	W
	SOT23-5	0.25	W

Note: P_D is measured at Ta=25°C.

Recommended Operating Range

Parameter	Value	Unit
V_{IN}	2.5 to 20	V

Electrical Characteristics

Ta=25°C, V_{IN}=V_{OUT}+1.0V, I_{OUT}=1mA, C_{IN}=1μF, C_{OUT}=1μF, unless otherwise specified

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage	—		—	—	20	V
ΔV_{OUT}	Output Voltage Tolerance	—		−2	—	2	%
I_{SS}	Quiescent Current	I_{OUT}=0mA, V_{CE}=V_{IN}		—	3	5	μA
ΔV_{LOAD}	Load Regulation (1)	1mA ≤ I_{OUT} ≤ 500mA		—	0.004	0.008	%/mA
ΔV_{LINE}	Line Regulation	V_{OUT}+1.0V ≤ V_{IN} ≤ 20.0V		—	0.2	0.3	%/V
V_{DROP}	Dropout Voltage (2)	ΔV_{OUT}=2%, I_{OUT}=100mA	1.5 ≤ V_{OUT} ≤ 1.8V	—	170	—	mV
			2.5V ≤ V_{OUT} ≤ 2.7V	—	100	—	mV
			3.0V ≤ V_{OUT} ≤ 5.0V	—	60	—	mV
$\frac{\Delta V_{OUT}}{\Delta Ta}$	Temperature Coefficient	−40°C < Ta < 105°C		—	±0.7	—	mV/°C
I_{LIM}	Current Limit (3)	ΔV_{OUT}=10%		500	—	—	mA
T_{SHD}	Shutdown Temperature	—		—	160	—	°C
T_{REC}	Recovery Temperature	—		—	130	—	°C
I_{SD}	Shutdown Current	CE input voltage ≤ 0.8V		—	0.5	1.0	μA
V_{IH}	CE Input High Threshold	V_{OUT}+1V ≤ V_{IN} ≤ 20V		2	—	—	V
V_{IL}	CE Input Low Threshold	V_{OUT}+1V ≤ V_{IN} ≤ 20V		—	—	0.8	V
PSRR	Power Supply Rejection Ratio	V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=10mA	f=100Hz	—	70	—	dB
		V_{IN}=V_{OUT}+1.0V, I_{OUT}=50mA	f=10Hz	—	55	—	
			f=1kHz	—	40	—	
			f=10kHz	—	27	—	
			f=100kHz	—	7	—	

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Noise	Output Noise Voltage	V_{OUT}=5V, I_{OUT}=10mA, BW=10Hz~100kHz	—	75	—	μV_{RMS}

Note: 1. Load regulation is measured at a constant junction temperature, using pulse testing with a low ON time and is guaranteed up to the maximum power dissipation. Power dissipation is determined by the input/output differential voltage and the output current. Guaranteed maximum power dissipation will not be available over the full input/output range. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - Ta) / \theta_{JA}$.

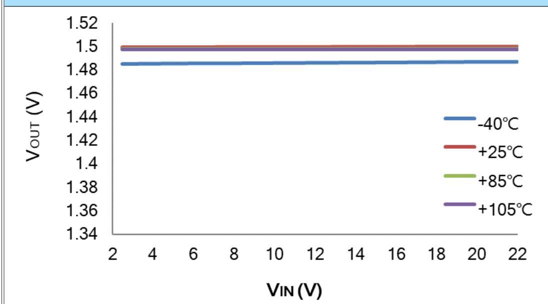
2. Dropout voltage is defined as the input voltage minus the output voltage that produces a 2% change in the output voltage from the value at $V_{IN} = V_{OUT} + 1V$ with a fixed load.

3. Current limit is measured by pulsing for a short time.

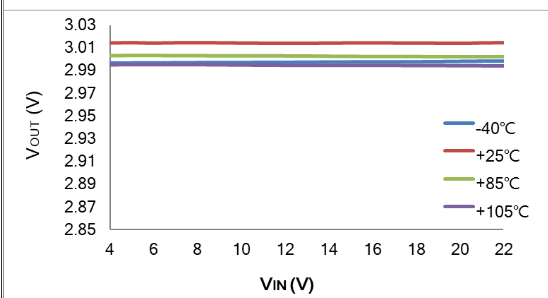
Typical Performance Characteristics

Test Condition: $V_{IN}=V_{OUT}$+1V, C_{IN}=1μF, C_{OUT}=1μF and Ta=25ºC, unless otherwise noted

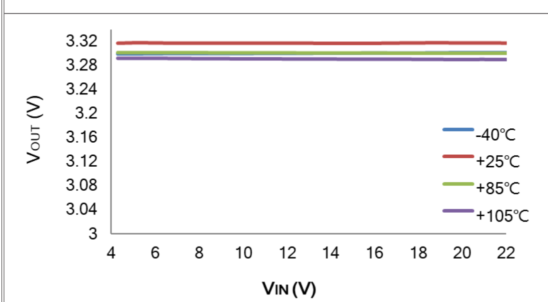
Output Voltage vs Input Voltage



Line Regulation: HT78R15 (I_{OUT}=1mA)

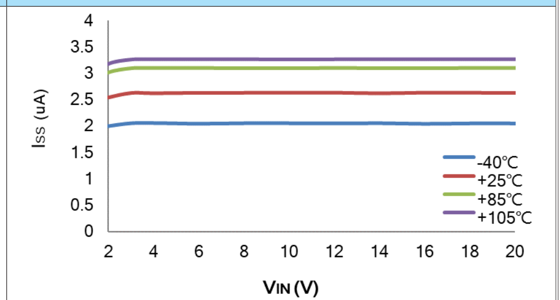


Line Regulation: HT78R30 (I_{OUT}=1mA)

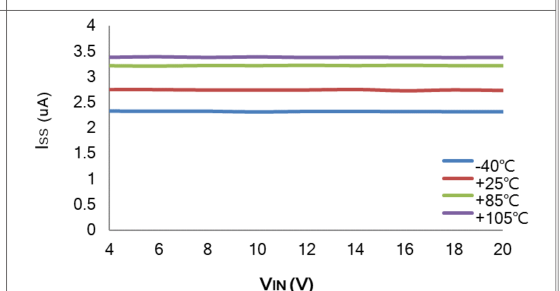


Line Regulation: HT78R33 (I_{OUT}=1mA)

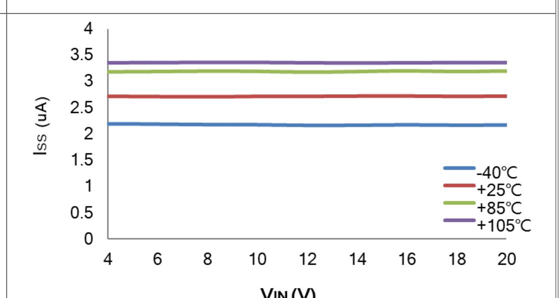
Quiescent Current vs Input Voltage



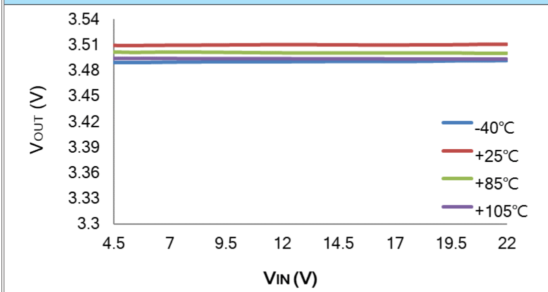
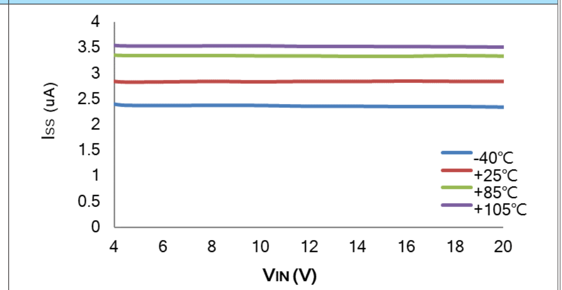
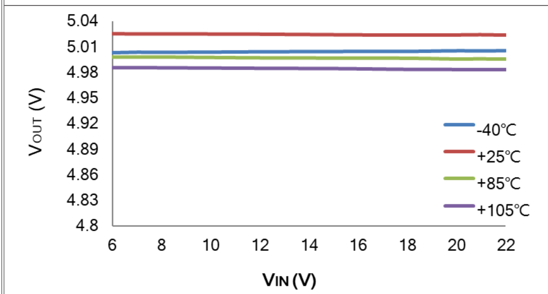
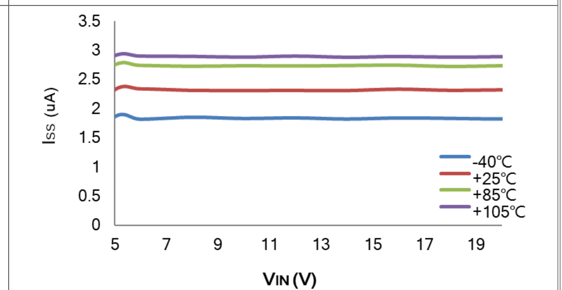
I_{SS} vs V_{IN}: HT78R15 (I_{OUT}=0mA)



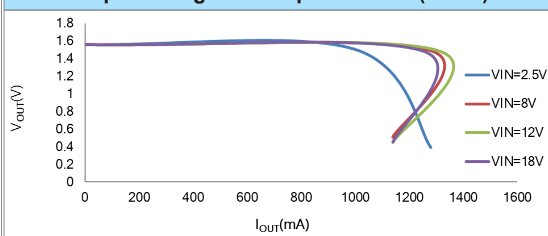
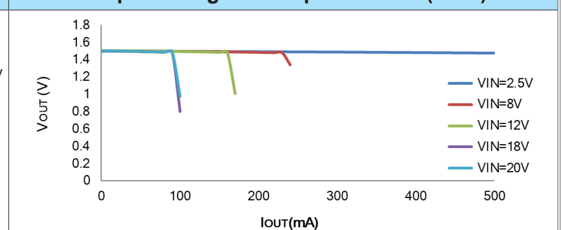
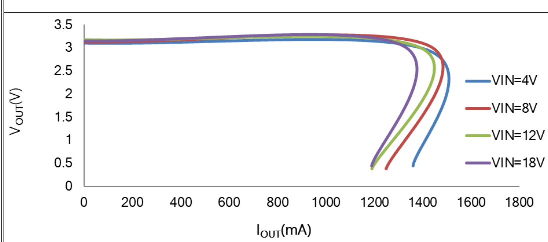
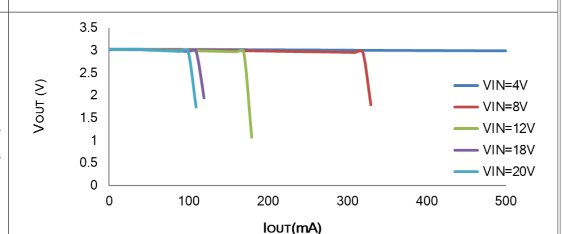
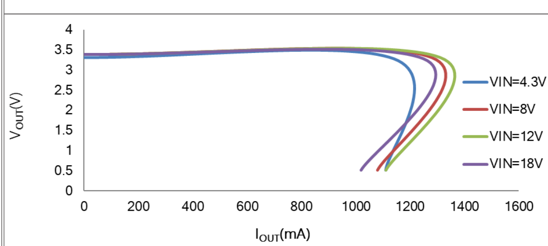
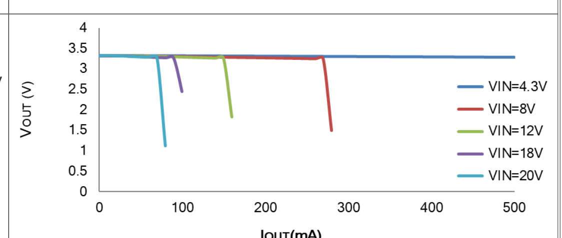
I_{SS} vs V_{IN}: HT78R30 (I_{OUT}=0mA)



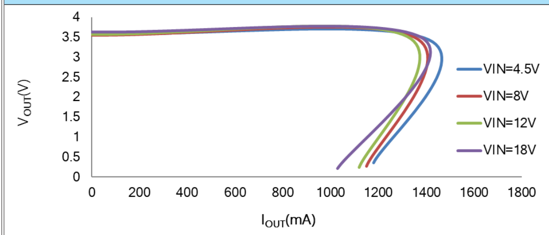
I_{SS} vs V_{IN}: HT78R33 (I_{OUT}=0mA)

Output Voltage vs Input Voltage	Quiescent Current vs Input Voltage
	
Line Regulation: HT78R35 (I_{OUT}=1mA)	I_{SS} vs V_{IN}: HT78R35 (I_{OUT}=0mA)
	
Line Regulation: HT78R50 (I_{OUT}=1mA)	I_{SS} vs V_{IN}: HT78R50 (I_{OUT}=0mA)

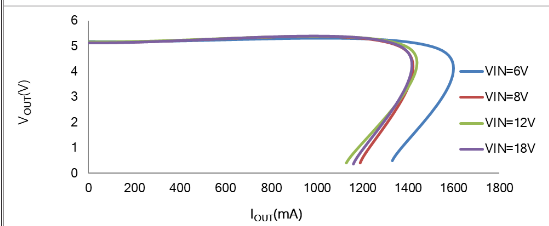
Test Condition: V_{IN}=V_{OUT}+1V, C_{IN}=1μF, C_{OUT}=1μF and Ta=25ºC, unless otherwise noted

Output Voltage vs. Output Current (Pulse)	Output Voltage vs Output Current (RMS)
	
I_{LM}: HT78R15	V_{OUT} vs I_{OUT}: HT78R15
	
I_{LM}: HT78R30	V_{OUT} vs I_{OUT}: HT78R30
	
I_{LM}: HT78R33	V_{OUT} vs I_{OUT}: HT78R33

Output Voltage vs. Output Current (Pulse)

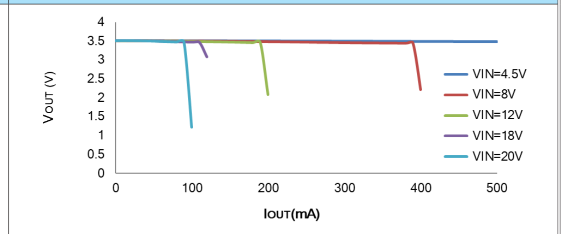


ILM: HT78R35

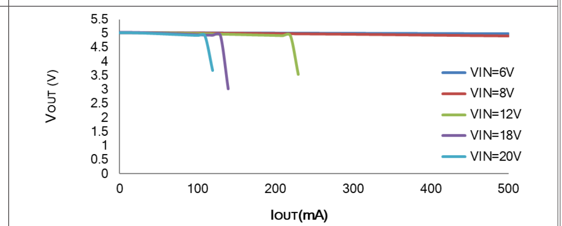


ILM: HT78R50

Output Voltage vs Output Current (RMS)



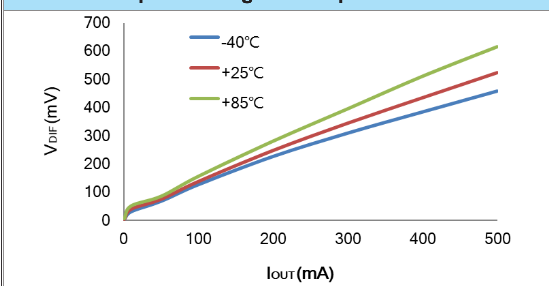
VOUT vs IOUT: HT78R35



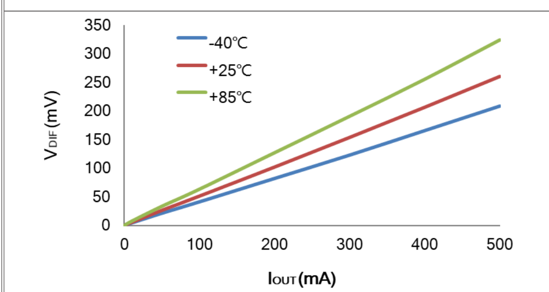
VOUT vs IOUT: HT78R50

Test Condition: $V_{IN}=V_{OUT}+1V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$ and Ta=25°C, unless otherwise noted

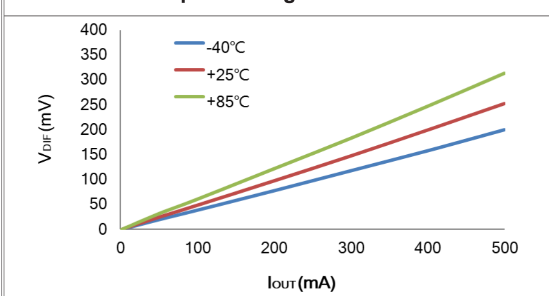
Dropout Voltage vs Output Current



Dropout Voltage: HT78R15

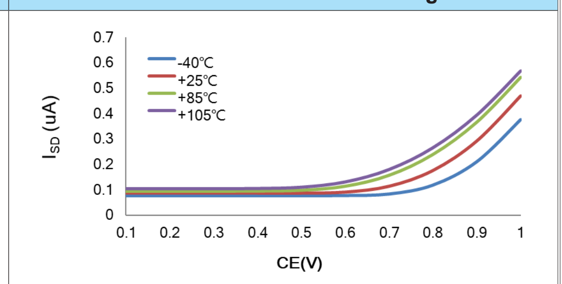


Dropout Voltage: HT78R30

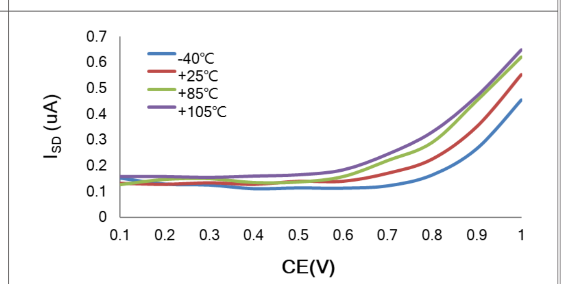


Dropout Voltage: HT78R33

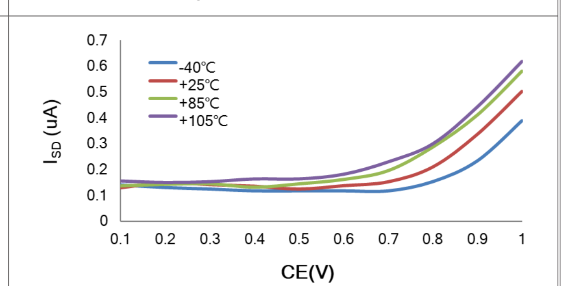
Shutdown Current vs CE Voltage



ISD vs CE: HT78R15

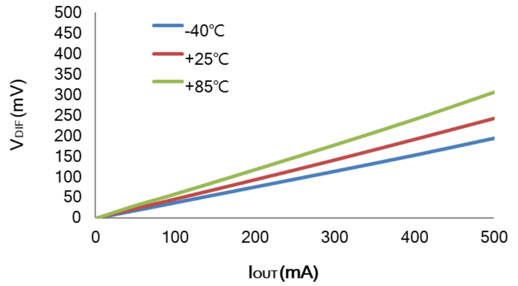


ISD vs CE: HT78R30

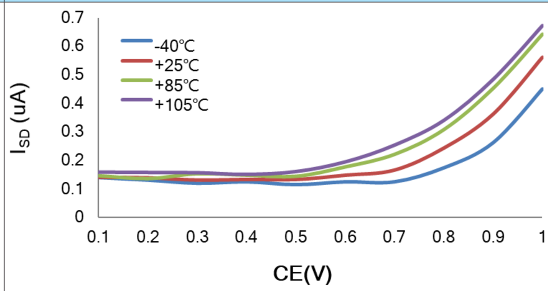


ISD vs CE: HT78R33

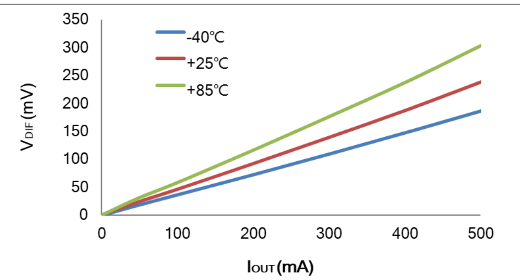
Dropout Voltage vs Output Current	Shutdown Current vs CE Voltage



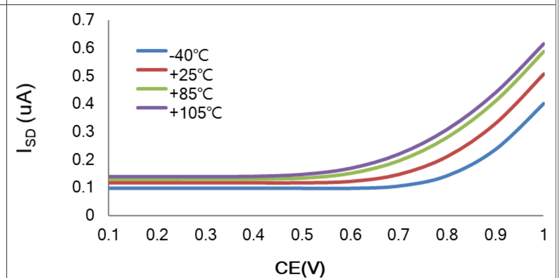
Dropout Voltage: HT78R35



I_{SD} vs CE: HT78R35



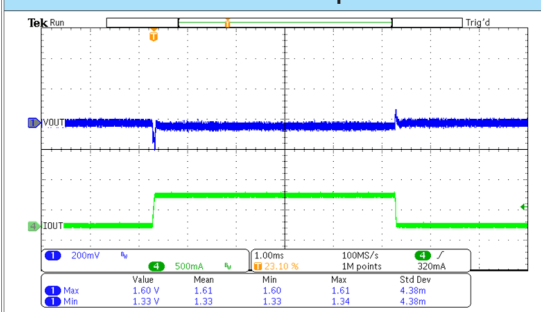
Dropout Voltage: HT78R50



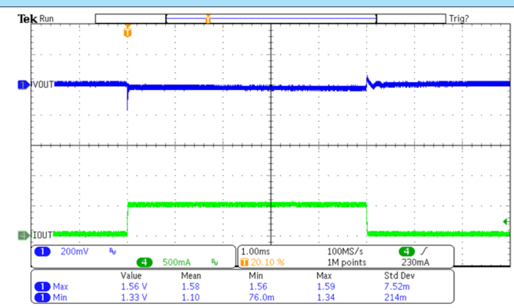
I_{SD} vs CE: HT78R50

Test Condition: $V_{IN}=V_{OUT}+1V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$ and Ta=25ºC, unless otherwise noted

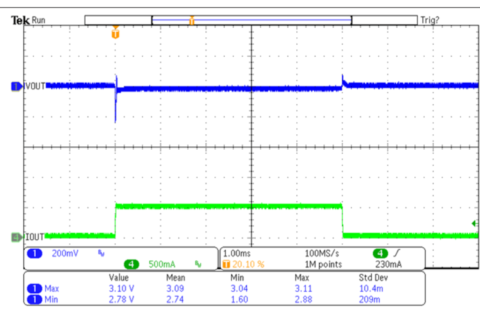
Load Transient Response 1	Load Transient Response 2



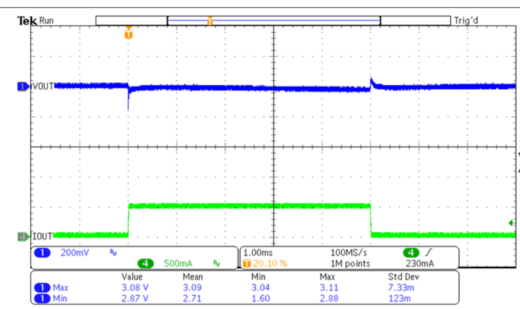
Load Transient Response:
HT78R15 (V_{IN}=2.5V, I_{OUT}=1mA to 500mA)



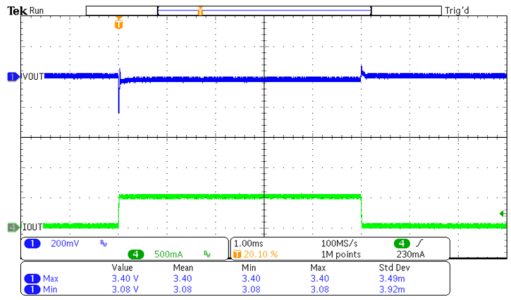
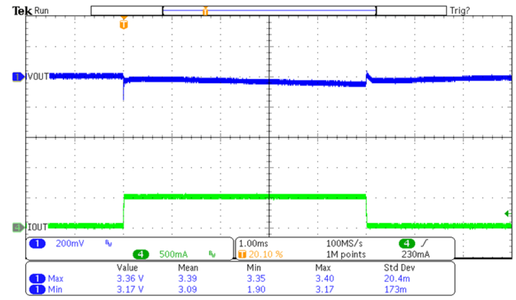
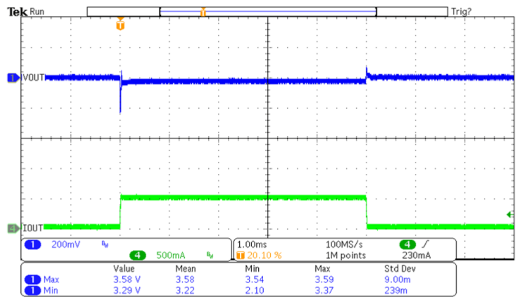
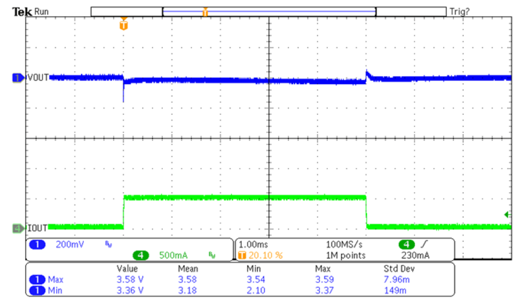
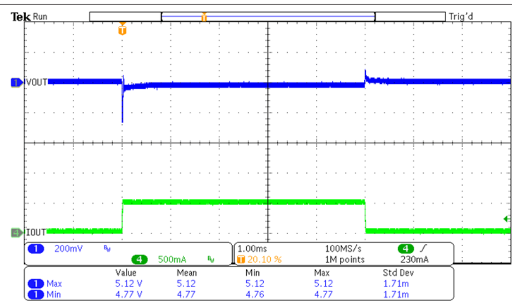
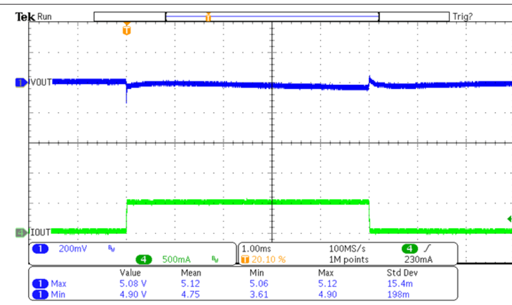
Load Transient Response:
HT78R15 (V_{IN}=20V, I_{OUT}=1mA to 500mA)



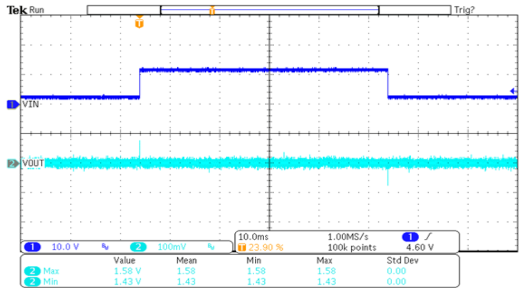
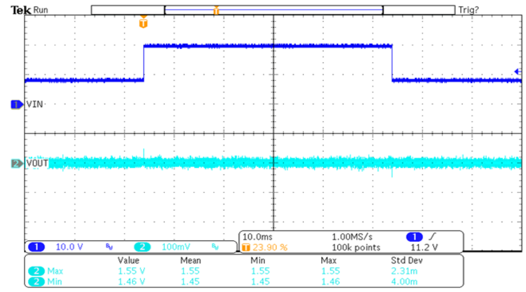
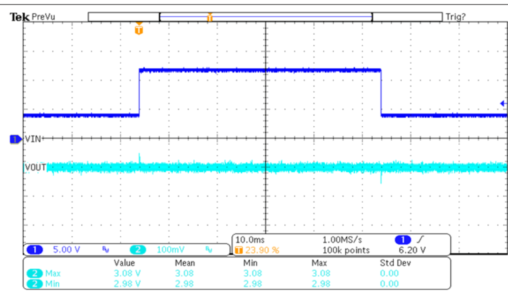
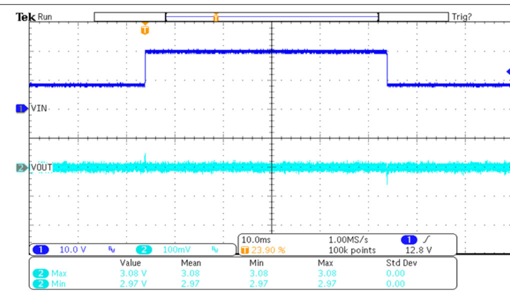
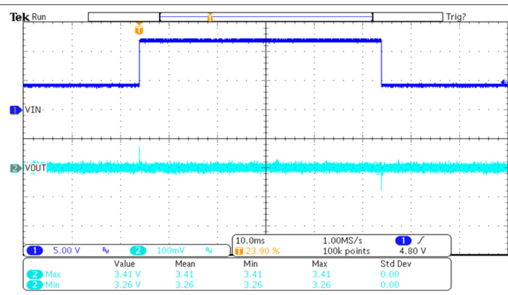
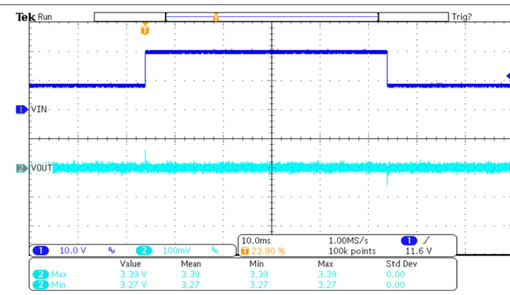
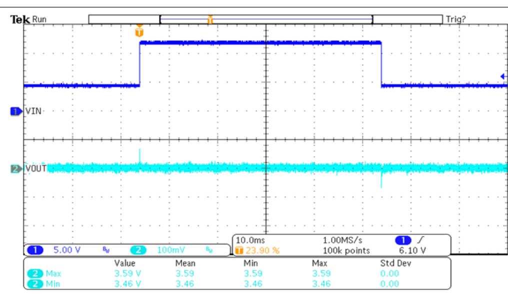
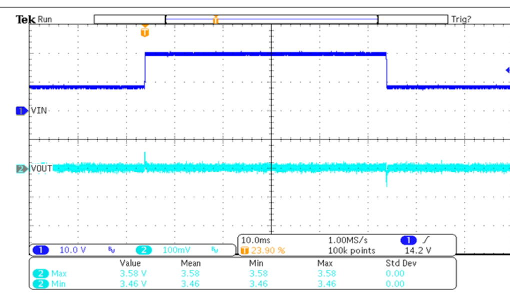
Load Transient Response:
HT78R30 (V_{IN}=4V, I_{OUT}=1mA to 500mA)

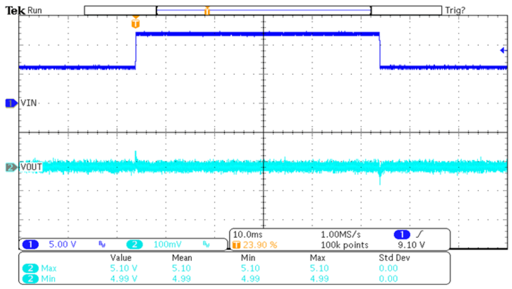
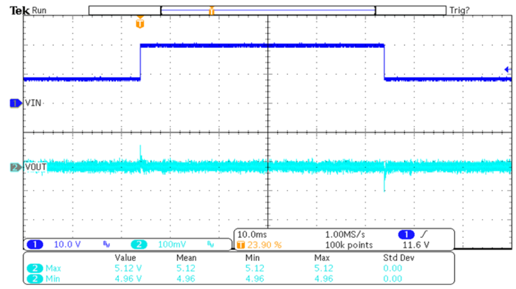


Load Transient Response:
HT78R30 (V_{IN}=20V, I_{OUT}=1mA to 500mA

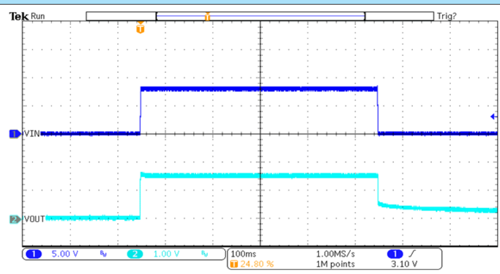
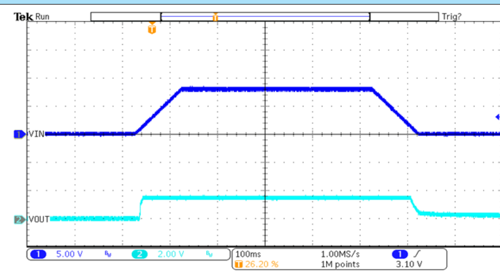
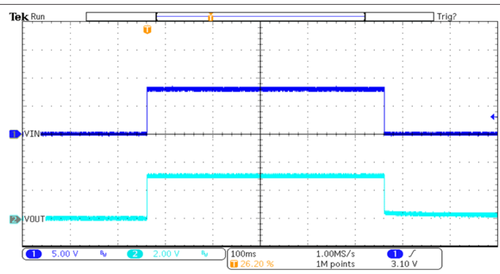
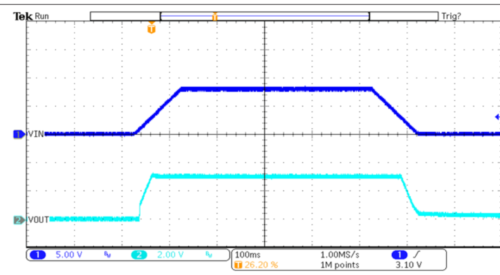
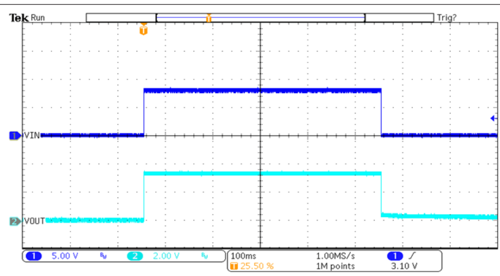
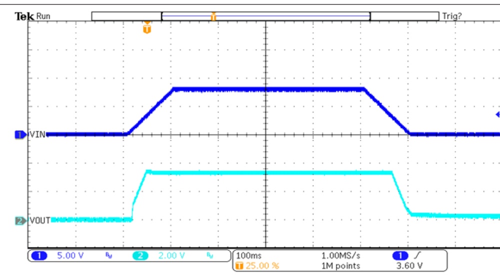
Load Transient Response 1	Load Transient Response 2
	
Load Transient Response: HT78R33 (V_{IN}=4.3V, I_{OUT}=1mA to 500mA)	Load Transient Response: HT78R33 (V_{IN}=20V, I_{OUT}=1mA to 500mA)
	
Load Transient Response: HT78R35 (V_{IN}=4.5V, I_{OUT}=1mA to 500mA)	Load Transient Response: HT78R35 (V_{IN}=20V, I_{OUT}=1mA to 500mA)
	
Load Transient Response: HT78R50 (V_{IN}=6V, I_{OUT}=1mA to 500mA)	Load Transient Response: HT78R50 (V_{IN}=20V, I_{OUT}=1mA to 500mA)

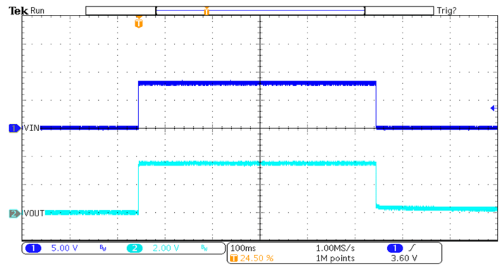
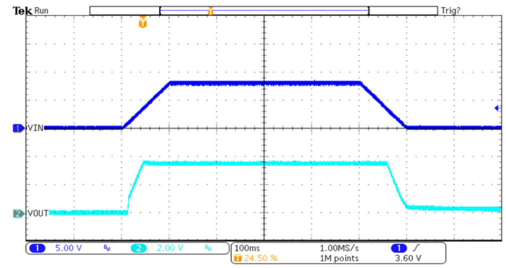
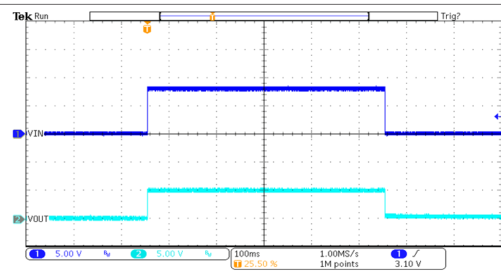
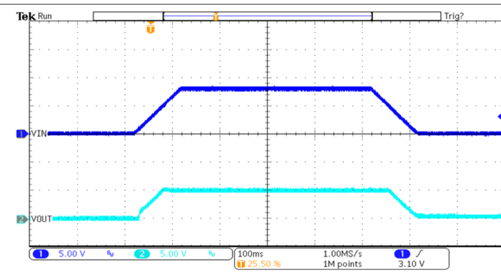
Test Condition: $V_{IN}=V_{OUT}+1V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$ and Ta=25°C, unless otherwise noted

Line Transient Response 1	Line Transient Response 2
	
Line Transient Response: HT78R15 (V_{IN}=2.5V to 12V, I_{OUT}=10mA)	**Line Transient Response: HT78R15 (V_{IN}=8V to 20V, I_{OUT}=10mA)**
	
Line Transient Response: HT78R30 (V_{IN}=4V to 12V, I_{OUT}=10mA)	**Line Transient Response: HT78R30 (V_{IN}=8V to 20V, I_{OUT}=10mA)**
	
Line Transient Response: HT78R33 (V_{IN}=4.3V to 12V, I_{OUT}=10mA)	**Line Transient Response: HT78R33 (V_{IN}=8V to 20V, I_{OUT}=10mA)**
	
Line Transient Response: HT78R35 (V_{IN}=4.5V to 12V, I_{OUT}=10mA)	**Line Transient Response: HT78R35 (V_{IN}=8V to 20V, I_{OUT}=10mA)**

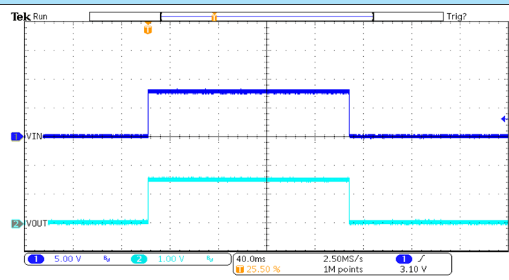
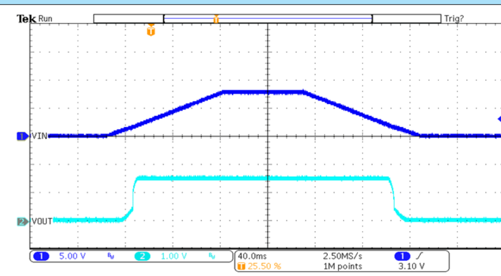
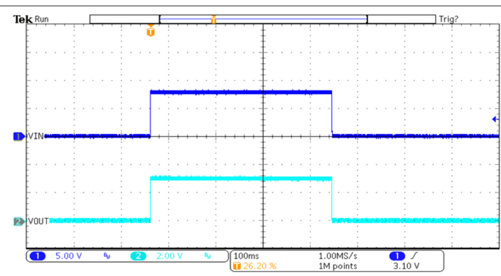
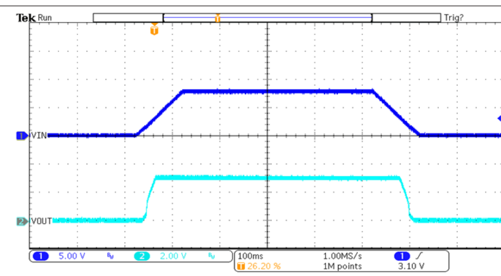
Line Transient Response 1	Line Transient Response 2
	
Line Transient Response: HT78R50 **(V_{IN}=6V to 12V, I_{OUT}=10mA)**	**Line Transient Response: HT78R50** **(V_{IN}=8V to 20V, I_{OUT}=10mA)**

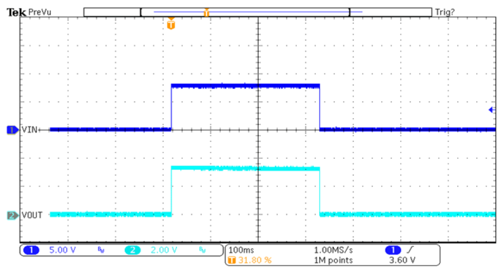
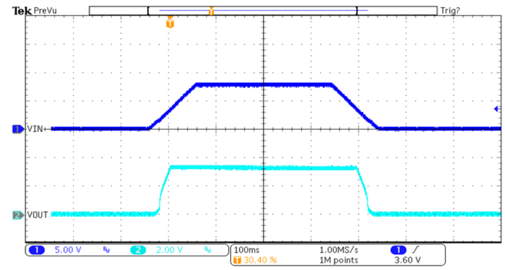
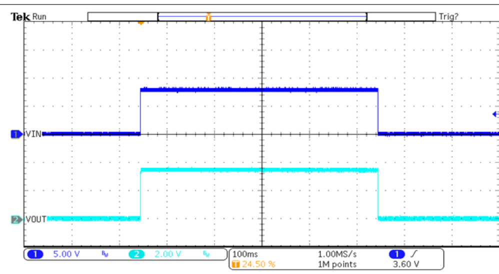
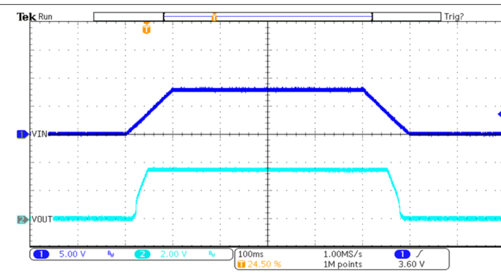
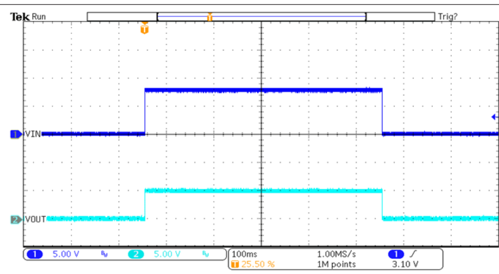
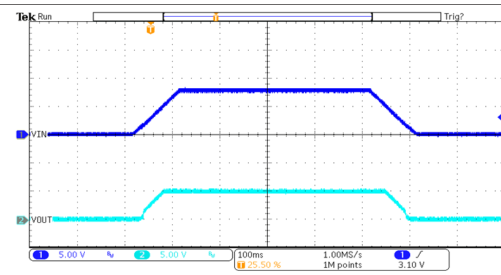
Test Condition: V_{IN}=V_{OUT}+1V, C_{IN}=1μF, C_{OUT}=1μF and Ta=25°C, unless otherwise noted

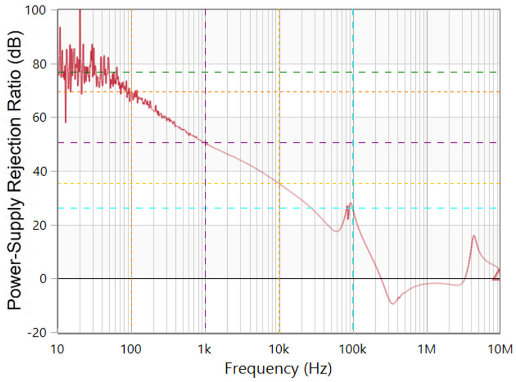
Power ON/OFF Response (I_{OUT}=0mA)	
	
Power On/Off Response:HT78R15 **(V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=0.1ms)**	**Power On/Off Response: HT78R15** **(V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=100ms)**
	
Power On/Off Response:HT78R30 **(V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=0.1ms)**	**Power On/Off Response: HT78R30** **(V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=100ms)**
	
Power On/Off Response:HT78R33 **(V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=0.1ms)**	**Power On/Off Response: HT78R33** **(V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=100ms)**

Power ON/OFF Response (I_{OUT}=0mA)	
	
Power On/Off Response: HT78R35 (V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=0.1ms)	**Power On/Off Response: HT78R35 (V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=100ms)**
	
Power On/Off Response: HT78R50 (V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=0.1ms)	**Power On/Off Response: HT78R50 (V_{IN}=8V, I_{OUT}=0mA, T_{RISE}=T_{FALL}=100ms)**

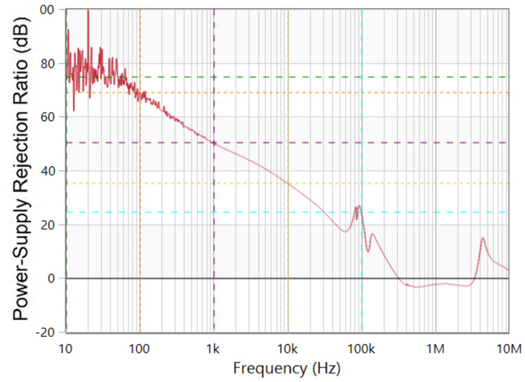
Test Condition: V_{IN}=V_{OUT}+1V, C_{IN}=1μF, C_{OUT}=1μF and Ta=25°C, unless otherwise noted

Power ON/OFF Response (I_{OUT}=500mA)	
	
Power On/Off Response: HT78R15 (V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=0.1ms)	**Power On/Off Response: HT78R15 (V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=100ms)**
	
Power On/Off Response: HT78R30 (V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=0.1ms)	**Power On/Off Response: HT78R30 (V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=100ms)**

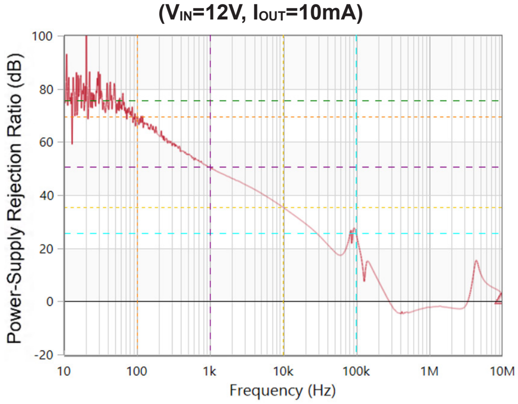
<table>
<tr><th colspan="2">Power ON/OFF Response (I_{OUT}=500mA)</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Power On/Off Response: HT78R33
(V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=0.1ms)</td><td>Power On/Off Response: HT78R33
(V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=100ms)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Power On/Off Response: HT78R35
(V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=0.1ms)</td><td>Power On/Off Response: HT78R35
(V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=100ms)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Power On/Off Response: HT78R50
(V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=0.1ms)</td><td>Power On/Off Response: HT78R50
(V_{IN}=8V, I_{OUT}=500mA, T_{RISE}=T_{FALL}=100ms)</td></tr>
</table>



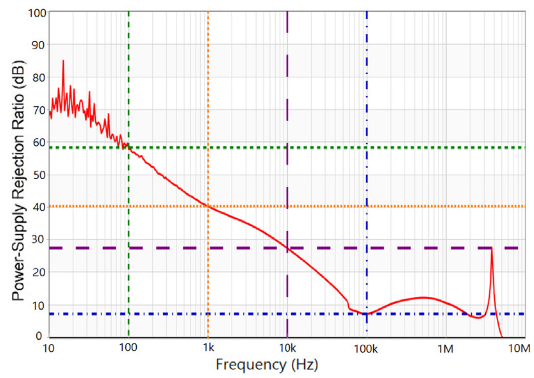
PSRR vs Frequency and V_{IN}: V_{OUT}=1.5V (V_{IN}=12V, I_{OUT}=10mA)



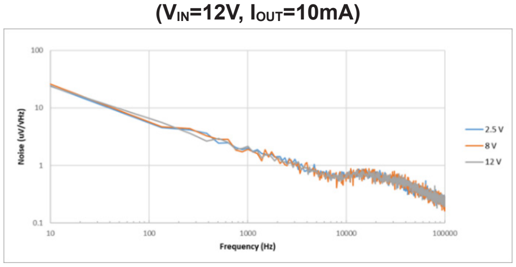
PSRR vs Frequency and V_{IN}: V_{OUT}=5.0V (V_{IN}=12V, I_{OUT}=10mA)



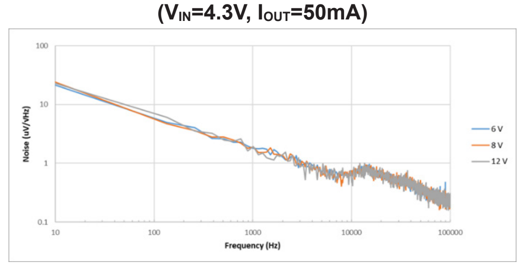
PSRR vs Frequency and V_{IN}: V_{OUT}=3.3V (V_{IN}=12V, I_{OUT}=10mA)



PSRR vs Frequency and V_{IN}: V_{OUT}=3.3V (V_{IN}=4.3V, I_{OUT}=50mA)



Noise vs Frequency and V_{IN}: V_{OUT}=1.5V (V_{IN}=2.5V/8V/12V)



Noise vs Frequency and V_{IN}: V_{OUT}=5.0V (V_{IN}=6V/8V/12V)

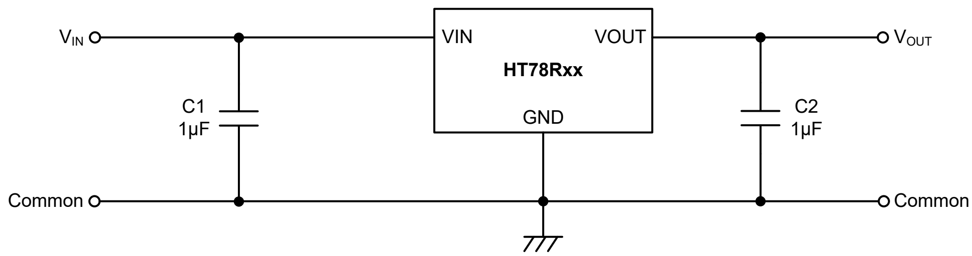
Application Circuits

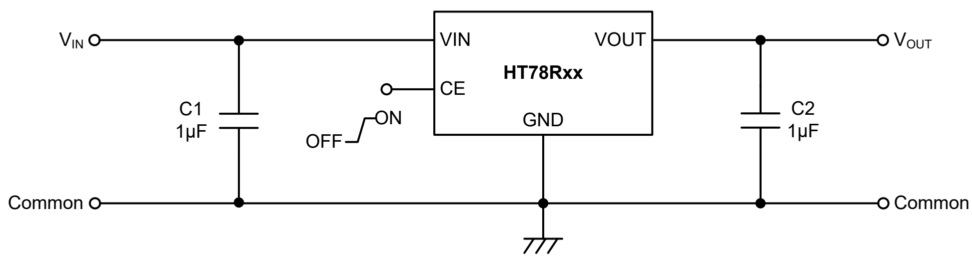
The circuits provided in this chapter are for reference only.

For the purposes of clarity, some of the detailed component parameters shall depend on the application.

Basic Circuits

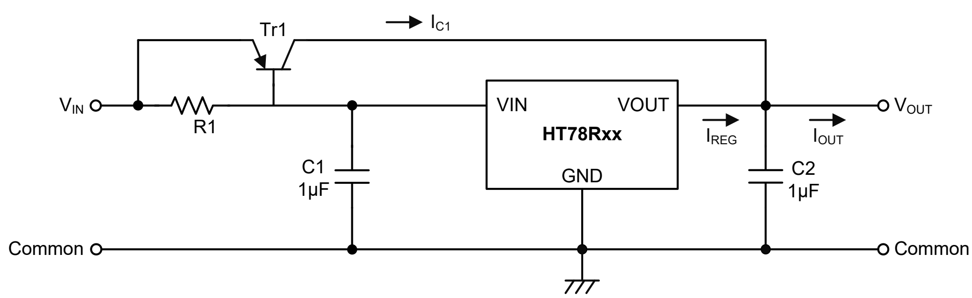
C_{IN}=C1, C_{OUT}=C2





High Output Current Positive Voltage Regulator

C_{IN}=C1, C_{OUT}=C2

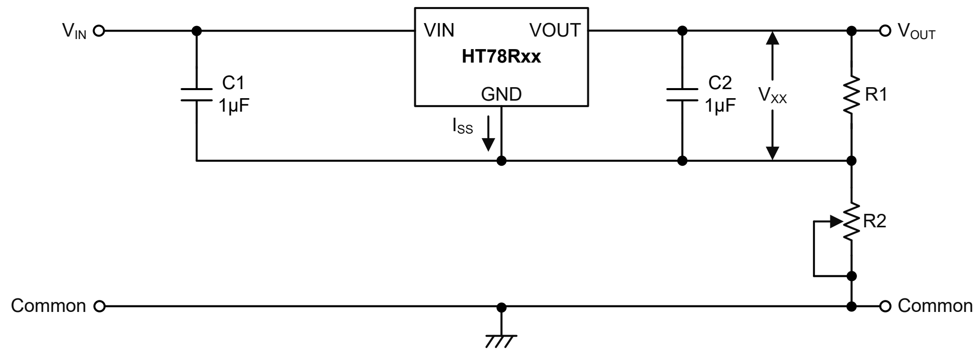


$R1=V_{BE1}/[I_{REG}-I_{C1}/(1+\beta)]$

$I_{OUT}=I_{C1}+I_{REG}$

Increased Output Voltage Circuit

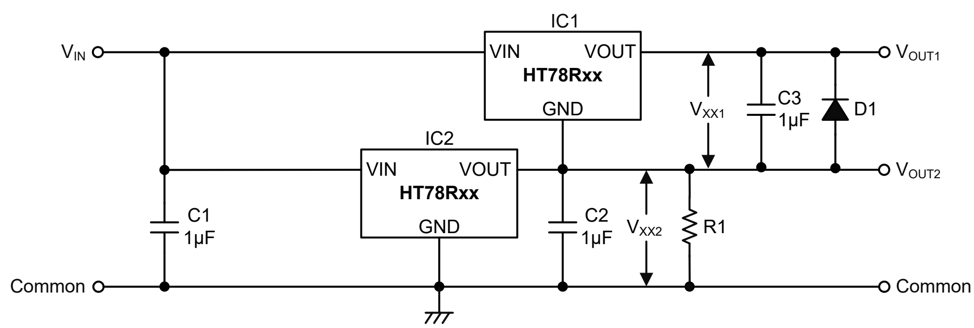
C_{IN}=C1, C_{OUT}=C2



$V_{OUT}=V_{XX}\times(1+R2/R1)+I_{SS}\times R2$

Dual Supply Circuit

C_{IN}=C1, C_{OUT}=C2.C3

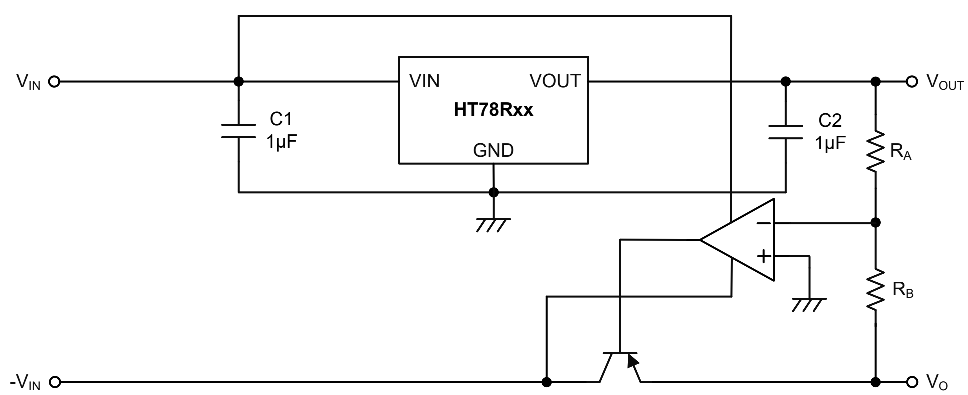


$V_{OUT1}=V_{XX2}+V_{XX1}$

$V_{OUT2}=V_{XX2}$

Tracking Voltage Regulator

C_{IN}=C1, C_{OUT}=C2



$-V_O=V_{OUT}\times R_B/R_A$

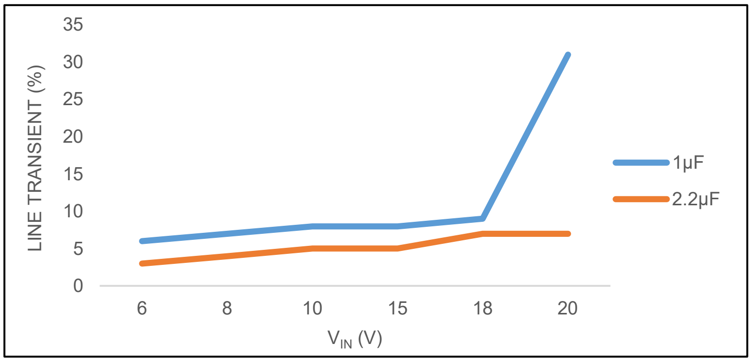
Application Information

Input Capacitor C_{IN} Considerations

It is recommended that the input capacitor be at least 1μF and be ceramic type for better temperature coefficient and lower ESR (Equivalent Series Resistance).

Output Capacitor C_{OUT} Considerations

The output capacitance plays an important role in keeping the output voltage stable. For the ceramic type capacitor, the capacitance should be at least 1.0μF. For better linear transient output characteristics, the C_{OUT} capacitance can be increased to 2.2μF, refer to the diagram below (V_{IN}=6V~20V, I_{OUT}=10mA).



OCP and OTP Protections

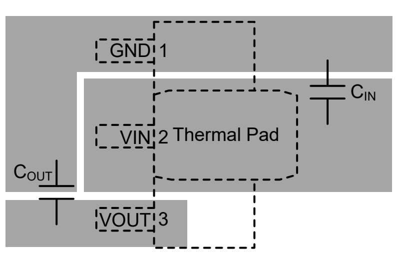
The devices implement the over current protection and over junction temperature protection to prevent device damage even if the output is shorted to ground. When the output is shorted to ground, the output current will be clamped to I_{LIM} and the junction temperature will rise. Once the junction temperature exceeds 150°C, the devices will shut down the power element to prevent thermal damage. The protection will be released when the junction temperature falls to 130°C. When the SOT23-5 package is used for applications with input voltage above 18V, because this package has poor thermal conductivity, the devices may be damaged due to the internal instantaneous temperature rise when the output is shorted.

Layout Consideration Guide

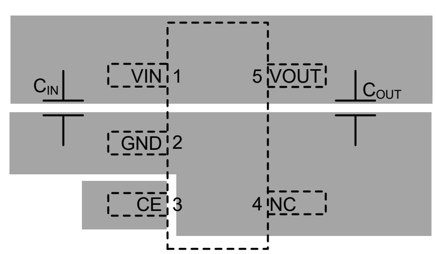
There are some important points to note on the PCB layout.

1. The VIN input capacitor, C_{IN}, must be placed close to the VIN pin.
2. The VOUT output capacitor, C_{OUT}, must be placed close to the VOUT pin.
3. The copper trace between the VIN input and the device VIN pin should be as wide as possible.
4. The SOT89 packaging PCB design must reserve thermally conductive copper foil.

SOT89



SOT23-5



Thermal Considerations

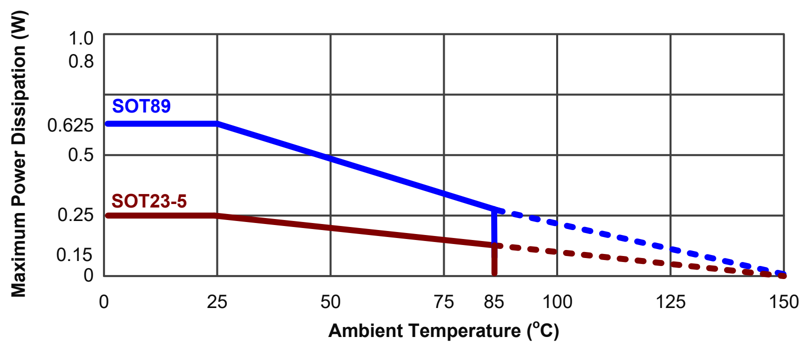
The maximum power dissipation depends on the thermal resistance of the package, the PCB layout, the rate of the surrounding airflow and the difference between the junction and ambient temperature. The maximum power dissipation can be calculated using the following formula:

$$P_{D(MAX)} = (T_{J(MAX)} - Ta) / \theta_{JA}$$

Where $T_{J(MAX)}$ is the maximum junction temperature, Ta is the ambient temperature and θ_{JA} is the junction-to-ambient thermal resistance of the device package in degrees per watt. The following table shows the θ_{JA} values for various package types.

Package Type	θ_{JA} (°C/W)
SOT89	200°C/W
SOT23-5	500°C/W

For maximum operating rating conditions, the maximum junction temperature is 150°C. However, it is recommended that the maximum junction temperature does not exceed 125°C during normal operation to maintain an adequate margin for device reliability. The de-rating curves of different packages for maximum power dissipation are as follows:



Package Information

Note that the package information provided here is for consultation purposes only. As this information may be updated at regular intervals users are reminded to consult the Holtek website for the latest version of the Package/Carton Information.

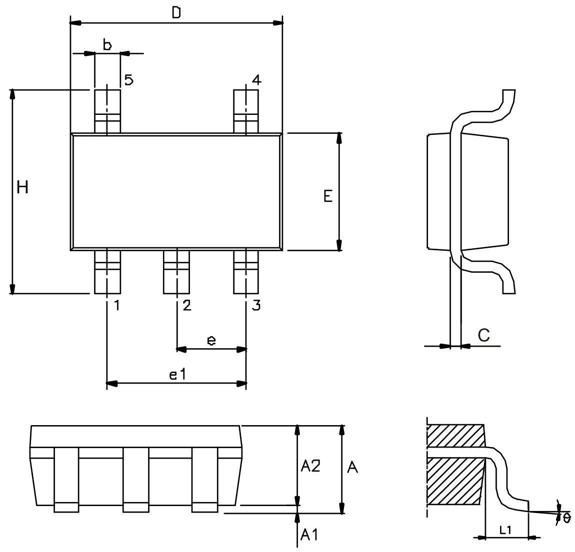
Additional supplementary information with regard to packaging is listed below. Click on the relevant section to be transferred to the relevant website page.

- Package Information (include Outline Dimensions, Product Tape and Reel Specifications)

- The Operation Instruction of Packing Materials

- Carton information

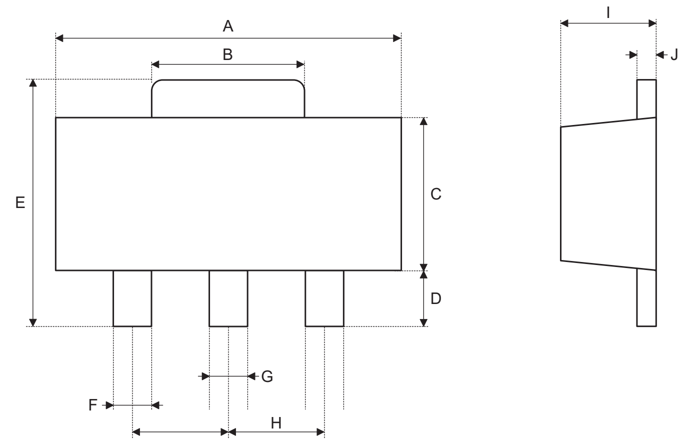
5-pin SOT23 Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	—	0.057
A1	—	—	0.006
A2	0.035	0.045	0.051
b	0.012	—	0.020
C	0.003	—	0.009
D	0.114 BSC		
E	0.063 BSC		
e	0.037 BSC		
e1	0.075 BSC		
H	0.110 BSC		
L1	0.024 BSC		
θ	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	—	1.45
A1	—	—	0.15
A2	0.90	1.15	1.30
b	0.30	—	0.50
C	0.08	—	0.22
D	2.90 BSC		
E	1.60 BSC		
e	0.95 BSC		
e1	1.90 BSC		
H	2.80 BSC		
L1	0.60 BSC		
θ	0°	—	8°

3-pin SOT89 Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.173	—	0.185
B	0.053	—	0.072
C	0.090	—	0.106
D	0.031	—	0.047
E	0.155	—	0.173
F	0.014	—	0.019
G	0.017	—	0.022
H	0.059 BSC		
I	0.055	—	0.063
J	0.014	—	0.017

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	4.40	—	4.70
B	1.35	—	1.83
C	2.29	—	2.70
D	0.80	—	1.20
E	3.94	—	4.40
F	0.36	—	0.48
G	0.44	—	0.56
H	1.50 BSC		
I	1.40	—	1.60
J	0.35	—	0.44