DESCRIPTION

MT7990 is a high precision primary-side constant voltage controller while achieving power factor correction. Both of regulations of constant - voltage (CV) and current - limiting (CL) are integrated into the MT7990.

MT7990 outputs constant voltage while the LED current is within the range of current limiting, it will limit the output current while the output voltage decreases as the load increases.

MT7990 can adjust the working mode automatically to save efficiency and enlarge output loading range. It works under Quasi-Resonant Mode (QRM) at heavy loading, under Discontinuous Conduction Mode (DCM) at medium loading and under Pulse Frequency Mode (PFM) at light loading. So that it can be achieved to save efficiency and enlarge output loading range. Various protection schemes are integrated to improve robustness, including over temperature protection (OTP), over voltage protection (OVP), and short circuit protection (SCP), etc.

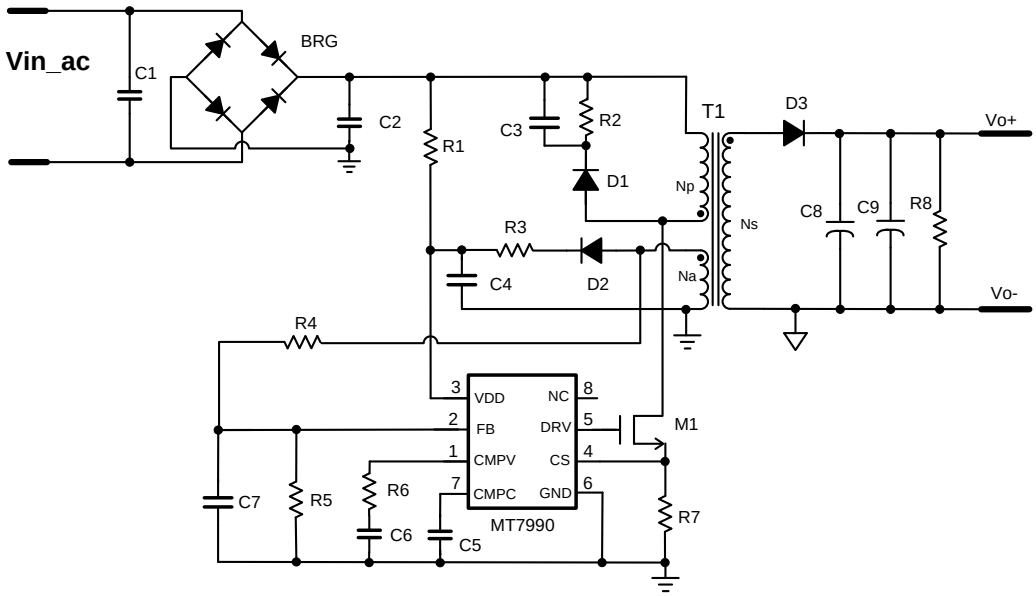
FEATURES

- Start-up without internal/external HV MOS
- Wide output loading range
- QRM at heavy loading to reduce EMI
- Accurate output voltage sensing and cable drop compensation
- Fast response for CV regulation
- Low output ripple for CV regulation
- Various protection schemes
- Power-on soft-start
- Available in SOP8 package

APPLICATIONS

- Intelligent LED lighting
- Battery chargers for cellular phones, pads, power tools, etc.
- High PF, low ripple LED driver

Typical Application Circuit



ABSOLUTE MAXIMUM RATINGS

VDD/DRV pin Voltage range	-0.3V to VDD Clamp
COMPC/COMPV/CS/FB pins voltage range	-0.3V to 6V
Lead temperature (soldering, 10 sec.)	260°C
P_{DMAX} (Maximum Power)	0.8W
Storage Temperature range	-55°C to 150°C

Recommended operating conditions

Supply voltage range	7.2V to 24V
Operating Temperature range	-40°C to 105°C

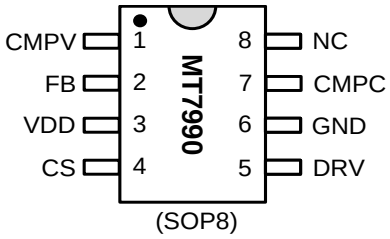
Thermal resistance①

Junction to ambient ($R_{\theta JA}$)	128°C/W

Note:

① *$R_{\theta JA}$ is measured in the natural convection at TA = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard. Test condition: Device mounted on 2" X 2" FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.*

PIN CONFIGURATIONS



(SOP8)

Chip Mark

MT7990

YY WW xx

Manufacture code

Week code

Year code

PIN DESCRIPTION

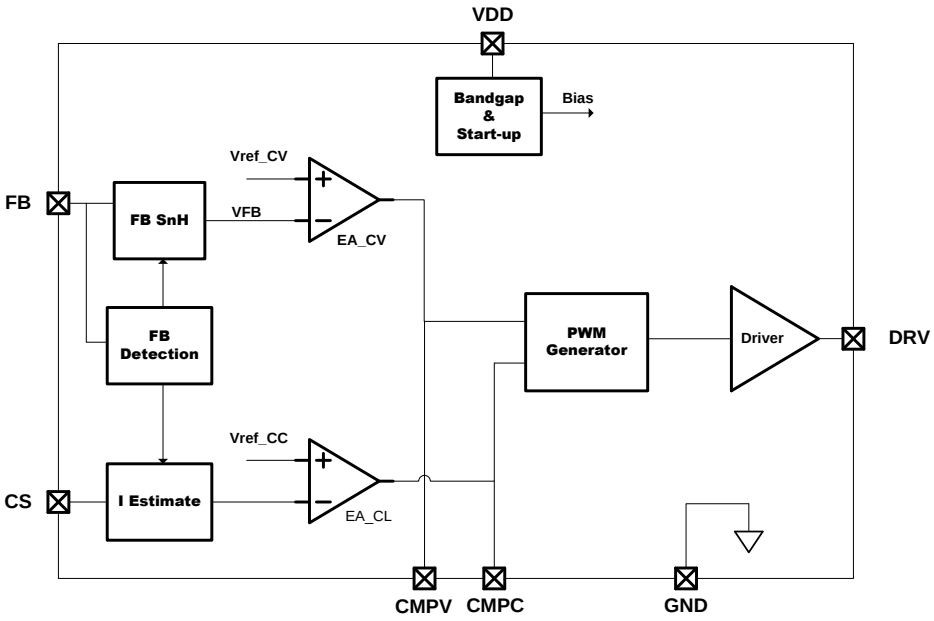
Name	Pin No.	Description
CMPV	1	Constant voltage loop compensation pin
FB	2	Feedback pin
VDD	3	Power supply
CS	4	Current sensing pin
DRV	5	Drive signal for external power MOSFET.
GND	6	Chip ground.
CMPC	7	Current limiting compensation.
NC	8	No connection.

ELECTRICAL CHARACTERISTICS

(Test conditions: V_{DD}=15V, T_A=25°C unless otherwise stated.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Start-up (VDD Pin)						
V_{STP}	Start-up Voltage	VDD Ramp-up from 0V		18		V
UVLO	Under Voltage Lockout	VDD Ramp-down from (V_{STP}+1V)		7.2		V
I_{STP}	Start-up Current	VDD=15V		30		μA
OVP1	Threshold of Over Voltage Protection of VDD			28		V
I_{CLAMP}	Sinking Current Capability to Clamp VDD			5		mA
HYS-$_{OVP1}$	Hysteresis of OVP1			1.7		V
Power Supply Current (VDD Pin)						
I_Q	Quiescent Current	No Loading at DRV Pin		4		mA
Control Loop						
V_{REF-CL}	Voltage Reference for CL Loop	Close the Feedback Loop		400		mV
V_{REF-CV}	Voltage Reference for CV Loop	Close the Feedback Loop		2.5		V
V_{CMPC-H}	Upper Limit of CMPC	CS=0V		3.2		V
$V_{CMPC-PRE}$	Pre-charge for CMPC Pin			1.4		V
SCP	Threshold of Short Circuit Protection at DSEN Pin			400		mV
OVP2	Threshold of Over Voltage Protection at DSEN Pin			3.2		V
LEB1	Leading Edge Blanking time at FB Pin			2.4		μS
MinT	Minimum Switching Period			10		μS
MaxT	Maximum Switching Period at PFM			1		mS
Current Sense Pin(CS Pin)						
OCP	Threshold of Over Current Protection at CS Pin			1.6		V
LEB2	Leading Edge Blank for CS Pin			200		nS
Temperature Protection						
OTP	Over temperature protection			150		°C
Hys-$_{OTP}$	Hysteresis of OTP			15		°C
Hard Drive Stage (Drive Pin)						
I_{SINK}	Maximum driver pull-down current	C_{LOAD}=100nF, DRV Pin Falls from VDD to 0V		2		A
I_{SOURCE}	Maximum driver pull-up current	C_{LOAD}=100nF, DRV Ramp-up from 0V to VDD		1		A

BLOCK DIAGRAM



APPLICATION INFORMATION

The MT7990 is a constant voltage controller. The selection of constant voltage or current limiting regulation is done automatically by determining which one requires less power.

MT7990 works under Quasi-Resonant Mode (QRM) at heavy loading, under Discontinuous Conduction Mode (DCM) at medium loading, under Pulse Frequency Mode (PFM) at light loading and under Hiccup Mode at ultra light loading.

The MT7990 provides various protection schemes to keep the system in safe normal state.

Start Up

VDD is charged by the rectified main-line voltage through the resistor R1 (as shown in the application circuit). As VDD reaches 18V, MT7990 starts to work, and the pin CMPV and CMPC are pre-charged. When the minimum voltage of CMPV and CMPC reach 1.4V, the DRV pin starts to output PWM signal. MT7990 will shut down as VDD falls below 7.2V.

The start-up sequence is shown in Fig. 1.

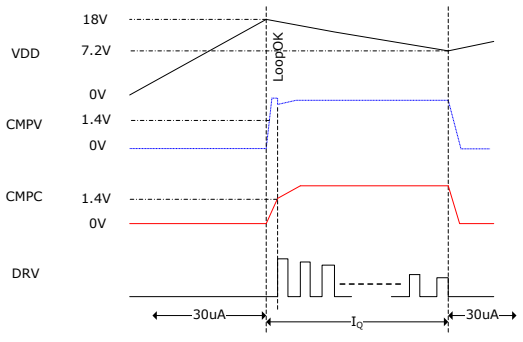


Fig. 1 Start-up sequence

Constant Voltage Control

The output voltage is sensed by FB pin, and gives feedback to the internal error amplifier to compare with an internal 2.5V reference voltage. Thus the duty cycle of PWM is modulated. Refer to Fig. 2.

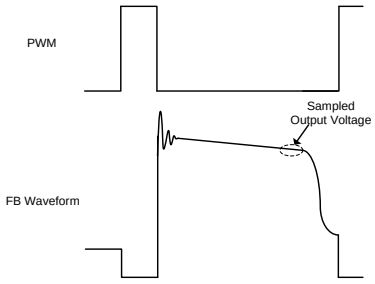


Fig. 2 FB Waveform Sensing

The output voltage is set by auxiliary winding reference resistor R4, R5, secondary turns Ns, and auxiliary turns Na:

$$Vout = V_{REF\_CV} \frac{R4+R5}{R5} \frac{Ns}{Na} \qquad (1)$$

The output end of internal error amplifier connects to the network of external frequency compensation through R6 and C6, as shown in the application circuit. By choosing a proper R6 and C6 ensures that the system achieves frequency stable and high PF.

Safety Operating Range

The safety operating range of the MT7990 is shown in fig. 3.

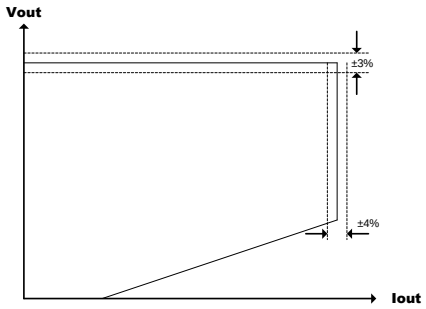


Fig. 3 Safety operating range

When the load current is heavier than the rated current, the output current is sensed by pin CS and FB, and gives feedbacks to the internal error amplifier to compare with the internal 0.4V reference voltage, hence to modulate the duty cycle of PWM. So the system maximum output current is limited within the range of rated output current.

The rated output current is set by reference resistor R7 of CS pin, primary winding turns Np and secondary winding turns Ns:

$$Iout = \frac{Np}{2 \cdot Ns} \frac{V_{REF\_CC}}{R7} \qquad (2)$$

Switching Mode at Different Loading

MT7990 works under QRM at heavy loading. The turn-on of PWM is triggered by the falling edge of FB's waveform right at the minimum of drain voltage after the end of demagnetization time (Tdmg). Refer to Fig. 4.

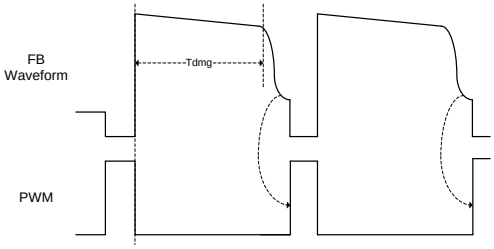


Fig. 4 QRM turned-on mode

When the loading goes lighter, the turn-on time (T_{ON}) and demagnetization time (Tdmg) of PWM will be small. The MT7990 limits the minimum switching period within 10uS.

If the loading continues to reduce, the turn-on time (T_{ON}) of PWM keeps decreasing too. When the T_{ON} drops to 0.5μS (Min. On-time), the system enters PFM mode, MT7990 starts to modulate the minimum switching period.

MT7990 provides varies of switching mode to improve efficiency and enlarge output loading range.

LED Over Voltage Protection Setup

MT7990 implements two types of over-voltage protection scheme:

1. VDD Over Voltage Protection

When the VDD voltage exceeds 28V, the PWM signal will be temporarily shut-down, about 30mS, then the PWM signal will be restarted again. If VDD exceeds 28V accumulated for three times, the PWM signal is latched off until the VDD voltage drops to 7.2V. MT7990 will

repeat this behavior until output over-voltage condition removes. Refer to Fig. 5.

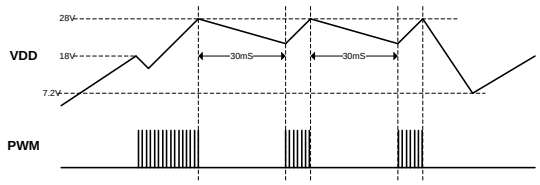


Fig. 5 VDD OVP waveform

2. FB Over-Voltage Protection

The FB OVP sampling period is shown in Fig.6.

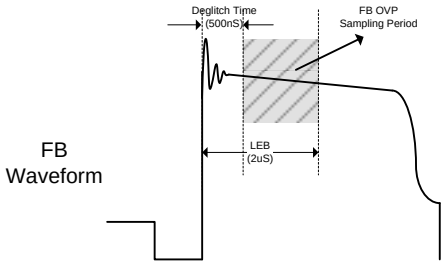


Fig. 6 FB OVP Sensing

If FB's voltage exceeds 3.2V for three times, the PWM signal be latched off until the VDD voltage drops to 7.2V, mean while the quiescent current becomes 30uA. Then the VDD is re-charged to be 18V through a start-up resistor R1, the system re-starts. If the FB voltage is detected over 3.2V again, MT7990 will repeat the behavior until output over voltage condition removes.

LED Short - Circuit Protection

If the FB voltage is detected less than 400mV, the system enters short-circuit protection state. Refer to Fig. 7.

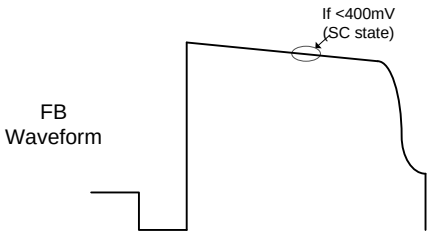


Fig. 7 FB short-circuit protection sensing

If the system enters short-circuit state longer than 30mS, PWM signal is latched off until the VDD voltage drops to 7.2V.

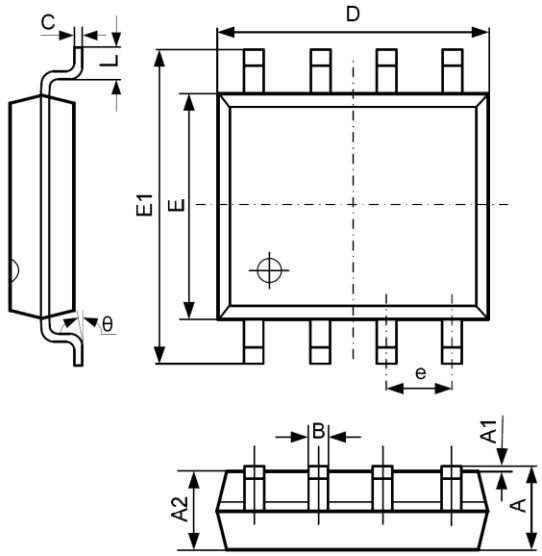
Over-Current and Over-Temperature Protection

The MT7990 immediately turns off the PWM signal once the voltage at CS pin exceeds 1.6V.

When the temperature of chip exceeds 150°C, The MT7990 stops PWM signal output until the chip temperature drops to 15°C. If the temperature reaches 150°C for three times, MT7990 turns off the PWM signal until the VDD voltage drops to 7.2V.

PACKAGE INFORMATION

SOP-8 PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°