

Over Current Protection IC



General Description

FP131 is a current detection and over current protection IC. It includes a current shunt comparator and shutdown comparator with a precision shunt regulator like FP431. The rail current detection gain can be adjusted with three external resistors. The regulator output CSO pin is connected to a shutdown comparator for driving a protection circuit like a photo-coupler to shutdown the converter's primary side PWM IC when over current occurs. The voltage shunt regulator has a 1.25V reference for switching power supply secondary output voltage feedback.

FP131 can be used for OCP and output voltage feedback function with few external parts. It is suitable for application in secondary main rail power supply of SPS or isolated fly-back DC-DC converter.

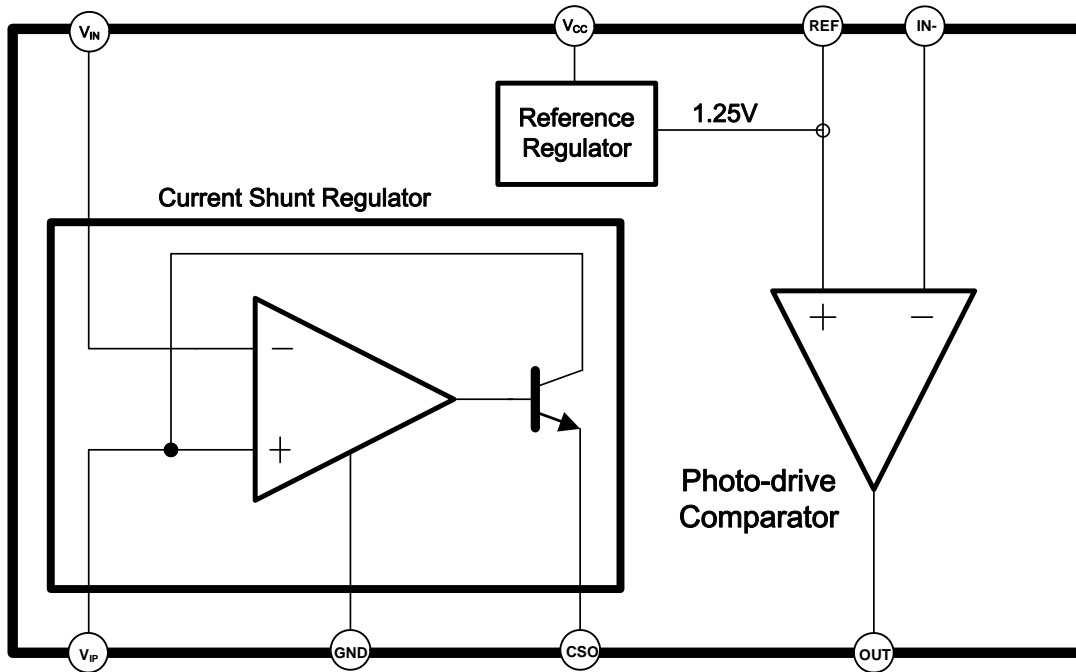
Features

- Wide Operating Voltage Range: +2.7V~ +28V
- Comparator Reference Voltage: 1.25V (2%)
- Independent Shunt and Supply Voltages
- Adjustable Sense Gain
- Low Input Offset Voltage
- Output Sink Current Capability up to 16mA
- Package: SOP-8L

Typical Application Circuit

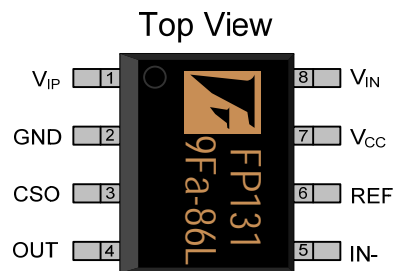
- SPS
- DC-DC Converter
- Isolated Fly-back DC-DC Converter
- Current Sense Instrument

Function Block Diagram



Pin Descriptions

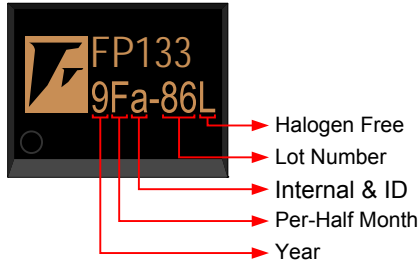
SOP-8L



Name	No.	I / O	Description
V _{IP}	1	I	Positive Input of Current Shunt OPA
GND	2	P	IC Ground
CSO	3	I	Output of Current Shunt OPA to Inverting Input of Shutdown Comparator
OUT	4	P	Output of Comparator
IN-	5	I	Negative Input of Comparator
REF	6	I	1.25V Reference
V _{CC}	7	P	IC Power Supply
V _{IN}	8	I	Inverting Input of Current Shunt OPA

Marking Information

SOP-8L



Halogen Free: Halogen free product indicator

Lot Number: Wafer lot number's last two digits

For Example: 132386TB → 86

Internal ID: Internal Identification Code

Per-Half Month: Production period indicated in half month time unit

For Example: January → A (Front Half Month), B (Last Half Month)

February → C (Front Half Month), D (Last Half Month)

Year: Production year's last digit

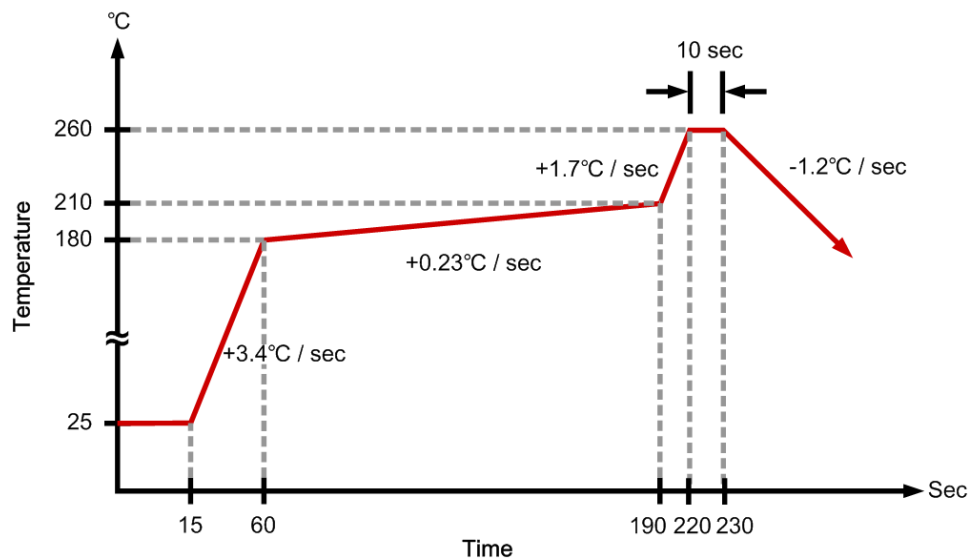
Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP131DR-LF	-20°C ~ +85°C	SOP-8L	2500EA	Tape & Reel

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}				30	V
Current Shunt Regulator Common Mode Inputs Voltage			-0.3		30	V
Current Shunt Regulator Differential Inputs Voltage		$V_{IP}-V_{IN}$	-30		1.5	V
Photo-drive Comparator Common Mode Inputs Voltage	IN-				$V_{CC}-1.5$	V
CSO Voltage			-0.3		V_{CC}	V
OUT Voltage			-0.3		30	V
OUT Sink Current					25	mA
Operating Junction Temperature	T_J		-20		+150	°C
Operating Ambient Temperature Range	T_A		-20		+85	°C
Storage Temperature Range	T_S		-55		+150	°C
Power Dissipation		$T_A=25^\circ\text{C}$			570	mW
Lead Temperature(soldering, 10 sec)					+260	°C

IR Re-flow Soldering Curve



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Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}		2.7		28	V
Operating Temperature			-20		+85	°C

DC Electrical Characteristics

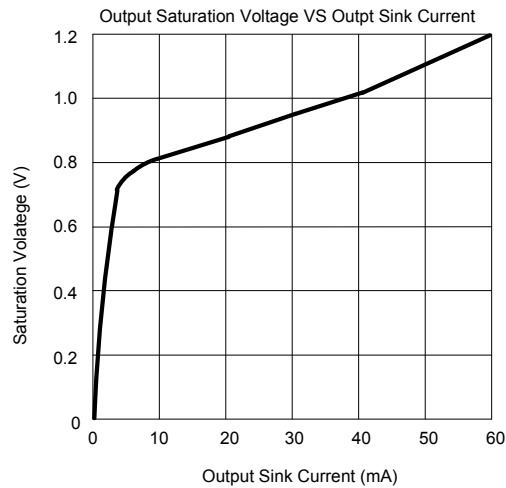
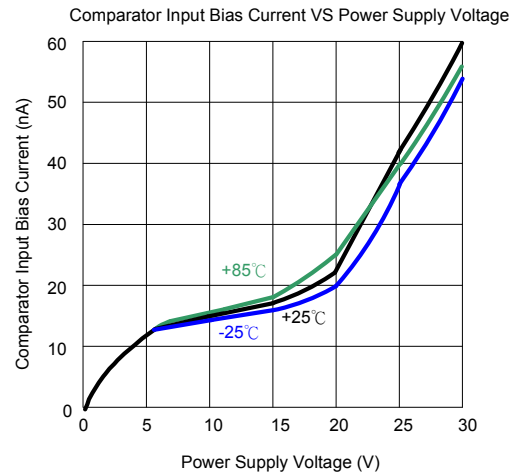
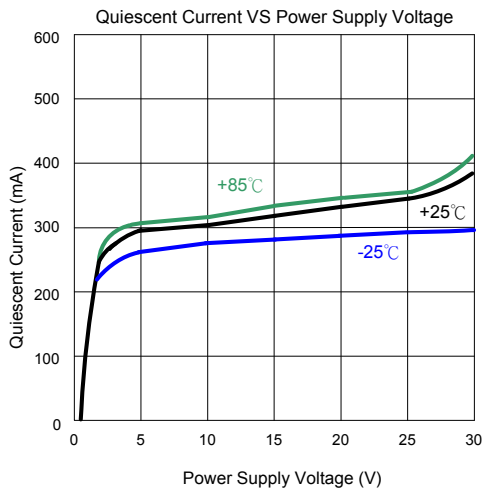
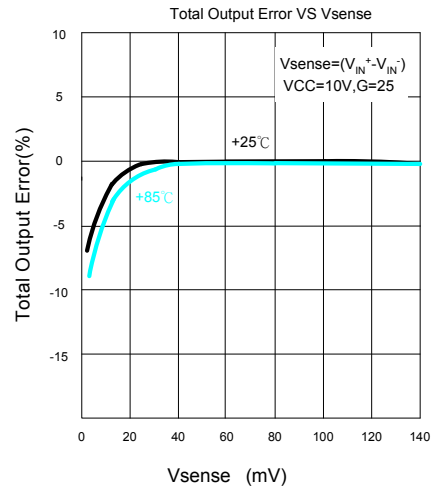
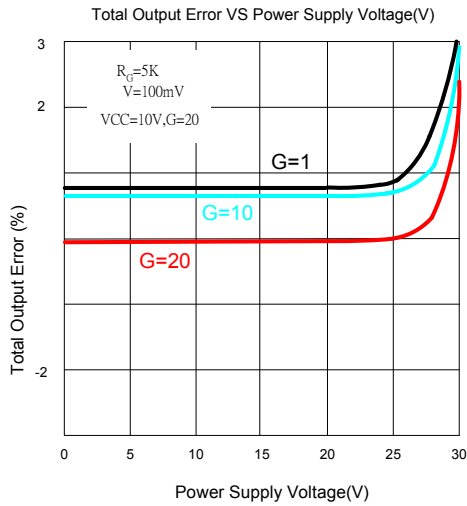
($V_{CC}=5V$, $T_A=-20^{\circ}C\sim+85^{\circ}C$, $V_{IP}=12V$, $R_{OUT}=125k\Omega$ unless otherwise noted)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Shunt Comparator Section						
Full Scale Sense Voltage	V_{SENSE}	$V_{SENSE}=V_{IP} - V_{IN}$		100	500	mV
Common-Mode Input Voltage	V_{CM}		2.7		28	V
Common-Mode Rejection	CMRR	$V_{IP}=2.7V$ to 28V, $V_{SENSE}=50mV$	100	120		dB
Input Offset Voltage vs Temp	$V_{OFFSET}(T_A)$	T_{MIN} to T_{MAX}		4		$\mu V / ^{\circ}C$
Input Offset Voltage vs V_{CC}	$V_{OFFSET}(V_{CC})$	$V_{IN}=2.7V$ to 28V, $V_{SENSE}=50mV$		2.5	10	$\mu V / V$
Input Bias Current	I_{BIAS}	V_{IP}, V_{IN}		2		μA
Non-linearity Error	NLE	$V_{SENSE}=10mV$ to 150mV			± 1	%
Total Output Error	TOE	$V_{SENSE}=100mV$			± 2	%
Output Impedance	R_{OUT}			1 5		$G\Omega \mu F$
Voltage Swing to V_{CC}	V_{SCC}			$V_{CC}-0.8$		V
Voltage Swing to V_{CM}	V_{SCM}			$V_{CM}-0.5$		V
Bandwidth	BW	$R_{OUT}=125K\Omega$		32		KHz
Settling Time	T_S	5V Step, $R_{OUT}=125K\Omega$		30		μS
Total Output-Current Noise	I_{NOISE}	BW=100KHz		3		nA
Photo-drive Comparator Section						
Input Offset Voltage	V_{OFFSET}			1.0	5.0	mV
Input Bias Current	I_{BIAS}			25	250	nA
Common-Mode Voltage (IN-)	V_{CM}		-0.3	-	$V_{CC}-1.5$	V
Voltage Gain	A_V		50	200		V/mV
Large Signal Response Time				300		nS
Response Time				1.3		μS
Output Sink Current	I_{SINK}	$V_{REF}-V_{IN}=-0.75V$, $V_{OUT} \leq 1.0V$		16		mA
Saturation Voltage	V_{SAT}	$V_{REF}-V_{IN}=-0.75V$ $I_{SINK} \leq 10mA$			1000	mV
Output Leakage Current		$V_{REF}-V_{IN} = 1.25V$ $V_{OUT} = 28V$		0.1	1	μA
Reference Section						
Reference Voltage (2%)	V_{REF}	$T_A=25^{\circ}C$	1.225	1.25	1.275	V
Line Regulation		$3V \leq V_{CC} \leq 28V$		2	15	mV
Total Device Section						
Power Supply Current	I_{CC}	$V_{CC}=30V$		400		μA

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Typical Characteristics

$V_{IN}=12V, T_A=25^{\circ}C$

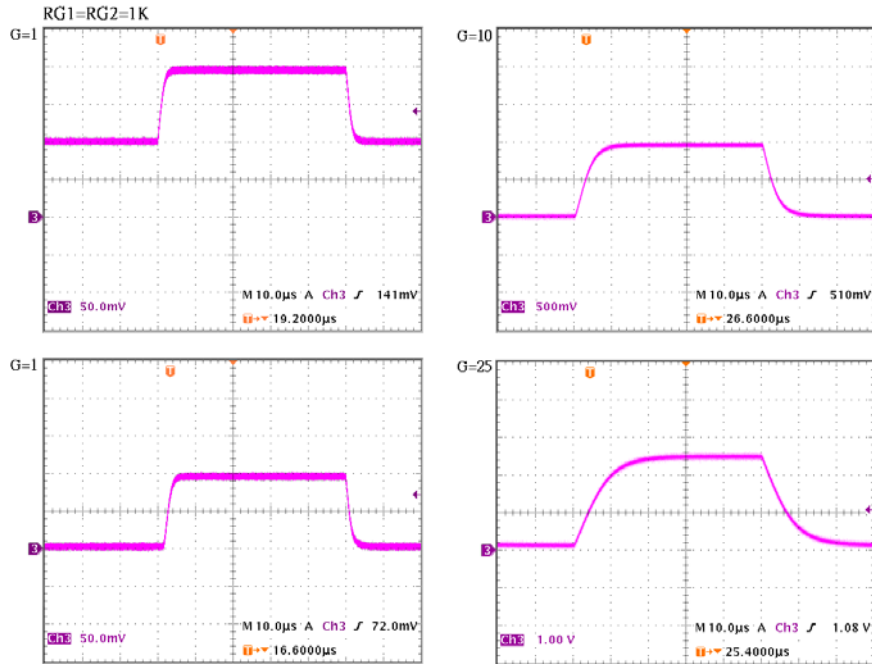


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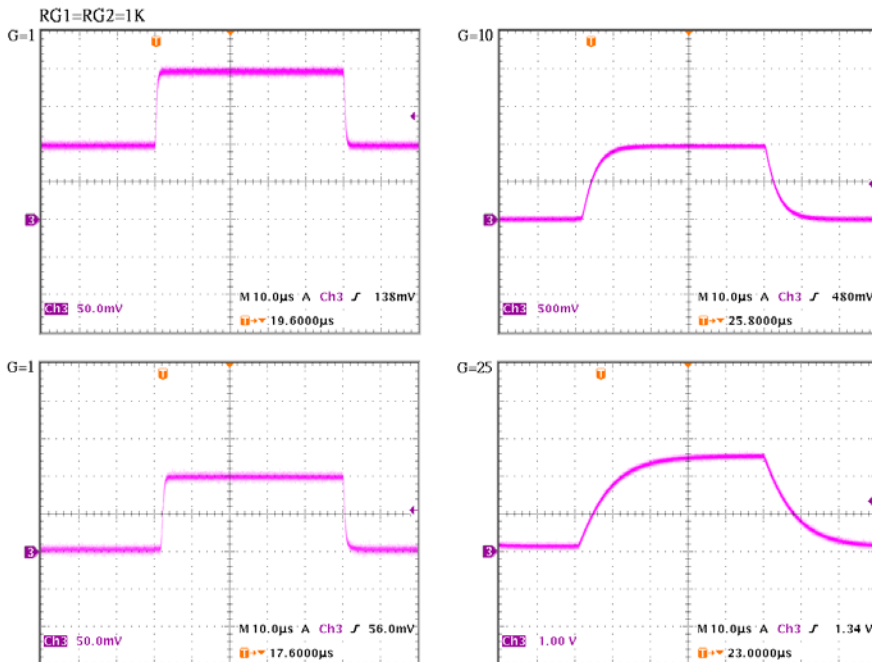
Typical Characteristics

$V_{IN}=12V, V_{CC}=5V, T_A=25^{\circ}C$

RG1=RG2=1K Ω



RG1=RG2=5K Ω



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Function Description

Current Shunt Regulator

The figure below shows the FP131 current shunt block. Load current (I_S) flows from power supply and a dropout voltage ($V_{IN}^+ - V_{IN}^-$) appears across the sense resistor (R_S).

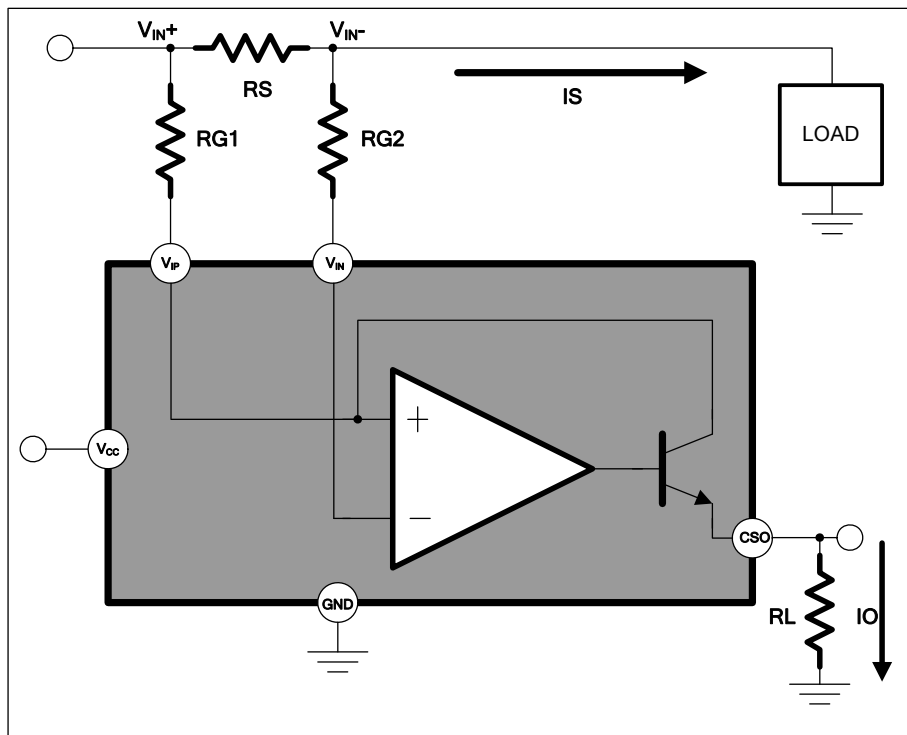
Assume the internal NPN transistor's collector current is same as the emitter current (I_O) and V_{IP} is very close to V_{IN} , the FP131 transfer function will be:

$$I_O = \frac{V_{IN}^+ - V_{IN}^-}{R_{G1}} \quad \text{---- (1)}$$

In this figure, the ($V_{IN}^+ - V_{IN}^-$), is equal to $I_S \times R_S$ and the current shunt output voltage (V_{CSO}) is equal to $I_O \times R_L$. The final transfer function for rail current measurement in this application is:

$$V_{CSO} = G \times I_S \times R_S \quad \text{---- (2)}$$

$$G = R_L / R_{G1} \quad \text{---- (3)}$$



Note

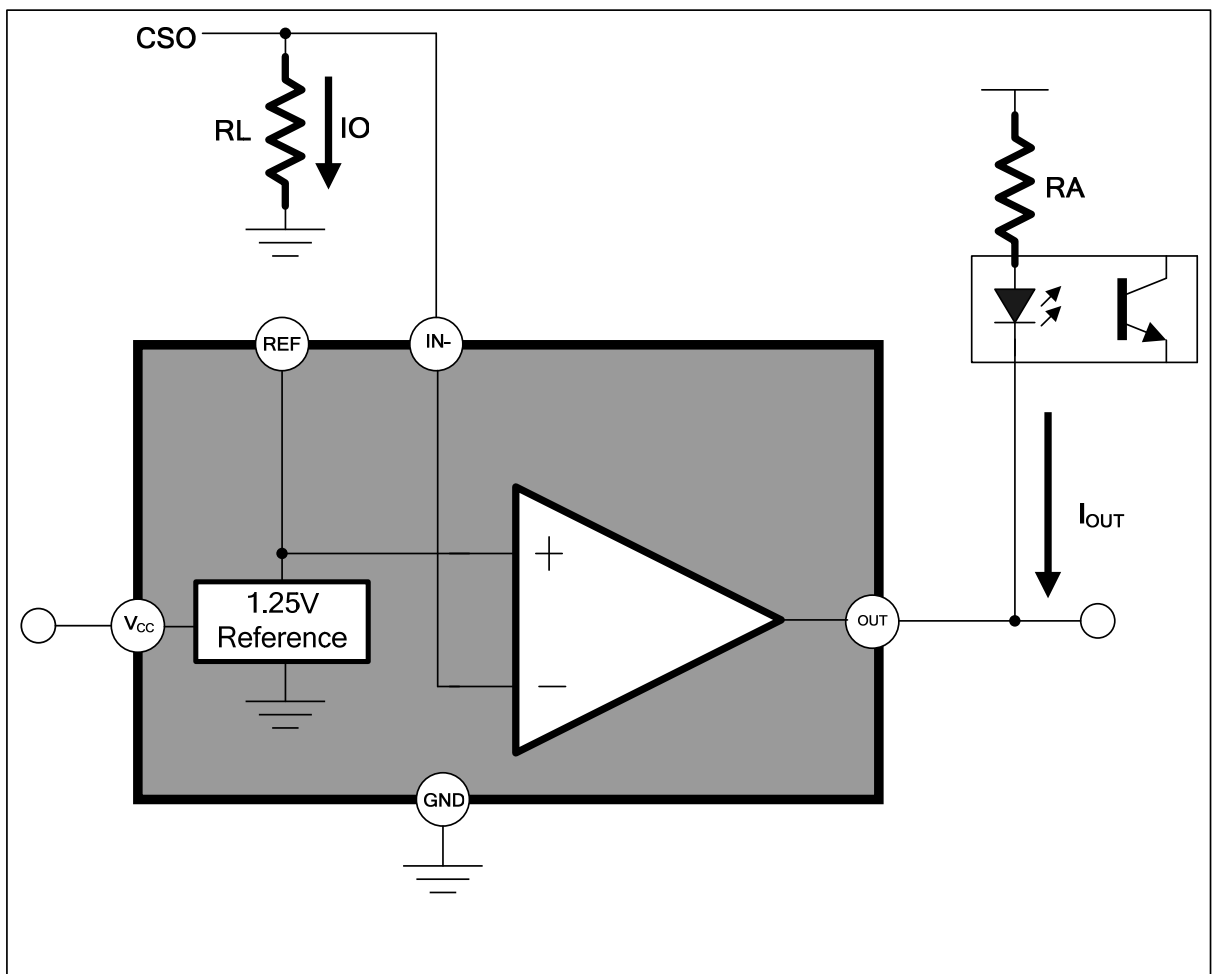
1. The minimum operating voltages of V_{CC} , V_{IP} and V_{IN} are 2.7V. If these supply voltages are lower than 2.7V, the transfer function at current shunt output (CSO) of FP131 is no longer correct.
2. Do not force a V_{IN} voltage 15V higher than V_{IP} . This condition would generate a leakage current and an incorrect voltage at FP131's output.

Photo-drive Comparator

The figure below shows the FP131 comparator. It has an internal reference 1.25V connecting to the IN+ of comparator with high current sink output. That makes FP131 suitable for OCP protection circuits using photo-coupler.

By connecting the current shunt output (CSO) to comparator IN- input for the load current (I_S) detection. The comparator output can drive the photo-coupler for the over load protection.

When the load current (I_S) is increasing, the transfer function gain would amplify the CSO voltage until the value ($I_O \cdot R_L$) is more than 1.25V. The comparator output would change from high to low state and sink the photo-coupler current (I_{OUT}).

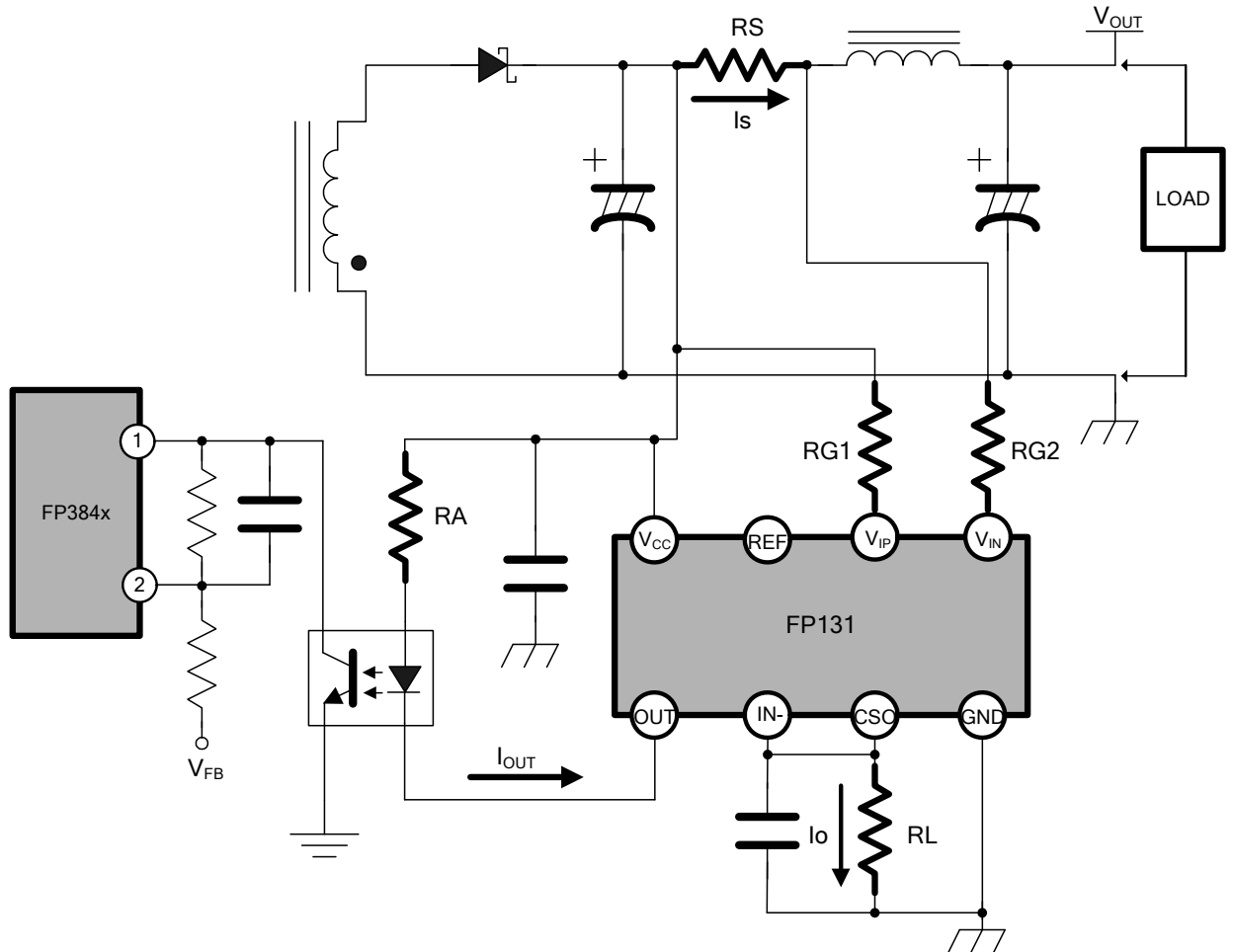


Note

1. The 1.25V reference output does not have any source and sink capability. Any resistance divider from 1.25V bias voltage would degrade its precision.
2. The comparator has an input hysteresis (200mV typically) for noise rejection. If IN- voltage is larger than 1.25V (REF) reference, the output (OUT) would change from high state to low, and when IN- voltage is lower than 1.0V, the output (OUT) would change to high again.

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Application Information

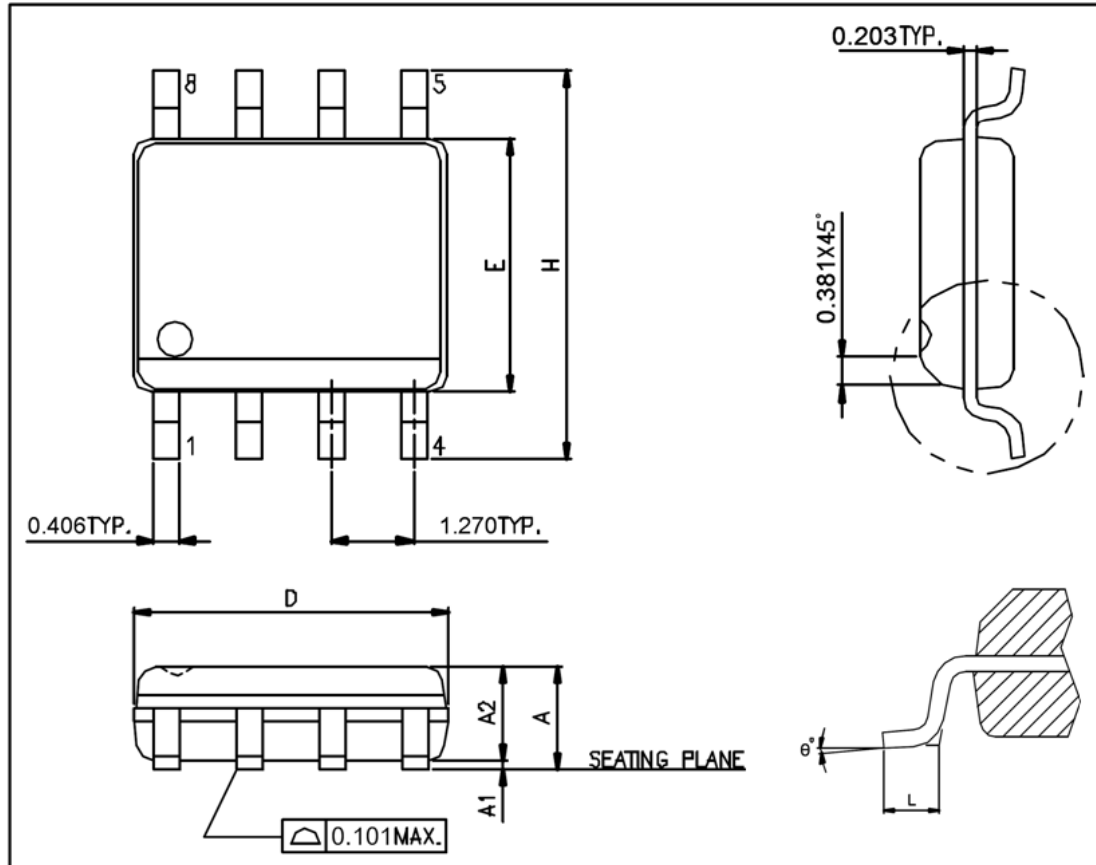


Adaptor secondary over current detection/protection circuit

The above circuit is a simple application for AC / DC adaptor over current protection (OCP) function. For example, when load current (I_S) increases, the FP131 CSO voltage would increase as equation (2) until the IN- voltage, connected to CSC pin, is higher than 1.25V reference. Then a sink current (I_{OUT}) flows through the photo-coupler, and FP384x PWM IC will change the NMOS drive terminal to a minimum duty cycle current limitation for secondary over current protection. The primary side auxiliary voltage can not maintain the FP384x's power supply high enough, the FP384x will be shutdown until AC line start-up voltage re-start the PWM IC.

Package Outline

SOP-8L



UNIT: mm

Symbols	Min. (mm)	Max. (mm)
A	1.346	1.752
A1	0.101	0.254
A2	1.092	1.498
D	4.800	4.978
E	3.810	3.987
H	5.791	6.197
L	0.406	1.270
θ°	0°	8°

Note:

1. Package dimensions are in compliance with JEDEC Outline: MS-012 AA.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E" does not include inter-lead flash, or protrusions.

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