Over Current Protection IC

Halogen Free

General Description

FP131 is a main rail 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 primary side PWM IC when over current occurs. The voltage shunt regulator has a 2.5V 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

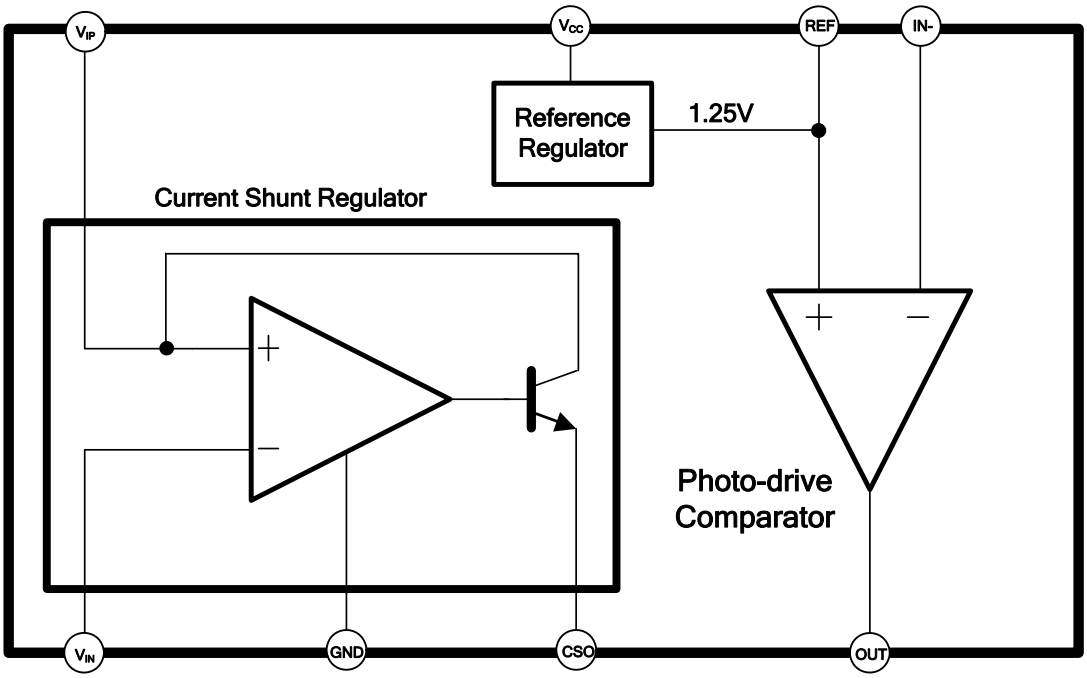
- Wide operating voltage range: +2.7V~ +28V
- Independent shunt and supply voltage
- Low input offset voltage
- Sense gain adjustable
- Comparator reference voltage: 1.25V (2%)
- Output sink current capability up to 16mA
- Package: SOP-8L

Typical Application Circuit

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

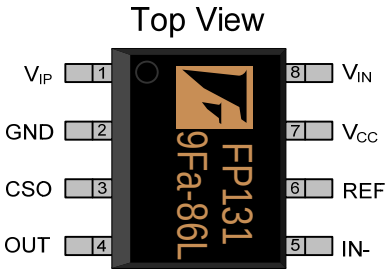
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Function Block Diagram



Pin Descriptions

SOP-8L

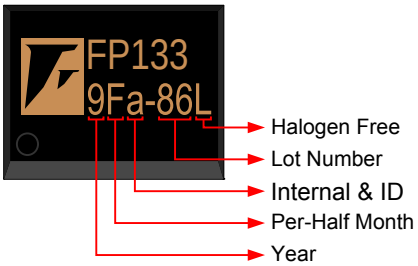


Name	No.	I / O	Description
V_{IP}	1	I	Positive Input of Current Shunt OPA
GND	2	P	IC Ground
CSO	3	I	Output of Current Shunt OPA to Inverting Input of Shutdown Comparator
OUT	4	P	Output of Comparator
IN-	5	I	Negative Input of Comparator
REF	6	I	2.5V Reference
V_{CC}	7	P	IC Power Supply
V_{IN}	8	I	Inverting Input of Current Shunt OPA

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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

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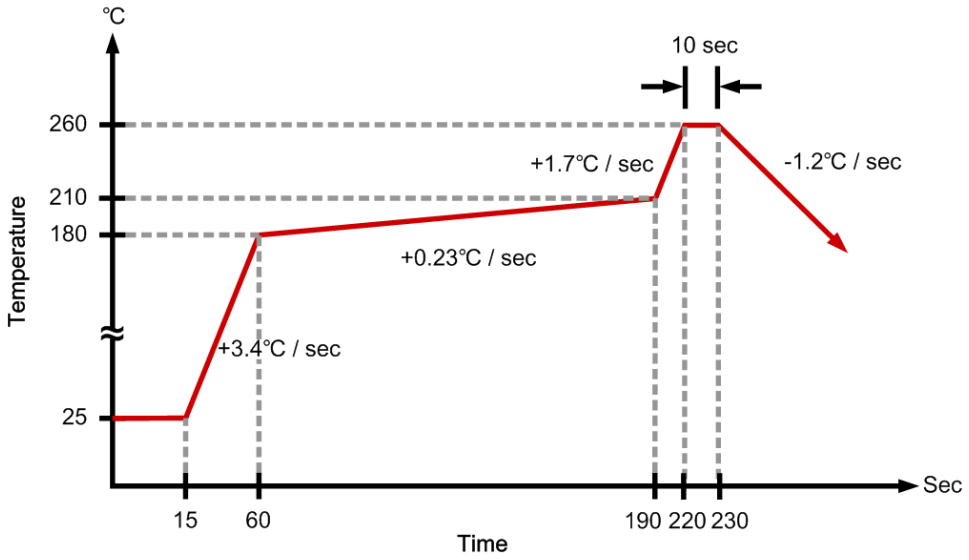
Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP131DR-LF	-20°C ~ +105°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				+150	°C
Operating Ambient Temperature Range	T_A		-20		+85	°C
Storage Temperature Range	T_S		-55		+150	°C
Power Dissipation		T_A=25°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

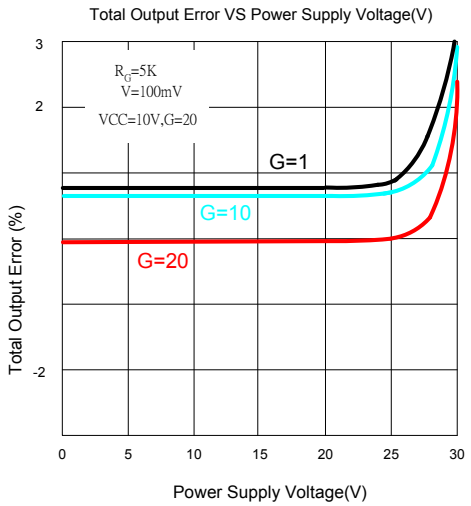
(V_{CC}=5V, T_A= -20°C~+85°C, V_{IP}=12V, R_{OUT}=125kΩ unless otherwise noted)

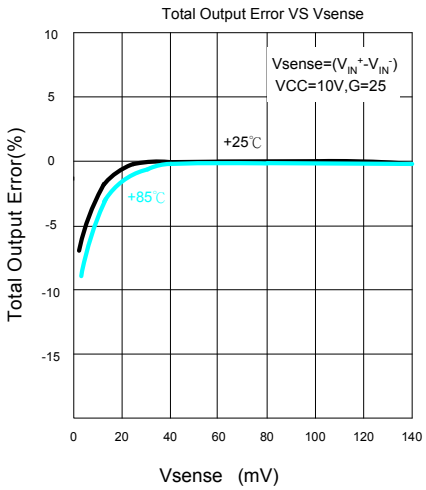
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Shunt Comparator Section						
Full Scale Sense Voltage	V_{SENSE}	$V_{SENSE}=V_{IP}$ - V_{IN}		100	500	mV
Common-Mode Input Voltage	V_{CM}		2.7		28	V
Common-Mode Rejection	CMRR	V_{IP}=2.7V to 28V, V_{SENSE}=50mV	100	120		dB
Input Offset Voltage vs Temp	V_{OFFSET} (T_A)	T_{MIN} to T_{MAX}		4		µV / °C
Input Offset Voltage vs V_{CC}	V_{OFFSET} (V_{CC})	V_{IN}=2.7V to 28V, V_{SENSE}=50mV		2.5	10	µV / 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		GΩ||pF
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}=125KΩ		32		kHz
Settling Time	T_S	5V Step, R_{OUT}=125KΩ		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} ≦ 1.0V		16		mA
Saturation Voltage	V_{SAT}	V_{REF}-V_{IN}-=-0.75V I_{SINK} ≦ 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℃	1.225	1.25	1.275	V
Line Regulation		3V≦V_{CC} ≦28V		2	15	mV
Total Device Section						
Power Supply Current	I_{CC}	V_{CC}=30V		400		µA

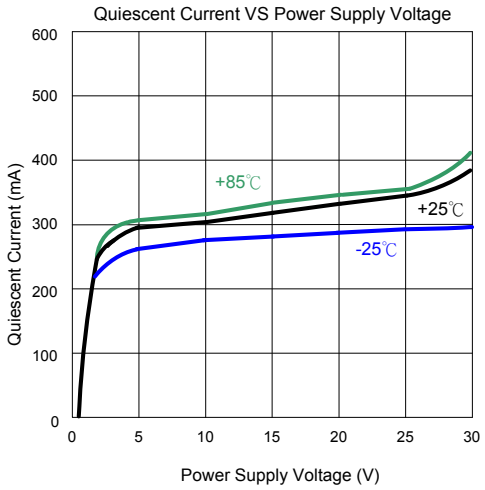
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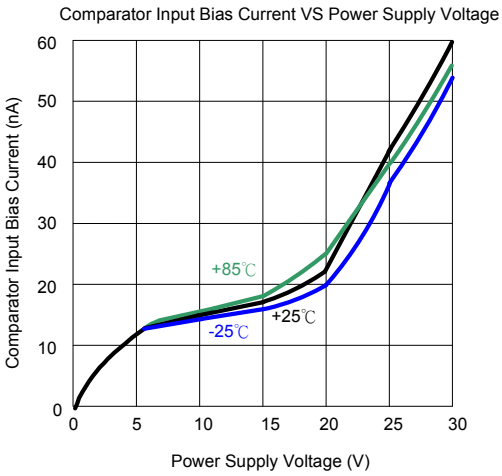
Typical Characteristics

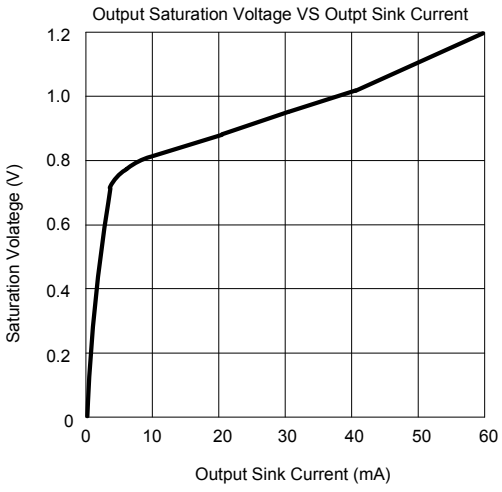
T_A=+25℃,V_{IN}=+12V









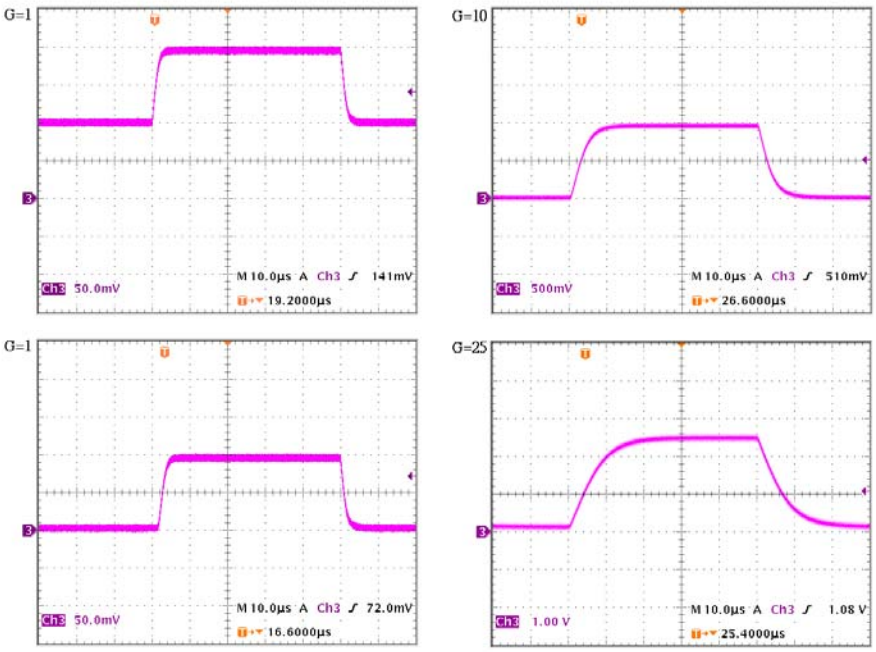


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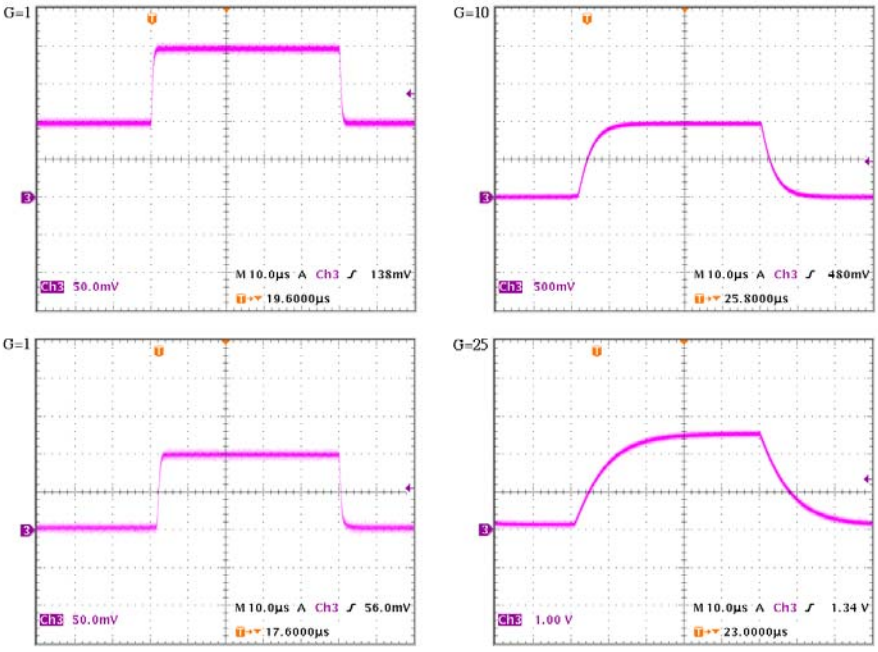
Typical Characteristics

T_A=+25℃,V_{CC}=5V,V_{IN}=+12V

RG1=RG2=1KΩ



RG1=RG2=5KΩ



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Function Description

Current Shunt Regulator

The figure below shows the FP131 current shunt block, load current (I_S) flowing from power supply and a dropout voltage (V_{IN}^+-V_{IN}^-) at the sense resistor (R_S).

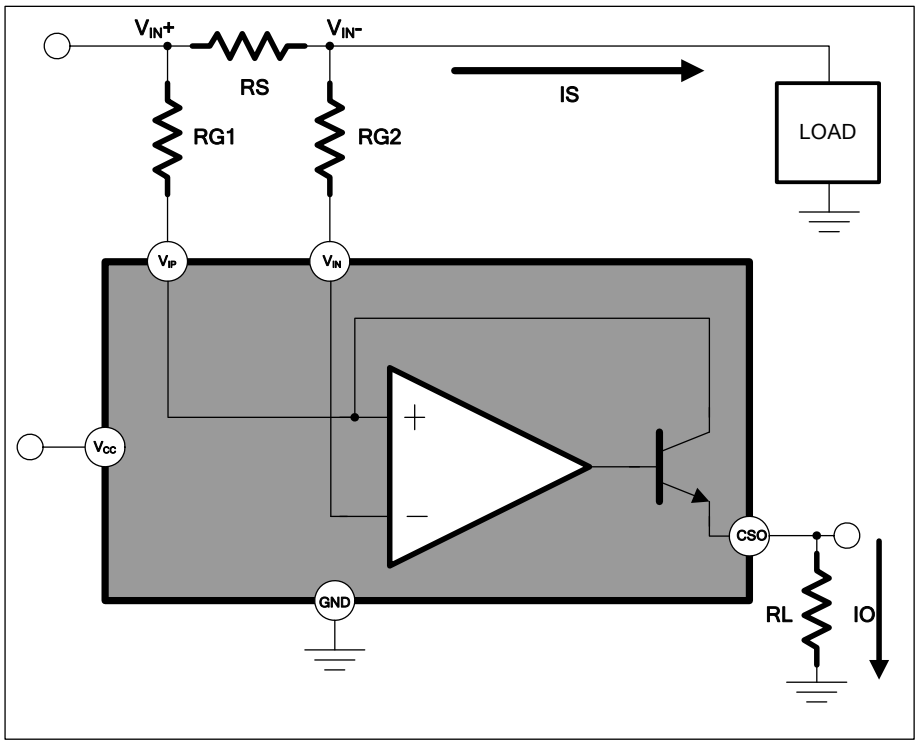
Assume internal NPN transistor collector current is same as emitter current (I_O) and V_{IP} is very close to V_{IN}, the FP131 transfer function is:

$$I_O = \frac{V_{IN}^+ - V_{IN}^-}{RG1} \quad \text{----- (1)}$$

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

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

$$G = R_L / RG1 \quad \text{----- (3)}$$



Note

1. The minimum operating voltages of V_{CC}, V_{IP} and V_{IN} are 2.7V, if these supply voltages are low than 2.7V, the transfer function at current shunt output (CSO) of FP131 isn't correct.
2. Don't force a V_{IN} voltage that is over 15V than V_{IP}, this condition would generate a leakage current and an incorrect voltage at FP131 output.

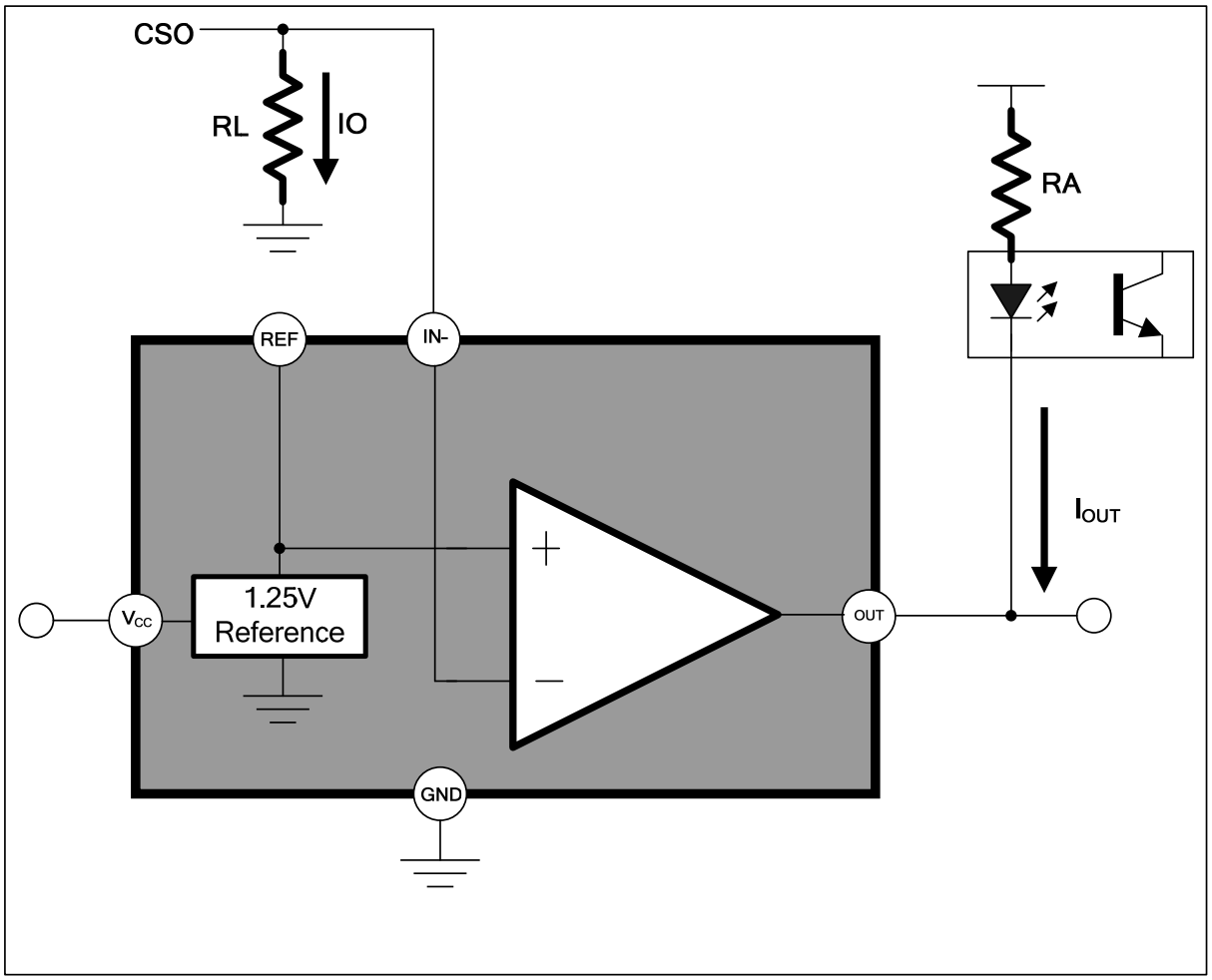
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Photo-drive Comparator

The figure shows the FP131 comparator, it has an internal reference 1.25V connecting to the IN+ of comparator and high sink current output ability for an OCP protection circuit using photo-coupler.

The current shunt output (CSO) connects to IN- for the load current (I_S) detection and comparator connects to 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*RL) is more than 1.25V, comparator output would change from high to low state and sink the photo-coupler current (I_{OUT}).



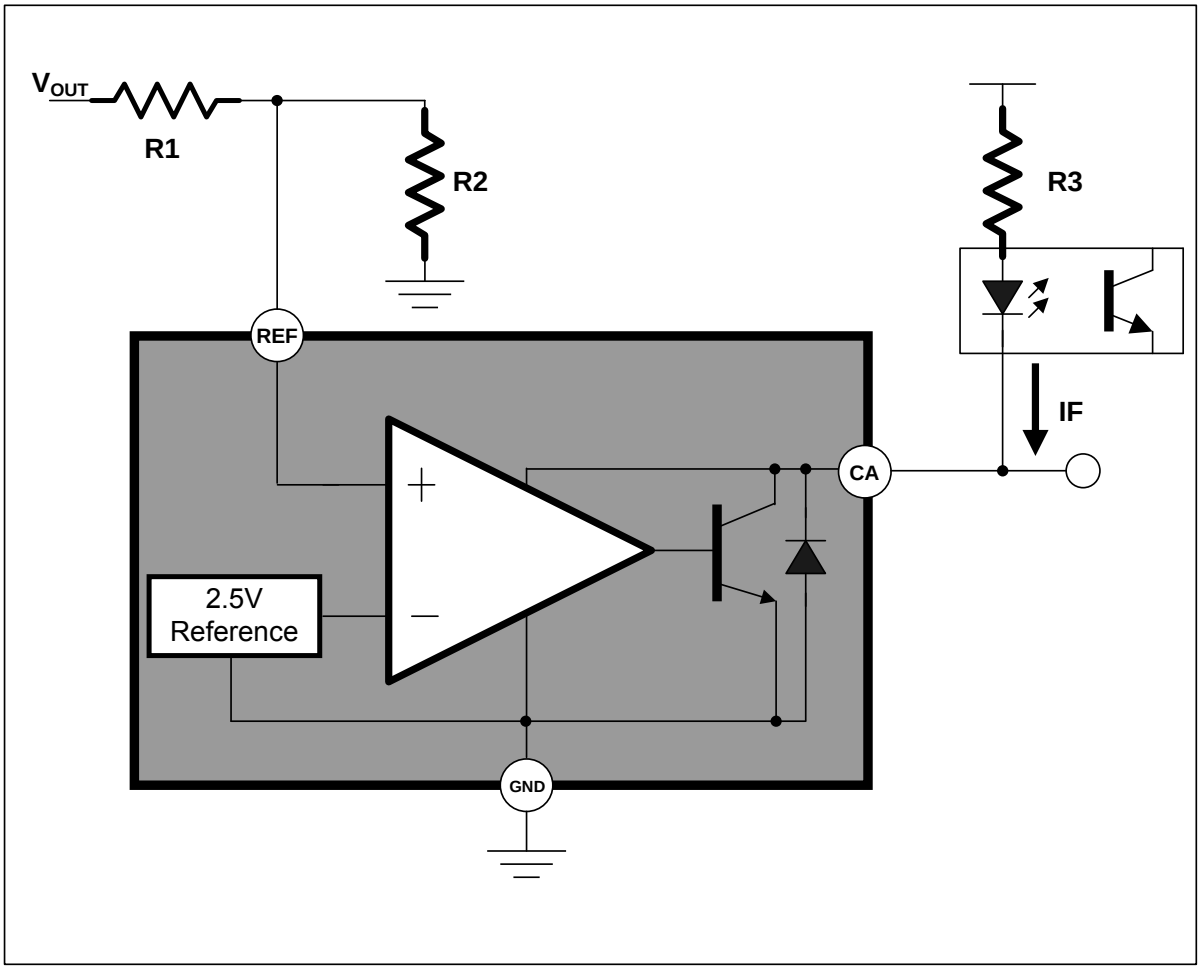
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Voltage Shunt Regulator

The figure below shows the FP131 voltage shunt regulator. It includes an internal 2.5V voltage reference connecting to the comparator inverting input. The comparator's high cathode current sink ability is designed for photo-coupler driving.

The V_{OUT} equation is:

$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times 2.5V \quad \text{---- (4)}$$

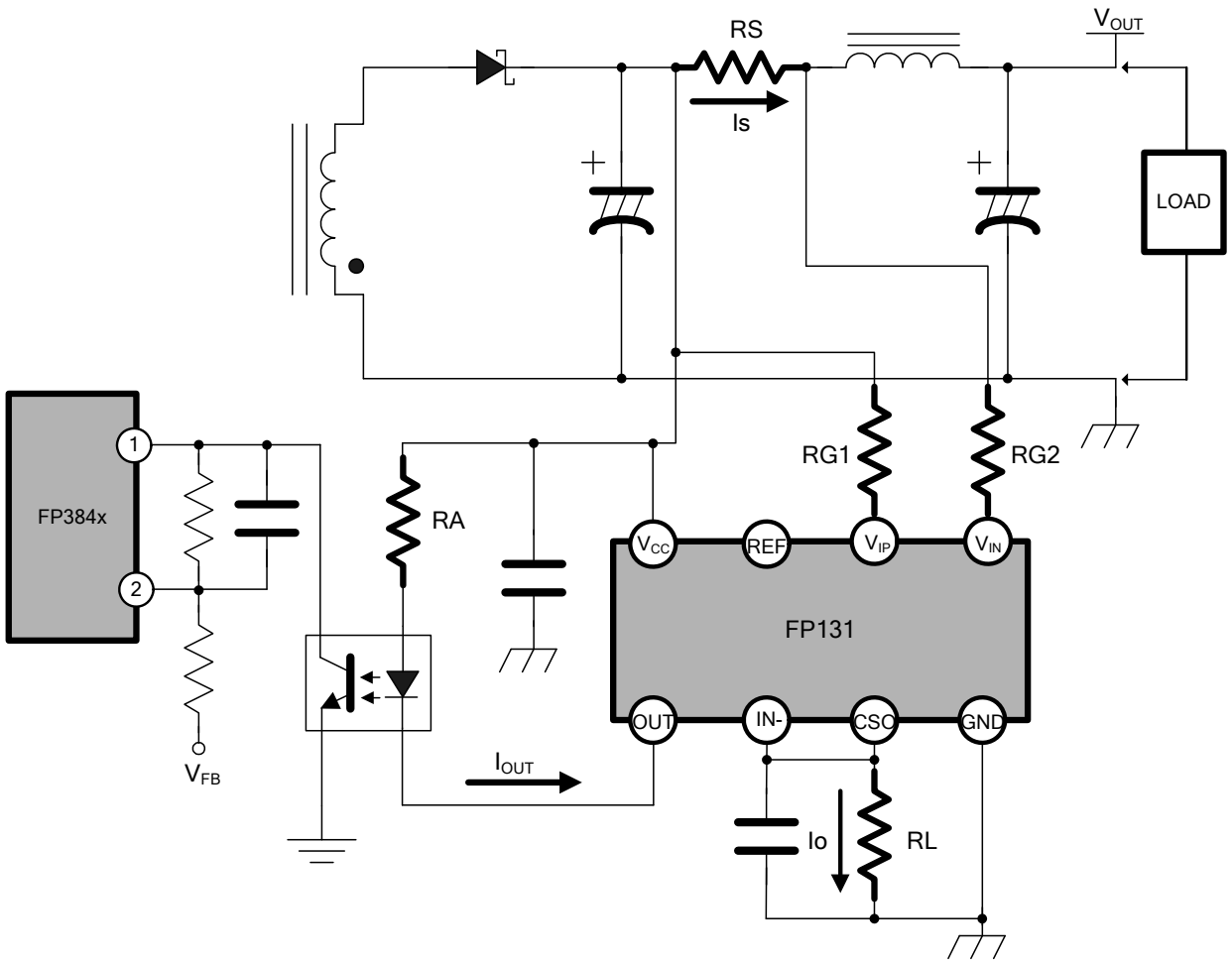


Note

1. The 1.25V reference output doesn't have any source and sink capability, any resistance divider from 1.25V bias voltage would change its precision.
2. The comparator has an input hysteresis (typ. 200mV) for noise rejection, if IN- voltage is large 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



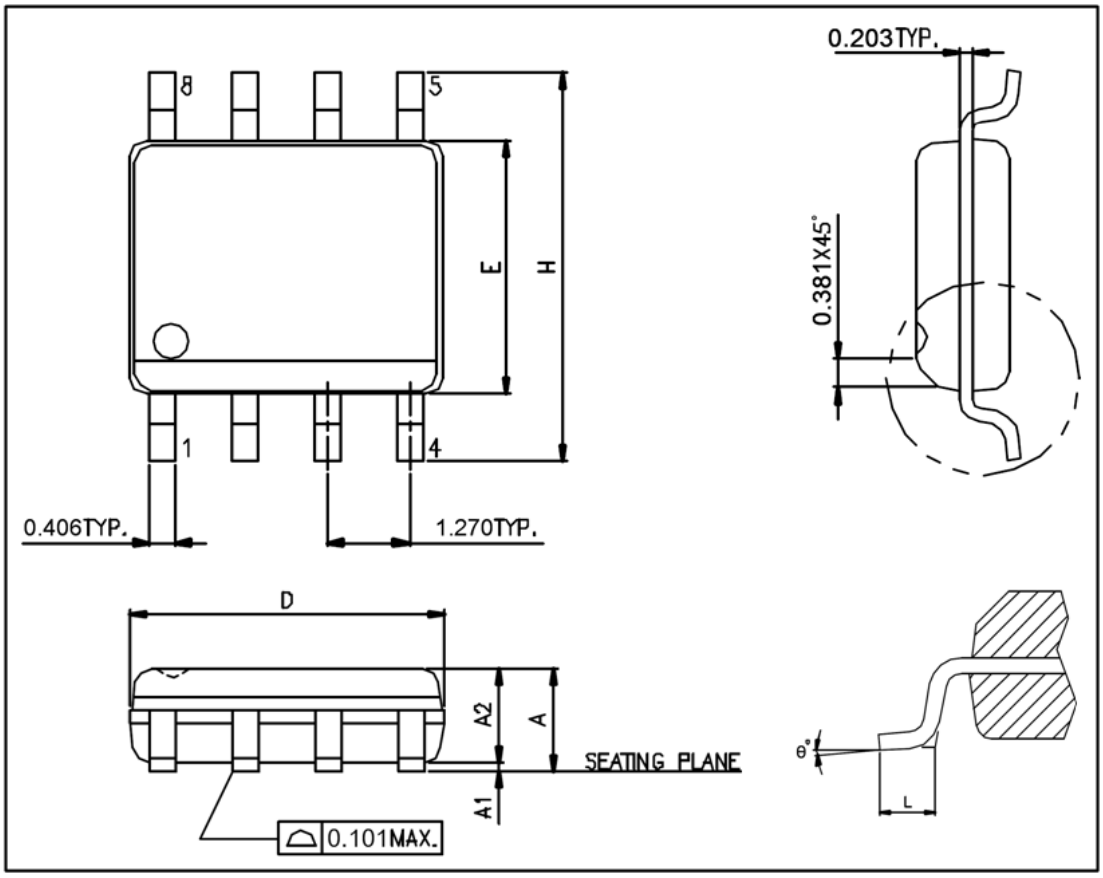
Adaptor secondary over current detection/protection circuit

The above circuits are 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 formula (2) until the IN- connecting to CSO pin is higher than 1.25V reference, that has a sink current (I_{OUT}) flowing 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, and primary side auxiliary voltage can not maintain the FP384x power supply, the FP384x will be shutdown until AC line start-up voltage is re-start the PWM IC.

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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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