

LOW POWER OFF LINE SMPS PRIMARY SWITCHER

Mains type	SO-8	DIP8
European (195 - 265 Vac)	8 W	13 W
US / Wide range (85 - 265 Vac)	5 W	8 W

- FIXED 60 KHZ SWITCHING FREQUENCY
- 9V TO 38V WIDE RANGE V_{DD} VOLTAGE
- CURRENT MODE CONTROL
- AUXILIARY UNDERVOLTAGE LOCKOUT WITH HYSTERESIS
- HIGH VOLTAGE START UP CURRENT SOURCE
- OVERTEMPERATURE, OVERCURRENT AND OVERVOLTAGE PROTECTION WITH AUTORESTART

The VIPer12A combines a dedicated current mode PWM controller with a high voltage Power



PACKAGE	TUBE	T&R
SO-8	VIPer12AS	VIPer12AS13TR
DIP-8	VIPer12ADIP	

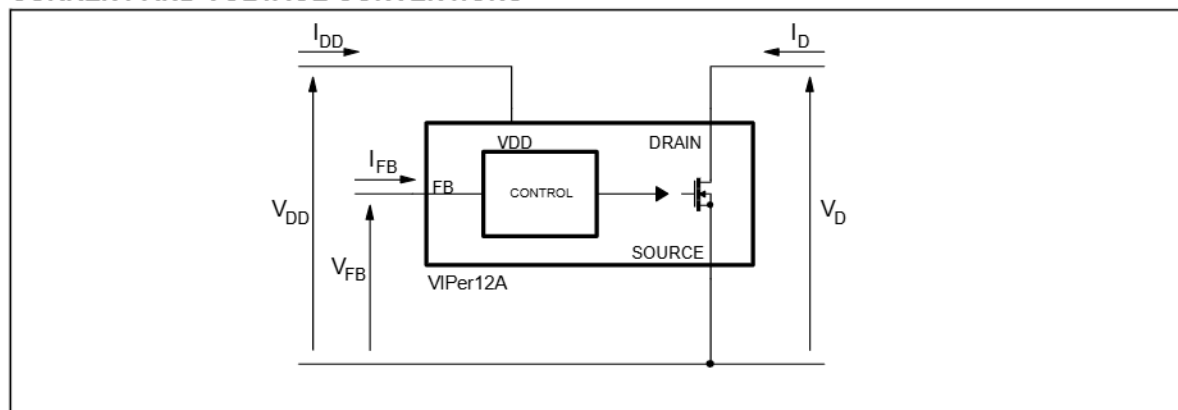
- Large input voltage range on the V_{DD} pin accommodates changes in auxiliary supply voltage. This feature is well adapted to battery charger adapter configurations.
- Automatic burst mode in low load condition.
- Overvoltage protection in hiccup mode.

The schematic diagram illustrates a MOSFET switching circuit with various protection and control features. The circuit is powered by a VDD supply and a 42V source. A REGULATOR block provides an INTERNAL SUPPLY. A 60kHz OSCILLATOR is connected to the S input of a flip-flop (FF). The flip-flop has inputs R1, R2, R3, and R4, and outputs Q and S. An OVERTEMP DETECTOR block is connected to the R1 input. An OVERVOLTAGE LATCH block is connected to the S input. A BLANKING block is connected to the Q output. A PWM LATCH block is connected to the S input. A 0.23V reference voltage is connected to the BLANKING block. A 230Ω resistor is connected to the drain of the MOSFET. A 1kΩ resistor is connected to the source of the MOSFET. The MOSFET's gate is connected to the output of the PWM LATCH block. The MOSFET's drain is connected to the 42V source through a switch labeled ON/OFF. The MOSFET's source is connected to the FB (feedback) input. The circuit also includes a REGULATOR block, an INTERNAL SUPPLY, and a 60kHz OSCILLATOR.

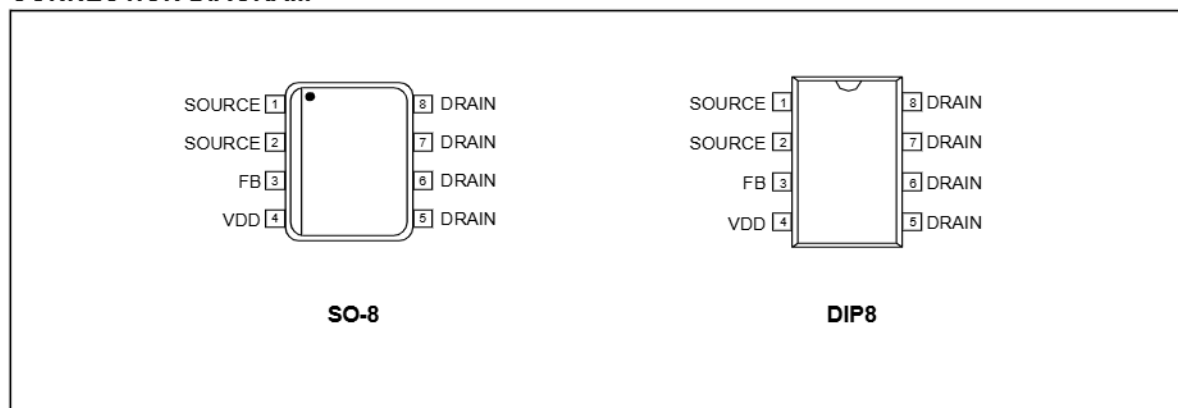
PIN FUNCTION

Name	Function
V_{DD}	Power supply of the control circuits. Also provides a charging current during start up thanks to a high voltage current source connected to the drain. For this purpose, an hysteresis comparator monitors the V_{DD} voltage and provides two thresholds: - V_{DDon} : Voltage value (typically 14.5V) at which the device starts switching and turns off the start up current source. - V_{DDoff} : Voltage value (typically 8V) at which the device stops switching and turns on the start up current source.
SOURCE	Power MOSFET source and circuit ground reference.
DRAIN	Power MOSFET drain. Also used by the internal high voltage current source during start up phase for charging the external V_{DD} capacitor.
FB	Feedback input. The useful voltage range extends from 0V to 1V, and defines the peak drain MOSFET current. The current limitation, which corresponds to the maximum drain current, is obtained for a FB pin shorted to the SOURCE pin.

CURRENT AND VOLTAGE CONVENTIONS



CONNECTION DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{DS(sw)}$	Switching Drain Source Voltage ($T_J=25 \dots 125^\circ\text{C}$) (See note 1)	-0.3 ... 730	V
$V_{DS(st)}$	Start Up Drain Source Voltage ($T_J=25 \dots 125^\circ\text{C}$) (See note 2)	-0.3 ... 400	V
I_D	Continuous Drain Current	Internally limited	A
V_{DD}	Supply Voltage	0 ... 50	V
I_{FB}	Feedback Current	3	mA
V_{ESD}	Electrostatic Discharge: Machine Model ($R=0\Omega$; $C=200\text{pF}$) Charged Device Model	200 1.5	V kV
T_J	Junction Operating Temperature	Internally limited	$^\circ\text{C}$
T_C	Case Operating Temperature	-40 to 150	$^\circ\text{C}$
T_{stg}	Storage Temperature	-55 to 150	$^\circ\text{C}$

Note: 1. This parameter applies when the start up current source is off. This is the case when the V_{DD} voltage has reached V_{DDon} and remains above V_{DDoff} .
 2. This parameter applies when the start up current source is on. This is the case when the V_{DD} voltage has not yet reached V_{DDon} or has fallen below V_{DDoff} .

THERMAL DATA

Symbol	Parameter	Max Value	Unit
$R_{thj-case}$	Thermal Resistance Junction-Pins for: SO-8 DIP8	25 15	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal Resistance Junction-Ambient for: SO-8 DIP8	(See note 1) 55 (See note 1) 45	$^\circ\text{C/W}$

Note: 1. When mounted on a standard single-sided FR4 board with 200 mm² of Cu (at least 35 μm thick) connected to all DRAIN pins.

ELECTRICAL CHARACTERISTICS ($T_J=25^\circ\text{C}$, $V_{DD}=18\text{V}$, unless otherwise specified)**POWER SECTION**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BV_{DSS}	Drain-Source Voltage	$I_D=1\text{mA}$; $V_{FB}=2\text{V}$	730			V
I_{DSS}	Off State Drain Current	$V_{DS}=500\text{V}$; $V_{FB}=2\text{V}$; $T_J=125^\circ\text{C}$			0.1	mA
R_{DSon}	Static Drain-Source On State Resistance	$I_D=0.2\text{A}$ $I_D=0.2\text{A}$; $T_J=100^\circ\text{C}$		27	30 54	Ω
t_f	Fall Time	$I_D=0.1\text{A}$; $V_{IN}=300\text{V}$ (See fig.1) (See note 1)		100		ns
t_r	Rise Time	$I_D=0.2\text{A}$; $V_{IN}=300\text{V}$ (See fig.1) (See note 1)		50		ns
C_{oss}	Drain Capacitance	$V_{DS}=25\text{V}$		40		pF

Note: 1. On clamped inductive load

VIPer12ADIP / VIPer12AS

ELECTRICAL CHARACTERISTICS ($T_J=25^\circ\text{C}$, $V_{DD}=18\text{V}$, unless otherwise specified)

SUPPLY SECTION

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{DDch}	Start Up Charging Current	$V_{DS}=100\text{V}$; $V_{DD}=5\text{V} \dots V_{DDon}$ (See fig. 2)		-1		mA
I_{DDoff}	Start Up Charging Current in Thermal Shutdown	$V_{DD}=5\text{V}$; $V_{DS}=100\text{V}$ $T_J > T_{SD} - T_{HYST}$	0			mA
I_{DD0}	Operating Supply Current Not Switching	$I_{FB}=2\text{mA}$		3	5	mA
I_{DD1}	Operating Supply Current Switching	$I_{FB}=0.5\text{mA}$; $I_D=50\text{mA}$ (Note 1)		4.5		mA
D_{RST}	Restart Duty Cycle	(See fig. 3)		16		%
V_{DDoff}	V_{DD} Undervoltage Shutdown Threshold	(See fig. 2 & 3)	7	8	9	V
V_{DDon}	V_{DD} Start Up Threshold	(See fig. 2 & 3)	13	14.5	16	V
V_{DDhyst}	V_{DD} Threshold Hysteresis	(See fig. 2)	5.8	6.5	7.2	V
V_{DDovp}	V_{DD} Overvoltage Threshold		38	42	46	V

Note: 1. These test conditions obtained with a resistive load are leading to the maximum conduction time of the device.

OSCILLATOR SECTION

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
F_{OSC}	Oscillator Frequency Total Variation	$V_{DD}=V_{DDoff} \dots 35\text{V}$; $T_J=0 \dots 100^\circ\text{C}$	54	60	66	kHz

PWM COMPARATOR SECTION

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
G_{ID}	I_{FB} to I_D Current Gain	(See fig. 4)		320		
I_{Dlim}	Peak Current Limitation	$V_{FB}=0\text{V}$ (See fig. 4)	0.32	0.4	0.48	A
I_{FBsd}	I_{FB} Shutdown Current	(See fig. 4)		0.9		mA
R_{FB}	FB Pin Input Impedance	$I_D=0\text{mA}$ (See fig. 4)		1.2		k Ω
t_d	Current Sense Delay to Turn-Off	$I_D=0.2\text{A}$		200		ns
t_b	Blanking Time			500		ns
t_{ONmin}	Minimum Turn On Time			700		ns

OVERTEMPERATURE SECTION

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
T_{SD}	Thermal Shutdown Temperature	(See fig. 5)	140	170		$^\circ\text{C}$
T_{HYST}	Thermal Shutdown Hysteresis	(See fig. 5)		40		$^\circ\text{C}$

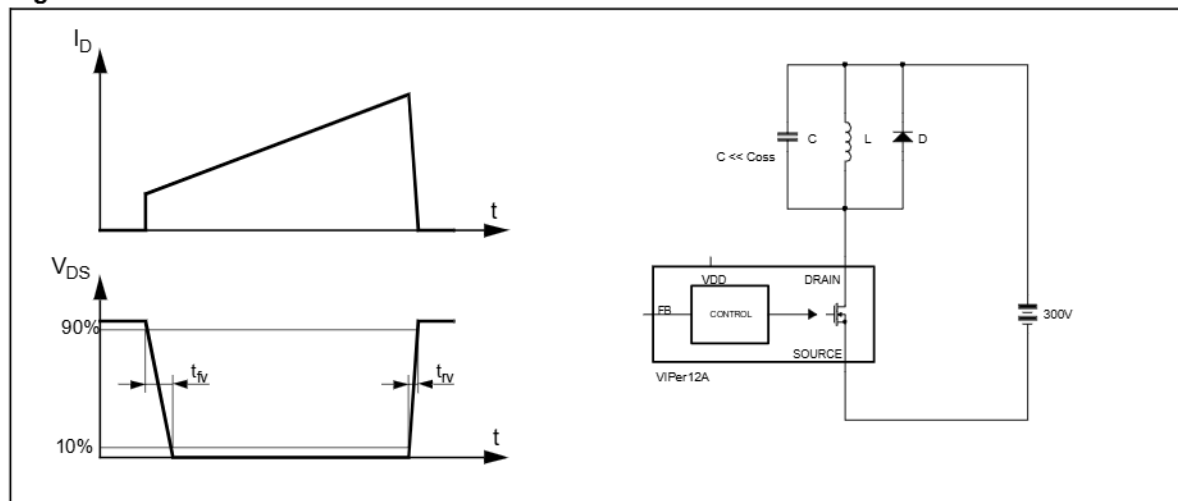
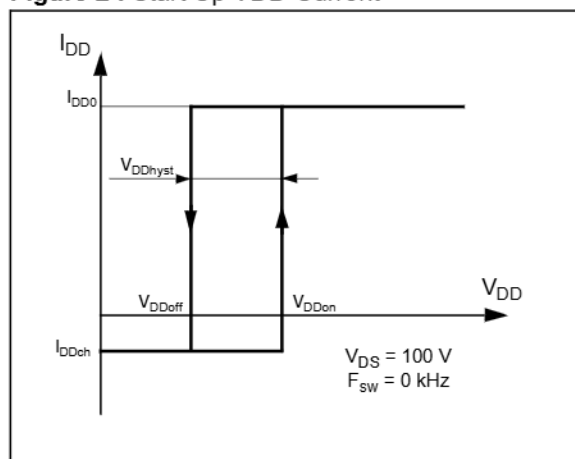
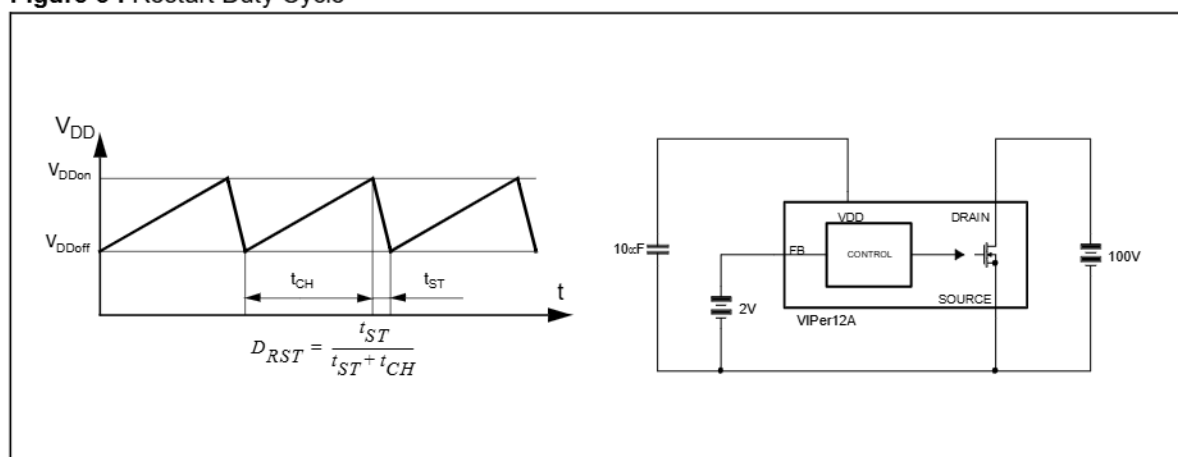
Figure 1 : Rise and Fall Time

Figure 2 : Start Up VDD Current

Figure 3 : Restart Duty Cycle


Figure 4 : Peak Drain Current Vs. Feedback Current

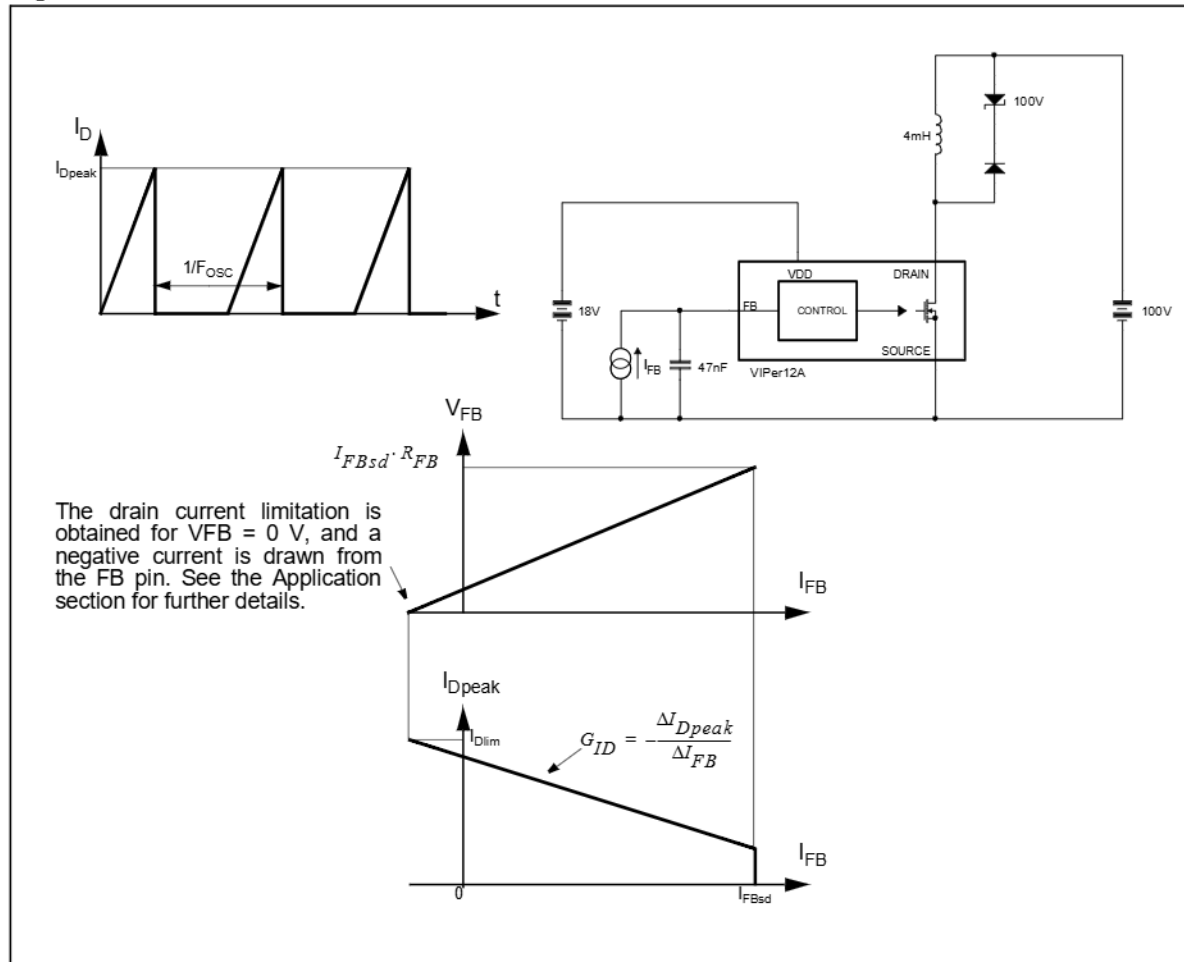


Figure 5 : Thermal Shutdown

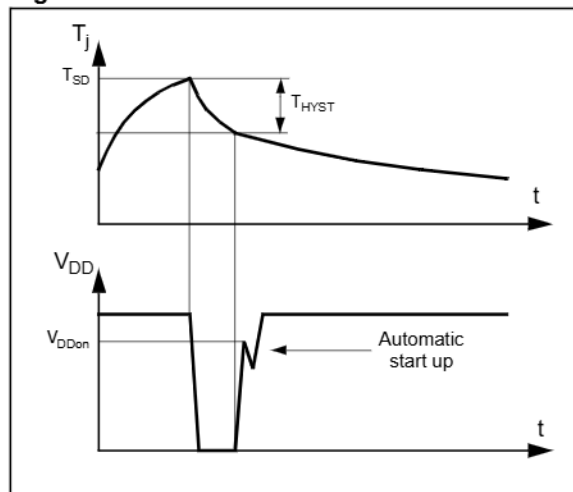


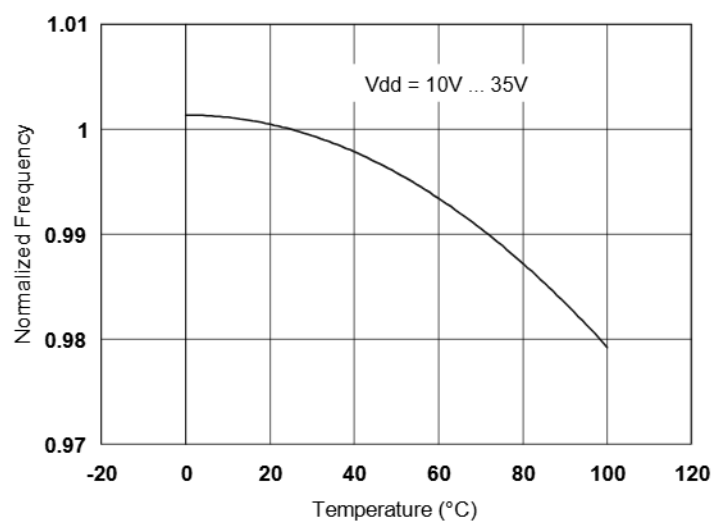
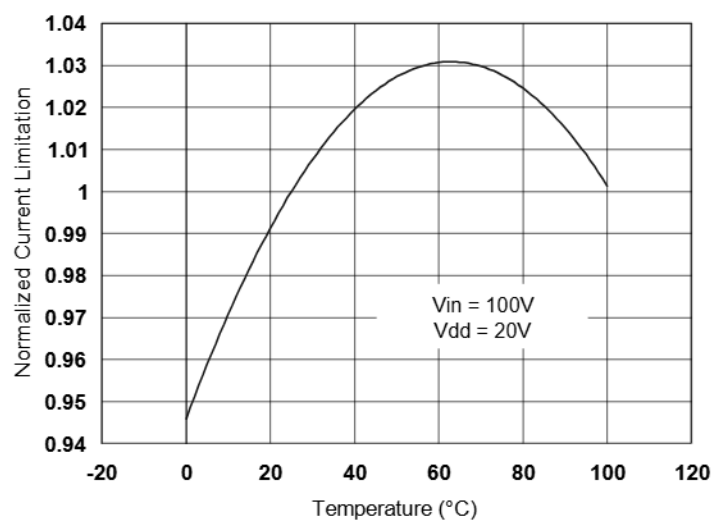
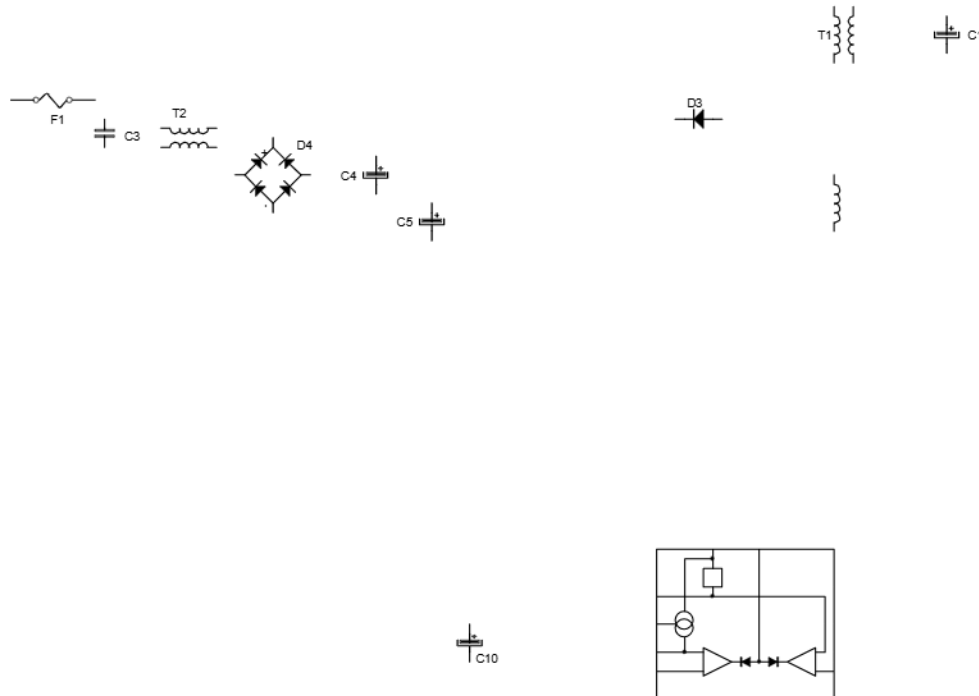
Figure 6 : Switching Frequency vs Temperature**Figure 7 : Current Limitation vs Temperature**

Figure 8 : Rectangular U-I output characteristics for battery charger



RECTANGULAR U-I OUTPUT CHARACTERISTIC

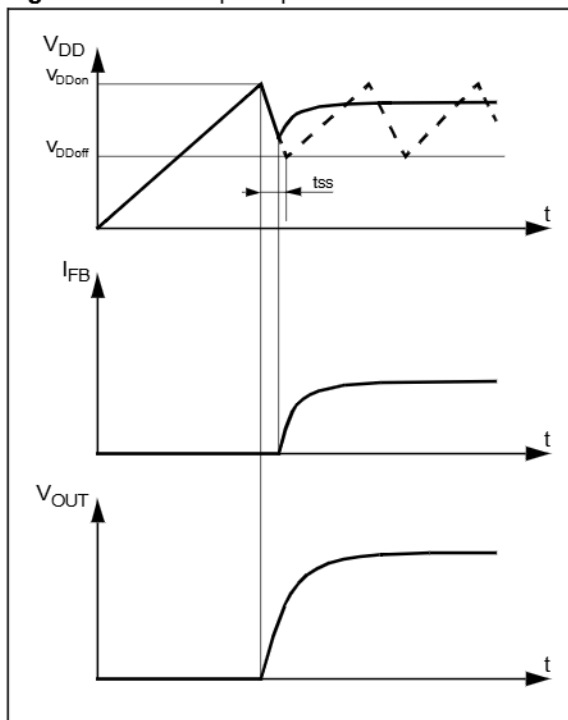
A complete regulation scheme can achieve combined and accurate output characteristics. Figure 8 presents a secondary feedback through an optocoupler driven by a TSM101. This device offers two operational amplifiers and a voltage reference, thus allowing the regulation of both output voltage and current. An integrated OR function performs the combination of the two resulting error signals, leading to a dual voltage and current limitation, known as a rectangular output characteristic.

This type of power supply is especially useful for battery chargers where the output is mainly used in current mode, in order to deliver a defined charging rate. The accurate voltage regulation is also convenient for Li-ion batteries which require both modes of operation.

WIDE RANGE OF V_{DD} VOLTAGE

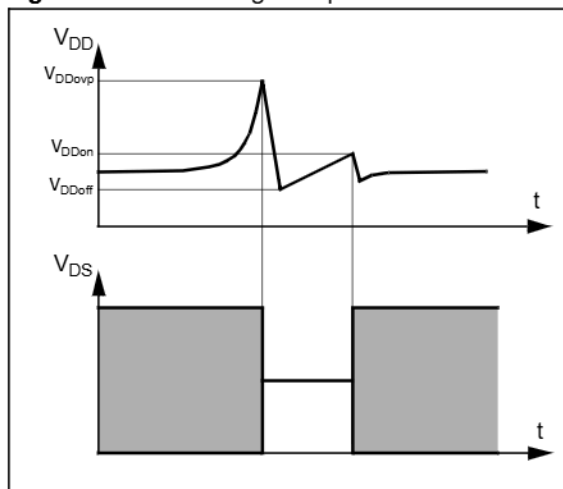
The V_{DD} pin voltage range extends from 9V to 38V. This feature offers a great flexibility in design to achieve various behaviors. In figure 8 a forward configuration has been chosen to supply the device with two benefits:

- as soon as the device starts switching, it immediately receives some energy from the auxiliary winding. C5 can be therefore reduced and a small ceramic chip (100 nF) is sufficient to insure the filtering function. The total start up time from the switch on of input voltage to output voltage presence is dramatically decreased.
- the output current characteristic can be maintained even with very low or zero output voltage. Since the TSM101 is also supplied in forward mode, it keeps the current regulation up whatever the output voltage is. The V_{DD} pin voltage may vary as much as the input voltage, that is to say with a ratio of about 4 for a wide range application.

Figure 11 : Start Up Sequence

the regulation point where the secondary loop begins to send a current in the optocoupler. At this point, the converter enters a regulated operation where the FB pin receives the amount of current needed to deliver the right power on secondary side.

This sequence is shown in figure 11. Note that during the real starting phase t_{ss} , the device consumes some energy from the V_{DD} capacitor, waiting for the auxiliary winding to provide a continuous supply. If the value of this capacitor is too low, the start up phase is terminated before receiving any energy from the auxiliary winding and the converter never starts up. This is illustrated also in the same figure in dashed lines.

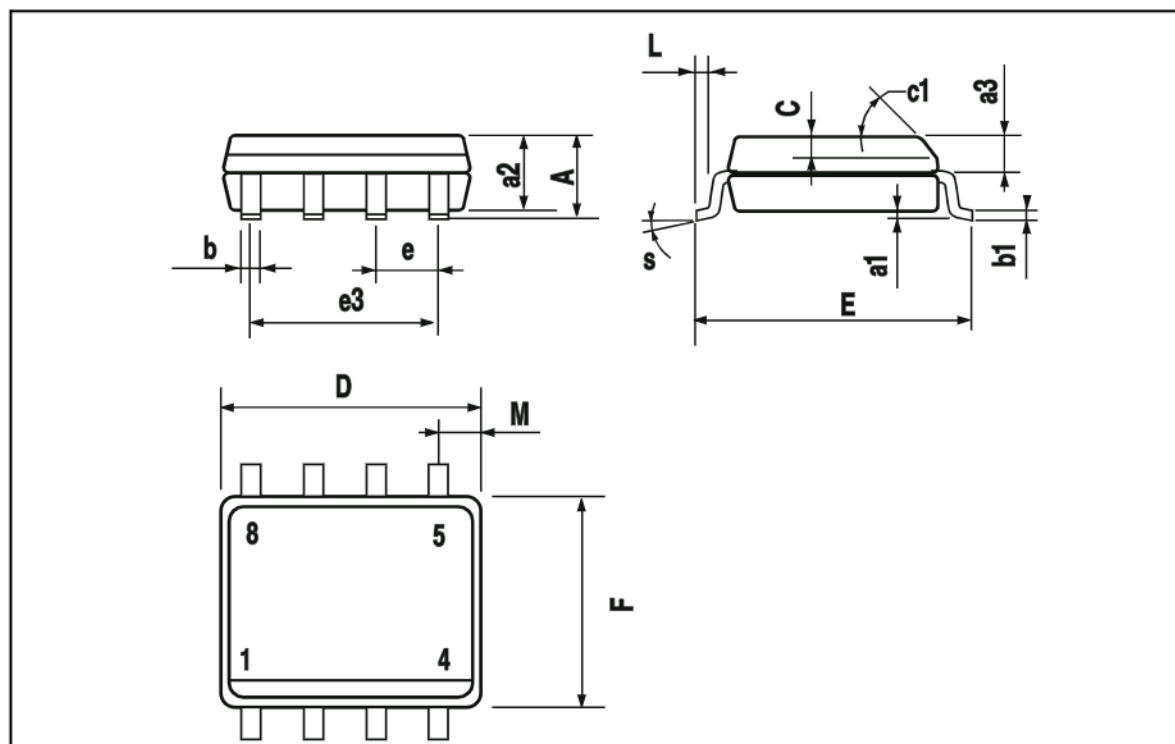
Figure 12 : Overvoltage Sequence

OVERVOLTAGE THRESHOLD

An overvoltage detector on the V_{DD} pin allows the VIPer12A to reset itself when V_{DD} exceeds V_{DDovp} . This is illustrated in figure 12, which shows the whole sequence of an overvoltage event. Note that this event is only latched for the time needed by V_{DD} to reach V_{DDoff} , and then the device resumes normal operation automatically.

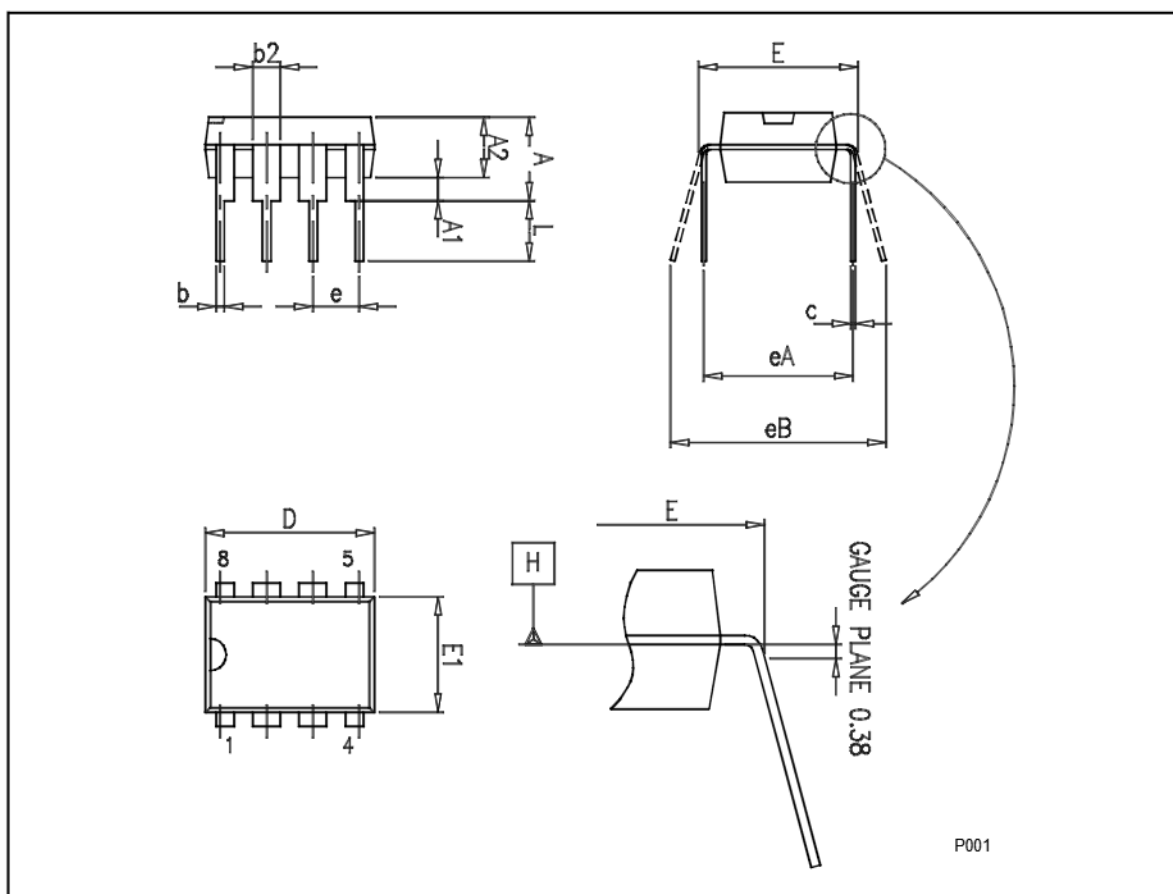
SO-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.25	0.003		0.009
a2			1.65			0.064
a3	0.65		0.85	0.025		0.033
b	0.35		0.48	0.013		0.018
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.019
c1	45 (typ.)					
D	4.8		5	0.188		0.196
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4	0.14		0.157
L	0.4		1.27	0.015		0.050
M			0.6			0.023
S	8 (max.)					
L1	0.8		1.2	0.031		0.047

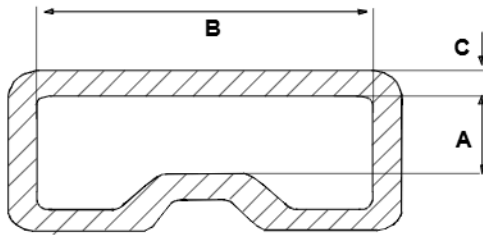


Plastic DIP-8 MECHANICAL DATA

DIM.	mm.		
	MIN.	TYP	MAX.
A			5.33
A1	0.38		
A2	2.92	3.30	4.95
b	0.36	0.46	0.56
b2	1.14	1.52	1.78
c	0.20	0.25	0.36
D	9.02	9.27	10.16
E	7.62	7.87	8.26
E1	6.10	6.35	7.11
e		2.54	
eA		7.62	
eB			10.92
L	2.92	3.30	3.81
Package Weight	Gr. 470		



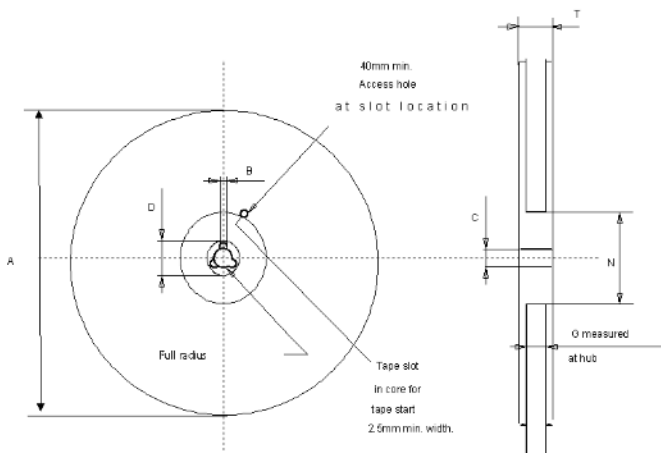
SO-8 TUBE SHIPMENT (no suffix)



Base Q.ty	100
Bulk Q.ty	2000
Tube length (± 0.5)	532
A	3.2
B	6
C (± 0.1)	0.6

All dimensions are in mm.

TAPE AND REEL SHIPMENT (suffix "13TR")



REEL DIMENSIONS

Base Q.ty	2500
Bulk Q.ty	2500
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / -0)	12.4
N (min)	60
T (max)	18.4

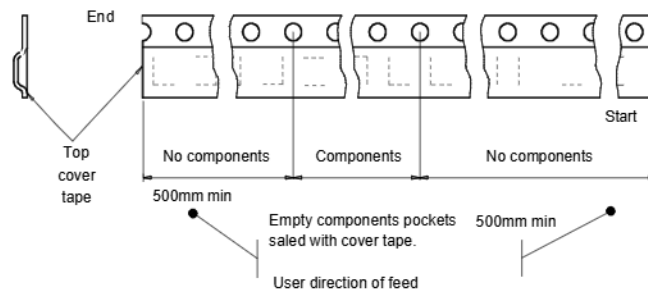
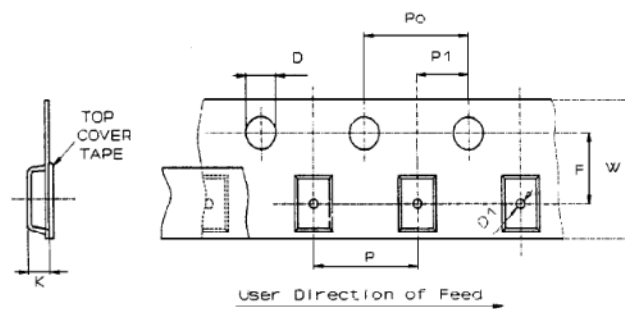
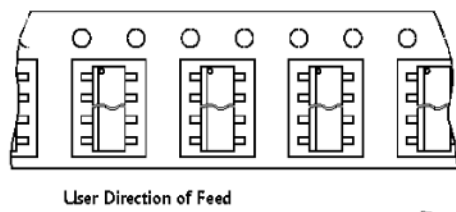
All dimensions are in mm.

TAPE DIMENSIONS

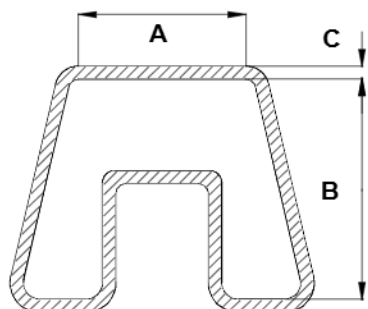
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

Tape width	W	12
Tape Hole Spacing	P0 (± 0.1)	4
Component Spacing	P	8
Hole Diameter	D ($\pm 0.1/-0$)	1.5
Hole Diameter	D1 (min)	1.5
Hole Position	F (± 0.05)	5.5
Compartment Depth	K (max)	4.5
Hole Spacing	P1 (± 0.1)	2

All dimensions are in mm.



DIP-8 TUBE SHIPMENT (no suffix)



Base Q.ty	20
Bulk Q.ty	1000
Tube length (± 0.5)	532
A	8.4
B	11.2
C (± 0.1)	0.8

All dimensions are in mm.

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