

### QUASI-RESONANT CURRENT MODE PWM+PFM CONTROLLER

#### General Description

KIC3926S is a quasi-resonant current mode PWM+PFM controller IC for high performance, low standby power offline flyback converter application.

This circuit features multi-mode control. At heavy load, it operates in QR mode to reduce switch loss, in the high line input voltage, and it operates in fixed frequency(65KHz) CCM mode in the low line input voltage, At medium load or light load, it works in QR+PFM mode to improve the conversion efficiency. At no load, it enters burst mode to reduce the standby power dissipation.

KIC3926S features low startup current. A large value startup resistor can be used to minimize the standby power.

KIC3926S integrates comprehensive protections coverage including over-current protection(OCP), over-load protection(OLP), output over-voltage protection, VDD over-voltage and under-voltage lockout etc.

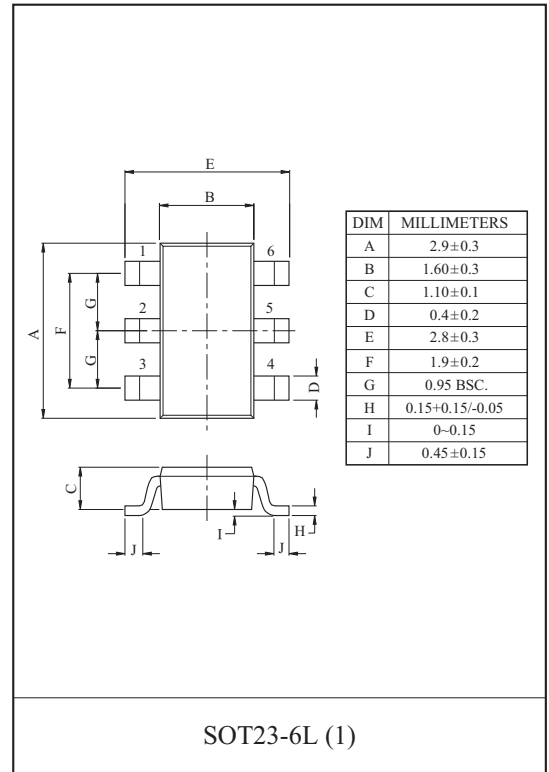
#### Features

- Multi-mode control
- QR mode for EMI and low switch loss
- PFM mode at light load condition for higher conversion efficiency
- 3  $\mu$ A low startup current
- Internal leading edge blanking
- Soft Start
- VDD Over-voltage protection (OVP)
- Under-voltage lockout (UVLO)
- Adjustable over-voltage protection (OVP)
- Adjustable peak current compensation
- Cycle-by-cycle current limiting

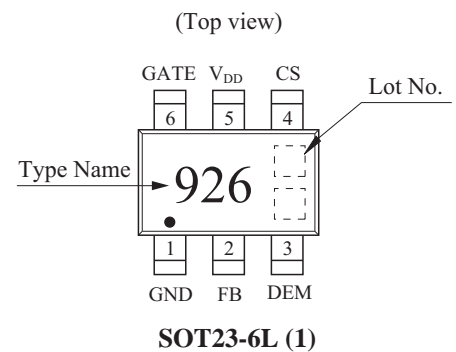
OLP	OLP Delay	Internal V <sub>DD</sub> OVP	Output OVP	Internal OTP	CS Pin Open
Auto Recovery	90ms	Auto Recovery	Auto Recovery	Auto Recovery	Auto Recovery

#### Applications

- Charger
- Adapters
- Set-Top Box Power Supplies
- Auxiliary Power Supplies for LCD TV, PC and White Goods

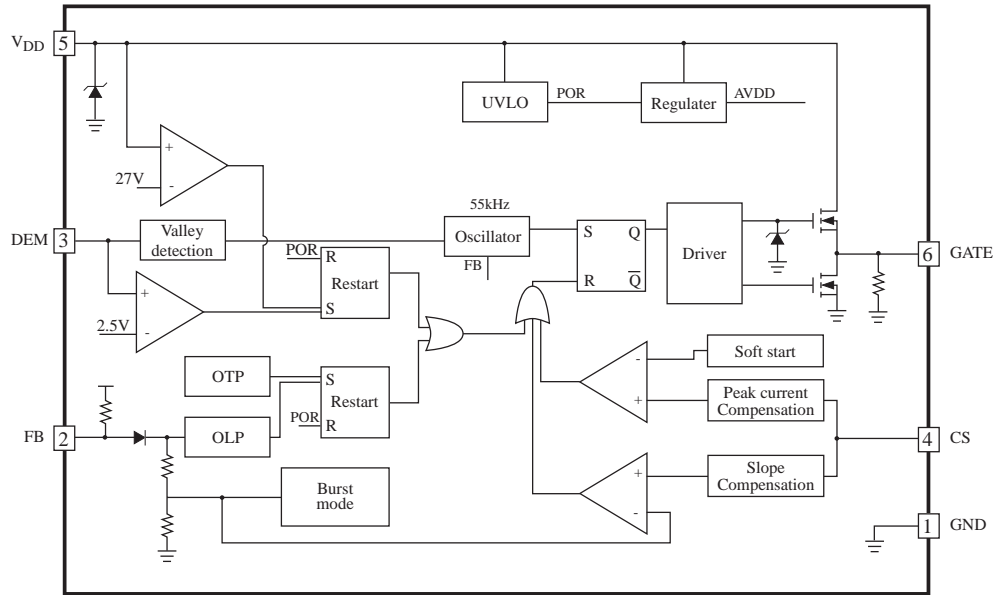


#### Pin Configurations



# KIC3926S

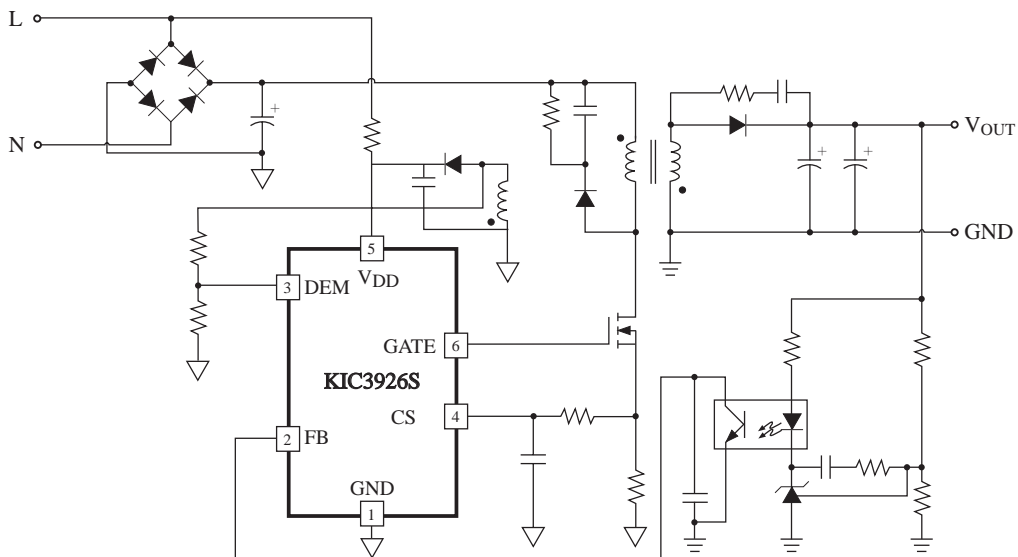
## Functional Block Diagram



## Pin Description

Pin No.	Function	Description
1	GND	Ground
2	FB	Feedback input pin
3	DEM	Magnetic core demagnetization detection pin, used for QR Mode detection. Peak current compensation and output overvoltage protection
4	CS	Current sense input
5	V <sub>DD</sub>	Power supply pin
6	GATE	Gate driver output pin

## Typical Application Circuit



# KIC3926S

## Absolute Maximum Ratings

Characteristics	Symbol	Rating	Units
Supply Voltage	$V_{DD}$	30	V
FB Voltage	$V_{FB}$	-0.3 ~ 6	V
SENSE Voltage	$V_{CS}$	-0.3 ~ 6	V
DEM Voltage	$V_{DEM}$	-0.3 ~ 6	V
Power Dissipation *Note )	$P_D$	900	mW
Junction Temperature Range	$T_j$	-20 ~ 150	
Storage Temperature Range	$T_{stg}$	-55 ~ 150	

\* Note ) Package mounted on a ceramic board (600mm<sup>2</sup> × 0.8mm<sup>2</sup>)

## Electrical Characteristics (Unless otherwise specified, Ta=25 )

Characteristics	Symbol	Test Condition	Min	Typ	Max	Unit
<b>Power Supply Section</b>						
Startup Current	$I_{VDD\_ST}$	$V_{DD}=V_{START}-1V$	-	-	3	μA
Operation Current	$I_{VDD}$	$V_{DD}=17V, V_{FB}=3V$	-	0.8	-	mA
IDLE Current	$I_{STATIC}$	$V_{DD}=17V, V_{FB}=0V$	-	0.75	-	mA
Start up Voltage	$V_{START}$	-	14.5	15.5	16.5	V
Shut down Voltage	$V_{SHUT}$	-	6.5	7.5	8.5	V
Internal $V_{DD}$ OVP Threshold	$V_{VDD\_OVP}$		26	27	28	V
$V_{DD}$ Clamp Voltage	$V_{VDD\_CLP}$	$I_{VDD}=10mA$	-	30	-	V
<b>Feedback Section</b>						
PWM Gain	$A_{VCS}$	$V_{FB}/ V_{SENSE}$	-	3	-	V/V
FB Open Loop Voltage	$V_{FB\_OPEN}$	-	-	5	-	V
FB Short Circuit Current	$I_{FB\_SHORT}$	FB short connected to ground	-	170	-	μA
FB OL Threshold Voltage	$V_{FB\_OL}$	-	-	4.2	-	V
OLP an-interference Time	$T_{D\_OL}$	-	-	90	-	ms
Frequency decreasing start	$V_{FB\_FD\_START}$	-	-	1.8	-	V
Burst mode enter	$V_{FB\_BURST\_ENTER}$	-	-	0.9	-	V
Burst mode exit	$V_{FB\_BURST\_EXIT}$	-	-	1	-	V
FB Input Impedance	$Z_{FB\_IN}$	-	-	45	-	kΩ
Maximum Duty Cycle	$D_{MAX}$	$V_{DD}=17V, V_{FB}=3V, V_{SENSE}=0V$	-	80	-	%
<b>Current Sense Section</b>						
LEB Time	$T_{LEB}$	-	-	400	-	ns
CS OCP Detection Threshold	$V_{CS\_OC}$	-	-	0.7	-	V

# KIC3926S

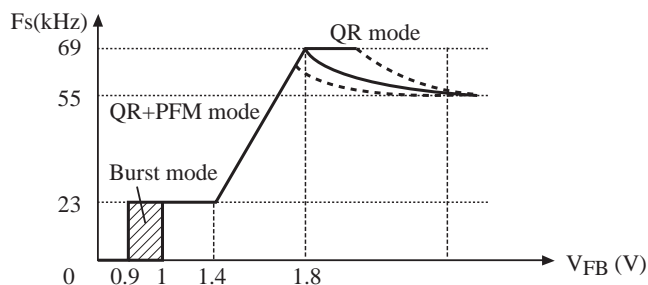
Characteristics	Symbol	Test Condition	Min	Typ	Max	Unit
<b>Switching Frequency Section</b>						
Oscillation Frequency	$f_S$	-	50	55	60	kHz
QR Mode Max. Frequency	$f_{OSCMAX\_QR}$	-	62	69	75	kHz
Light Load Mode Frequency	$f_{S\_LLM}$	-	-	23	-	kHz
<b>Soft Start</b>						
Soft Start Time	$T_{SS}$	-	-	4	-	ms
<b>DEM</b>						
Demagnetization Detection Threshold	$V_{TH\_DEM}$	-	-	100	-	mV
Resonance Restrain Time	$T_{SUPP}$	-	-	2	-	$\mu$ s
Output OVP Voltage	$V_{TH\_OVP}$	-	-	2.5	-	V
<b>Gate Driver</b>						
Output Low Level	$V_{OL}$	$V_{DD}=16V, I_O=-20mA$	-	-	0.8	V
Output High Level	$V_{OH}$	$V_{DD}=16V, I_O=20mA$	10	-	-	V
Output Clamp Voltage Level	$V_{OH\_CLAMP}$	-	-	16	-	V
Output Rising Time	$T_R$	$V_{DD}=16V, C_L=1nF$	-	400	-	ns
Output Falling Time	$T_F$	$V_{DD}=16V, C_L=1nF$	-	80	-	ns
<b>Over Temperature Protection</b>						
OTP	$T_{OTP}$	-	-	-	150	

## Function Description

KIC3926S is a quasi-resonant current mode PWM+PFM controller used in applications for offline flyback converter. The description of functions is as follows.

### 1. Multi-mode control for efficiency Improvement

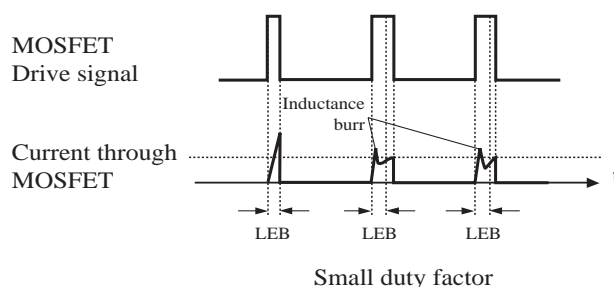
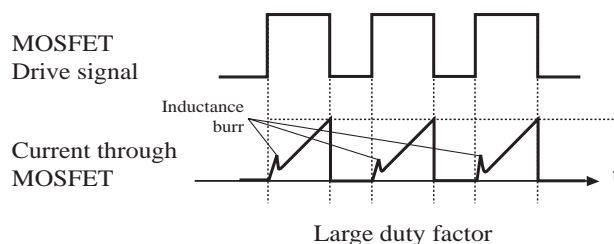
KIC3926S has many operating modes. At heavy load ( $V_{FB} > 1.8V$ ), there are two operating modes for the system, when line input voltage is low, the system works in CCM mode with PWM control and fixed frequency of 55kHz, when line input voltage is high, it works in QR mode with max. frequency limited to 69kHz for lower switch loss. At medium load or light load ( $1.4V < V_{FB} < 1.8V$ ), it works in QR+PFM mode and frequency decreases to 23kHz, improves conversion efficiency. At no load or very light load ( $V_{FB} < 0.9V$ ), it enters burst mode to decrease standby power dissipation.



### 2. Leading Edge Blanking (LEB)

An internal leading edge blanking circuit chops off the sensed voltage spike at initial internal power MOSFET on state due to snubber diode reverse recovery. So that the external RC filter circuit on SENSE input is no longer required.

During the blanking period, the PWM comparator and OC comparator are disabled and MOSFET keeps on state. The minimum on time of MOSFET is just LEB time.



### 3. Peak current compensation

KIC3926S features External adjustable peak current compensation, It detects the current flowing through DEM pin, which is proportional to the input voltage, when the MOSFET turn on, and compensates the peak current. Adjust internal resistor keeps the same limit output power under different input voltages.

### 4. Soft Start

KIC3926S features an internal 4ms soft start.

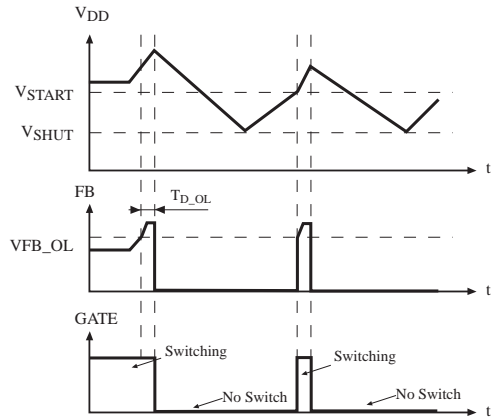
### 5. Gate Driver

The power MOSFET is driven by a dedicated gate driver for power switch control. Too weak the gate drive strength results in higher switch loss of MOSFET while too strong gate drive results the compromise of EMI. A good tradeoff is achieved through the built-in totem pole gate design with right output strength and dead time control. The output high voltage of GATE is clamped at 17V to protect the external MOSFET.

## 6. Over-load Protection (OLP)

When FB input voltage is higher than over load protection (OLP) threshold 4.2V and lasts for OLP delay time  $T_{D\_OL}$ , the circuit enters into over-load protection status, and the MOSFET is off. The system will auto recovery.

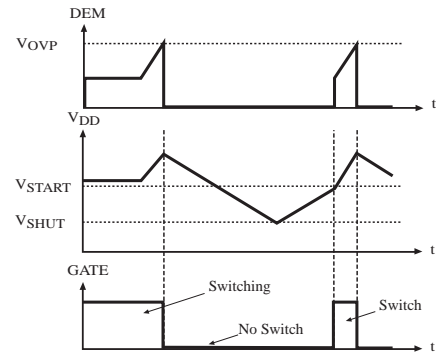
Waveforms of over-load protection are shown as below.



## 8. Adjustable Output Over-voltage Protection

DEM pin is used for output voltage detection during MOSFET off and secondary winding freewheeling period. If DEM voltage exceeds OVP voltage 2.5V, output over-voltage protection is initialized to cut off MOSFET, The system will auto recovery.

Waveforms of output voltage overvoltage protection are shown as below.



## 7. VDD Over-voltage Protection (OVP)

When VDD is too high, VDD over-voltage protection (OVP) is activated to turn off the MOSFET, The system will auto recovery..

Waveforms of VDD overvoltage protection are shown as below.

