



## Description

S2278SA combines a dedicated current mode PWM mode controller with a  $1.9\ \Omega/700\text{V}$  MOSFET.

S2278SA has high efficiency, low standby power consumption, low EMC and low cost. It is applied to the off-line fly-back converter in the range of 20W output power.

S2278SA offers comprehensive protection functions, including Cycle-by-Cycle current limitation (OCP), over temperature protection (OTP), under voltage lockout (UVLO) on VCC, over voltage protection on VCC and off-chip.

S2278SA is offered in SOP7 package.

## Features

- ⌘ Digit frequency shuffling technology to improve EMI performance.
- ⌘ Fixed 65kHz PWM switching frequency.
- ⌘ Leading-edge blanking on current sense.
- ⌘ Internal synchronized slope compensation.
- ⌘ Low standby power consumption ( $<75\text{mW}@AC\ 230\text{V}$ )

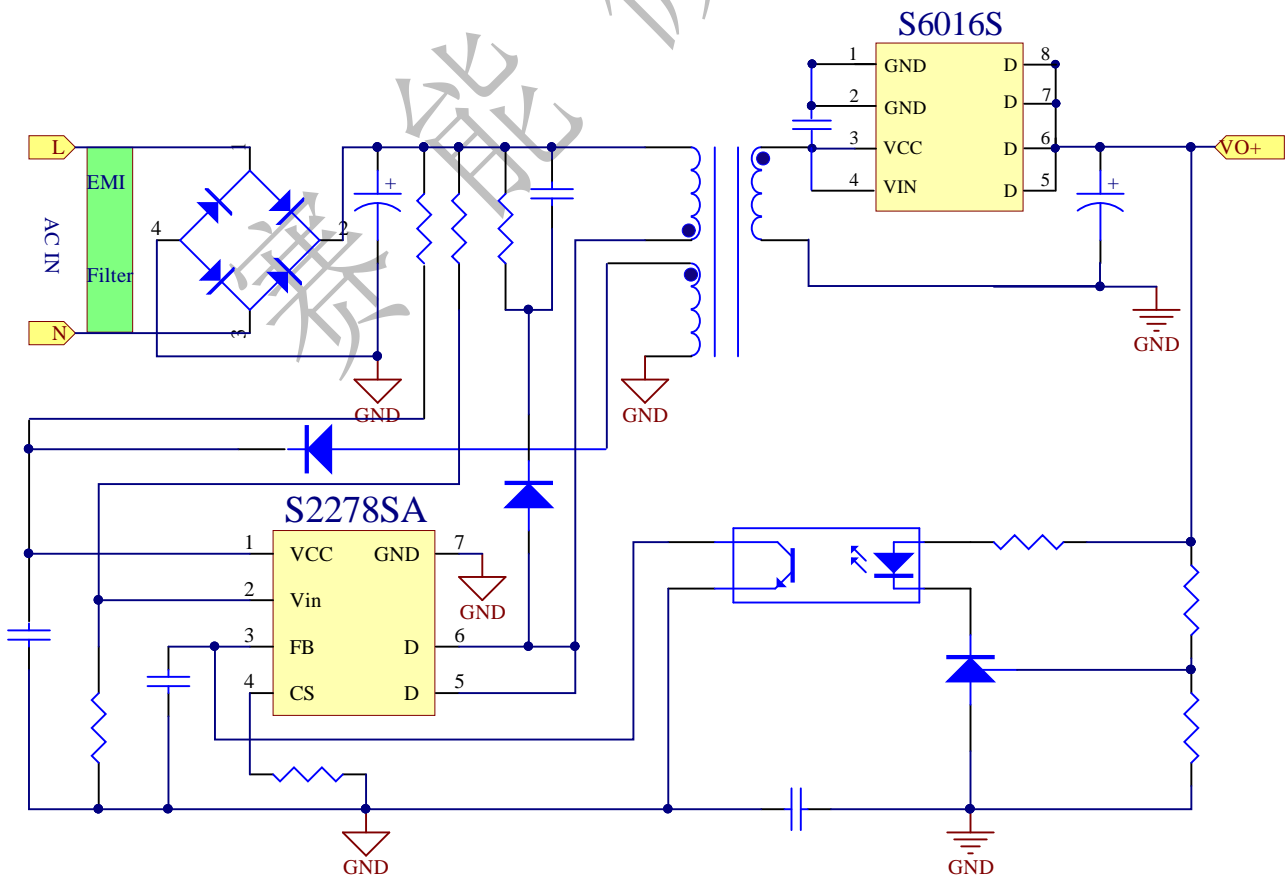
- ⌘ Soft-start to reduce MOSFET Vds stress during power on
- ⌘ Comprehensive protection function
  - 1、 Under voltage locked with hysteresis (UVLO) on VCC.
  - 2、 Over voltage protection (OVP) on VCC and off-chip.
  - 3、 Cycle-by-Cycle current limitation.
  - 4、 Over load protection (OLP)
  - 5、 Over temperature protection (OTP)
  - 6、 Current limitation compensation to obtain the same output current in universal ac line input
- ⌘ Low start-up current ( $<10\mu\text{A}@VCC=12\text{V}$ )

## Applications

- ⌘ Cell Phone Charger
- ⌘ Digital Cameras Charger
- ⌘ Battery charger

## Application Circuit

Two large value resistors are connected to VCC capacitor in startup circuit



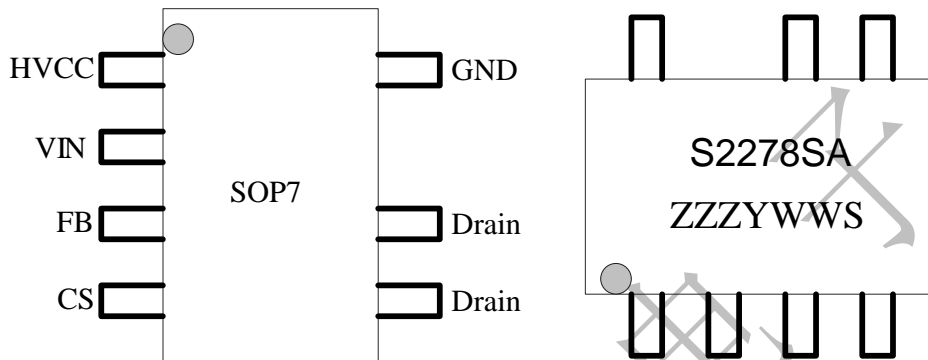


## Output table

Product	230VAC±15%	85-265VAC
S2278SA	Open Frame1	Open Frame1
	20W	18W

Note:Maximum practical continuous power is in the open frame structure at 45°C ambient temperature. The output power would be higher possible with extra heat sink or air circulation to reduce thermal resistance.

## Pin Assignment & Marking Information



<b>ZZZ:</b>	LOT NO
<b>Y:</b>	Year code (2020=A,2021=B)
<b>WW:</b>	week code ( 01-52 )
<b>H:</b>	Assembly House code

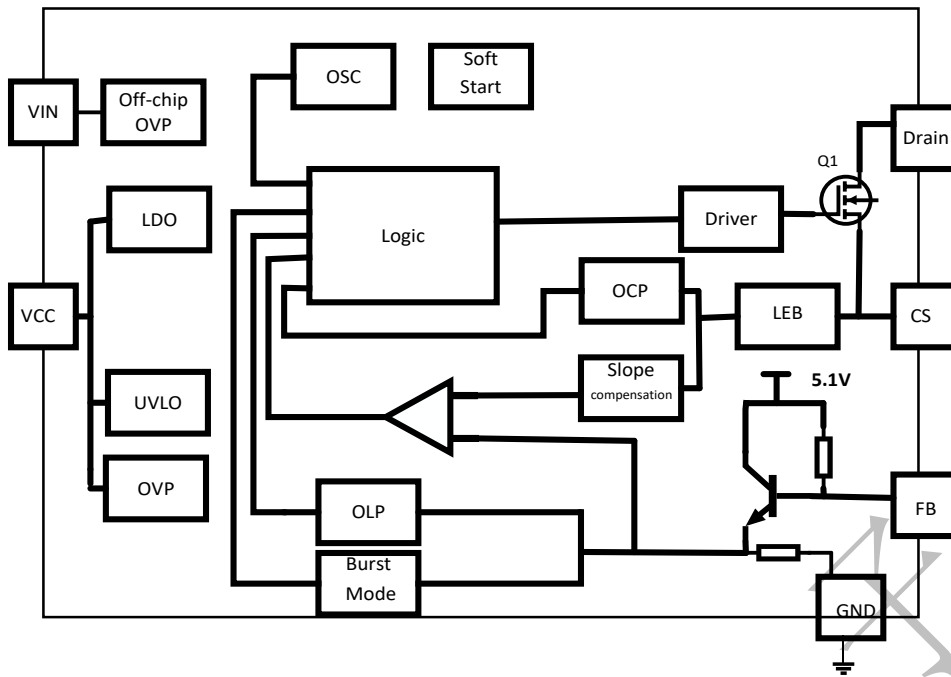
## Ordering Information

Part number	Package	MOQ(PCS)
S2278SA	SOP7	4000

## Pin Description

Pin name	Pin number	Pin type	Function description
HVCC	1	Power	Power Supply
VIN	2	Input	Off-chip OVP
FB	3	Feedback Input	Feedback Input Pin.The PWM duty cycle is determined by this pin voltage level and current-sense signal at Pin 4
CS	4	Current Monitoring	Current Sensing
Drain	5,6	Internal MOSFET Drain	Internal HV MOSFET Drain.Connected to the primary lead of the transformer
GND	7	GND	ground

## Block Diagram



## Absolute Maximum Rating

Symbol	Parameter	Value	Unit
Drain	Internal HV MOS Drain voltage	-0.7~700	V
VFB	FB Input Voltage	-0.3~7	V
VCS	Current-sense Input Voltage	-0.3~7	V
V VIN	VIN Input Voltage	-0.3~7	V
Tj	Operating Junction Temperature	-20~150	°C
Tstg	Storage Temperature	-40~150	°C
Vcc-clamp	VCC Clamp Voltage	44	V
Icc	VCC DC Clamp Current	10	mA

Note: Stresses above absolute maximum ratings may cause permanent damage to the device. Exposure to absolutely maximum-rated conditions for extended periods may affect device reliability.

## Recommended Operating Conditions

Symbol	Parameter	Value	Unit
VCC	VCC supply voltage	9-41	V
Ts	Operating shell temperature	-10-110	°C
Drain	Internal HV MOS Drain voltage	-0.7-700	V
Lead temperature	(Soldering, 10sec)	260	°C

## ESD information

Symbol	Test condition	Value	Unit
Vesd-HBD	Human model Except Drain	2	KV
Vesd-MM	Machine Model	150	V

## Thermal characteristics

Characteristics	Symbol	Rating	Unit
Thermal resistance, Junction to shell	Rθjc	19	°C/W

**Electrical Characteristics** ( $T_A = 25\text{ }^\circ\text{C}$ , if not otherwise noted)

VCC						
Symbol	Parameter	Test Condition	MIN	Type	MAX	Unit
VCC-Op	Operation Voltage		9		41	V
UVLO-On	Turn-Off threshold		6.8	7.8	8.2	V
UVLO-Off	Turn-on threshold		13	13.4	16.5	V
I_VCC-ST	Start-up Current	VCC=12V		3	10	uA
I_VCC-Op	Operation Current	VCC=16V;FB=2.0V		1.5		mA
VCC-OVP	VCC over voltage protection		41		43	V
FB						
VFB_Open	V_FB Open Loop Voltage			5.7		V
IFB_Short	FB Pin Short Current	FB Shorted to GND		380		uA
VTH_PL	Power limiting FB Threshold			3.7		V
TD_PL	Power limiting Debounce			60		ms
ZFB_IN	Input Impedance			30		kΩ
Max_Duty	Maximum duty cycle			75		%
CS						
TLEB	Leading edge Blanking Time	Vgate=5V	100	400	750	ns
Zsense	Input impedance			40		kΩ
VTH_OC	OCP threshold	Duty=0	0.66	0.7	0.74	V
Oscillator Section						
Fosc	Frequency	Oscillation	55	60	64	khz
Fosc_BM	Burst mode frequency		17	25	28	khz
VIN						
Vovp	Off-chip over voltage protection			2		V
HV MOSFET						
BVdss	breakdown voltage		700			V
Rds_on	Static Drain to Source on resistance			1.9		Ω



## Application Information:

S2278SA combines a dedicated current mode PWM mode controller with a 1.9Ω/700V MOSFET. S2278SA has high efficiency, low standby power consumption, low EMC and low cost.

## Start up Control:

S2278SA has very low start-up current that is less than 10uA. Therefore, a large resistor can be used in start-up circuit of switch power supply. This will minimize standby dissipation. The typical resistance of start-up resistor is 4M ohms.

## Operating Current:

The Operating current of S2278SA is less than 1.5mA. Therefore, S2278SA can have good efficiency.

## Frequency shuffling for EMI improvement:

The frequency Shuffling is implemented in S2278SA. The oscillation frequency is modulated with a random source so that the harmonic energy is spread out. The spread spectrum minimizes the conduction EMI and therefore reduces system design challenge.

## Burst Mode Operation:

At zero load or light load condition, the main power dissipation in a switching mode power supply is from switching on the MOSFET, the core of transformer and the snubber circuit. The magnitude of power dissipation is proportional to the number of switching frequency within certain period. Less switching frequency can reduce the power dissipation. S2278SA adjusts the switching frequency according to the loading condition. The PWM pulse width is kept greater than 1.2uS at any load condition. From light load to no load, the FB voltage drops. While the FB voltage is less than 1.1V, the gate pin output is disabled and kept low, while the FB voltage is higher than 1.2V, the gate output recovers to normal working mode. This is called 'burst mode'. To reduce audio noise, the switching frequency will be kept higher than 20KHz in burst mode.

## Oscillator Operation:

The switching frequency is internally fixed at 65kHz. No external frequency setting components are required on PCB design.

## Current Sensing and Leading-Edge Blanking:

Cycle-by-Cycle current limitation is offered in S2278SA. The switching current is detected by a resistor into the CS pin. An internal leading-edge blanking circuit chops off the CS voltage spike at initial so that the external RC filtering on CS pin is no longer required. The current limiting is disabled and thus cannot turn off the external MOSFET during the blanking period. PWM duty cycle is determined by the voltage in the SENSE pin and the FB pin.

## Internal Synchronized Slope Compensation:

Slope compensation circuit adds voltage ramp onto the SENSE voltage according to PWM pulse width. This greatly improves the close loop stability at CCM and prevents the sub-harmonic oscillation and thus reduces the output ripple voltage. Slope compensation also help S2278SA obtain the same output current in universal ac input voltage.

## Protection Controls:

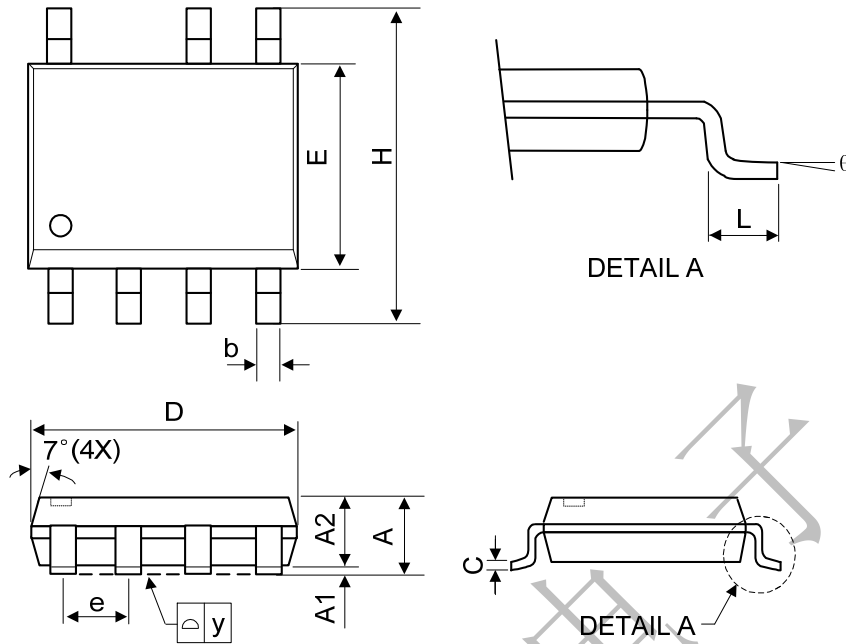
S2278SA has comprehensive protection functions, including Cycle-by- Cycle current limitation (OCP), Over Load Protection (OLP) and over voltage clamp, Under Voltage Lockout on VCC (UVLO), Over Temperature Protection (OTP), Over voltage protection on VCC and off-chip.

## Current limitation compensation:

To obtain the same output current capability, the OLP threshold voltage is compensated for the different input AC voltage. This function makes the current of OLP is in consistency whatever the AC input is (110V or 220V).

**Package Information**

SOP7



SYMBOL	MILLIMETER			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	1.75	-	-	0.069
A1	0.1	-	0.25	0.04	-	0.1
A2	1.25	-	-	0.049	-	-
C	0.1	0.2	0.25	0.0075	0.008	0.01
D	4.7	4.9	5.1	0.185	0.193	0.2
E	3.7	3.9	4.1	0.146	0.154	0.161
H	5.8	6	6.2	0.228	0.236	0.244
L	0.4	-	1.27	0.015	-	0.05
b	0.31	0.41	0.51	0.012	0.016	0.02
e	1.27 BSC			0.050 BSC		
y	-	-	0.1	-	-	0.004
θ	0°	-	8°	0°	-	8°