42V Micro-Power Isolated Flyback Converter

GENERAL DESCRIPTION

SiLM6601 is a micropower isolated flyback converter. It regulates the output voltage by sampling the isolated output voltage from the primary side without third winding or opto-isolator. The output voltage is programmed with a single external resistor. Internal compensation and soft start further reduce external components. Low ripple burst mode operation maintains high efficiency at light load while minimizing the output voltage ripple. The SiLM6601 integrates a 1.2A, 65V power Mosfet along with all high voltage circuitry and control logic in a SOT23-5 package.

The SiLM6601 operates from an input voltage range of 2.7V to 42V and can deliver up to 6W of isolated output power. High level integration, boundary and low ripple burst mode control make it easy to be used.

FEATURES

- 2.7V to 42V input voltage range
- 1.2A, 65V internal power switch
- Low quiescent current
  - 145uA in sleep mode
  - 350uA in active mode
- Boundary mode operation at heavy load
- Low ripple burst mode operation at light load
- Single external resistor to program the output
- No third winding or opto-isolator required for regulation
- Internal compensation and soft start
- Output short protection
- Package: SOT23-5

APPLICATIONS

- Isolated power supply for industrial, medical and automation
- Isolated auxiliary power supplies

TYPICAL APPLICATION CIRCUIT

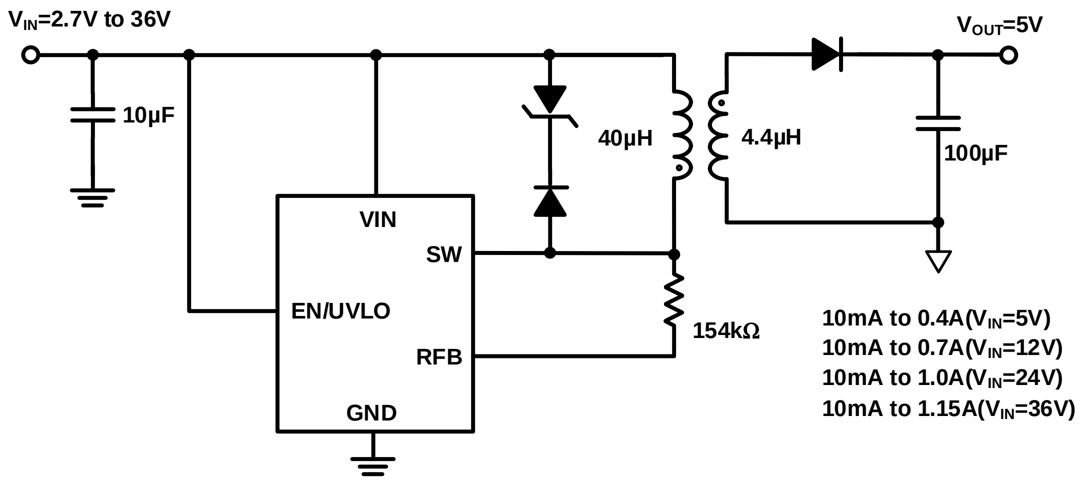
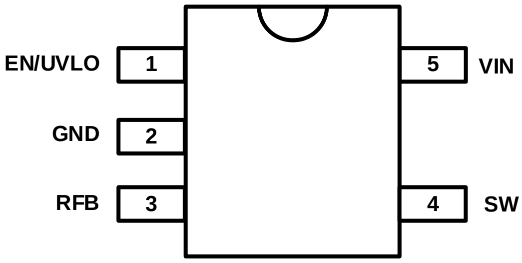


Figure 1. 5V Output Typical Application

Table of Contents

PIN CONFIGURATION

Package	Pin Configuration (Top View)
SOT23-5	

PIN FUNCTION DESCRIPTIONS

No.	Pin Name	Function Description
1	EN/UVLO	Enable/Under voltage lockout, used to enable the SiLM6601. When the voltage on this pin is greater than 1.2V, the SiLM6601 is enabled. This pin can be used to program the VIN under voltage lockout threshold using a resistor divider from VIN to ground. If UVLO function is not used, tie this pin directly to input voltage.
2	GND	Ground.
3	RFB	Input Pin for external feedback resistor. Connect a resistor between RFB and SW pin to program the output voltage.
4	SW	Drain of the 65V internal power Mosfet. Connect to the input voltage through the primary winding.
5	VIN	Input Supply. The VIN pin supplies current to internal circuitry and serves as a reference voltage for the feedback circuitry connected to the RFB pin. Put a bypass capacitor between VIN and GND pin.

ORDERING INFORMATION

Operation Temperature: -40°C to +125°C

Order Part No.	Package	QTY
SiLM6601AD-7G	SOT23-5	3000/Reel

FUNCTIONAL BLOCK DIAGRAM

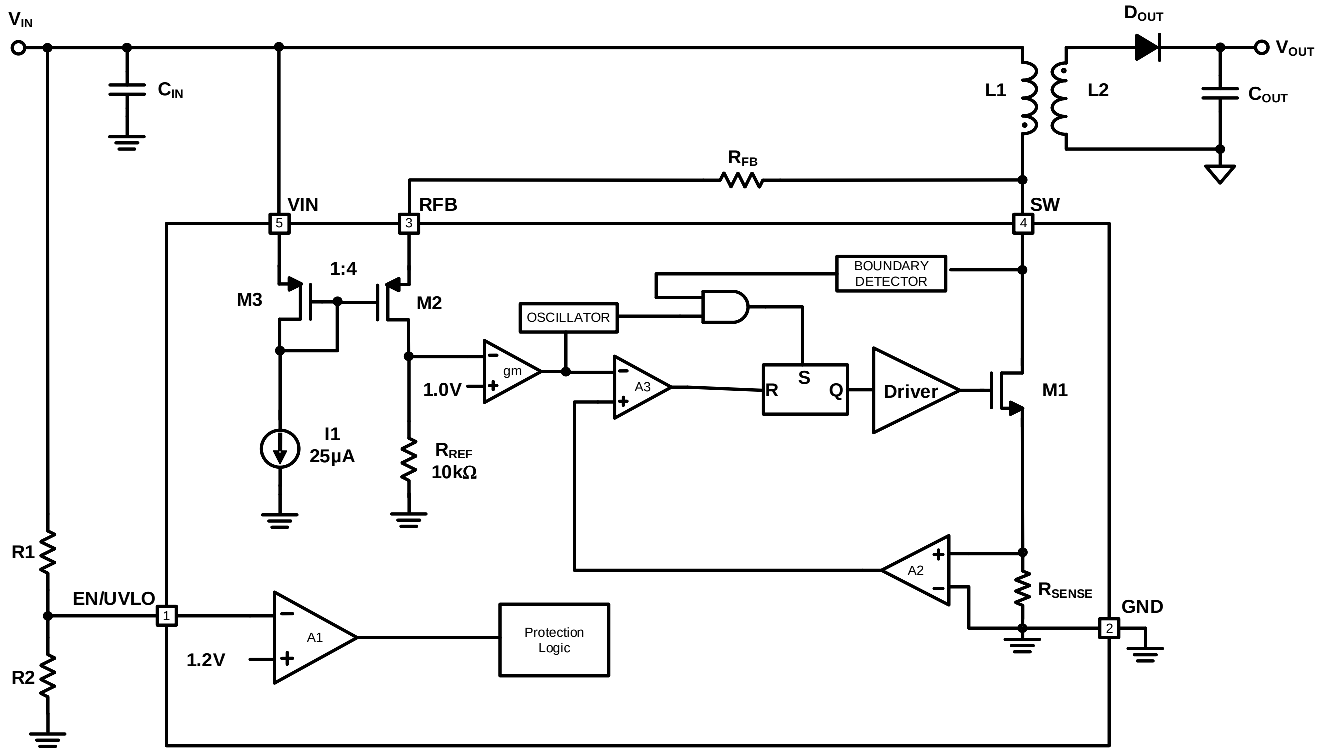


Figure 2. Functional Block Diagram

ABSOLUTE MAXIMUM RATINGS

Parameter	Ratings
VIN	42V
SW	65V
EN/UVLO	VIN
RFB	VIN-0.5V to VIN
I_{RFB}, Current into RFB	200uA
Operation Junction Temperature, T_J	-40°C to 150°C
Storage temperature, T_S	-65°C to 150°C
Lead Soldering Temperature（10 sec）	300°C

ELECTRICAL CHARACTERISTICS

V_{IN}=5V, $V_{EN/UVLO}$=V_{IN}, T_J=25°C for typical specifications and T_J= -40°C to 125°C for minimum/maximum specifications, unless otherwise noted.

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{IN}	Input voltage range		2.7		42	V
V_{UVLO_R}	Input voltage UVLO rising threshold			2.55	2.65	V
V_{UVLO_F}	Input voltage UVLO falling threshold		2.25	2.35		V
I_{SD}	Current on VIN at Shutdown mode	EN/UVLO=0V		1	2.5	uA
I_{SLP}	Current on VIN at sleep mode	Sleep mode (Switch off)		145	190	uA
I_Q	Current on VIN at active mode	Active mode (Switch on)		350	420	uA
V_{EN_R}	Enable rising threshold			1.2	1.3	V
V_{EN_F}	Enable falling threshold		1.0	1.1		V
f_{MIN}	Minimum switching frequency		8.5	10	11.5	kHz
$t_{ON(MIN)}$	Minimum switch on time			145		ns
$t_{OFF(MAX)}$	Maximum switch off time			195		us
$I_{SW(MAX)}$	Maximum SW current limit		1.2	1.4	1.7	A
$I_{SW(MIN)}$	Minimum SW current limit		0.25	0.35	0.45	A
R_{DSON}	Switch ON-Resistance	I_{SW}=500mA		0.39		Ω
I_{LKG}	Switch leakage current	V_{IN}=42V, V_{SW}=65V		0.5	2.5	uA
I_{RFB}	RFB regulation current		96	100	104	uA
	RFB regulation current line regulation	2.7V<V_{IN}<42V			0.1	%/V

OPERATION THEROY

The SiLM6601 is micropower isolated flyback converter available in a 5-lead TSOT-23 package. The output voltage is programmed with a single external resistor. By integrating the loop compensation and soft-start inside, the part further reduces the number of external components. Many of the blocks are similar to those found in traditional switching regulators including reference, regulators, oscillator, logic, current amplifier, current comparator, driver, and power switch. The novel sections include a flyback pulse sense circuit, a sample-and-hold error amplifier, and a boundary mode detector, as well as the additional logic for boundary conduction mode, discontinuous conduction mode, and low ripple Burst Mode operation.

Boundary Conduction Mode Operation

The SiLM6601 features boundary conduction mode operation at heavy load, where the device turns on the primary power switch when the secondary current is zero. Boundary conduction mode is a variable frequency, variable peak-current switching scheme. The power switch turns on and the transformer primary current increases until an internally controlled peak current limit. After the power switch turns off, the voltage on the SW pin rises to the output voltage multiplied by the primary-to-secondary transformer turns ratio plus the input voltage. When the secondary current through the output diode falls to zero, the SW pin voltage collapses and rings around V_{IN}. A boundary mode detector senses this event and turns the power switch back on.

Boundary conduction mode returns the secondary current to zero every cycle, so parasitic resistive voltage drops do not cause load regulation errors. Boundary conduction mode also allows the use of smaller transformers compared to continuous conduction mode and does not exhibit sub-harmonic oscillation.

Discontinuous Conduction Mode Operation

As the load gets lighter, boundary conduction mode increases the switching frequency and decreases the switch peak current at the same ratio. Running at a higher switching frequency up to several MHz increases switching and gate charge losses. To avoid this scenario, the SiLM6601 has an additional internal oscillator, which clamps the maximum switching frequency to be less than 400kHz (typ). Once the switching frequency hits the internal frequency clamp, the part starts to delay the switch turn-on and operates in discontinuous conduction mode.

Low Ripple Burst Mode Operation

Unlike traditional flyback converters, the SiLM6601 has to turn on and off at least for a minimum amount of time and with a minimum frequency to allow accurate sampling of the output voltage. The inherent minimum switch current limit and minimum switch-off time are necessary to guarantee the correct operation of specific applications.

As the load gets very light, the SiLM6601 starts to fold back the switching frequency while keeping the minimum switch current limit. So, the load current is able to decrease while still allowing minimum switch-off time for the sample-and-hold error amplifier. Meanwhile, the part switches between sleep mode and active mode, thereby reducing the effective quiescent current to improve light load efficiency. In this condition, the SiLM6601 operates in low ripple Burst Mode. The 10kHz (typ) minimum switching frequency determines how often the output voltage is sampled and also the minimum load requirement.

APPLICATION INFORMAITON

Output Voltage

The R_{FB} resistor is the only external resistor used to program the output voltage. The SiLM6601 operates similar to traditional current mode switchers, except in the use of a unique flyback pulse sense circuit and a sample-and-hold error amplifier, which sample and therefore regulate the isolated output voltage from the flyback pulse.

Operation is as follows: when the power switch M1 turns off, the SW pin voltage rises above the VIN supply. The amplitude of the flyback pulse, the difference between the SW pin voltage and VIN supply, is given as:

$$V_{FLBK}=(V_{OUT}+V_F+I_{SEC}\times ESR)\times N_{PS}$$

V_F: Output diode forward voltage

I_{SEC}: Transformer secondary current

ESR: Total impedance of secondary circuit

N_{PS}: Transformer effective primary to secondary turns ratios

The flyback voltage is then converted to a current I_{RFB} by the flyback pulse sense circuit (M2 and M3). This current I_{RFB} also flows through the internal 10k R_{REF} resistor to generate a ground-referred voltage. The resulting voltage feeds to the inverting input of the sample-and-hold error amplifier. Since the sample-and-hold error amplifier samples the voltage when the secondary current is zero, the (I_{SEC} x ESR) term in the V_{FLBK} equation can be assumed to be zero.

An internal reference voltage, V_{IREF} (1.0V), feeds to the non-inverting input of the sample-and-hold error amplifier. The relatively high gain in the overall loop causes the voltage across R_{REF} resistor to be nearly equal to V_{IREF}. The resulting relationship between V_{FLBK} and V_{IREF} can be expressed as:

$$\left(\frac{V_{FLBK}}{R_{FB}}\right)\times R_{REF}=V_{IREF}$$

or

$$V_{FLBK}=\left(\frac{V_{IREF}}{R_{REF}}\right)\times R_{FB}=I_{RFB}\times R_{FB}$$

V_{IREF}: Internal reference voltage.

I_{RFB}: R_{FB} regulation current, which is 100μA

Combination with the previous V_{FLBK} equation yields an equation for V_{OUT}, in terms of the R_{FB} resistor, transformer turns ratio, and diode forward voltage:

$$V_{OUT}=100uA\times\frac{R_{FB}}{N_{ps}}-V_F$$

Output Temperature Coefficient

The first term in the V_{OUT} equation does not have temperature dependence, but the output diode forward voltage V_F has a significant negative temperature coefficient (－1mV/°C to －2mV/°C). Such a negative temperature coefficient produces approximately 200mV to 300mV voltage variation on the output voltage across temperature.

For higher voltage outputs, such as 12V and 24V, the output diode temperature coefficient has a negligible effect on the output voltage regulation. For lower voltage outputs, such as 3.3V and 5V, however, the output diode temperature coefficient does count for an extra 2% to 5% output voltage regulation.

Select RFB Resistor Value

The SiLM6601 uses a unique sampling scheme to regulate the isolated output voltage. Due to the sampling nature, the scheme contains repeatable delays and error sources, which will affect the output voltage and force a re-evaluation of the R_{FB} resistor value. Therefore, a simple two-step process is required to choose feedback resistor R_{FB}.

Rearrangement of the expression for V_{OUT} and yields the starting value for R_{FB}:

$$R_{FB}=\frac{N_{PS}*(V_{OUT}+V_F)}{100uA}$$

V_{OUT}: Output voltage

V_F: Output diode forward voltage, which is around 0.3V

N_{PS}: Transformer effective primary to secondary turns ratio

Power up the circuits with the starting R_{FB} value, and measure the regulated output voltage, $V_{OUT(MEAS)}$. The final R_{FB} value can be adjusted to:

$$R_{FB(FINAL)}=\frac{V_{OUT}}{V_{OUT(MEAS)}}*R_{FB}$$

Once the final R_{FB} value is selected, the regulation accuracy from board to board for a given application will be very consistent, typically under ±5% when including device variation of all the components in the system (assuming resistor tolerances and transformer windings matching within ±1%). However, if the transformer or the output diode is changed, or the layout is dramatically altered, there may be some change in V_{OUT}.

Primary Inductance Requirement

The SiLM6601 obtains output voltage information from the reflected output voltage on the SW pin. The conduction of secondary current reflects the output voltage on the primary SW pin. The sample-and-hold error amplifier needs a minimum 450ns to settle and sample the reflected output voltage. In order to ensure proper sampling, the secondary winding needs to conduct current for a minimum of 450ns. The following equation gives the minimum value for primary-side magnetizing inductance:

$$L_{PRI}\geq\frac{t_{OFF(MIN)}*N_{PS}*(V_{OUT}+V_F)}{I_{SW(MIN)}}$$

$t_{OFF(MIN)}$: Minimum switch off time, 450ns

$I_{SW(MIN)}$: Minimum switch current limit,350mA (Typ)

In addition to the primary inductance requirement for the minimum switch-off time, the SiLM6601 has minimum switch-on time that prevents the device from turning on the power switch shorter than approximately 145ns. This minimum switch-on time is mainly for leading-edge blanking the initial switch turn-on current spike.

If the inductor current exceeds the desired current limit during that time, oscillation may occur at the output as the current control loop will lose its ability to regulate. Therefore, the following equation relating to maximum input voltage must also be followed in selecting primary-side magnetizing inductance:

$$L_{PRI}\geq\frac{t_{ON(MIN)}*V_{IN(MAX)}}{I_{SW(MIN)}}$$

$t_{ON(MIN)}$: Minimum switch on time, 145ns

In general, choose a transformer with its primary magnetizing inductance about 30% larger than the minimum values calculated above. A transformer with much larger inductance will have a bigger physical size and may cause instability at light load.

Turns Ratio

When choosing the R_{FB} resistor to set output voltage, the user has relative freedom in selecting a transformer turns ratio to suit a given application. In contrast, the use of simple ratios of small integers, e.g., 3:1, 2:1, 1:1, provides more freedom in settling total turns and mutual inductance.

Typically, choose the transformer turns ratio to maximize available output power. For low output voltages (3.3V or 5V), a larger N:1 turns ratio can be used with multiple primary windings relative to the secondary to maximize the transformer's current gain (and output power). However, remember that the SW pin sees a voltage that is equal to the maximum input supply voltage plus the output voltage multiplied by the turns ratio.

In addition, leakage inductance will cause a voltage spike ($V_{LEAKAGE}$) on top of this reflected voltage. This total quantity needs to remain below the 65V absolute maximum rating of the SW pin to prevent breakdown of the internal power switch. Together these conditions place an upper limit on the turns ratio, N_{PS}, for a given application. Choose a turns ratio low enough to ensure:

$$N_{PS}<\frac{65V-V_{IN(MAX)}-V_{LEAKAGE}}{V_{OUT}+V_F}$$

For lower output power levels, choose a smaller N:1 turns ratio to alleviate the SW pin voltage stress. Although a 1:N turns ratio makes it possible to have very high output voltages without exceeding the breakdown voltage of the internal power switch, the multiplied parasitic capacitance through turns ratio may cause the switch turn-on current spike ringing beyond 145ns leading-edge blanking, thereby producing light load instability in certain applications. So any 1:N turns ratio should be fully evaluated before its use with the SiLM6601. The turns ratio is an important element in the isolated feedback scheme, and directly affects the output voltage accuracy. Make sure the transformer manufacturer specifies turns ratio accuracy within ±1%.

Saturation Current

The current in the transformer windings should not exceed its rated saturation current. Energy injected once the core is saturated will not be transferred to the secondary and will instead be dissipated in the core. When designing custom transformers to be used with the SiLM6601, the saturation current should always be specified by the transformer manufacturers.

Winding Resistance

Resistance in either the primary or secondary windings will reduce overall power efficiency. Good output voltage regulation will be maintained independent of winding resistance due to the boundary/discontinuous conduction mode operation of the SiLM6601.

Undervoltage Lockout (UVLO)

A resistive divider from VIN to the EN/UVLO pin implements undervoltage lockout (UVLO). The EN/UVLO pin rising threshold is set at 1.2V with 100mV hysteresis.

Figure 3 shows the implementation of external shutdown control while still using the UVLO function. The NMOS grounds the EN/UVLO pin when turned on, and puts the SiLM6601 in shutdown with quiescent current less than 2.5uA.

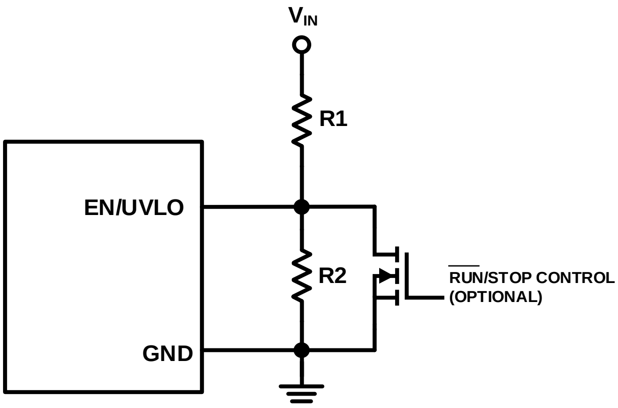


Figure 3. Undervoltage Lockout（UVLO）

Minimum Load Requirement

The SiLM6601 samples the isolated output voltage from the primary side flyback pulse waveform. The flyback pulse occurs once the primary switch turns off and the secondary winding conducts current. In order to sample the output voltage, the SiLM6601 has to turn on and off at least for a minimum amount of time and with a minimum frequency. The SiLM6601 delivers a minimum amount of energy even during light load conditions to ensure accurate output voltage information. The minimum energy delivery creates a minimum load requirement, which can be approximately estimated as:

$$I_{LOAD(MIN)}=\frac{L_{PRI}*I_{SW(MIN)}{}^{2}*f_{MIN}}{2*V_{OUT}}$$

L_{PRI}: Transformer primary inductance

$I_{SW(MIN)}$: Minimum switch current limit, 450mA (max)

f_{MIN} : Minimum switching frequency, 11.5kHz (max)

The SiLM6601 typically needs less than 0.5% of its full output power as minimum load. Alternatively, a Zener diode with its breakdown of 20% higher than the output voltage can serve as a minimum load if pre-loading is not acceptable. For a 5V output, use a 6V Zener with cathode connected to the output.

Output Short Protection

When the output is heavily overloaded or shorted, the reflected SW pin waveform rings longer than the internal blanking time. If no protection scheme is applied, after the 450ns minimum switch-off time, the excessive ring might falsely trigger the boundary mode detector and turn the power switch back on again before the secondary current falls to zero. The part then runs into continuous conduction mode at maximum switching frequency, and the switch current may run away. To prevent the switch current from running away under this condition, the SiLM6601 gradually folds back both maximum switch current limit and switching frequency as the output voltage drops from regulation. As a result, the switch current remains below 1.4A (typ) maximum switch current limit. In the worst-case scenario where the output is directly shorted to ground through a long wire and the huge ring after folding back still falsely triggers the boundary mode detector, a secondary overcurrent protection ensures that the SiLM6601 can still function properly. Once the switch current hits 2.2A overcurrent limit, a soft-start cycle initiates and throttles back both switch current limit and switching frequency very hard. This output short protection prevents the switch current from running away and limits the average output diode current.

DESIGN EXAMPLE

Use the following design example as a guide to design applications for the SiLM6601. The design example involves designing a 5V output with a 500mA load current and an input range from 8V to 32V.

$V_{IN(MIN)}$ = 8V, $V_{IN(NOM)}$ = 12V, $V_{IN(MAX)}$ = 32V, V_{OUT} = 5V, I_{OUT} = 500mA

Step1: Select the Turns Ratio of the Transformer

$$N_{PS} < \frac{65V - V_{IN(MAX)} - V_{LEAKAGE}}{(V_{OUT} + V_F)}$$

$V_{LEAKAGE}$: Margin for transformer leakage spike, suppose it is 15V

V_F: Output diode forward voltage, it's around 0.3V

In this example, N_{PS} < (65V−32V−15V)/(5V+0.3V) = 3.4

The choice of transformer turns ratio is critical in determining output current capability of the converter. Table 1 shows the switch voltage stress and output current capability at different transformer turns ratio.

Table 1. Switch voltage stress and output current capability vs turn ratio

N_{PS}	$V_{SW(MAX)}$ at $V_{IN(MAX)}$(V)	$I_{OUT(MAX)}$ at $V_{IN(MIN)}$(mA)	DUTY CYCLE(%)
1:1	37.3	330	14-40
2:1	42.6	470	25-57
3:1	47.9	540	33-67

Since only N_{PS}=3 can meet the 500mA output current requirement, N_{PS}=3 is chosen in this example.

Step2: Determine the Primary Inductance

Primary inductance for the transformer must be set above a minimum value to satisfy the minimum switch-off and switch-on time requirements:

$$L_{PRI} \geq \frac{t_{OFF(MIN)} * N_{PS} * (V_{OUT} + V_F)}{I_{SW(MIN)}}$$

$$L_{PRI} \geq \frac{t_{ON(MIN)} * V_{IN(MAX)}}{I_{SW(MIN)}}$$

$t_{OFF(MIN)}$=450ns

$t_{ON(MIN)}$=145ns

$I_{SW(MIN)}$=350mA(typ)

In this example：

$$L_{PRI} \geq \frac{450ns*3*(5V+0.3V)}{350mA} = 20.4\mu H$$

$$L_{PRI} \geq \frac{145ns*32V}{350mA} = 13.3\mu H$$

Most transformers specify primary inductance with a tolerance of ±20%. With other component tolerance considered, choose a transformer with its primary inductance 30% larger than the minimum values calculated above. L_{PRI} = 40μH is then chosen in this example.

Once the primary inductance has been determined, the maximum load switching frequency can be calculated as:

$$f_{SW}=\frac{1}{t_{ON}+t_{OFF}}=\frac{1}{\frac{I_{SW}}{\frac{V_{IN}}{L_{PRI}}}+\frac{I_{SW}}{\frac{N_{PS}*(V_{OUT}+V_F)}{L_{PRI}}}}$$

$$I_{SW}=\frac{V_{OUT}*I_{OUT}*2}{\eta*V_{IN}*D}$$

In this example：

$$D=\frac{3*(5V+0.3V)}{3*(5V+0.3V)+12V}=0.57$$

$$I_{SW}=\frac{2*5V*0.5A}{0.85*12V*0.57}=0.86A$$

f_{SW}=199kHz

The transformer also needs to be rated for the correct saturation current level across line and load conditions. A saturation current rating larger than 2A is necessary to work with the SiLM6601.

Step3: Select the Output Diode

Two main criteria for choosing the output diode include forward current rating and reverse voltage rating. The maximum load requirement is a good first-order guess as the average current requirement for the output diode. A conservative metric is the maximum switch current limit multiplied by the turns ratio.

$I_{DIODE(MAX)}=I_{SW(MAX)}*N_{PS}$

In this example：

$I_{DIODE(MAX)}$=4.5A

Next calculate reverse voltage requirement using maximum V_{IN}:

$$V_{REVERSE}=V_{OUT}+\frac{V_{IN(MAX)}}{N_{PS}}$$

In this example：

$$V_{REVERSE}=5V+\frac{32V}{3}=15.6V$$

Here choose the B530C, 30V/5A as the diode.

Step4: Select the Output Capacitor

The output capacitor should be chosen to minimize the output voltage ripple while considering the increase in size and cost of a larger capacitor. Use the equation below to calculate the output capacitance:

$$C_{OUT}=\frac{L_{PRI}*I_{SW}^2}{2*V_{OUT}*\Delta V_{OUT}}$$

In this example, design for output voltage ripple less than 1% of V_{OUT}， which is 50mV.

$$C_{OUT}=\frac{40\mu H*(0.86A)^2}{2*5V*0.05V}=60\mu F$$

Remember ceramic capacitors lose capacitance with applied voltage. The capacitance can drop to 40% of quoted capacitance at the maximum voltage rating. So a 100µF, 10V rating ceramic capacitor is chosen.

Step5: Snubber Circuit

The snubber circuit protects the power switch from leakage inductance voltage spike. A DZ snubber is recommended for this application because of lower leakage inductance and larger voltage margin. The Zener and the diode need to be selected. The maximum Zener breakdown voltage is set according to the maximum VIN:

$V_{ZENER(MAX)}\leq 65V-V_{IN(MAX)}$

In this example：

$V_{ZENER(MAX)} \leq 65V-32V=33V$

A 20V Zener with a maximum of 21V will provide optimal protection and minimize power loss. So, a 20V/0.2W Zener MMSZ5250BS from Diodes Incorporated is chosen.

Choose a diode that is fast and has sufficient reverse voltage breakdown:

$V_{REVERSE} > V_{SW(MAX)}$

$V_{SW(MAX)} = V_{IN(MAX)} + V_{ZENER(MAX)}$

In this example：

$V_{REVERSE} > 53V$

A 100V/0.3A diode 1N4148W-7-F from Diodes Incorporated is chosen.

Step6: Select the RFB Resistor

Use the following equation to calculate the starting value for R_{FB}:

$$R_{FB} = \frac{N_{PS} * (V_{OUT} + V_F)}{100uA}$$

In this example：

$$R_{FB} = \frac{3 * (5V + 0.3V)}{100uA} = 159k\Omega$$

Depending on the tolerance of standard resistor values, the precise resistor value may not exist. For 1% standard values, a 158kΩ resistor should be close enough. As discussed in the Select RFB Resistor Value section, the final R_{FB} value should be adjusted on the measured output voltage.

Step7: Select the EN/UVLO Resistors

Calculate the R1 value according to the minimum input voltage, $V_{IN(MIN)}$.

$$\frac{V_{EN/UVLO}}{R_2} = \frac{V_{IN(MIN)}}{(R_1 + R_2)}$$

In this example：

$R_2 = 100k\Omega$

$$\frac{1.2V}{100k\Omega} = \frac{8V}{(R_1 + 100k\Omega)}$$

$R_1 = 566k\Omega$

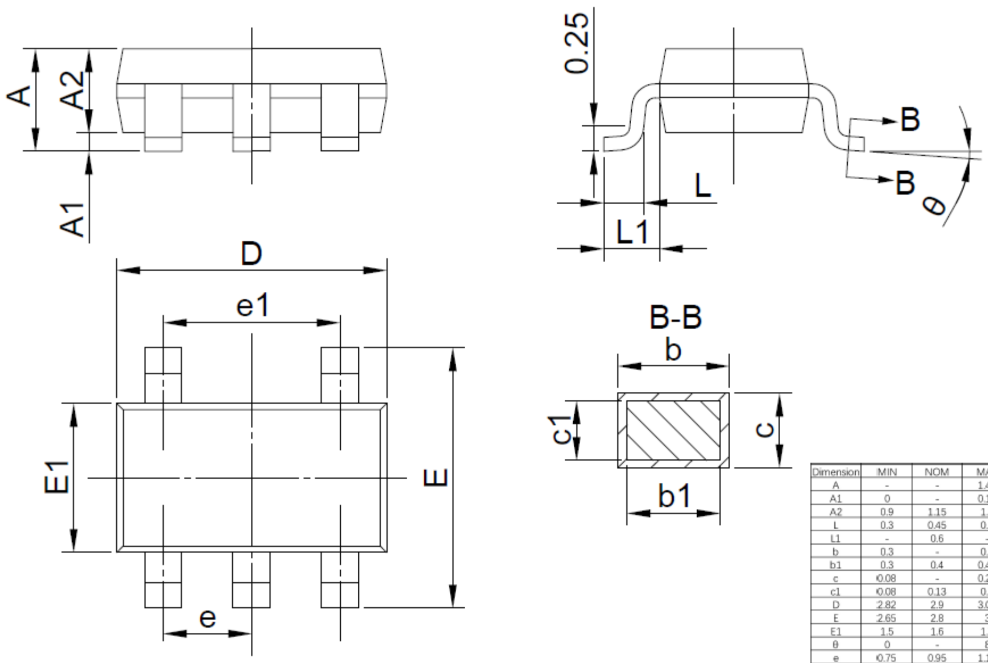
Step8: Minimum Load

The theoretical minimum load can be approximately estimated as:

$$I_{LOAD(MIN)} = \frac{40\mu H * (450mA)^2 * 11.5kHz}{2 * 5V} = 9.32mA$$

Remember to check the minimum load requirement in real application. The minimum load occurs at the point where the output voltage begins to climb up as the converter delivers more energy than what is consumed at the output. The real minimum load for this application is about 9.32mA. In this example, a 410Ω resistor is selected as the minimum load.

PACKAGE CASE OUTLINES



Dimension	MIN	NOM	MAX
A	-	-	1.45
A1	0	-	0.15
A2	0.9	1.15	1.3
L	0.3	0.45	0.6
L1	-	0.6	-
b	0.3	-	0.5
b1	0.3	0.4	0.45
c	0.08	-	0.22
c1	0.08	0.13	0.2
D	2.82	2.9	3.02
E	2.65	2.8	3
E1	1.5	1.6	1.7
θ	0	-	8
e	0.75	0.95	1.15
e1	1.8	-	2
Unit : mm			

Figure 4. SOT23-5 Outline Dimensions

REVISION HISTORY

Note: page numbers for previous revisions may differ from page numbers in current version

Page or Item	Subjects (major changes since previous revision)
Rev 1.0 datasheet: 2023-12-18	
Whole document	Initial datasheet released