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Start up switches for switch mode power supplies

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The use of Zetex medium voltage MOSFETS for switch mode power supplies

High voltage start up

Many topologies of switching power supplies power the control circuits from an auxiliary tap on the main switching transformer or coil. This method avoids the need for costly house keeping supplies. However the adoption of this scheme presents the designer with the challenge of creating the initial voltage on the control circuit at start up. Any continuous delivery of current from a high voltage line will cause unwanted dissipation and loss of efficiency. Such a scheme may even take a system out of operational specification for low energy standby applications and may even degrade reliability figures.

The main requirement for the design of this start up supply is to provide a high enough current to raise the control IC supply and additionally charge any associated smoothing capacitance. At a pre determined voltage the controller will initiate the first few pulses into the main power supply switch transistor. Once this occurs the supply will become self sustaining and the start up path can be switched off.

With start up currents of the order of tens of milliamps and high voltages across the device power dissipations can be high for many milliseconds while start up occurs.

For AC line operated systems the typical requirement is 450V VDs devices and for 48V DC-DC systems 100 to 200V is usually required.

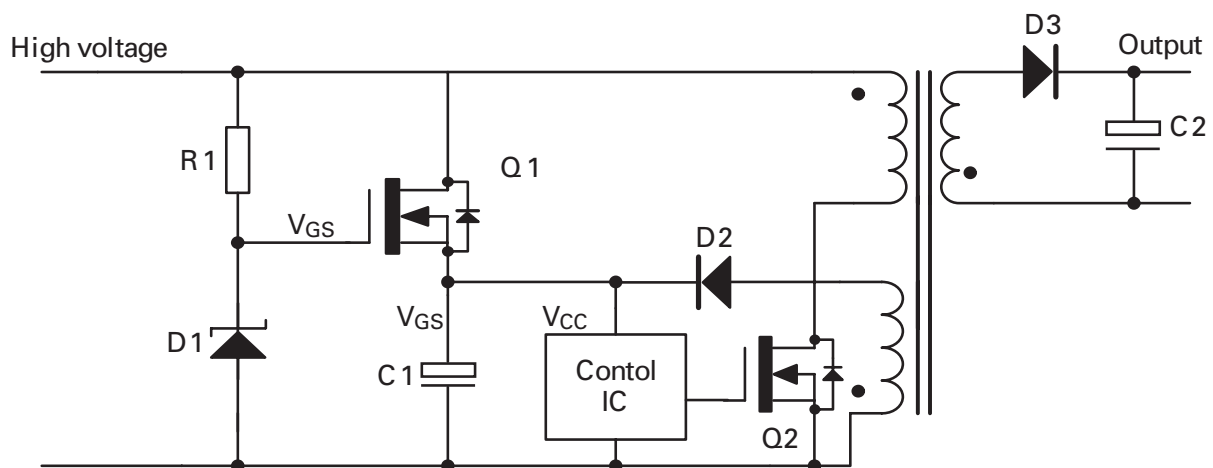


Figure 1 High voltage MOSFET start up circuit

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Operation

Figure 1 shows the MOSFET start up circuit where the MOSFET is biased on by a low current in R1 to form a resistive pass element. C1 charges up to the point where the control IC becomes active, the maximum value of V_{CC} in this phase are limited by Zener voltage D1 minus V_{GS} .

Once the control IC becomes active drive pulses are issued to Q2 to form normal switching action in the transformer and power is now fed to the control IC via D2. It is therefore important for the designer to chose a value for D1 so that the supply via D2 is high is greater than D1 minus V_{GS} thus biasing off Q1 in normal operation.

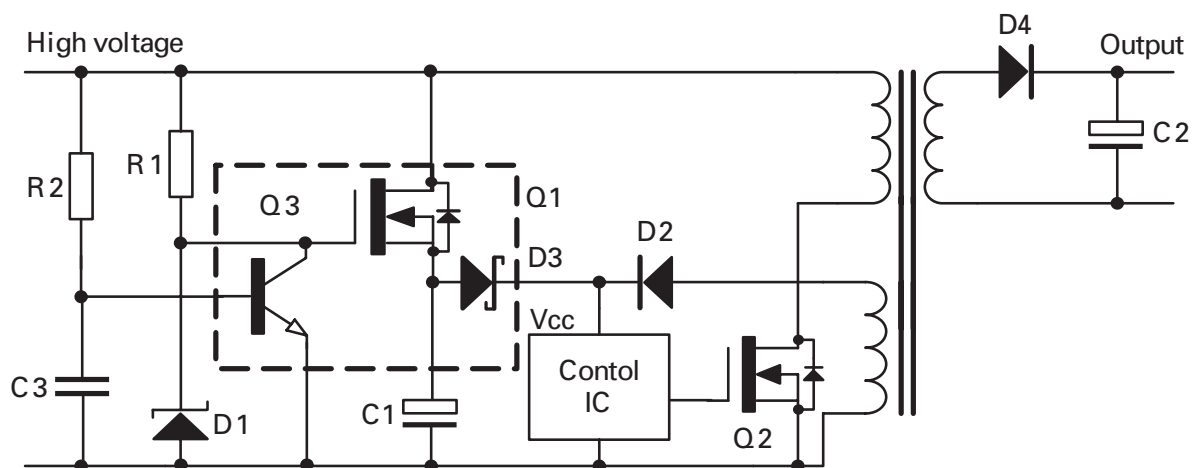


Figure 2 Improved high voltage MOSFET start up circuit

In addition to the basic requirements fault protection may be added such that if the control IC supply can not be raised by the start up circuit a time out occurs to prevent excessive dissipation in the start up MOSFET. By using an additional transistor a simple circuit could be constructed as shown in Figure 2.

Figure 2 shows the modified circuit with a time out function to prevent Q1 remaining on and over heating if the power supply can not start. Q3 is simply turned on after a delay from the time constant of R2 and C3. This circuit provides additional protection under all operating conditions and allows the use of smaller devices than if constant on time of Q1 in a fault mode had to be designed for.

Zetex manufactures a range of medium voltage MOSFETS and bipolar transistors suitable for use in this application contained in small outline packages with some offering additional pin spacing for creep age distance compliancy.

Table 1 MOSFETS suitable for start up circuits

Device	Applications	Type	Package	V _{DS} (V)	I _D (mA)	I _{DPulse} (A)	P _D (W) ^(*)
ZXMN0545G4	Universal	N-channel	SOT223	450	140	0.60	2
ZVN2120G	Lower line voltage	N-channel	SOT223	200	320	2.00	2
ZXMN10A07Z	Telecoms	N-channel	SOT89	100	1500	4.20	1.5
ZXMN10A07F	Telecoms	N-channel	SOT23	100	1500	3.50	0.625
ZXMN10A08E6	Telecoms	N-channel	SOT23-6	100	2500	8.6	1.7
ZXMN10A08DN8	Telecoms	Dual N-channel	DN8	100	2600	9.00	1.25

NOTES:

(*) Based on 25 x 25mm FR4

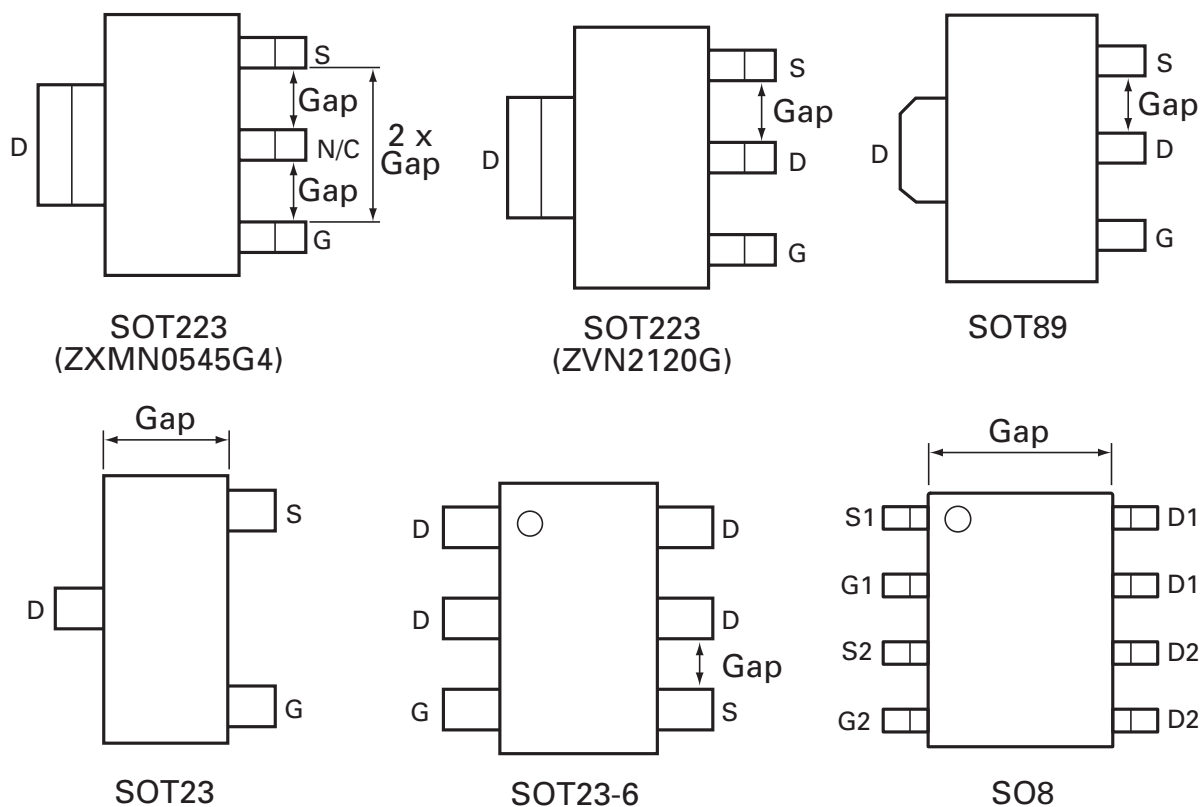


Figure 3 MOSFETS suitable for start up circuits

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The use of Zetex medium voltage bipolar transistors in switch mode power supplies

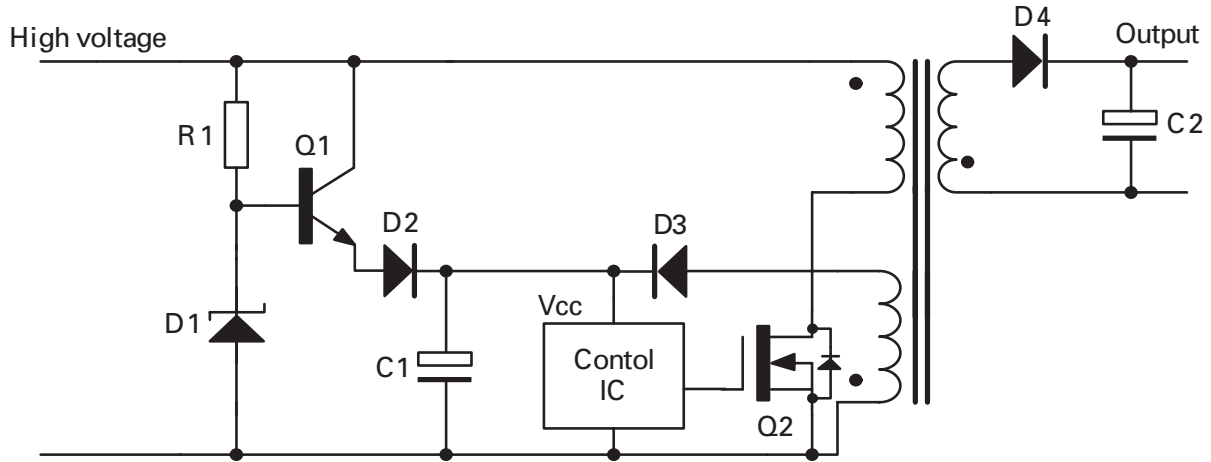


Figure 4 High voltage bipolar start up circuit

Operation

Figure 4 shows the Zetex bipolar start up circuit where the bipolar Q1 is biased on by a low current in R1 to form a resistive pass element. C1 charges up to the point where the control IC becomes active. The maximum value of V_{CC} in this phase is limited by Zener voltage D1 minus V_{BE} of Q1 and the V_F of D2.

Once the control IC becomes active drive pulses are issued to Q2 to form normal switching action in the transformer and power is now fed to the control IC via D3. It is therefore important for the designer to choose a value for D1 so that the supply via D2 is high is greater than D1 minus V_{BE} Q1 thus biasing off Q1 in normal operation.

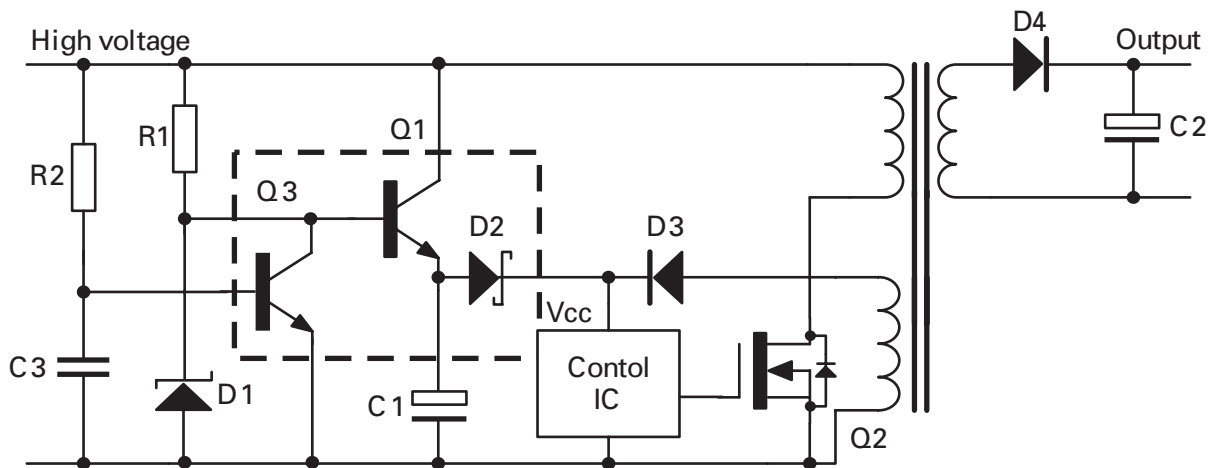


Figure 5 Improved high voltage bipolar start up circuit

In addition to the basic requirements fault protection may be added such that if the control IC supply can not be raised by the start up circuit a time out occurs to prevent excessive dissipation in the start up bipolar. By using a small outline Zetex transistor a simple circuit could be constructed as shown in Figure 5.

Figure 5 shows the same circuits with a time out function to prevent Q1 remaining on and over heating if the power supply can not start. Q3 is simply turned on after a delay from the time constant of R2 and C3. This circuit provides additional protection under all operating conditions and allows the use of smaller devices than if constant on time of Q1 had to be designed for.

Zetex manufactures a range of medium voltage bipolar transistors suitable for use in this application contained in small outline packages.

Table 2 Examples of bipolar transistors suitable for start up circuits

Device	Applications	Type	Package	V _{CEO} (V)	I _C (mA)	I _{CPulse} (mA)	P _D (W) ^(*)
FMMT459	Telecoms	Bipolar	SOT23	500	150	50	0.625
FZT493	Line voltage	Bipolar	SOT223	100	1000	2000	2

NOTES:

(*) Based on 25 x 25mm FR4 board

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Notes:

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