

Application Note

Home Appliances and Metering

More and more home appliances are now using electronics to make them more efficient and to give them extra control features. In the past, these features would be limited to timers or simple heating controls. In 2009, these systems become more complex and the home becomes more intelligent. The drive for more efficiency and convenience is also behind the exploding market for electronic energy metering.

Organizations such as KNX develop protocols so that home appliances can communicate with each other using various standards. Other organizations focus upon wireless standards or communications via the mains.

The range of applications is now very wide and includes:

- smart metering
- control panels of washing machines, refrigerators etc...
- lighting controls of buildings
- heating controls
- support of the elderly
- connecting all the video/audio devices in the home
- luxury applications

and many more. Daily new applications are announced.

From a power management perspective, these products have one thing in common: they are low power applications. Future demands on energy efficiency and standby energy will eliminate linear power supplies. Also capacitive and resistive power supplies will no longer be allowed. So the market will be focused on small cost efficient 2-20W switched mode power supplies, built with a circuit as shown in Fig. 1. Diotec Semiconductor has a competitive product range for these SMPS products.

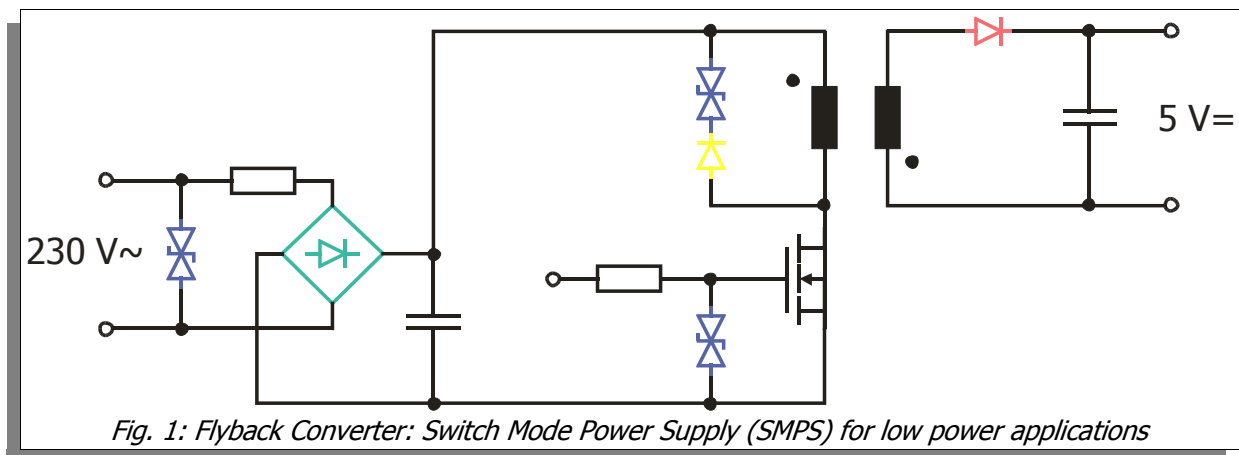
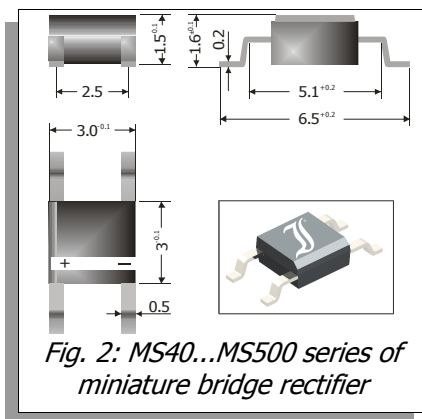


Fig. 1: Flyback Converter: Switch Mode Power Supply (SMPS) for low power applications

Input Rectifier

On the input bridge, we propose our new bridge rectifiers. For those lower power products, the MS series is optimal. Diotec optimized the cost of the 0.5A Bridge and eliminated all excess materials, see Fig. 2.



The product uses all the Diotec unique Quattro Chip construction.

Unlike bridge rectifiers from other suppliers, Diotec can easily make 800V and 1000V Bridge rectifiers. This feature is useful when the appliance is charged in the bathroom of a hotel room (uncontrolled transformer means voltages can be higher than the 240VAC mains) or in metering when the mains voltage increases.

Diotec obviously has a complete range of input rectifiers; we would like to specially highlight the GL34 / GL1 series and our 2A bridges.

The GL34 / GL1 series comes in a 3.5mm miniMELF and is produced with voltages up to 1000V. They can reduce space in applications that do not require full wave rectification.

The B250S2A series is an input rectifier bridge specified at 2.3A. This power may not be needed for home appliances, but some applications especially in metering need to work in a rugged environment and the 65A / 10ms half sine wave surge current of this bridge is an interesting feature.

Overview:

Diotec Bridge rectifiers

0.5 to 2 A nominal current, 20 to 1000V reverse voltage

SMD: **MYS40...380**, **MS40...500**, **S40...500**, **B40...500S**, **B40...380FS** (Fast), **CS10...50S** (Schottky)

through hole: **B40...500D**, **B40...380FD** (Fast recovery), **CS10...50D** (Schottky), **B40...500R** (round)

Diotec Single rectifiers

0.5 to 3 A nominal current, 50 to 2000V reverse voltage

SMD: **GL34...**, **GL1...**, **SM4001...7**, **SM5059...63**, **SM5400...08**, **S1...**, **S2...**, **S3...**


through hole: **1N4001...7**, **1N5391...99**, **1N5400K...08K**, **1N5400...08**, **BY251...55**

The Bridge and SMD products of Diotec use our proprietary Plasma EPOS passivation process. Some control circuits historically are very cost driven and use a cost efficient PCB material. They will not use SMD components. Diotec semiconductor still has the B250D series of through hole bridges for these applications.

Another product used quite often in this market is the 1N4007. These products are manufactured using an open junction silastic passivated technology. Whereas the quality of this component has improved over the years and customers may find the ppm ration acceptable, the reliability associated with Open Junction technology still remains poor. As such customers offering e.g. a 3 year warranty should be careful designing with these products and a Plasma EPOS device is recommended in the case of warranty.


Another advantage of Plasma EPOS process is that it allows Diotec semiconductor to build high voltage devices with on chip passivation.

A lot of electrical metering is done in a 3-phase environment. Two bridge rectifiers in parallel are needed because the neutral rectification is needed. 1000V in this circuit is marginal (when performing burst surge testing e.g.) so a 1200V SMA or MELF diode may help in these circuits. Also in industrial metering environments, new high power motors and robots operate off 690Vac. So the 2000V maximum limit of the Plasma EPOS process can be beneficial.



Plasma-EPOS

- ☺ *electrical passivation by Si_3N_4*
- ☺ *mechanical protection by *polysiloxane**
- ☺ *dry plasma etching*
- ☺ *environment friendly:*
no chemicals/solvents/detergents!



A general drawing included in this Application Note is that of a Flyback converter. This is the most common topology used in appliances but certainly not the only one.

In 2W or very low power products, sometimes full wave rectification is replaced by half wave rectification. Sometimes there is no need for electrical isolation. Also resonant converter designs are sometimes used. Some products require negative voltages to drive the display.

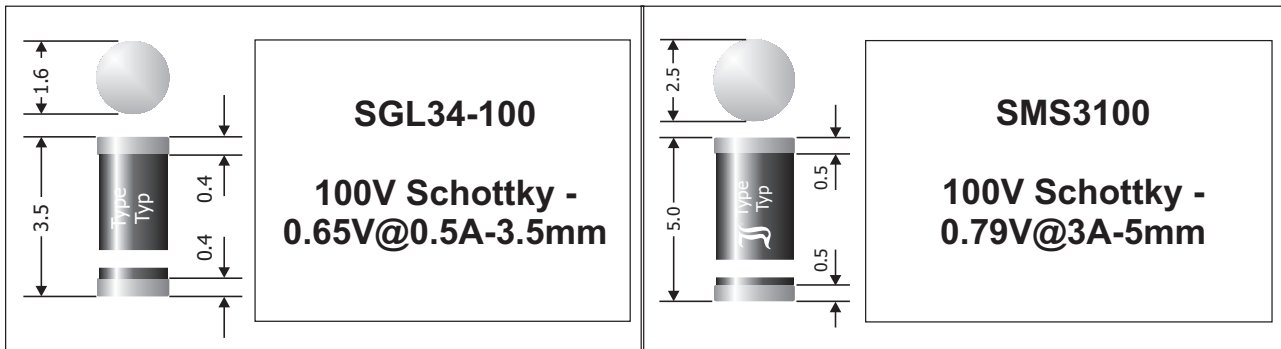
Output Rectifier

The output rectifiers used are quite similar on all topologies. The switching frequency of the main switch requires the usage of either Schottky or Fast Efficient rectifiers. The highest output voltage is usually for the display in the 15-20V range. These power supplies are typically handled by 200V Ultrafast recovery products. Typical partnames would be the US1, US2 and US3 series in SMD and the UF4003/4 and UF540x in axial packages.

A lot of designs require a 12V output. Here the Ultrafast recovery products above compete with 100V Schottky. The 100V Schottky parts offer a better efficiency but tend to be higher priced. Schottky rectifiers are off course always used on the 5V output rails.

One can use a number of industry standard Schottky rectifiers such as the SGL1, SK14, SK24 and SK34 depending on the current. To improve efficiency in home appliances, Diodec has a range of Schottky rectifiers such as the SMS2, SMS3, SK3xSMA, SK5x and SK8x which offer improved Vf specifications or better efficiency in a smaller packages. This may help your design.

Two examples would be:



Snubber

Most products use an integrated PWM/Transistor combination, available from many manufacturers in the market. They use different processes with different avalanche capability. This determines the complexity of the snubber. Apart from the active clamps drawn in the circuit, also RCD clamps are quite popular.

Overview Diodec TVS-/Fast-Diodes

TGL34-..., TGL41-..., P4SMA..., P6SMB..., 1.5SMC...; (150 bis 1500 W peak; up to 550 V!)

RGL34..., RGL1..., SA154...160, FR1..., FR2..., FR3...; (0.5 to 3 A)

Protection

Smart appliances now communicate with each other. When the networking is done using a wired datacommunication line, they will need protection as per the EN61000-4-x norms for the CE sign. Protection is needed against ESD, EFT and Lightning and in general Transient Voltage Suppressors are used. The product range from Diodec includes the BZW04, BZW06, P4KE, P6KE series and the TGL41, P4SMA and P6SMB series of SMD TVS diodes.

In general, for higher voltage datalines 600W TVS diodes are used, whereas 400W TVS diodes are more competitive on lower voltage datalines. In environments exposed to a lot of spikes, the ZY and ZPY series of higher power zeners are more robust than pressure contact small signal zeners.