

Application Note

Home Appliances and Smart 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. Nowadays, 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. The name smart meters can cover a broad variety of applications, from electricity meters to gas meters to water meters. The common advantage is that they eliminate reading of the meters and allow automatic transfer of the data.

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. Diodec Semiconductor has a competitive product range for these SMPS products.

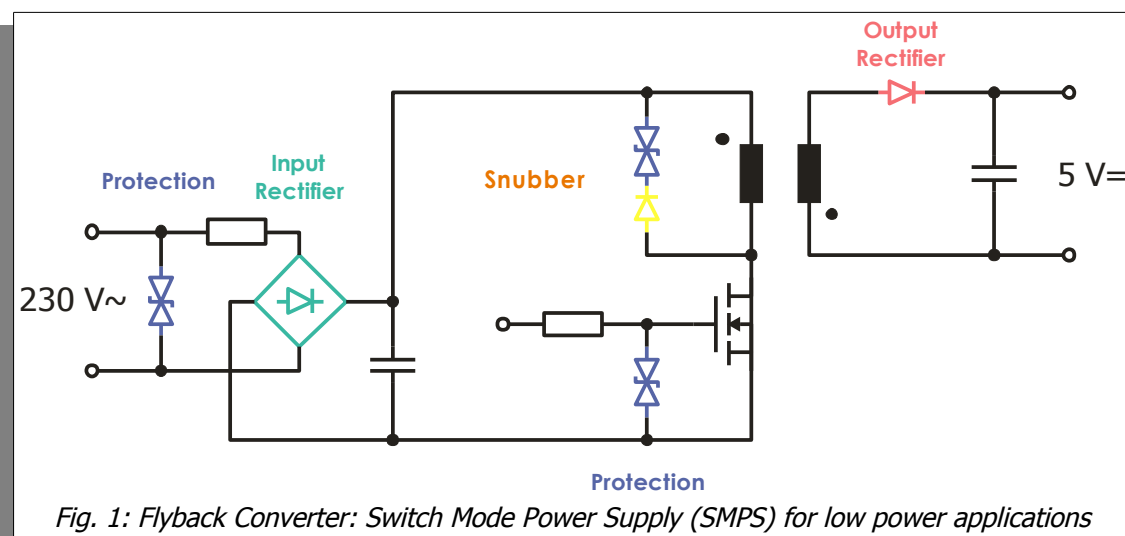
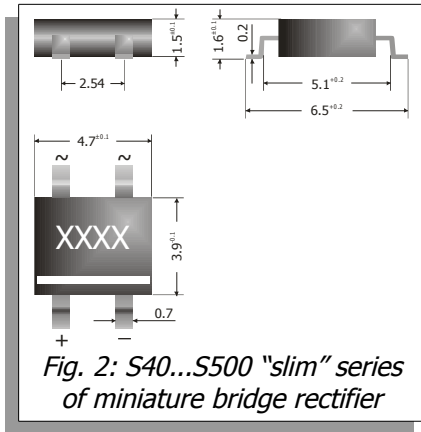


Fig. 1: Flyback Converter: Switch Mode Power Supply (SMPS) for low power applications

Input Rectifier

On the input bridge, we propose our new bridge rectifiers. For those lower power products, the Sxxx-SLIM series is optimal. Diotec optimized the cost of the 0.8A Bridge and offers it in a low profile package, see Fig. 2.



The product uses all the Diotec unique Quattrochip 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 240V_{AC} 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 (Mini)MELF series and our new "Protectifier[®]" bridges:

The GL1/AL1 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 AL1 are tested for controlled avalanche, which provides extra support in this area.

The SM400x/SM5xx/SM2000 series in 5mm MELF offers up to 2000V of reverse voltage and a forward surge current capability of 40A at 10ms pulses.

The S250K series is a "Protectifier[®]" bridge specified at 1A with high reverse robustness. Some applications especially in metering need to work in a rugged environment and the 75A / 1000 μ s forward surge current of this bridge is an interesting feature. It can be used at up to 280V_{AC} mains.

Diotec Bridge Rectifiers ¹⁾

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

SMD: MYS40...MYS380, **S40...S500**, **S125K...S250K**, B40...B500S, B40...B500S15A; B40...380FS (Fast), CS10...50S (Schottky)

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

Diotec Single Rectifiers ¹⁾

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

SMD: GL1A...M, **AL1A...M**, SL1A...M, SM4001...7, **SM513...SM2000**, SM5059...5063, SM5400...5408, **S1A...Y**, S2A...S2Y, S3A...S3Y

through hole: 1N4001...7, **EM513...518**, 1N5391...99, 1N5400K...08K, 1N5400...08, **BY251...55**, **BY1600...2000**

1 Preferred types are printed **bold**


Home Appliances and Smart Metering

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 690V_{AC}. So the 2000V maximum limit of the Plasma EPOS process can be beneficial.



Plasma-EPOS

by  **Diotec**
Semiconductor

- ☺ *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 of 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, Diotec has a range of Schottky rectifiers such as the SMS2, SMS3, SK3xSMA, SK5x and SK8x which offer improved V_F specifications or better efficiency in a smaller packages. This may help your design.

Snubber

There are many smart metering ICs on the market and system requirements may vary between the different IC vendors. However the auxiliary supply usually will have a snubber to protect the MOSFET or other switching element. Typical components would be the P6KE TVS or 2W ZY zener series as axial diodes in the 150-200V range (on a 230/240V_{AC} mains) combined with the UF4005-7. The surface mount equivalents would be the SMB TVS products with the EAL1/US1/ES1 series.

Overview Diotec TVS-/Fast-/Ultrafast-Diodes ¹⁾

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

RGL1A...M, **RAL1A...M**, SA154...160, FR1A...M, FR2A...M, FR3A...M; (0.5 to 3 A);

EGL1A...M, **EAL1A...M**, **SUF4001...7**, **US1A...M**, US2A...M, US3A...M; **ES1A...J**, ES2A...J, ES3A...J; (**0.5 to 3 A**);

Protection

Smart appliances now communicate with each other. When the networking is done using a wired data-communication 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 Diotec includes the BZW04, BZW06, P4KE, P6KE series and the TGL41, P4SMA and P6SMB series of SMD TVS diodes.

In general, for higher voltage data-lines 600W TVS diodes are used, whereas 400W TVS diodes are more competitive on lower voltage data-lines. 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.

1 Preferred types are printed **bold**