Power Supply

- Input & Output Rectifier
  - HV Rectifier Avalanche Rectifier
  - Schottky Diodes
- Snubber/Protection
  - Ultrafast Diodes
  - TVS Diodes

Main Circuit Board

- Control & Protection
  - Small Signal Diodes and Transistors
  - Adjustable Voltage Regulator
  - Zener and ESD-Protection Diodes
  - CLD (Constant Current Regulator)

Power Supply

Input Rectification

HV Rectifier and Avalanche Diodes

Part no	Package	I_{FAV}	V_{RRM}	E_{RSM}
S1W ... S2Y	DO-214AB/SMA	1 A	1600 ... 2000 V	N/A
S2W ... S2Y	DO-214AB/SMB	2 A	1600 ... 2000 V	N/A
SM516 .... SM2000	DO-213AB/ Melf	1 A	1600 ... 2000 V	N/A
AM2000 [1]) ***NEW***	DO-213AB/ Melf	1 A	1600 V	20 mJ

See also notes on page 4 and 5

Output Rectification

Schottky Diodes

Part no	Package	I_{FAV}	V_{RRM}
SDB13HS, SDB14HS	SOD-323	1 A	30 ... 40 V
SKL14 ... SKL110	SOD-123F	1 A	40 ... 100 V
SK14 ... SK115	SMA	1 A	40 ... 150 V
SK34 ... SK315SMA	SMA	3 A	40 ... 150 V

Snubber/Protection

TVS Diodes

Part no	Package	P_{PPM}	V_{WM}	V_{BR}
TGL34-...	DO-213AA/MiniMelf	150 W	5.5 ... 171 V	6.8 ... 200 V
SMF...	SOD-123F	200 W	5.0 ... 220 V	6.8 ... 260 V
TGL41-...	DO-213AB/Melf	400 W	5.5 ... 423 V	6.8 ... 520 V
P4SMA...	DO-214AC/SMA	400 W	5.0 ... 495 V	6.8 ... 550 V
P6SMB...	DO-214AA/SMB	600 W	5.0 ... 495 V	6.8 ... 550 V
1.5SMC...	DO-214AB/SMC	1500 W	5.0 ... 495 V	6.8 ... 550 V

Ultrafast Diodes

Part no	Package	I_{FAV}	V_{RRM}	E_{RSM}
EGL1G ... EGL1M	DO-213AA/MiniMelf	1 A	400 ... 1000 V	N/A
EAL1G ... EAL1M [1])	DO-213AA/MiniMelf	1 A	400 ... 1000 V	20 mJ
USL1G ... USL1M	SOD-123F	1 A	400 ... 1000 V	N/A
SUF4004 ... SUF4007	DO-213AB/Melf	1 A	400 ... 1000 V	N/A
US1G ... US1M	DO-214AC/SMA	1 A	400 ... 1000 V	N/A
US3G ... US3M	DO-214AB/SMC	3 A	400 ... 1000 V	N/A

TVS and Ultrafast in ***a single package!***

Part no	Package	P_{PPM}	V_R	V_{BR}
TGL200U06	DO-213AB/Melf (SMD)	300 W	600 V	200 V
PKC-136 ***NEW***	DO-15 (axial lead)	600 W	700 V	160 V

[1] Avalanche rated

Main Circuit Board

Control & Protection

Small Signal Diodes

Part no	Package	I_{FAV}	V_{RRM}
1N4148WS	SOD-323	150 mA	100 V
BAV99	SOT-23	215 mA	85 V

Small Signal Transistors

Part no	Package	I_C	V_{CEO}
MMBT2222A	SOT-23	600 mA	40 V
BC846C	SOT-23	100 mA	65 V
BC846CW	SOT-323	100 mA	65 V

Zener Diodes

Part no	Package	P_{tot}	V_Z
MM3Z...	SOD-323	300 mW	2.4 ... 47 V
ZMC...	Micro Melf	500 mW	2.4 ... 75 V
BZT52...	SOD-123	500 mW	2.4 ... 75 V
ZMM...	SOD-80C	500 mW	2.4 ... 75 V

CLD (Constant Current Regulator)

Part no	Package	I_{Pnom}	V_{AK}
CL15 ... 40MD [2]) ***NEW***	DO-213AA/MiniMelf	15 ... 40 mA	90 V
CL15 ... 40M35	DO-214AC/SMA	15 ... 40 mA	90 V

ESD Protection

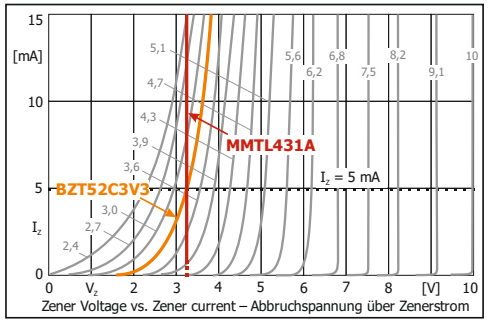
Part no	Package	P_{PPM}	V_{WM}
ESD3Z...	SOD-323	350 W	5, 12 V
ESD5Z...	SOD-523	158 ... 240 W	3.3 ... 12 V

Schottky Diodes

Part no	Package	I_{FAV}	V_{RRM}
BAT54A	SOT-23	200 mA	30 V
BAS40-05	SOT-23	200 mA	40 V

Adjustable Precision Shunt Regulator

Part no	Package	I_K	V_O
MMTL431A [2]) ***NEW***	SOT-23	1 ... 100 mA	2.5 ... 36 V



Comparison between a low voltage Zener diode BZT52C3V3 and the MMTL431A adjusted to 3.3V: The shunt regulator shows a mostly perfect linearity with very tight tolerance and low temperature dependence.

[2] Under development

Considerations on the 3~ Input Stage

The 3~ mains voltage a smart meter is connected to can have values of up to 500 V_{RMS}, see Fig 1: *Typical worldwide mains voltages*. This corresponds to a peak voltage V_{PK} of 707 V.

Overlaid surges can lead to much higher voltages V_{PK} than the √2 value of V_{RMS}, as shown in the picture. Table 1: *Comparison of input rectifiers* shows two possible cases:

a) Slow but high energetic surges. A typically used 510 V_{RMS} varistor will clamp such transients to less than 1355 V (refer to industry standard varistor specs).

b) Very fast transients with less energy. Varistors are rather slow, so the transient can reach the rectifier diode and cause (pre-) damages. Solutions are here either standard rectifier having 2000 V of V_{RRM}, or Avalanche rectifier.

The controlled avalanche breakdown must be as low as possible in order to reduce avalanche energy and thus reliability. A device having 1600 V of V_{RRM} is a good compromise for the needs of Smart Meters: Above the 1355 V varistor clamping voltage and well below 2000 V for low avalanche energies.

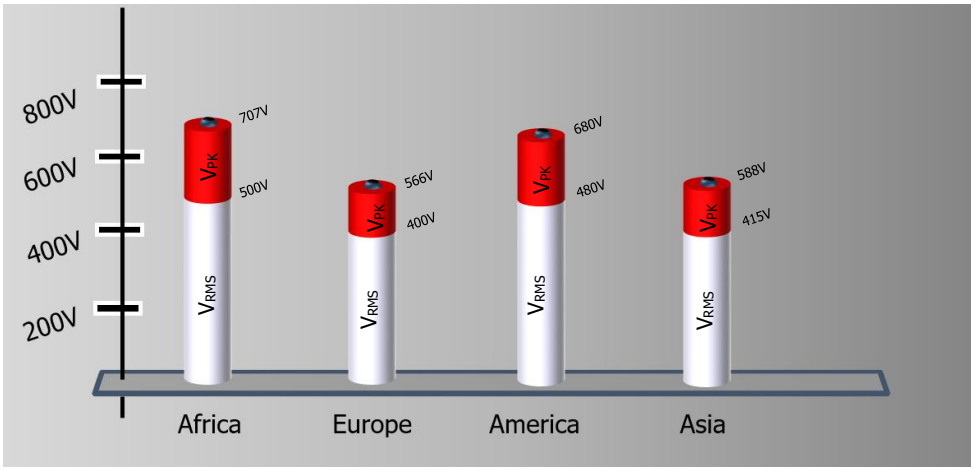
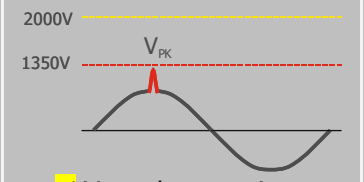
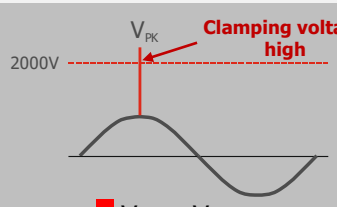
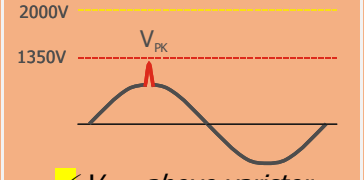
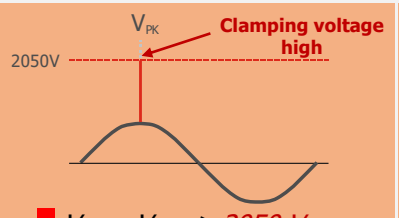
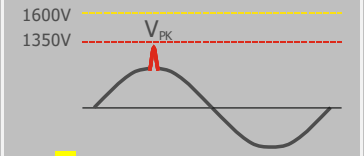
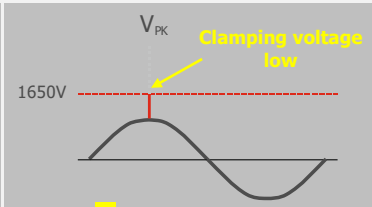


Fig 1: Typical worldwide mains voltages (non-industrial)

Table 1: Comparison of input rectifiers

Device Type	Features	**Case a)** Slow/high energetic transient	**Case b)** Very fast/low energetic spike	Judgement
SM2000 (HV Rectifier)	V_{RRM} = **2000 V**	 ✓ V_{RRM} above varistor clamping voltage	 ✗ $V_{PK} \geq V_{RRM}$ **Risk of device damage!**	+ Lower cost – Requires additional protection
Hypothetical Device (HV Avalanche Rectifier)	*V_{RRM} = **2000 V*** *$V_{RSM} \geq 2050$ V* ***Avalanche** rated*	 ✓ *V_{RRM} above varistor clamping voltage*	 ✗ *$V_{PK} = V_{RSM} \geq 2050$ V* *$E_{RSM} \propto V_{RSM}$ high!* ***Risk of device damage!***	*– Very high cost* *– Requires additional protection* ***Not recommended!***
AM2000 (Avalanche Rectifier)	V_{RRM} = 1600 V $V_{RSM} \geq$ 1650 V **Avalanche** rated	 ✓ V_{RRM} above varistor clamping voltage	 ✓ $V_{PK} = V_{RSM} \geq$ 1650 V $E_{RSM} \propto V_{RSM}$ low! **Improved reliability!**	– Higher cost + Better reliability

Disclaimer

This application note describes device proposals and shall not be considered as assured and proven solution for any circuit.
No warranty or guarantee, expressed or implied is made regarding the capacity, performance or suitability of any device, circuit etc.