EPCOS Product Brief 2014

# Protection Devices for On-Board Chargers


www.epcos.com

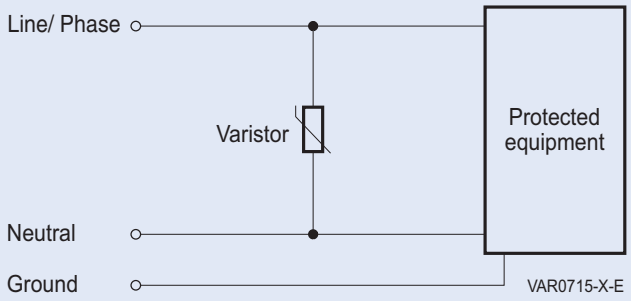
# Protection Devices for On-Board Chargers

The batteries of electric and hybrid vehicles can be charged either at public charging points or at home using home charge devices (wall box).

For this purpose, electric and hybrid vehicles are equipped with an on-board charger (OBC). The electronics of the OBC controls and monitors the process of charging the battery. Overvoltages can occur during charging which can damage or destroy the electronics of the OBC.

Varistors (Figure 1) or a combination of varistors and surge arresters are used (Figure 2 circuit 2 x varistor and 1 x surge arrester) to protect the OBC against such overvoltages.

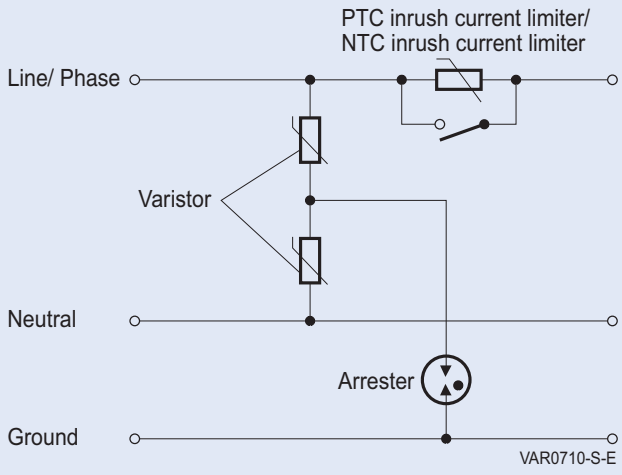
**Figure 1 Overvoltage protection concept with varistors (line to line protection)**




The SNF14 and SNF20 series of disk varistors were the first varistors worldwide to be developed specifically for overvoltage protection in 110/ 230 V AC networks and that are able to satisfy the tough requirements of the AEC-Q200, Rev. D standard, which is widely used in the automotive industry.

The SNF automotive product series features varistors with disk diameters of 14 mm and 20 mm in the voltage range of 275 V AC to 625 V AC. These disk varistors are suitable for use in both AC and DC applications.

**Figure 2 Overvoltage protection concept with varistors and surge arresters (line to line and line to ground protection)**





For further information please contact your EPCOS sales office.

# SIOV Metal Oxide Varistors, SNF14

## Leaded Varistors, AdvanceD Series

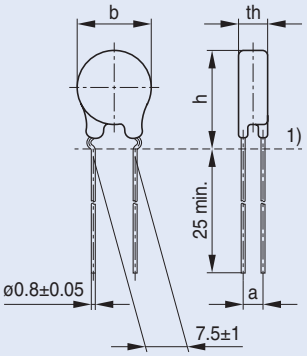
## Electrical specification and ordering codes

| Ordering code | Maximum ratings ($T_a$ = 125 °C) | | | | | Characteristics ($T_a$ = 25 °C) | | | | Approvals | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_{RMS}$ V | $V_{DC}$ V | $I_{max}$ (8/20) 1 time A | $W_{max}$ (2 ms) 1 time J | $P_{max}$ W | $V_V$ (1 mA) V $\Delta V_V$ | $v_{c,max}$ ($i_c$) V | $i_c$ A | $C_{typ}$ (1 kHz) pF | UL 1449 | AEC-Q200, Rev. D |
| B72214X2131K501 | 130 | 170 | 6000 | 50 | 0.6 | 205 ±10% | 340 | 50 | 880 | ● | ● |
| B72214X2141K501 | 140 | 180 | 6000 | 55 | 0.6 | 220 ±10% | 360 | 50 | 820 | ● | ● |
| B72214X2151K501 | 150 | 200 | 6000 | 60 | 0.6 | 240 ±10% | 395 | 50 | 750 | ● | ● |
| B72214X2171K501 | 175 | 225 | 6000 | 70 | 0.6 | 270 ±10% | 455 | 50 | 670 | ● | ● |
| B72214X2211K501 | 210 | 270 | 6000 | 80 | 0.6 | 330 ±10% | 545 | 50 | 580 | ● | ● |
| B72214X2231K501 | 230 | 300 | 6000 | 90 | 0.6 | 360 ±10% | 595 | 50 | 530 | ● | ● |
| B72214X2251K501 | 250 | 320 | 6000 | 100 | 0.6 | 390 ±10% | 650 | 50 | 490 | ● | ● |
| B72214X2271K501 | 275 | 350 | 6000 | 110 | 0.6 | 430 ±10% | 710 | 50 | 440 | ● | ● |
| B72214X2301K501 | 300 | 385 | 6000 | 125 | 0.6 | 470 ±10% | 775 | 50 | 400 | ● | ● |
| B72214X2321K501 | 320 | 420 | 6000 | 136 | 0.6 | 510 ±10% | 840 | 50 | 370 | ● | ● |
| B72214X2351K501 | 350 | 460 | 5000 | 136 | 0.6 | 560 ±10% | 910 | 50 | 340 | ● | ● |
| B72214X2381K501 | 385 | 505 | 5000 | 136 | 0.6 | 620 ±10% | 1025 | 50 | 315 | ● | ● |
| B72214X2421K501 | 420 | 560 | 5000 | 136 | 0.6 | 680 ±10% | 1120 | 50 | 290 | ● | ● |
| B72214X2461K501 | 460 | 615 | 5000 | 150 | 0.6 | 750 ±10% | 1240 | 50 | 260 | ● | ● |
| B72214X2511K501 | 510 | 670 | 5000 | 165 | 0.6 | 820 ±10% | 1355 | 50 | 240 | ● | ● |
| B72214X2551K501 | 550 | 745 | 5000 | 180 | 0.6 | 910 ±10% | 1500 | 50 | 215 | ● | ● |

Operating temperature for all types: –40/+125 °C

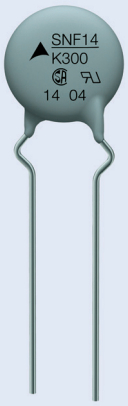
## Dimensional drawing

| Ordering code | Type SIOV- | $b_{max}$ mm | $h_{max}$ mm | $th_{max}$ mm | a±1 mm |
|---|---|---|---|---|---|
| B72214X2131K501 | SNF14K130E2S5 | 17.5 | 23.0 | 7.6 | 1.9 |
| B72214X2141K501 | SNF14K140E2S5 | 17.5 | 23.0 | 7.7 | 2.0 |
| B72214X2151K501 | SNF14K150E2S5 | 17.5 | 23.0 | 7.8 | 2.1 |
| B72214X2171K501 | SNF14K175E2S5 | 17.5 | 23.0 | 7.9 | 2.2 |
| B72214X2211K501 | SNF14K210E2S5 | 17.5 | 23.0 | 8.0 | 1.9 |
| B72214X2231K501 | SNF14K230E2S5 | 17.5 | 23.0 | 8.1 | 2.0 |
| B72214X2251K501 | SNF14K250E2S5 | 17.5 | 23.0 | 8.2 | 2.1 |
| B72214X2271K501 | SNF14K275E2S5 | 17.5 | 23.0 | 8.4 | 2.2 |
| B72214X2301K501 | SNF14K300E2S5 | 17.5 | 23.0 | 8.6 | 2.3 |
| B72214X2321K501 | SNF14K320E2S5 | 17.5 | 23.5 | 8.8 | 2.4 |
| B72214X2351K501 | SNF14K350E2S5 | 17.5 | 23.5 | 9.5 | 2.9 |
| B72214X2381K501 | SNF14K385E2S5 | 17.5 | 23.5 | 10.1 | 3.4 |
| B72214X2421K501 | SNF14K420E2S5 | 17.5 | 23.5 | 10.5 | 3.6 |
| B72214X2461K501 | SNF14K460E2S5 | 17.5 | 23.5 | 10.8 | 3.8 |
| B72214X2511K501 | SNF14K510E2S5 | 17.5 | 23.5 | 11.1 | 4.0 |
| B72214X2551K501 | SNF14K550E2S5 | 17.5 | 23.5 | 11.5 | 4.7 |




1) Seating plane to IEC 60717

VAR0713-V-E



# SIOV Metal Oxide Varistors, SNF20

## Leaded Varistors, AdvanceD Series

EPCOS

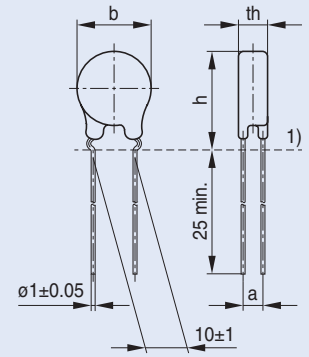
### Electrical specification and ordering codes

| Ordering code | Maximum ratings ($T_a$ = 125 °C) | | | | | Characteristics ($T_a$ = 25 °C) | | | | Approvals | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_{RMS}$ | $V_{DC}$ | $I_{max}$ (8/20) 1 time | $W_{max}$ (2 ms) 1 time | $P_{max}$ | $V_V$ (1 mA) | $v_{c,max}$ ($i_c$) | $i_c$ | $C_{typ}$ (1 kHz) | UL 1449 | AEC-Q200, Rev. D |
| | V | V | A | J | W | V $\Delta V_V$ | V | A | pF | | |
| B72220X2131K501 | 130 | 170 | 10000 | 100 | 1 | 205 ±10% | 340 | 100 | 1850 | ● | ● |
| B72220X2141K501 | 140 | 180 | 10000 | 110 | 1 | 220 ±10% | 360 | 100 | 1700 | ● | ● |
| B72220X2151K501 | 150 | 200 | 10000 | 120 | 1 | 240 ±10% | 395 | 100 | 1550 | ● | ● |
| B72220X2171K501 | 175 | 225 | 10000 | 135 | 1 | 270 ±10% | 455 | 100 | 1350 | ● | ● |
| B72220X2211K501 | 210 | 270 | 10000 | 160 | 1 | 330 ±10% | 545 | 100 | 1100 | ● | ● |
| B72220X2231K501 | 230 | 300 | 10000 | 180 | 1 | 360 ±10% | 595 | 100 | 1000 | ● | ● |
| B72220X2251K501 | 250 | 320 | 10000 | 195 | 1 | 390 ±10% | 650 | 100 | 940 | ● | ● |
| B72220X2271K501 | 275 | 350 | 10000 | 215 | 1 | 430 ±10% | 710 | 100 | 850 | ● | ● |
| B72220X2301K501 | 300 | 385 | 10000 | 250 | 1 | 470 ±10% | 775 | 100 | 780 | ● | ● |
| B72220X2321K501 | 320 | 420 | 10000 | 273 | 1 | 510 ±10% | 840 | 100 | 720 | ● | ● |
| B72220X2381K501 | 385 | 505 | 10000 | 273 | 1 | 620 ±10% | 1025 | 100 | 600 | ● | ● |
| B72220X2421K501 | 420 | 560 | 10000 | 273 | 1 | 680 ±10% | 1120 | 100 | 550 | ● | ● |

Operating temperature for all types: –40/+125 °C

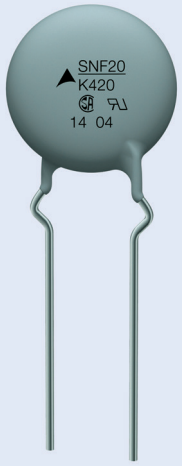
### Dimensional drawing

| Ordering code | Type SIOV- | $b_{max}$ mm | $h_{max}$ mm | $th_{max}$ mm | a±1 mm |
|---|---|---|---|---|---|
| B72220X2131K501 | SNF20K130E2S5 | 23.5 | 30.0 | 8.0 | 2.0 |
| B72220X2141K501 | SNF20K140E2S5 | 23.5 | 30.0 | 8.1 | 2.1 |
| B72220X2151K501 | SNF20K150E2S5 | 23.5 | 30.0 | 8.2 | 2.2 |
| B72220X2171K501 | SNF20K175E2S5 | 23.5 | 30.0 | 8.3 | 2.3 |
| B72220X2211K501 | SNF20K210E2S5 | 23.5 | 30.0 | 8.4 | 2.2 |
| B72220X2231K501 | SNF20K230E2S5 | 23.5 | 30.0 | 8.5 | 2.3 |
| B72220X2251K501 | SNF20K250E2S5 | 23.5 | 30.0 | 8.7 | 2.4 |
| B72220X2271K501 | SNF20K275E2S5 | 23.5 | 30.0 | 8.8 | 2.6 |
| B72220X2301K501 | SNF20K300E2S5 | 23.5 | 30.0 | 9.1 | 2.8 |
| B72220X2321K501 | SNF20K320E2S5 | 23.5 | 30.0 | 9.2 | 2.9 |
| B72220X2381K501 | SNF20K385E2S5 | 23.5 | 30.5 | 10.6 | 3.9 |
| B72220X2421K501 | SNF20K420E2S5 | 23.5 | 30.5 | 10.9 | 4.2 |




1) Seating plane to IEC 60717

VAR0714-W-E






For further information please contact your EPCOS sales office.

# 2-Electrode Arresters

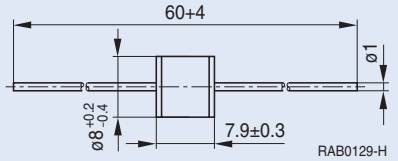
For gas-filled surge arresters, we recommend the use of types from the A71* or EHV6* series.
The surge arresters of the A71* or EHV6* series are available with rated DC spark-over voltages ranging from 800 V to 5500 V or from 800 V to 4500 V.
With the use of surge arresters in series with varistors the leakage current can be reduced to an absolute minimum.

## Medium-duty/ High-voltage types – A71-H**X
## 10 kA/ 10 A ● ø 8 × 8 mm

### Electrical specification and ordering codes

| **Type**<br>Ordering code | **A71-H08X**<br>B88069X2140S102 | **A71-H25X**<br>B88069X2190S102 | **A71-H35X**<br>B88069X2200S102 | |
|---|---|---|---|---|
| **Nom. DC spark-over voltage $V_{sdcN}$** | 800 | 2500 | 3500 | V |
| **Impulse spark-over voltage @ 1 kV/µs** | < 1100 | < 3900 | < 4900 | V |
| **Maximum current @ 8/20 µs** | 15 | 15 | 15 | kA |
| **Service life 10 operations 8/20 µs** | 10 | 10 | 10 | kA |
| **Insulation resistance $R_{ins}$** | > 10 | > 10 | > 10 | GΩ |
| **Capacitance @ 1 MHz** | < 1 | < 1 | < 1 | pF |
| **UL 1449 approval** | ● | ● | ● | |

### Dimensional drawing

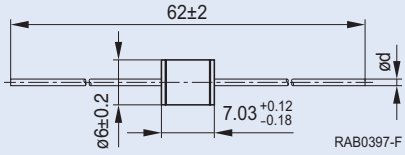



## Light-duty/ High-voltage types – EHV63-H**
## 3 kA ● ø 6 × 7 mm

### Electrical specification and ordering codes

| **Type**<br>Ordering code | **EHV63-H08**<br>on request | **EHV63-H30**<br>B88069X2553... | **EHV63-H36**<br>B88069X3003... | |
|---|---|---|---|---|
| **Nom. DC spark-over voltage $V_{sdcN}$** | 800 | 3000 | 3600 | V |
| **Impulse spark-over voltage @ 1 kV/µs** | < 1000 | < 3500 | < 4300 | V |
| **Maximum current @ 8/20 µs** | 5 | 5 | 5 | kA |
| **Service life 3 operations 8/20 µs** | 3 | 3 | 3 | kA |
| **Service life 300 operations 8/20 µs** | 100 | 100 | 100 | A |
| **Insulation resistance $R_{ins}$ @ 100 V DC** | > 1 | > 1 | > 1 | GΩ |
| **Capacitance @ 1 MHz** | < 1 | < 1 | < 1 | pF |
| **UL 1449 approval** | ● | ● | ● | |

### Dimensional drawing




**Safety note:** Surge arresters must not be operated directly in power supply networks. The follow current must be limited so that the arrester can be properly extinguished when the surge has decayed.

# PTC Thermistors, Inrush Current Limiters

In addition to varistors and surge arresters designed to assure protection from overvoltages, on-board chargers also use other protection devices. PTC thermistors, for example, are used to limit inrush currents. Unlike fixed resistors, which are also widely used, PTC thermistors are characterized by being inherently safe in the event of a fault. In the case of constant overcurrents, e.g. a short circuit, PTC thermistors become highly resistive without suffering damage.

EPCOS

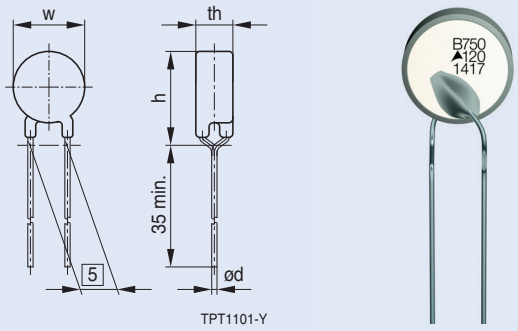
## Leaded disks, coated

### Electrical specifications and ordering codes

| Ordering code | Type | $V_{max}$ V AC | $V_{link,max}$ V DC | $R_R$ Ω | $\Delta R_R$ % | $T_{ref}$ (typ.) °C | $C_{th}$ J/K | $\tau_{th}$ s | Approvals | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | AEC-Q200, Rev. D |
| B59412C1130B070 | C1412 | 440 | 620 | 120 | ±25 | 130 | 2.1 | 100 | – | ● |
| B59451C1130B070 | C1451 | 440 | 620 | 56 | ±25 | 130 | 2.1 | 100 | – | ● |
| B59750C0120A070 | C750 | 260 | 360 | 25 | ±25 | 115 | 1.0 | 100 | ● | – |
| B59751C0120A070 | C751 | 260 | 360 | 50 | ±25 | 115 | 1.4 | 120 | ● | – |
| B59755C0115A070 | C755 | 560 | 800 | 500 | ±25 | 110 | 1.4 | 120 | ● | – |

### Dimensional drawing

| Type | $w_{max}$ mm | $h_{max}$ mm | $th_{max}$ mm | ød mm |
|---|---|---|---|---|
| C1412 | 15.0 | 19.0 | 7.5 | 0.8 |
| C1451 | 15.0 | 19.0 | 7.5 | 0.8 |
| C750 | 12.5 | 16.5 | 5.0 | 0.6 |
| C751 | 12.5 | 16.5 | 7.0 | 0.6 |
| C755 | 12.5 | 16.5 | 7.0 | 0.6 |



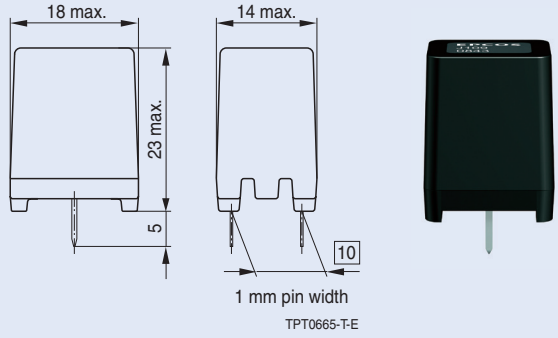

## PTC thermistors in phenolic resin plastic case

### Electrical specifications and ordering codes

| Ordering code | Type[1)] | $V_{max}$ V AC | $V_{link,max}$ V DC | $R_R$ Ω | $\Delta R_R$ % | $T_{ref}$ (typ.) °C |
|---|---|---|---|---|---|---|
| B59105J0130A020 | J105 | 260 | 360 | 22 | 25 | 130 |
| B59107J0130A020 | J107 | 440 | 620 | 56 | 25 | 130 |
| B59109J0130A020 | J109 | 560 | 800 | 100 | 25 | 130 |

A new product series of PTC thermistors is in preparation, which are packaged in a plastic case and are qualified to AEC-Q200, Rev. D.

### Dimensional drawing



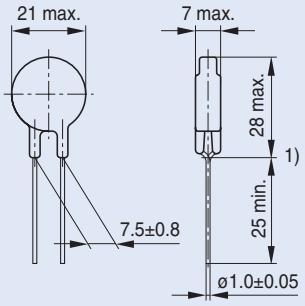
# NTC Thermistors, Inrush Current Limiters
## S364 Series

NTC inrush current limiters (NTC ICL) are another reliable solution for limiting inrush currents. They possess a high resistance at low temperatures (e.g. 25 °C), which limits the inrush currents. At higher powers, the NTC ICL is usually bridged with a relay or triac after the inrush current peaks have decayed. The NTC ICL must be selected so that it can carry the continuous current in the event that the relay is short-circuited.

### Electrical specifications and ordering codes

| Ordering code | $R_{25}$ Ω | $I_{max}$ (@ 0 … 60 °C) A | $I_{test}$ (@ 125 °C) A | $B_{25/100}$ K | $C_{test}$ (@ 110 V AC) µF | $C_{test}$ (@ 230 V AC) µF | Operating temperature min/max °C | Approval AEC-Q200, Rev. D |
|---|---|---|---|---|---|---|---|---|
| B57364S1109M000 | 1 | 16.0 | 4.6 | 2800 | 4000 | 1000 | –40/+125 | ● |
| B57364S1509M000 | 5 | 8.5 | 2.5 | 3060 | 4000 | 1000 | –40/+125 | ● |
| B57364S1100M000 | 10 | 7.5 | 2.2 | 3300 | 4000 | 1000 | –40/+125 | ● |

### Dimensional drawing




1) Seating plane to IEC 60717

ICL0041-F-E

# Symbols and Terms

| Symbol | Term |
|---|---|
| $B_{25/100}$ | B value determined by resistance measurement at 25 °C and 100 °C |
| $C_{test}$ | Test capacitance |
| $C_{typ}$ | Typical capacitance |
| $C_{th}$ | Heat capacitance |
| $i_c$ | Current at which $v_{c,max}$ is measured |
| $I_{max}$ | Maximum current |
| $I_{test}$ | Test current |
| $P_{max}$ | Maximum power |
| $R_R$ | Rated resistance |
| $\Delta R_R$ | Resistance tolerance |
| $R_{25}$ | Resistance at 25 °C |
| $T_{op}$ | Operating temperature |
| $T_{ref}$ | Reference temperature |
| $v_{c,max}$ | Maximum clamping voltage at specified current $i_c$ |
| $V_{clamp,max}$ | Maximum clamping voltage |
| $V_{DC}$ | DC voltage |
| $V_{link,max}$ | Maximum link voltage |
| $V_{max}$ | Maximum voltage |
| $V_{RMS}$ | AC operating voltage, root-mean-square value |
| $V_V$ | Varistor voltage |
| $W_{max}$ | Maximum energy absorption |
| $\tau_{th}$ | Thermal cooling time constant |

**Structure of ordering codes:** The ordering code for one and the same product can be represented differently in data sheets, data books, other publications and the website of EPCOS, or in order-related documents such as shipping notes, order confirmations and product labels. **The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products.** Detailed information can be found on the Internet under www.epcos.com/orderingcodes.



**© EPCOS AG** · A TDK Group Company
Edition 05/2014 · Ordering No. EPC:62022-7600 · Printed in Germany · PB 05142.