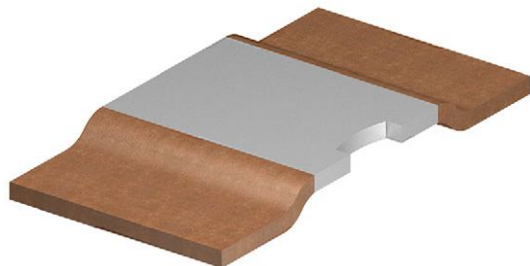




## Power Metal Strip® Resistors, Low Value (Down to 0.0001 Ω), Surface-Mount



### LINKS TO ADDITIONAL RESOURCES



### FEATURES

- All welded construction of the Power Metal Strip® resistors are ideal for all types of current sensing, voltage division and pulse applications
- Proprietary processing technique produces extremely low resistance values, down to 0.0001 Ω
- Sulfur resistance by construction that is unaffected by high sulfur environments
- Solid metal iron-chrome or manganese-copper alloy resistive element with low TCR (< 20 ppm/°C)
- Very low inductance 0.5 nH to 5 nH
- Low thermal EMF (< 3 μV/°C)
- AEC-Q200 qualified <sup>(1)</sup>
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

AUTOMOTIVE  
GRADERoHS  
COMPLIANTHALOGEN  
FREEGREEN  
(5-2008)

### Notes

- Follow link to Overview of Automotive Grade Products for more details: [www.vishay.com/doc?49924](http://www.vishay.com/doc?49924)
- “SMD Current Sense: AEC-Q200 vs. Vishay Qualification” technical note: [www.vishay.com/doc?30416](http://www.vishay.com/doc?30416)
- <sup>(1)</sup> Flame retardance test may not be applicable to some resistor technologies

### STANDARD ELECTRICAL SPECIFICATIONS

| GLOBAL MODEL | SIZE | POWER RATING<br>$P_{70^\circ\text{C}}$<br>W | TOLERANCE<br>% | RESISTANCE<br>VALUE RANGE<br>Ω | RESISTANCE VALUES<br>CURRENTLY AVAILABLE <sup>(1)</sup><br>Ω   | WEIGHT<br>(typical)<br>g/1000 pieces |
|--------------|------|---------------------------------------------|----------------|--------------------------------|----------------------------------------------------------------|--------------------------------------|
| WSL3921      | 3921 | 3.0                                         | 1.0, 5.0       | 0.1m to 4m                     | 0.1m, 0.2m, 0.3m, 0.4m, 0.5m, 0.7m, 1m, 1.5m, 2m, 2.5m, 3m, 4m | 281                                  |
| WSL5931      | 5931 | 5.0                                         | 1.0, 5.0       | 2m to 3m                       | 2m, 3m                                                         | 398                                  |
|              |      | 5.0                                         | 1.0, 5.0       | 0.1m to 1m                     | 0.1m, 0.2m, 0.3m, 0.5m, 1m                                     | 1253                                 |

### Notes

- “Thermal Management for Surface-Mount Devices” white paper: [www.vishay.com/doc?30380](http://www.vishay.com/doc?30380)
- <sup>(1)</sup> Other values may be available, contact factory

### GLOBAL PART NUMBER INFORMATION

Global Part Numbering: WSL3921L5000FEA (WSL3921, 0.0005 Ω, ± 1 %)

(visit [www.vishay.net](http://www.vishay.net) Vishay Dale parts numbering manual for all options)

|                            |   |   |   |   |   |   |                                               |   |                             |   |                                             |   |                                                                 |   |  |  |
|----------------------------|---|---|---|---|---|---|-----------------------------------------------|---|-----------------------------|---|---------------------------------------------|---|-----------------------------------------------------------------|---|--|--|
| W                          | S | L | 3 | 9 | 2 | 1 | L                                             | 5 | 0                           | 0 | 0                                           | F | E                                                               | A |  |  |
| GLOBAL MODEL<br>(7 digits) |   |   |   |   |   |   | RESISTANCE VALUE <sup>(1)</sup><br>(5 digits) |   | TOLERANCE CODE<br>(1 digit) |   | PACKAGING CODE <sup>(2)</sup><br>(2 digits) |   | SPECIAL <sup>(3)</sup><br>(up to 2 digits)                      |   |  |  |
| WSL3921<br>WSL5931         |   |   |   |   |   |   | L = mΩ<br>L5000 = 0.0005 Ω                    |   | F = ± 1.0 %<br>J = ± 5.0 %  |   | EA = lead (Pb)-free, tape/reel              |   | (dash number)<br>(up to 2 digits)<br>from 1 to 99 as applicable |   |  |  |

### Notes

- <sup>(1)</sup> WSL marking ([www.vishay.com/doc?30327](http://www.vishay.com/doc?30327))
- <sup>(2)</sup> Packaging code: EB (lead (Pb)-free) is a non-standard packaging code that designates a 1000 piece reel size. The non-standard packaging code is identical to our standard EA (lead (Pb)-free) packaged code, except that it has a package quantity of 1000 pieces
- <sup>(3)</sup> Follow link for customization capabilities: [www.vishay.com/doc?48163](http://www.vishay.com/doc?48163)



# **TECHNICAL SPECIFICATIONS**

| PARAMETER                                                                                                   | UNIT   | RESISTOR CHARACTERISTICS    |                                     |
|-------------------------------------------------------------------------------------------------------------|--------|-----------------------------|-------------------------------------|
|                                                                                                             |        | WSL3921                     | WSL5931                             |
| Component temperature coefficient (including terminal) <sup>(1)</sup><br>TCR measured from -55 °C to 150 °C | ppm/°C | ± 350 for 0.1 mΩ            | +300 for 0.1 mΩ (+25 °C to +170 °C) |
|                                                                                                             |        | ± 150 for 0.2 mΩ            | ± 225 for 0.2 mΩ                    |
|                                                                                                             |        | ± 170 for 0.3 mΩ and 0.4 mΩ | ± 175 for 0.3 mΩ and 0.5 mΩ         |
|                                                                                                             |        | ± 150 for 0.5 mΩ to 1 mΩ    | ± 75 for 1 mΩ to 3 mΩ               |
|                                                                                                             |        | ± 50 for 1.5 mΩ to 4 mΩ     | -                                   |
| Element TCR <sup>(2)</sup>                                                                                  | ppm/°C | < 20                        |                                     |
| Operating temperature range                                                                                 | °C     | -65 to +170                 |                                     |
| Maximum working voltage <sup>(3)</sup>                                                                      | V      | $(P \times R)^{1/2}$        |                                     |

## **Notes**

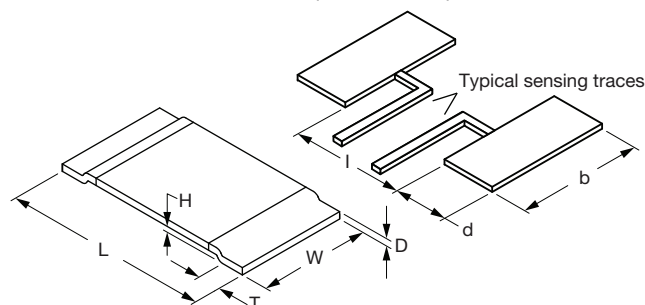
- Consult factory for detailed TCR performance across full temperature range as performance is resistance value specific
- "Temperature Coefficient of Resistance for Current Sensing" white paper: [www.vishay.com/doc?30405](http://www.vishay.com/doc?30405)

<sup>(1)</sup> Component TCR - total TCR that includes the TCR effects of the resistor element and the copper terminal

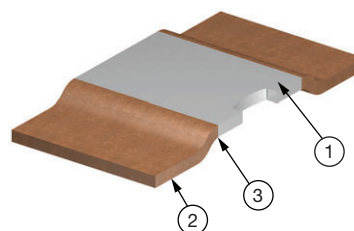
<sup>(2)</sup> Element TCR - only applies to the alloy used for the resistor element; refer to item 1 in the construction illustration on the following page

<sup>(3)</sup> Maximum working voltage - the WSL is not voltage sensitive, but is limited by power / energy dissipation and is also not ESD sensitive

## **DIMENSIONS in inches (millimeters)**



## **CONSTRUCTION OUTLINE**



- ① Resistive element: refer to table below for element material
- ② Terminal: solid copper
- ③ Terminal / element weld

## **Notes**

- 3D models available: 3921 model [www.vishay.com/doc?30315](http://www.vishay.com/doc?30315); 5931 model [www.vishay.com/doc?30317](http://www.vishay.com/doc?30317)
- Surface mount solder profile recommendations: [www.vishay.com/doc?31052](http://www.vishay.com/doc?31052)

| MODEL                    | DIMENSIONS in inches (millimeters) |                                 |                  |                                 | SOLDER PAD DIMENSIONS in inches (millimeters) |                                 |                                |
|--------------------------|------------------------------------|---------------------------------|------------------|---------------------------------|-----------------------------------------------|---------------------------------|--------------------------------|
|                          | L                                  | W                               | H <sup>(1)</sup> | T                               | d                                             | b                               | I                              |
| WSL3921                  | 0.394 ± 0.010<br>(10.0 ± 0.254)    | 0.205 ± 0.015<br>(5.20 ± 0.381) | 0.020<br>(0.5)   | 0.080 ± 0.010<br>(2.00 ± 0.254) | 0.106 ± 0.010<br>(2.70 ± 0.254)               | 0.244 ± 0.010<br>(6.20 ± 0.254) | 0.220 ± 0.005<br>(5.60 ± 0.13) |
| WSL3921<br>(0.1 mΩ only) |                                    |                                 |                  | 0.130 ± 0.010<br>(3.30 ± 0.254) | 0.156 ± 0.010<br>(3.96 ± 0.254)               |                                 | 0.148 ± 0.005<br>(3.76 ± 0.13) |
| WSL5931                  | 0.591 ± 0.010<br>(15.0 ± 0.254)    | 0.305 ± 0.015<br>(7.75 ± 0.381) | 0.020<br>(0.5)   | 0.157 ± 0.010<br>(4.00 ± 0.254) | 0.205 ± 0.010<br>(5.20 ± 0.254)               | 0.344 ± 0.010<br>(8.75 ± 0.254) | 0.220 ± 0.005<br>(5.60 ± 0.13) |

## **Note**

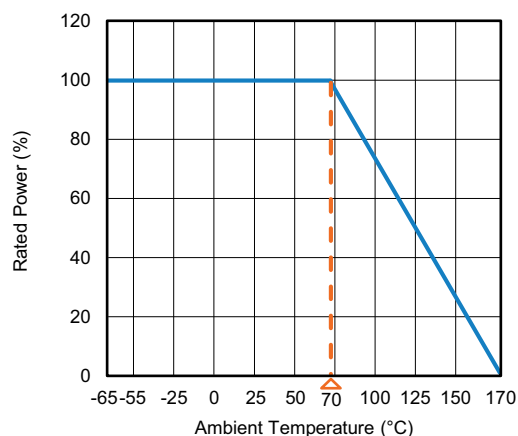
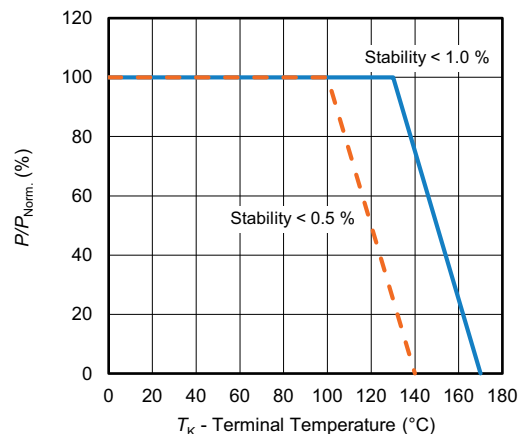
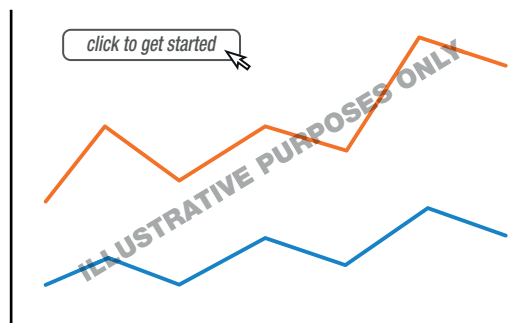
<sup>(1)</sup> H dimension is reference only. Total height is H dimension + D thickness ± 0.010" (± 0.254 mm)



| GLOBAL MODEL | RESISTANCE VALUE (mΩ) | TYPICAL THERMAL RESISTANCE (°C/W) <sup>(1)</sup> | "D" THICKNESS (INCHES) | ELEMENT MATERIAL |
|--------------|-----------------------|--------------------------------------------------|------------------------|------------------|
| WSL3921      | 0.1                   | 0.9                                              | 0.0560                 | Mn-Cu-Sn         |
| WSL3921      | 0.2                   | 2.7                                              | 0.0560                 | Mn-Cu-Sn         |
| WSL3921      | 0.3                   | 3.8                                              | 0.0510                 | Mn-Cu            |
| WSL3921      | 0.4                   | 4.3                                              | 0.0350                 | Mn-Cu            |
| WSL3921      | 0.5                   | 5.8                                              | 0.0300                 | Mn-Cu            |
| WSL3921      | 0.7                   | 6.3                                              | 0.0205                 | Mn-Cu            |
| WSL3921      | 1.0                   | 10.9                                             | 0.0150                 | Mn-Cu            |
| WSL3921      | 1.5                   | 8.3                                              | 0.0360                 | Fe-Cr            |
| WSL3921      | 2.0                   | 12.0                                             | 0.0270                 | Fe-Cr            |
| WSL3921      | 3.0                   | 20.7                                             | 0.0170                 | Fe-Cr            |
| WSL3921      | 4.0                   | 22.8                                             | 0.0130                 | Fe-Cr            |
| WSL5931      | 0.1                   | 1.6                                              | 0.0560                 | Mn-Cu-Sn         |
| WSL5931      | 0.2                   | 2.4                                              | 0.0485                 | Mn-Cu            |
| WSL5931      | 0.3                   | 3.5                                              | 0.0300                 | Mn-Cu            |
| WSL5931      | 0.5                   | 5.7                                              | 0.0180                 | Mn-Cu            |
| WSL5931      | 1.0                   | 7.2                                              | 0.0330                 | Fe-Cr            |
| WSL5931      | 2.0                   | 13.2                                             | 0.0155                 | Fe-Cr            |
| WSL5931      | 3.0                   | 19.3                                             | 0.0105                 | Fe-Cr            |

**Note**

<sup>(1)</sup> The full power rating of power metal strip resistors are dependent upon the ability of the circuit board to dissipate the heat energy created in the resistance element. It is recommended to follow common design practices for power semiconductors that ensure the junction temperature is maintained within thermal limits by using large pad surfaces, thermal vias, heavier copper weights, internal layers as well as other thermal spreading features. The thermal resistance values provided function in the same manner as junction to terminal temperature

**DERATING - AMBIENT TEMPERATURE****DERATING - TERMINAL TEMPERATURE****PULSE CAPABILITY**

[www.vishay.com/resistors/power-metal-strip-calculator](http://www.vishay.com/resistors/power-metal-strip-calculator)



| PERFORMANCE               |                                                                                                                                                                                                               |             |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| TEST                      | CONDITIONS OF TEST                                                                                                                                                                                            | TEST LIMITS |
| Thermal shock             | -55 °C to +150 °C, 1000 cycles, 15 min at each extreme                                                                                                                                                        | ± 1.0 %     |
| Short time overload       | Refer to link for short time overload performance and pulse capability;<br><a href="http://www.vishay.com/resistors/power-metal-strip-calculator/">www.vishay.com/resistors/power-metal-strip-calculator/</a> | ± 0.5 %     |
| Low temperature storage   | -65 °C for 24 h                                                                                                                                                                                               | ± 0.5 %     |
| High temperature exposure | 1000 h at +170 °C                                                                                                                                                                                             | ± 1.0 %     |
| Bias humidity             | +85 °C, 85 % RH, 10 % bias, 1000 h                                                                                                                                                                            | ± 0.5 %     |
| Mechanical shock          | 100 g's for 6 ms, 5 pulses                                                                                                                                                                                    | ± 0.5 %     |
| Vibration                 | Frequency varied 10 Hz to 2000 Hz in 1 min, 3 directions, 12 h                                                                                                                                                | ± 0.5 %     |
| Load life                 | 1000 h at +70 °C, 1.5 h "ON", 0.5 h "OFF"                                                                                                                                                                     | ± 1.0 %     |
| Resistance to solder heat | 3 x at 250 °C ± 5 °C for 30 s ± 5 s                                                                                                                                                                           | ± 0.5 %     |
| Moisture resistance       | MIL-STD-202, method 106, 0 % power, 7a and 7b not required                                                                                                                                                    | ± 0.5 %     |

**Note**

- Contact [ww2bresistors@vishay.com](mailto:ww2bresistors@vishay.com) for application specific performance requirements. Typical performance is better than stated test limits

| PACKAGING |                          |              |             |      |
|-----------|--------------------------|--------------|-------------|------|
| MODEL     | REEL                     |              |             |      |
|           | TAPE WIDTH               | DIAMETER     | PIECES/REEL | CODE |
| WSL3921   | 16 mm / embossed plastic | 330 mm / 13" | 3000        | EA   |
| WSL5931   | 24 mm / embossed plastic | 330 mm / 13" | 1500        | EA   |

**Notes**

- Embossed carrier tape per EIA-481
- (1) Additional packaging details at [www.vishay.com/doc?20051](http://www.vishay.com/doc?20051)



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