

## Description

The AP431S is a 3-terminal adjustable shunt regulator with guaranteed thermal stability over a full operation range. It features sharp turn-on characteristics, low temperature coefficient and low output impedance, which makes it ideal substitute for Zener diode in applications such as switching power supply, charger and other adjustable regulators.

The AP431S has the same electrical specifications as the industry standard 431 except that it features a low minimum cathode current for regulation. The typical value of 50µA makes the parts ideal for very low power dissipation applications.

The output voltage of AP431S can be set to any value between  $V_{REF}$  (2.5V/2.495V) and the corresponding maximum cathode voltage (36V).

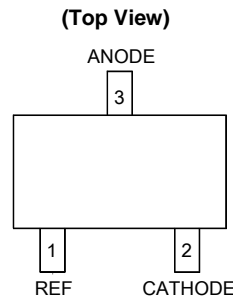
The AP431S is offered in two grade initial voltage tolerance at +25°C, 0.5% and 1%.

This IC is available in 3 packages: TO92 (ammo packing), SOT23 and SOT89.

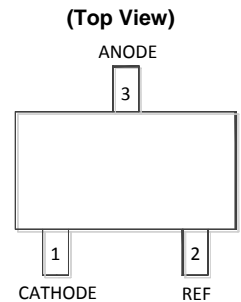
## Features

- Low Minimum Cathode Current for Regulation: 50µA (Typ.), 100µA (Max.)
- Programmable Precise Output Voltage from 2.5V/2.495V to 36V
- High Stability Under Capacitive Load
- Low Deviation of Reference Voltage Over Full Temperature Range: 11mV Typical (-40°C to +125°C)
- Sink Current Capacity from 100µA to 100mA
- Low Dynamic Impedance: 0.1Ω (Typ.)
- Wide Operating Temperature Range: -40°C to +125°C
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

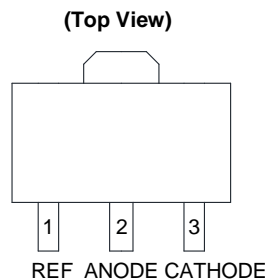
## Pin Assignments



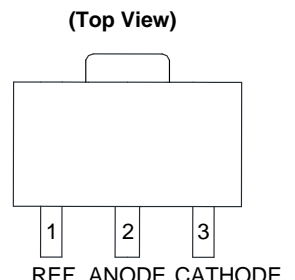
SOT23 (Package Code: N)



SOT23 (Package Code: N1)



SOT89 (Option 1)



SOT89 (Option 2)



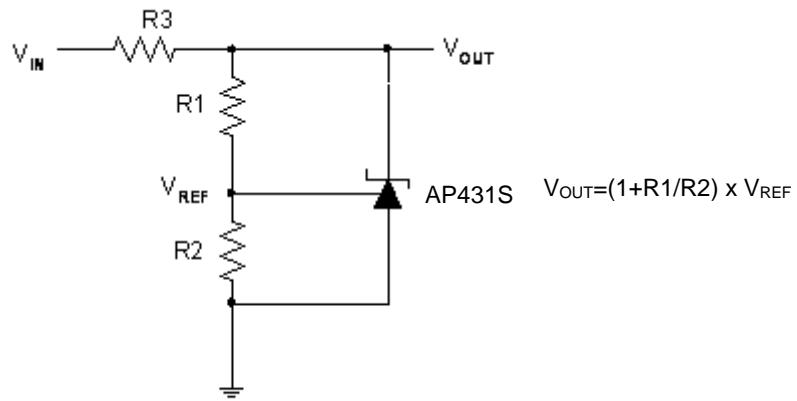
TO92 (Ammo Packing)

## Applications

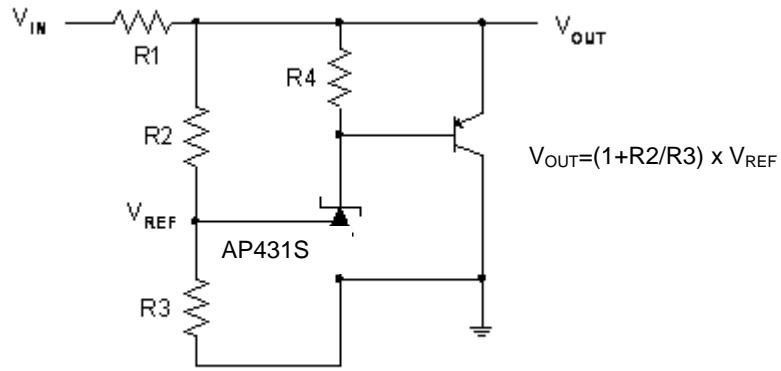
- Charger
- Voltage Adapter
- Switching Power Supply
- Graphic Card
- Precision Voltage Reference

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
  3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

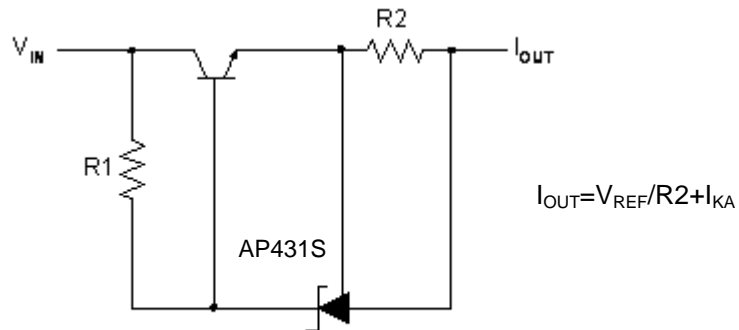
**Typical Applications Circuit**



Shunt Regulator

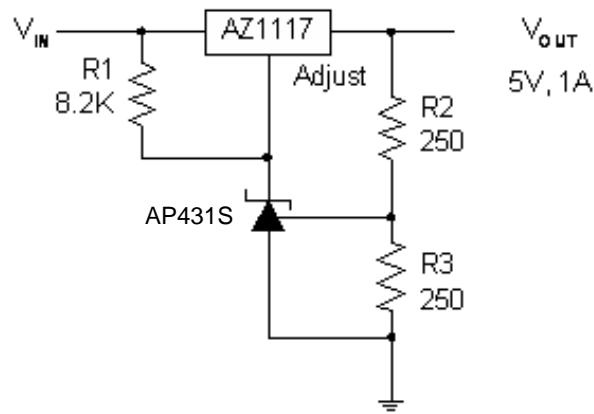


High Current Shunt Regulator

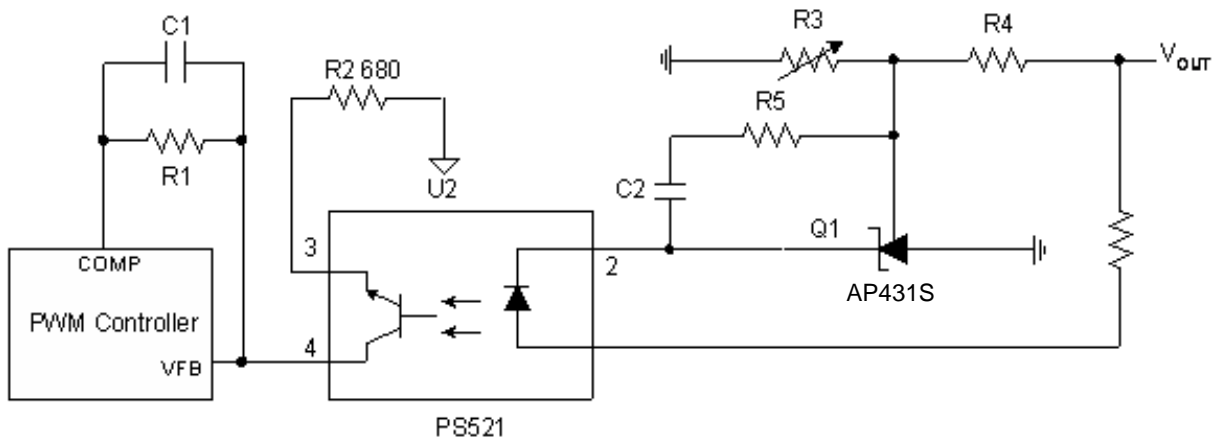


Current Source or Current Limit

**Typical Applications Circuit** (Cont.)

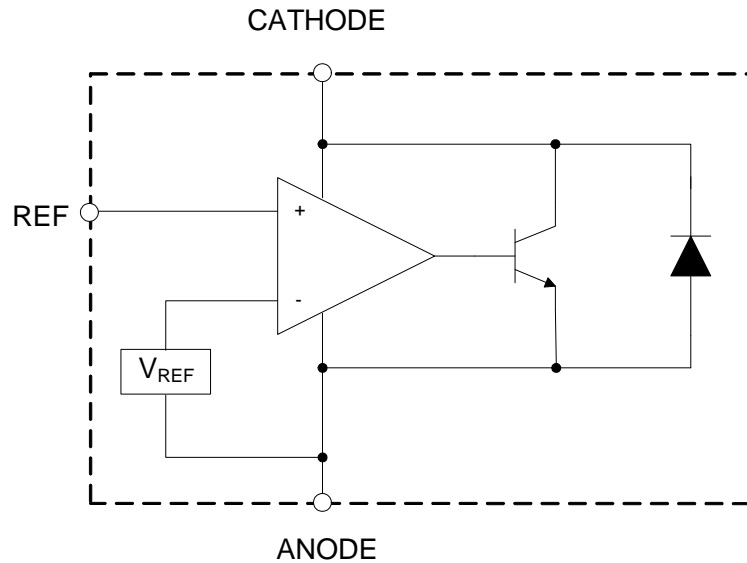


Precision 5V 1A Regulator



PWM Converter with Reference

**Functional Block Diagram**



**Absolute Maximum Ratings** (Note 4)

| Symbol    | Parameter                          | Rating      |     | Unit |
|-----------|------------------------------------|-------------|-----|------|
| $V_{KA}$  | Cathode Voltage                    | 40          |     | V    |
| $I_{KA}$  | Cathode Current Range (Continuous) | -100 to 150 |     | mA   |
| $I_{REF}$ | Reference Input Current Range      | 10          |     | mA   |
| $P_D$     | Power Dissipation                  | TO92        | 750 | mW   |
|           |                                    | SOT89       | 750 |      |
|           |                                    | SOT23       | 350 |      |
| $T_J$     | Junction Temperature               | +150        |     | °C   |
| $T_{STG}$ | Storage Temperature Range          | -65 to +150 |     | °C   |
| ESD       | ESD (Human Body Model)             | 5,500       |     | V    |
| ESD       | ESD (Machine Model)                | 300         |     | V    |

Note 4: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

**Recommended Operating Conditions**

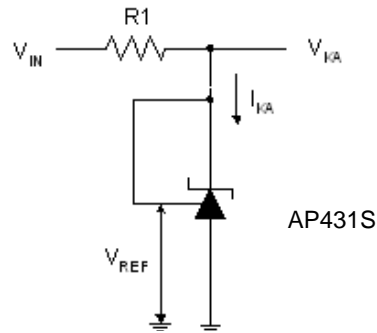
| Symbol   | Parameter                           | Min       | Max  | Unit |
|----------|-------------------------------------|-----------|------|------|
| $V_{KA}$ | Cathode Voltage                     | $V_{REF}$ | 36   | V    |
| $I_{KA}$ | Cathode Current                     | 0.1       | 100  | mA   |
| $T_A$    | Operating Ambient Temperature Range | -40       | +125 | °C   |

**Electrical Characteristics** ( $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

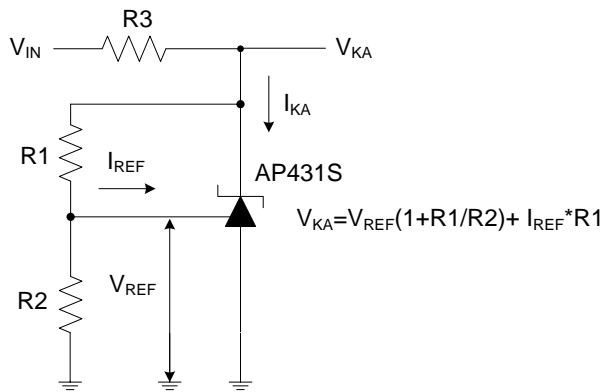
| Symbol                                 | Parameter   |      | Test Circuit | Conditions   | Min  | Typ   | Max   | Unit               |      |
|--|---|------|--------------|--|--|-------|-------|--------------------|------|
| $V_{REF}$                              | Reference Voltage   | 0.5% | 4            | $V_{KA} = V_{REF}, I_{KA} = 1\text{mA}$ (AP431SA)  | 2.487  | 2.500 | 2.512 | V                  |      |
|  |   |      |              | $V_{KA} = V_{REF}, I_{KA} = 1\text{mA}$ (AP431SHA)   | 2.483  | 2.495 | 2.507 |                    |      |
|  |   | 1.0% |              | $V_{KA} = V_{REF}, I_{KA} = 1\text{mA}$ (AP431SB)  | 2.475  | 2.500 | 2.525 |                    |      |
|  |   |      |              | $V_{KA} = V_{REF}, I_{KA} = 1\text{mA}$ (AP431SHB)   | 2.470  | 2.495 | 2.520 |                    |      |
| $\Delta V_{REF}$                       | Deviation of Reference Voltage Over Full Temperature Range            |      | 4            | $V_{KA} = V_{REF}$<br>$I_{KA} = 1\text{mA}$  | 0 to $+70^\circ\text{C}$                     | —     | 3     | 6                  | mV   |
|  |   |      |              |  | $-40$ to $+85^\circ\text{C}$                 | —     | 6     | 10                 |      |
|  |   |      |              |  | $-40$ to $+125^\circ\text{C}$                | —     | 11    | 18                 |      |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | Ratio of Change in Reference Voltage to the Change in Cathode Voltage |      | 5            | $I_{KA} = 1\text{mA}$  | $\Delta V_{KA} = 10\text{V}$ to $V_{REF}$    | —     | -1.0  | -2.7               | mV/V |
|  |   |      |              |  | $\Delta V_{KA} = 36\text{V}$ to $10\text{V}$ | —     | -0.5  | -2.0               |      |
| $I_{REF}$                              | Reference Current   |      | 5            | $I_{KA} = 1\text{mA}, R_1 = 10\text{k}\Omega, R_2 = \infty$  | —  | 0.2   | 0.5   | $\mu\text{A}$      |      |
| $\Delta I_{REF}$                       | Deviation of Reference Current Over Full Temperature Range            |      | 5            | $I_{KA} = 1\text{mA}, R_1 = 10\text{k}\Omega$<br>$R_2 = \infty, T_A = -40$ to $+125^\circ\text{C}$ | —  | 0.1   | 0.3   | $\mu\text{A}$      |      |
| $I_{KA}$ (Min)                         | Minimum Cathode Current for Regulation                                |      | 4            | $V_{KA} = V_{REF}$   | —  | 50    | 100   | $\mu\text{A}$      |      |
| $I_{KA}$ (Off)                         | Off-state Cathode Current   |      | 6            | $V_{KA} = 36\text{V}, V_{REF} = 0$   | —  | 0.05  | 1.0   | $\mu\text{A}$      |      |
| $Z_{KA}$                               | Dynamic Impedance   |      | 4            | $V_{KA} = V_{REF},$<br>$I_{KA} = 1$ to $100\text{mA}, f \leq 1.0\text{kHz}$                        | —  | 0.1   | 0.3   | $\Omega$           |      |
| $\theta_{JC}$                          | Thermal Resistance  |      | —            | TO92   | —  | 80    | —     | $^\circ\text{C/W}$ |      |
|  |   |      |              | SOT89  | —  | 80    | —     |                    |      |
|  |   |      |              | SOT23  | —  | 140   | —     |                    |      |

**Electrical Characteristics** (Cont.)

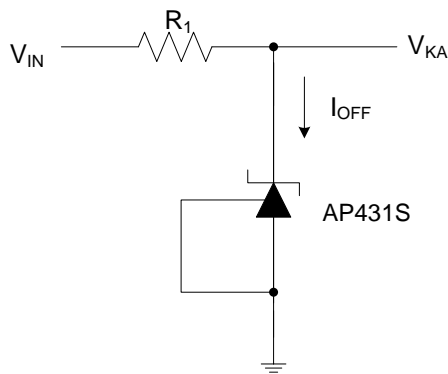
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Test Circuit 4 for  $V_{KA} = V_{REF}$



Test Circuit 5 for  $V_{KA} > V_{REF}$

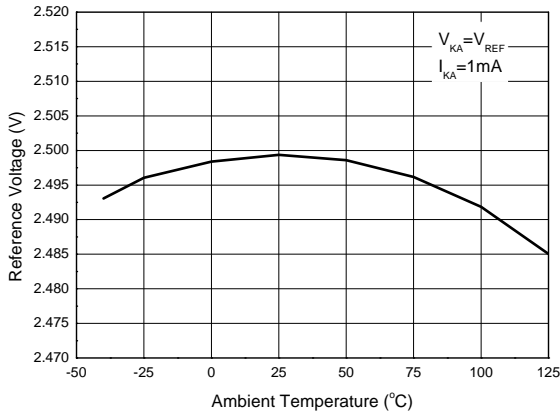


Test Circuit 6 for  $I_{OFF}$

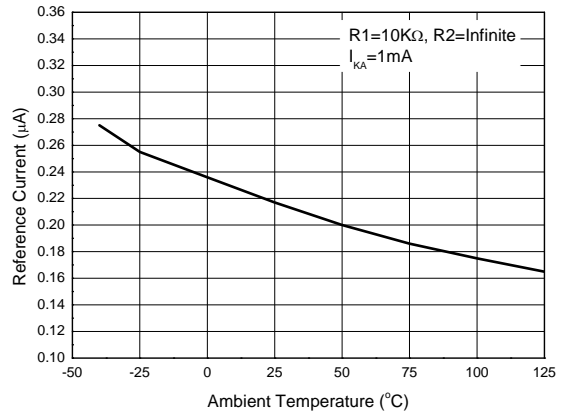
**Performance Characteristics**

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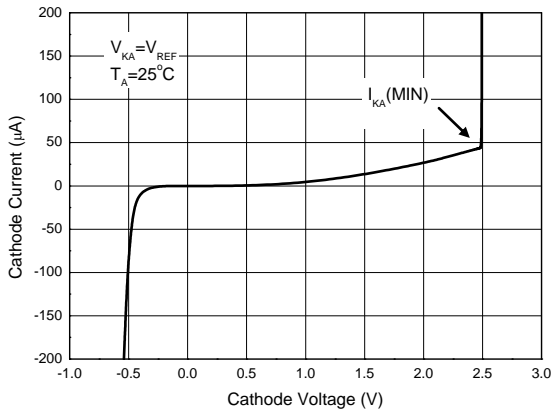
**Reference Voltage vs. Ambient Temperature**



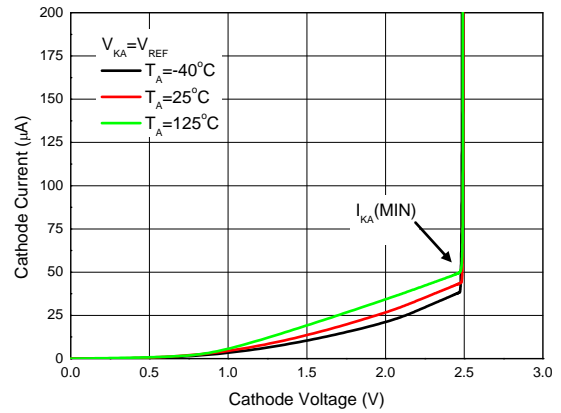
**Reference Current vs. Ambient Temperature**



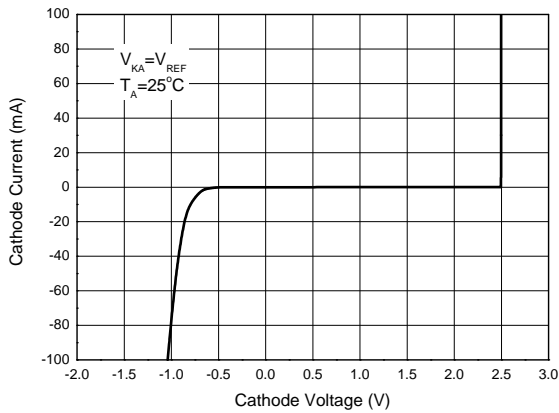
**Minimal Cathode Current for Regulation**



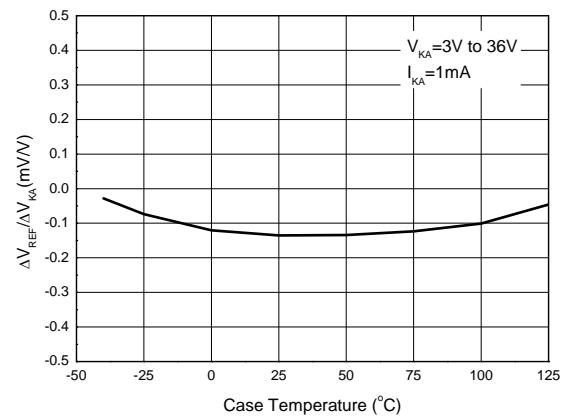
**Minimal Cathode Current for Regulation at Different Ambient Temperature**



**Cathode Current vs. Cathode Voltage**

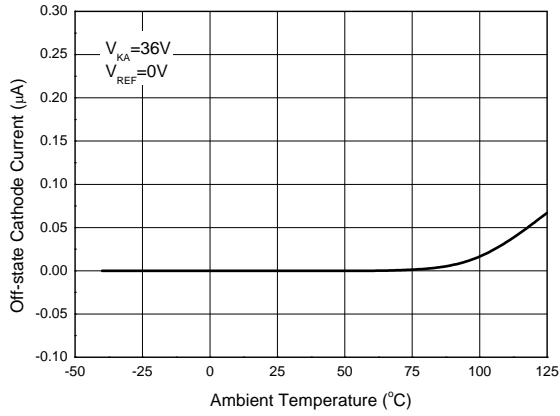


**Ratio of Delta Reference Voltage to Delta Cathode Voltage vs. Case Temperature**

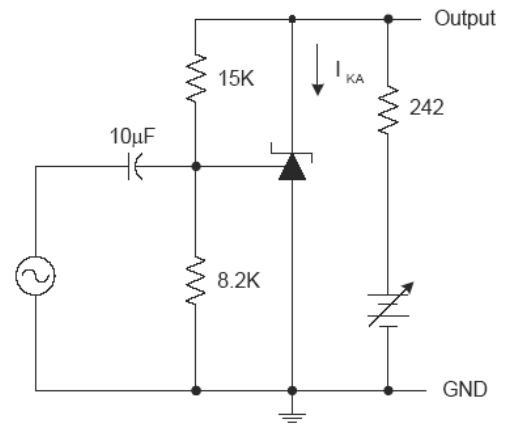
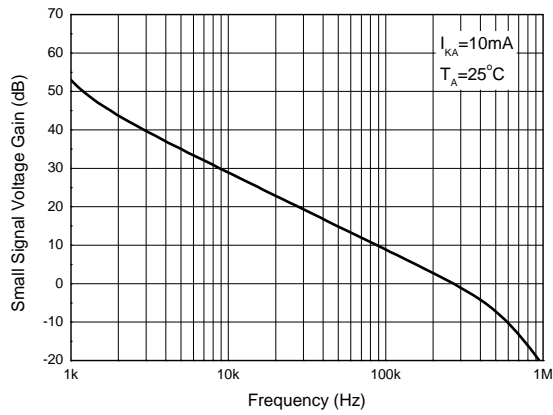


**Performance Characteristics (Cont.)**

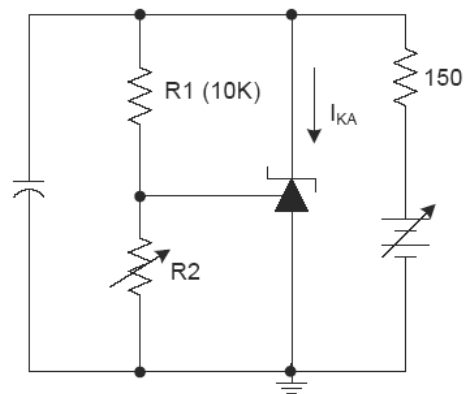
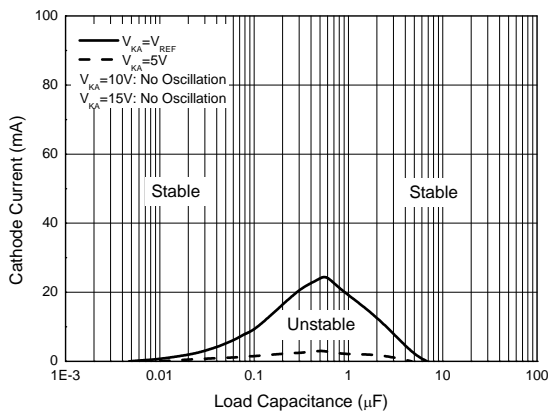
**Off-state Cathode Current vs. Ambient Temperature**



**Small Signal Voltage Gain vs. Frequency**



**Stability Boundary Conditions**

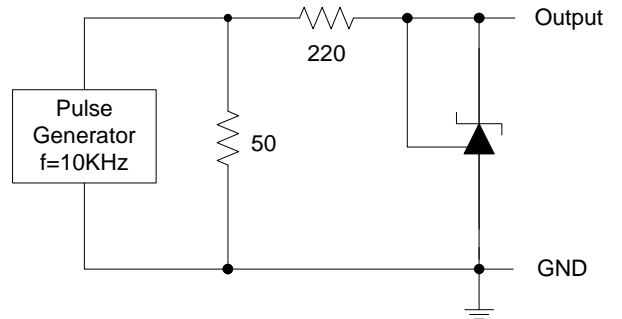
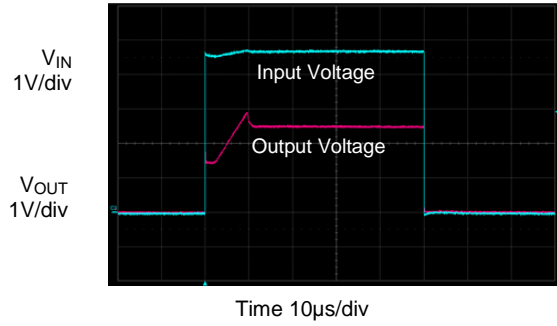


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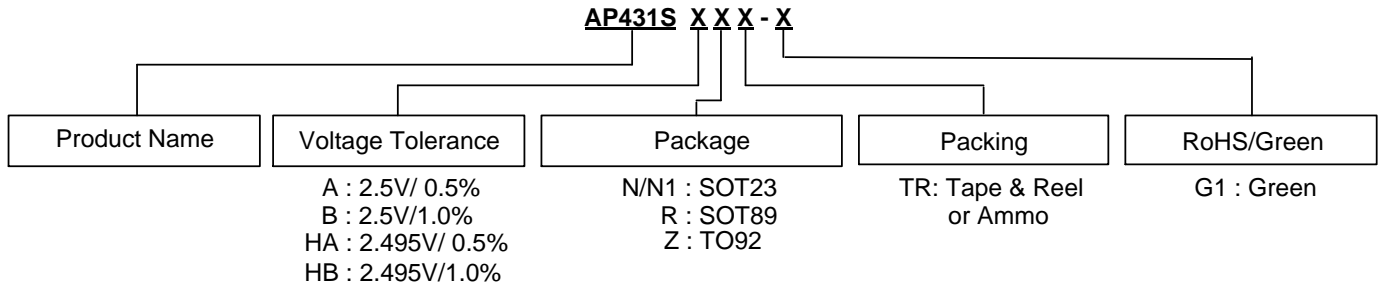


**Performance Characteristics** (Cont.)

**Pulse Response**



Ordering Information



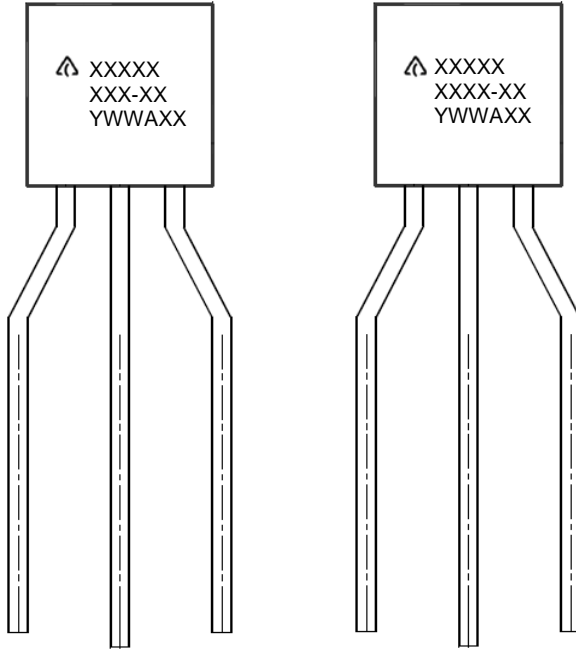
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| Package | Package Code | Temperature Range | Voltage Tolerance | Part Number     | Marking ID   | Packing           |
|---------|--------------|-------------------|-------------------|-----------------|--------------|-------------------|
| SOT23   | N            | -40 to +125°C     | 0.5%              | AP431SANTR-G1   | GCA          | 3,000/Tape & Reel |
|         | N1           |                   | 0.5%              | AP431SAN1TR-G1  | GCC          |                   |
|         | N            |                   | 0.5%              | AP431SHANTR-G1  | GCD          |                   |
|         | N1           |                   | 0.5%              | AP431SHAN1TR-G1 | GCE          |                   |
|         | N            |                   | 1.0%              | AP431SBNTR-G1   | GCB          |                   |
|         | N1           |                   | 1.0%              | AP431SBN1TR-G1  | GCF          |                   |
|         | N            |                   | 1.0%              | AP431SHBNTR-G1  | GCG          |                   |
|         | N1           |                   | 1.0%              | AP431SHBN1TR-G1 | GCH          |                   |
| SOT89   | R            | -40 to +125°C     | 0.5%              | AP431SARTR-G1   | G33M         | 1,000/Tape & Reel |
|         | R            |                   | 0.5%              | AP431SHARTR-G1  | G37M         |                   |
|         | R            |                   | 1.0%              | AP431SBRTR-G1   | G33R         |                   |
|         | R            |                   | 1.0%              | AP431SHBRTR-G1  | G33S         |                   |
| TO92    | Z            | -40 to +125°C     | 0.5%              | AP431SAZTR-G1   | AP431SAZ-G1  | 2,000/Ammo        |
|         | Z            |                   | 0.5%              | AP431SHAZTR-G1  | AP431SHAZ-G1 |                   |
|         | Z            |                   | 1.0%              | AP431SBZTR-G1   | AP431SBZ-G1  |                   |
|         | Z            |                   | 1.0%              | AP431SHBZTR-G1  | AP431SHBZ-G1 |                   |

**Marking Information**

(1) TO92 (Ammo Packing)

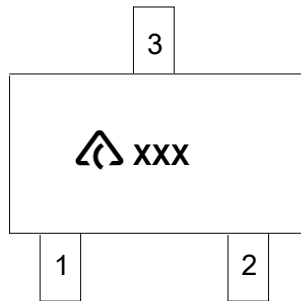
(Front View)




First and Second Lines: Logo and Marking ID  
(See Ordering Information)  
Third Line: Date Code  
Y: Year  
WW: Work Week of Molding  
A: Assembly House Code  
XX: Internal Code

(2) SOT23

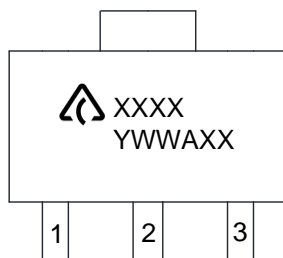
(Top View)



 : Logo  
XXX: Marking ID (See Ordering Information)

(3) SOT89

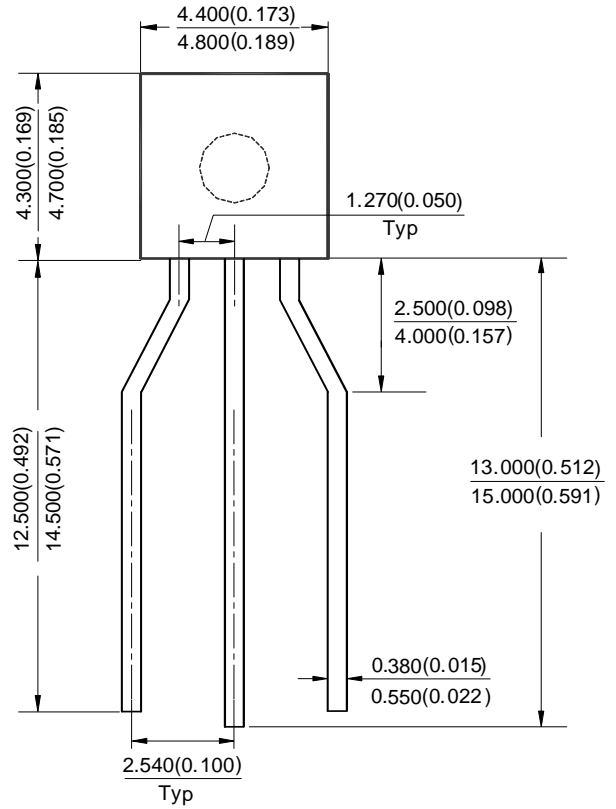
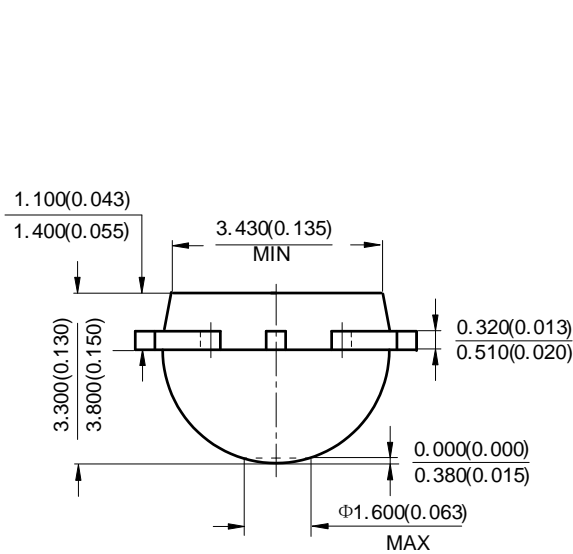
(Top View)



First Line: Logo and Marking ID  
(See Ordering Information)  
Second Line: Date Code  
Y: Year  
WW: Work Week of Molding  
A: Assembly House Code  
XX: Internal Code

**Package Outline Dimensions** (All dimensions in mm (inch).)

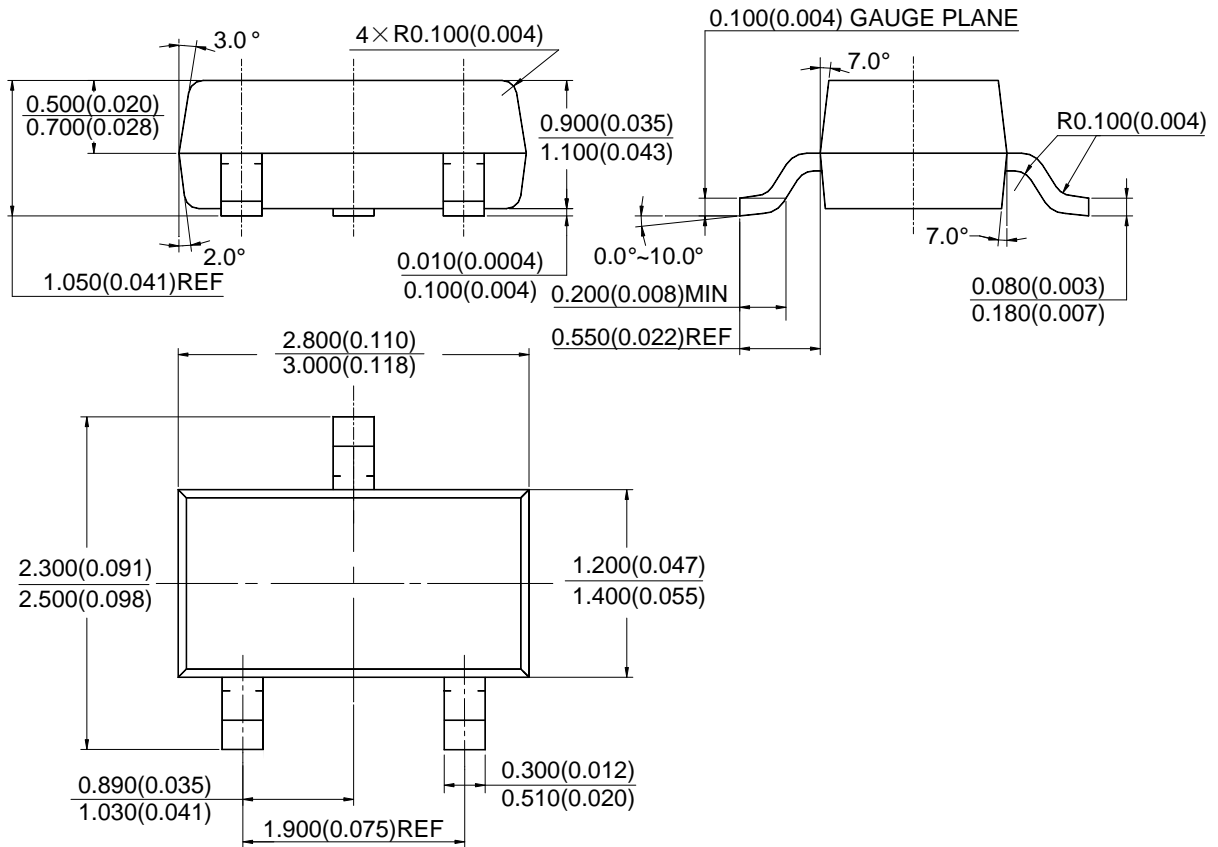
(1) Package Type: TO92 (Ammo Packing)



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**Package Outline Dimensions** (Cont.) ( All dimensions in mm(inch).)

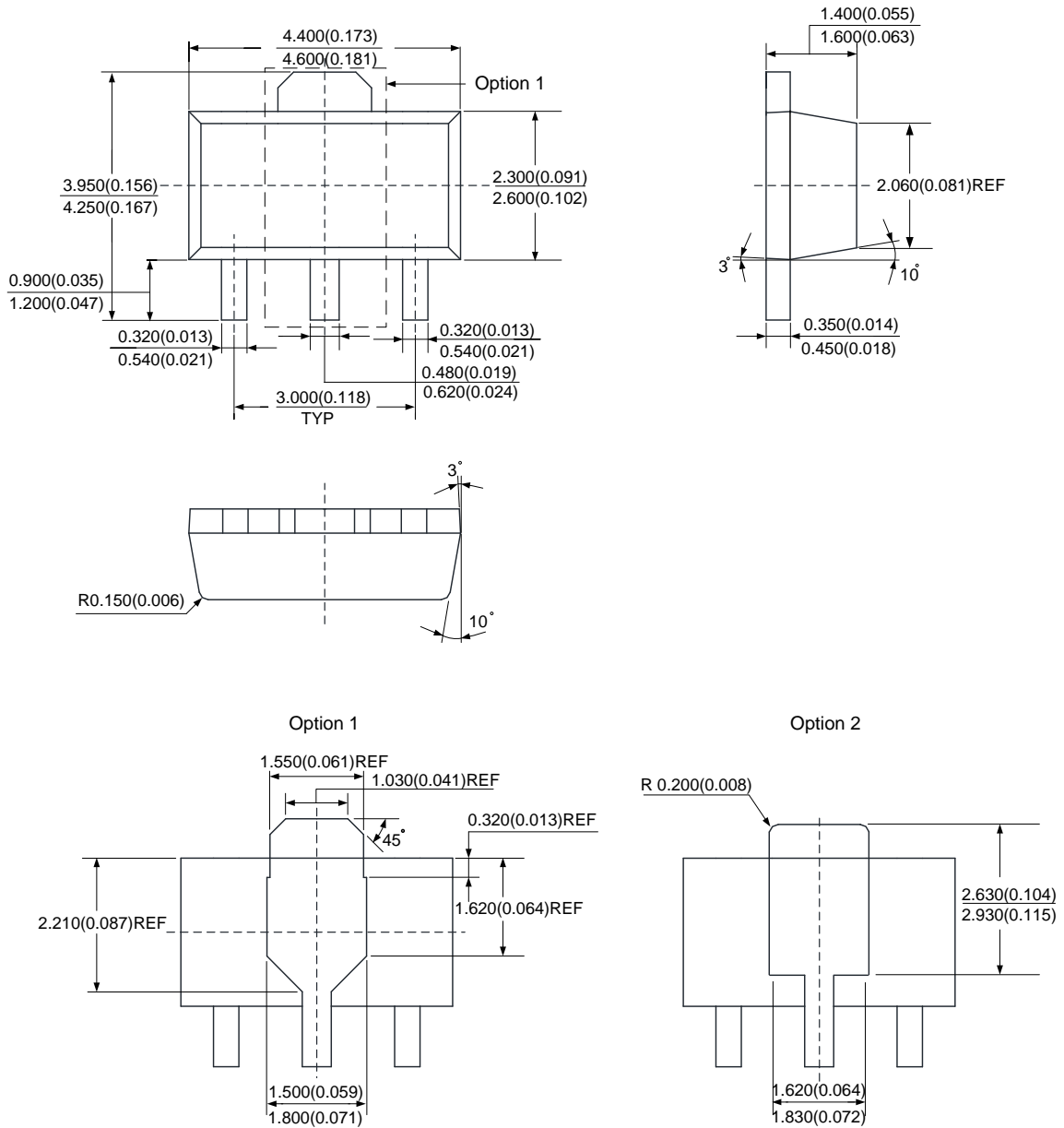
(2) Package Type: SOT23



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**Package Outline Dimensions** (Cont.) (All dimensions in mm(inch).)

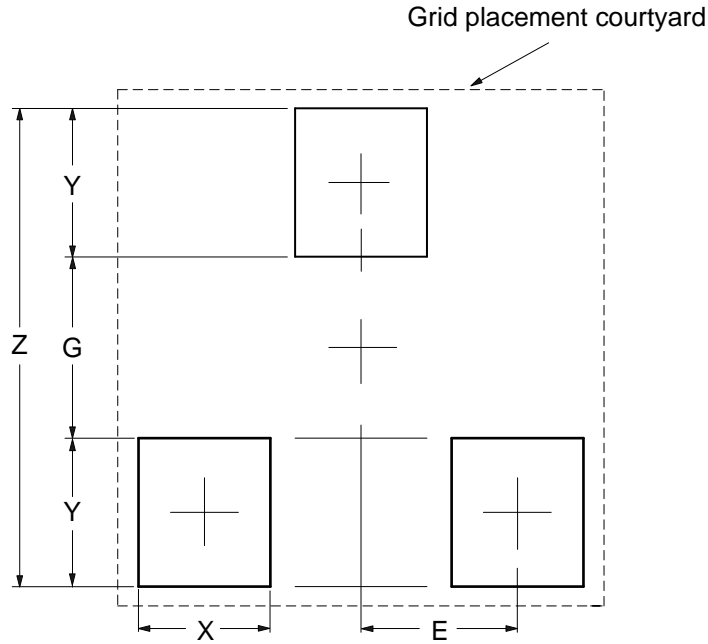
(3) Package Type: SOT89



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**Suggested Pad Layout**

(1) Package Type: SOT23

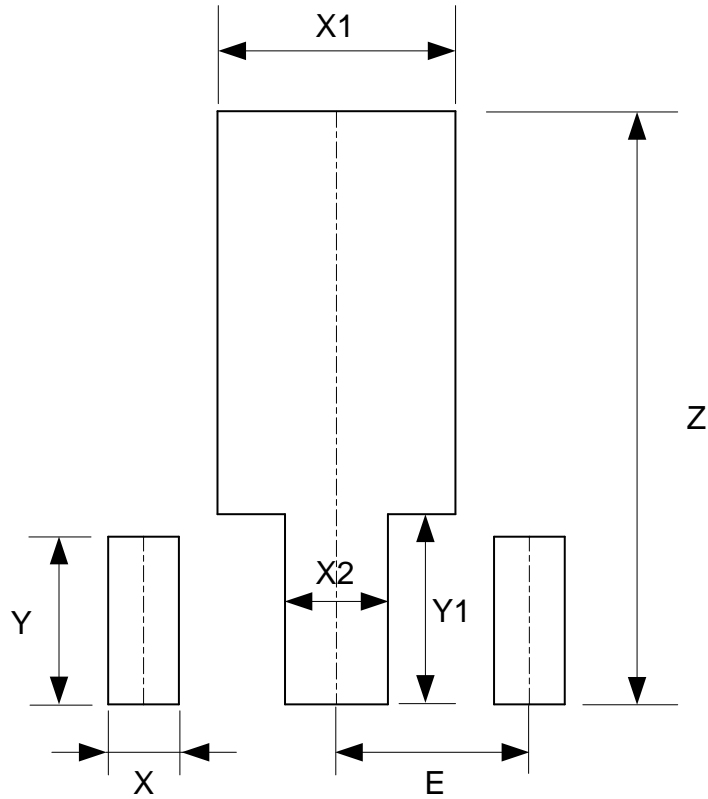


| Dimensions | Z<br>(mm)/(inch) | G<br>(mm)/(inch) | X<br>(mm)/(inch) | Y<br>(mm)/(inch) | E<br>(mm)/(inch) |
|------------|------------------|------------------|------------------|------------------|------------------|
| Value      | 2.900/0.114      | 1.100/0.043      | 0.800/0.031      | 0.900/0.035      | 0.950/0.037      |

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**Suggested Pad Layout (Cont.)**

(2) Package Type: SOT89



| Dimensions | Z<br>(mm)/(inch) | X<br>(mm)/(inch) | X1<br>(mm)/(inch) | X2<br>(mm)/(inch) | Y<br>(mm)/(inch) | Y1<br>(mm)/(inch) | E<br>(mm)/(inch) |
|------------|------------------|------------------|-------------------|-------------------|------------------|-------------------|------------------|
| Value      | 4.600/0.181      | 0.550/0.022      | 1.850/0.073       | 0.800/0.031       | 1.300/0.051      | 1.475/0.058       | 1.500/0.059      |

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- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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