



## Precision Adjustable Shunt Regulator

### FEATURES

- Trimmed Bandgap to 1%
- Wide Operating Current.....1mA to 150mA
- Extended Temperature Range.....0°C to 105°C
- Low Temperature Coefficient .....30 ppm/°C
- Offered in TO-92, SOIC, SOT-89, SOT-23-5
- Improved Replacement in Performance for TL431
- Low Cost Solution

### APPLICATIONS

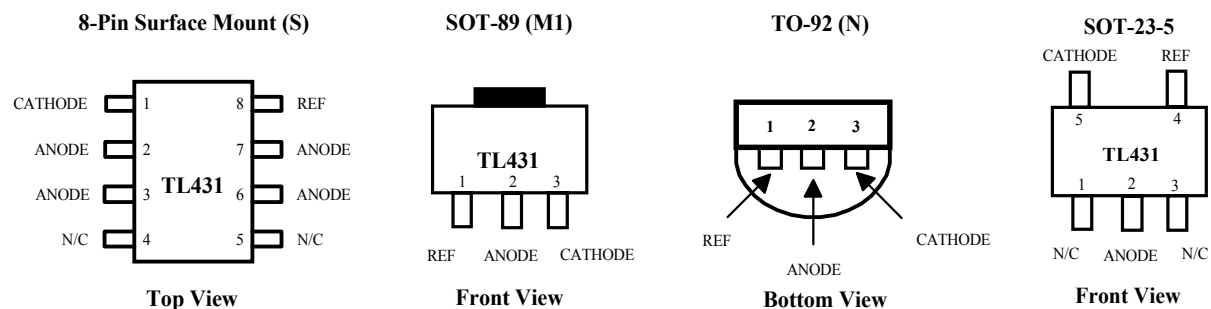
- Battery Operating Equipments
- Adjustable Supplies
- Switching Power Supplies
- Error Amplifiers
- Single Supply Amplifier
- Monitors / VCR / TV
- Personal Computers

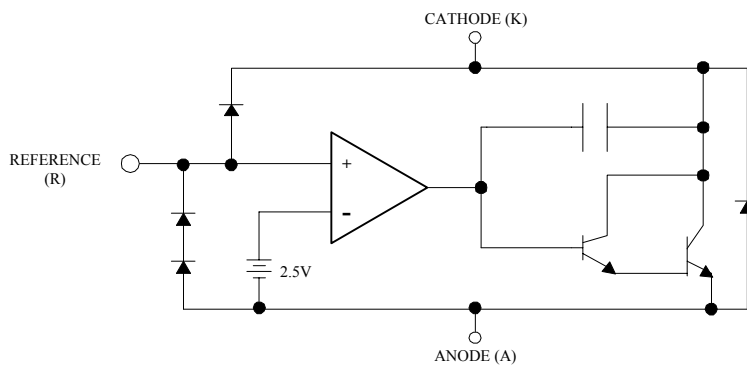
### PRODUCT DESCRIPTION

The TL431 is a 3-terminal adjustable shunt voltage regulator providing a highly accurate 1% bandgap reference. TL431 acts as an open-loop error amplifier with a 2.5V temperature compensation reference. The TL431 thermal stability, wide operating current (150mA) and temperature range (0°C to 105°C) makes it suitable for all variety of application that are looking for a low cost solution with high performance.

The output voltage may be adjusted to any value between  $V_{REF}$  and 36 volts with two external resistors. The TL431 is operating in full industrial temperature range of 0°C to 105°C. The TL431 is available in TO-92, SO-8, SOT-89 and SOT23-5 packages.

### PIN CONFIGURATIONS





## ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNITS
Cathode-Anode Reverse Breakdown	$V_{KA}$	37	V
Anode-Cathode Forward Current	$I_{AK}$	1	A
Operating Cathode Current	$I_{KA}$	150	mA
Reference Input Current	$I_{REF}$	10	mA
Continuous Power Dissipation at 25° C	$P_D$		
TO-92		775	mW
8L SOIC		750	mW
SOT-89		1000	mW
Junction Temperature	$T_J$	150	°C
Storage Temperature	$T_{STG}$	- 65 to 150	°C
Lead Temperature (Soldering 10 sec.)	$T_L$	300	°C

Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## RECOMMENDED CONDITIONS

PARAMETER	SYMBOL	RATING	UNIT
Cathode Voltage	$V_{KA}$	$V_{REF}$ to 20	V
Cathode Current	$I_K$	10	mA

## TYPICAL THERMAL RESISTANCES

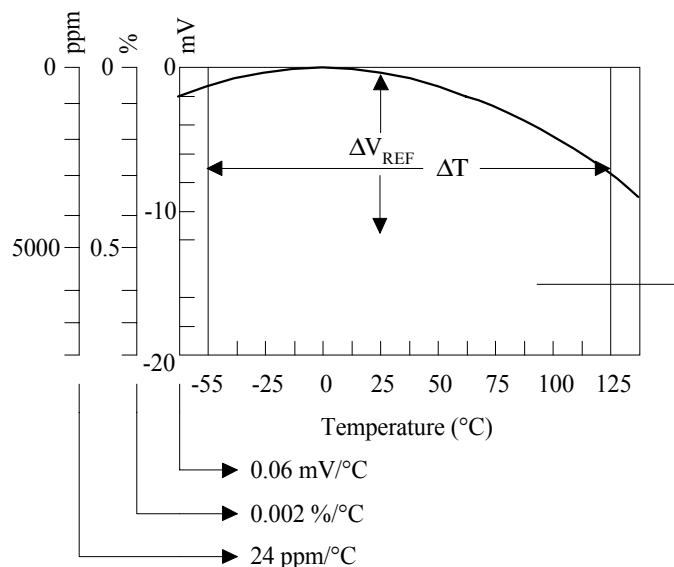
PACKAGE	$\theta_{JA}$	$\theta_{JC}$	TYPICAL DERATING
TO-92	160 °C/W	80 °C/W	6.3 mW/°C
SOIC	175 °C/W	45 °C/W	5.7 mW/°C
SOT-89	110 °C/W	8 °C/W	9.1 mW/°C

## ELECTRICAL CHARACTERISTICS at 25°C $I_K @ 10\text{mA}$ $V_K = V_{REF}$ , unless otherwise specified.

Parameter	Symbol	Test Conditions	Test Circuit	TL431			Unit
				Min	Typ	Max	
Reference Voltage	$V_{REF}$	$T_A = 25^\circ\text{C}$ Over Temp.	1 1	2.470 2.449	2.495	2.520 2.541	V
$\Delta V_{REF}$ with Temp.*	TC		1		0.07	0.20	mV/°C
Ratio of Change in $V_{REF}$ to Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_K}$	$V_{REF}$ to 10V 10V to 36V	2	-2.7 -2	-1.0 -0.4	0.3	mV/V
Reference Input Current	$I_{REF}$		2		0.7	4	$\mu\text{A}$
$I_{REF}$ Temp Deviation	$\Delta I_{REF}$	Over Temp.	2		0.4	1.2	$\mu\text{A}$
Min $I_K$ for Regulation	$I_{K(MIN)}$		1		0.4	1	mA
Off State Leakage	$I_{K(OFF)}$	$V_{REF} = 0\text{V}$ , $V_{KA} = 36\text{V}$	3		0.04	500	nA
Dynamic Output Impedance	$Z_{KA}$	$F < 1\text{kHz}$ $I_K = 1\text{-}150\text{mA}$	1		0.15	0.5	$\Omega$

TC = Test Circuit

### Calculating Average Temperature Coefficient (TC)



- $TC \text{ in mV}/^\circ\text{C} = \frac{\Delta V_{REF} \text{ (mV)}}{\Delta T_A}$
- $TC \text{ in } \%/^\circ\text{C} = \frac{\left( \frac{\Delta V_{REF}}{V_{REF} \text{ at } 25^\circ\text{C}} \right)}{\Delta T_A} \times 100$
- $TC \text{ in ppm}/^\circ\text{C} = \frac{\left( \frac{\Delta V_{REF}}{V_{REF} \text{ at } 25^\circ\text{C}} \right)}{\Delta T_A} \times 10^6$

### TEST CIRCUITS

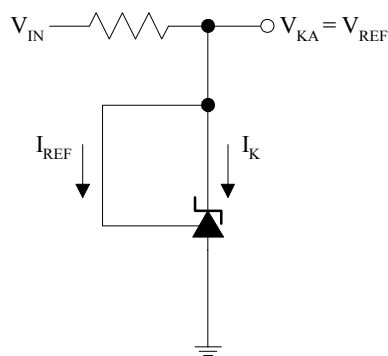


Figure 1a. Test Circuit 1

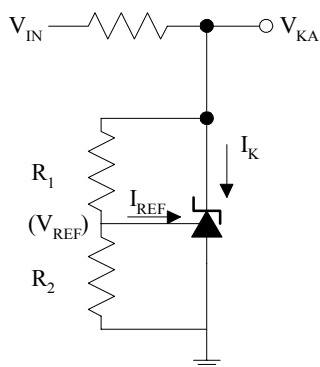


Figure 1b. Test Circuit 2

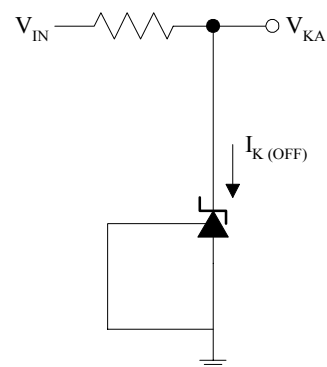


Figure 1c. Test Circuit 3

TYPICAL PERFORMANCE CURVES

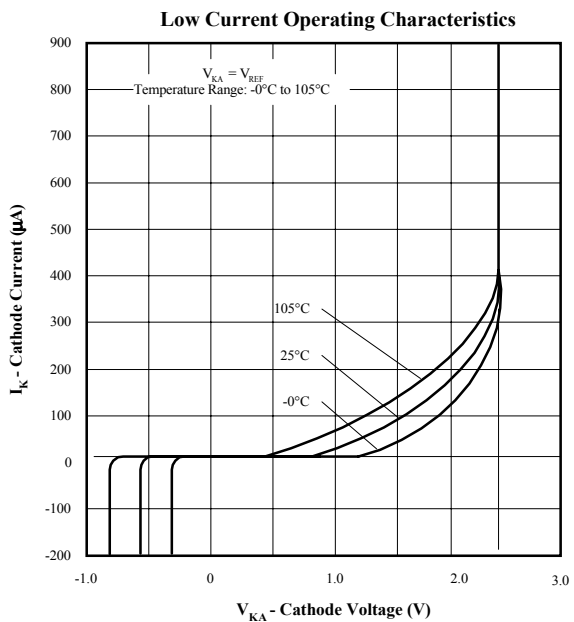


Figure 2

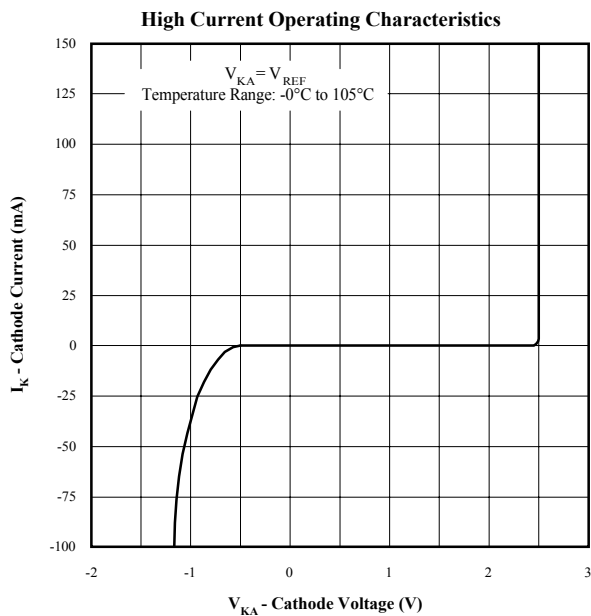


Figure 3

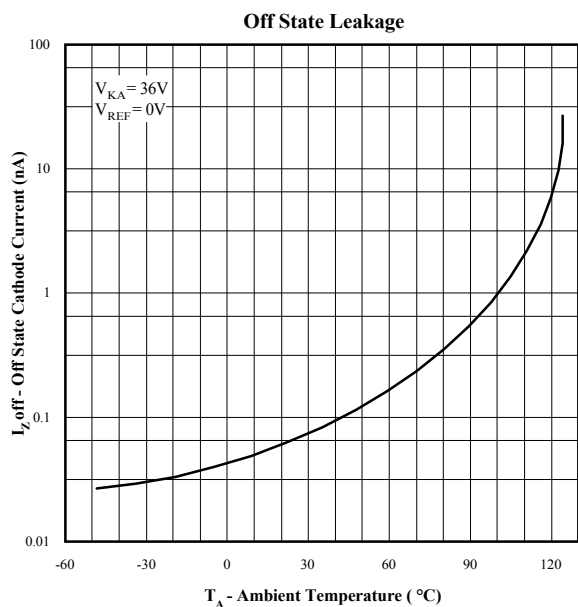


Figure 4

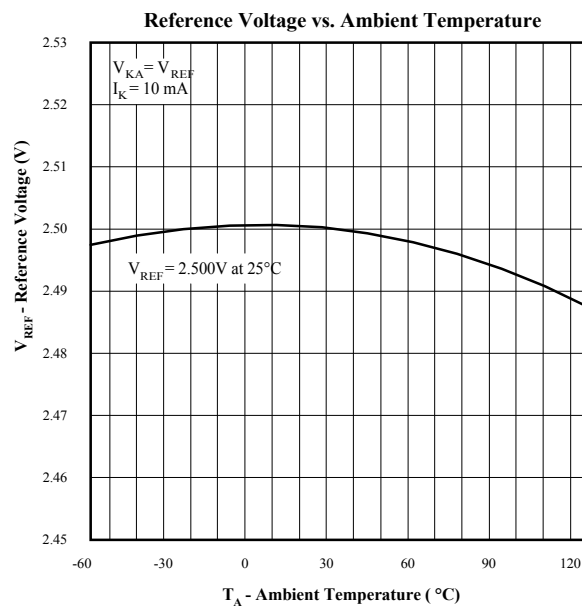


Figure 5

TYPICAL PERFORMANCE CURVES

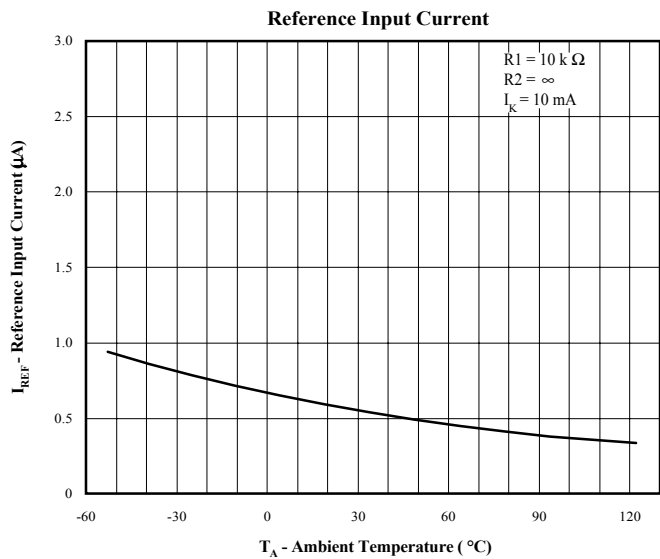


Figure 6

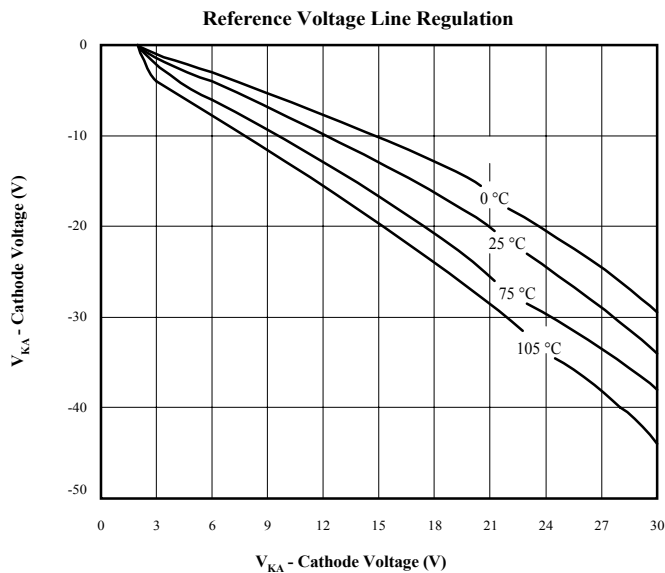


Figure 7

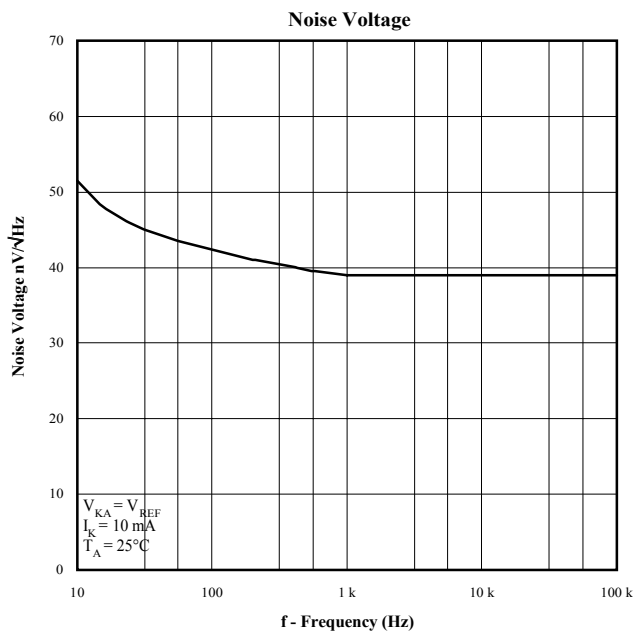


Figure 8

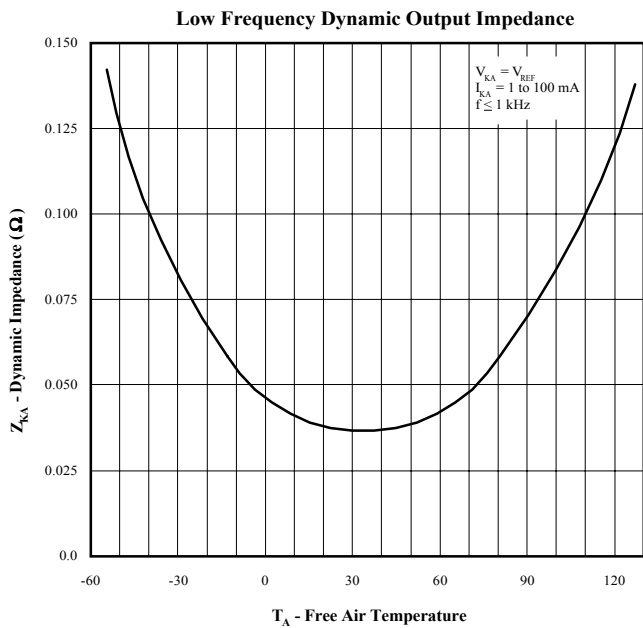
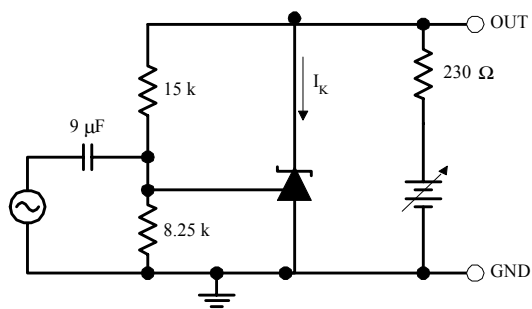
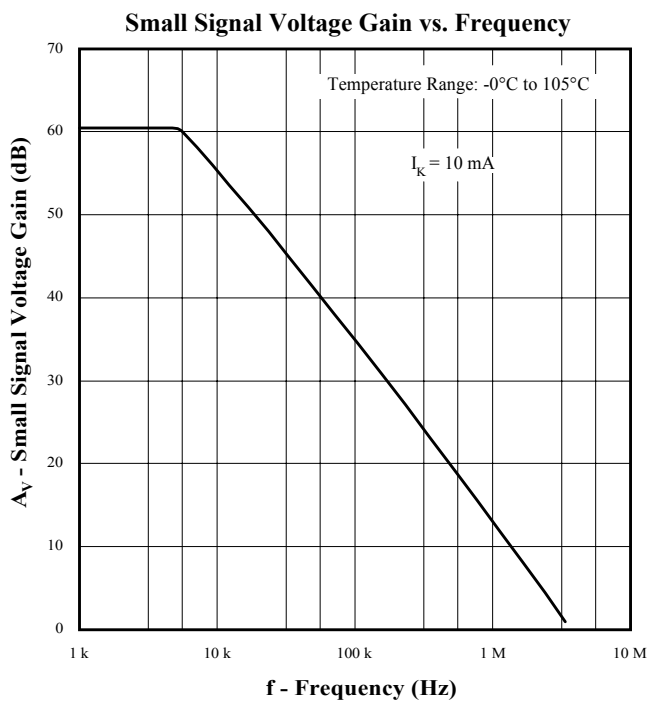
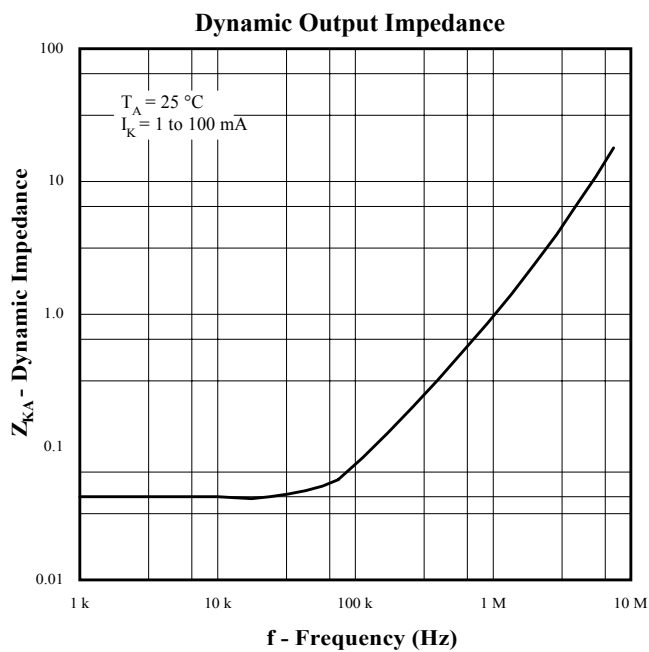


Figure 9

TYPICAL PERFORMANCE CURVES



## TYPICAL PERFORMANCE CURVES

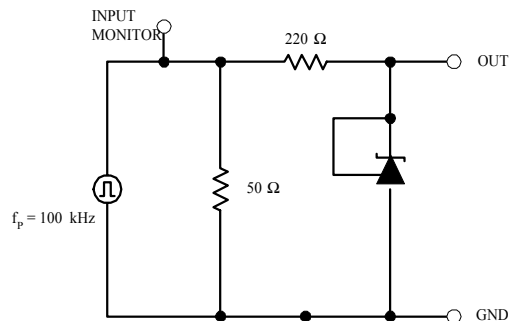
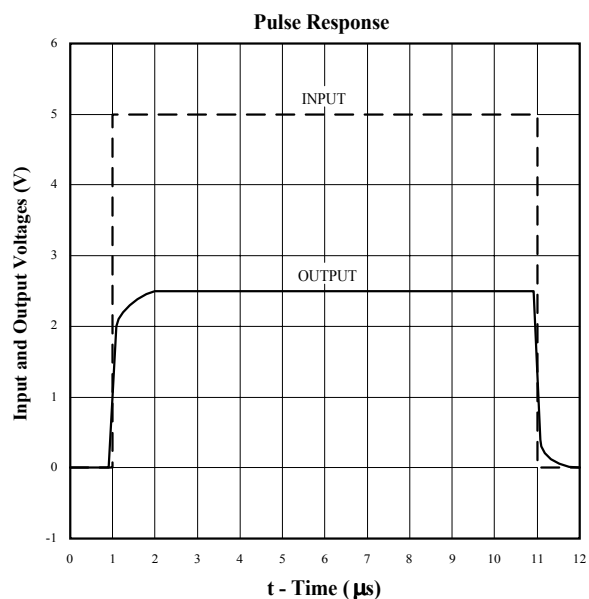


Figure 12

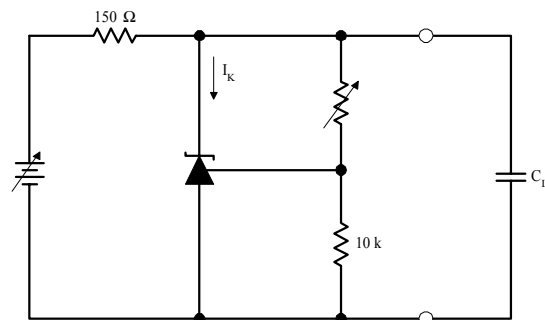
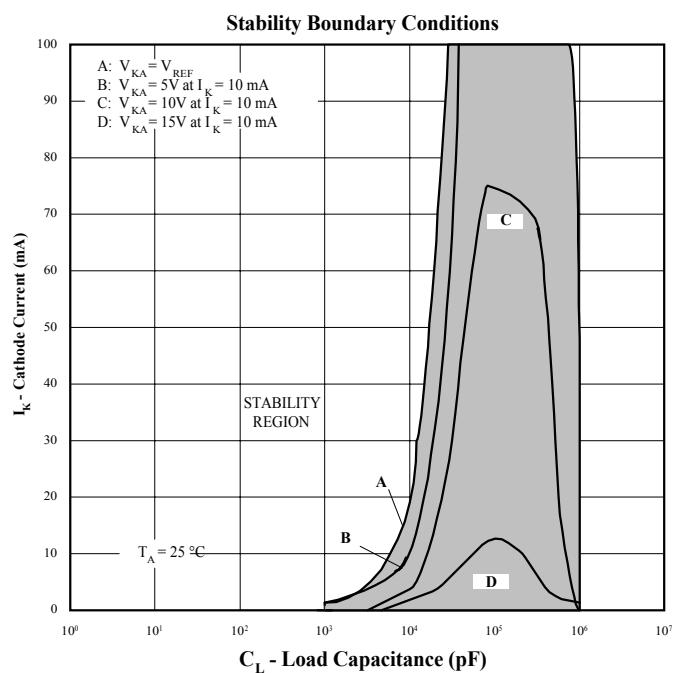


Figure 13