1.24V Programmable Shunt Voltage Reference

DESCRIPTION

The TS432AIX and TS432BIX is a three-terminal adjustable shunt regulator with specified thermal stability. The output voltage may be set to any value between V_{REF} (approximately 1.24V) and 18V with two external resistors. The TS432AIX and TS432BIX has a typical output impedance of 0.05Ω. Active output circuitry provides a very sharp turn-on characteristic, making the TS432AIX and TS432BIX excellent replacement for zener diode in many applications.

FEATURES

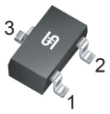
- Precision Reference Voltage
  TS432AI – 1.24V±1%
  TS432BI – 1.24V±0.5%
- Minimum cathode current: 20µA(typ.)
- Equivalent full range Temp. coefficient: 50ppm/ºC
- Programmable output voltage up to 18V
- Fast turn-on response
- Sink current capability of 80µA to 100mA
- Low dynamic output impedance: 0.2Ω
- Low output noise
- Compliant to RoHS Directive 2011/65/EU and in accordance to WEEE 2002/96/EC
- Halogen-free according to IEC 61249-2-21

APPLICATION

- SMPS
- Lighting
- Telecommunication
- Home appliance

Pb Pb-Free RoHS COMPLIANT HALOGEN FREE

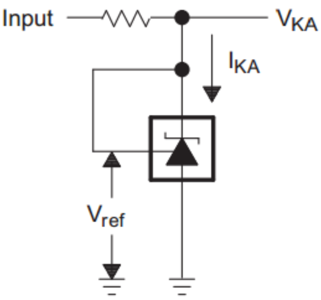
SOT-23



Pin Definition:
1. Reference
2. Cathode
3. Anode

Notes: MSL 1 (Moisture Sensitivity Level) per J-STD-020

SIMPLIFIED SCHEMATIC



ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Cathode Voltage	V_{KA}	18	V
Continuous Cathode Current	I_K	100	mA
Reference Input Current	I_{REF}	3	mA
Power Dissipation	P_D	0.35	W
Junction Temperature	T_J	+150	^oC
Operation Temperature Range	T_{OPER}	-40 ~ +105	^oC
Storage Temperature Range	T_{STG}	-65 ~ +150	^oC

Note:
1: Voltage values are with respect to the anode terminal unless otherwise noted.
2: Rating apply to ambient temperature at 25^oC

RECOMMEND OPERATING CONDITION

PARAMETER	SYMBOL	LIMIT	UNIT
Cathode Voltage (Note 1)	V_{KA}	18	V
Continuous Cathode Current Range	I_K	100	mA

ELECTRICAL SPECIFICATIONS (T_A=+25^oC, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT
Reference voltage	V_{REF}	V_{KA}=V_{REF}, I_K=10mA (Figure 1)	TS432AI	1.227	1.24	1.252	V
			TS432BI	1.233		1.246	
Deviation of reference input voltage	ΔV_{REF}	V_{KA}=V_{REF}, I_K=10mA (Figure 1) T_A=full range		--	10	25	mV
Radio of change in Vref to change in cathode Voltage	ΔV_{REF} /ΔV_{KA}	I_{KA}=10mA, V_{KA}=18V to V_{REF} (Figure 2)		--	-1.0	-2.7	mV/V
Reference Input current	I_{REF}	R1=10kΩ, R2=∞ I_{KA}=10mA (Figure 2)		--	0.25	0.5	µA
Deviation of reference input current, over temp.	ΔI_{REF}	R1=10kΩ, R2=∞, I_{KA}=10mA T_A= full range (Figure 2)		--	0.04	0.08	µA
Off-state Cathode Current	$I_{KA(off)}$	V_{REF} =0V (Figure 3), V_{KA} =18V		--	0.125	0.5	µA
Dynamic Output Impedance	$\vert Z_{KA} \vert$	f<1kHz, V_{KA}=V_{REF} (Figure 1) I_{KA}=1mA to 100mA		--	0.2	0.4	Ω
Minimum operating cathode current	I_{KA} (min)	V_{KA}=V_{REF} (Figure 1)		--	60	80	µA

Note: The deviation parameters ΔV_{REF} and ΔI_{REF} are defined as difference between the maximum value and minimum value obtained over the full operating ambient temperature range that applied.

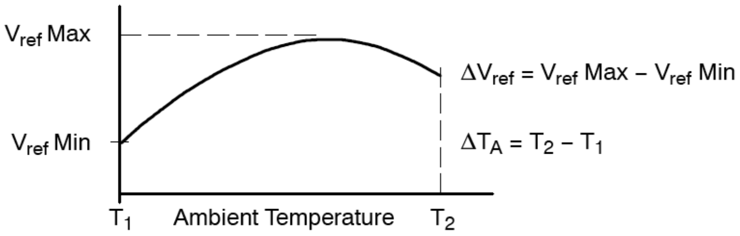
ORDERING INFORMATION

ORDERING CODE	PACKAGE	PACKING
TS432AIX RFG	SOT-23	3,000pcs / 7” Reel
TS432BIX RFG	SOT-23	3,000pcs / 7” Reel

DEVIATION PARAMETERS

* The average temperature coefficient of the reference input voltage, αV_{REF} is defined as:

$$\alpha V_{ref}\left(\frac{ppm}{^\circ C}\right) = \frac{\left(\dfrac{(\Delta V_{ref})}{V_{ref}\ (T_A = 25^\circ C)} \times 10^6\right)}{\Delta T_A}$$



Where:

T2-T1 = full temperature change.

αV_{REF} can be positive or negative depending on whether V_{REF} Min. or V_{REF} Max occurs at the lower ambient temperature. Example: ΔV_{REF}=7.2mV and the slope is positive, V_{REF}=1.241V at 25°C, ΔT=125°C

$$\alpha V_{ref}\left(\frac{ppm}{^\circ C}\right) = \frac{\dfrac{0.0072}{1.241} \times 10^6}{125} = 46\ ppm/^\circ C$$

Dynamic Impedance

The dynamic impedance Z_{KA} is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

When the device operating with two external resistors, R1 and R2, (refer to Figure 2) the total dynamic impedance of the circuit is given by:

$$|Z_{KA}'| = |Z_{KA}| \times \left(1 + \frac{R1}{R2}\right)$$

Calculating Deviation Parameters and Dynamic Impedance

TEST CIRCUIT

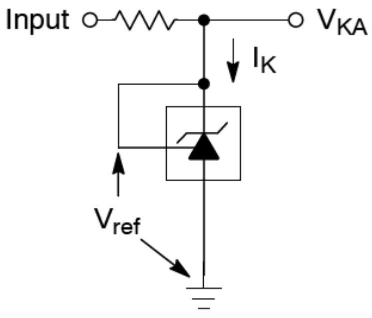


Figure 1: $V_{KA} = V_{REF}$

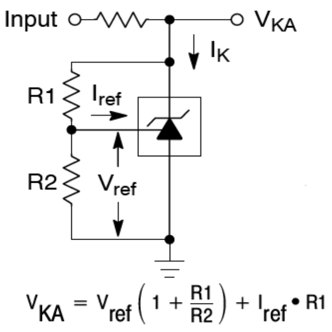


Figure 2: $V_{KA} > V_{REF}$

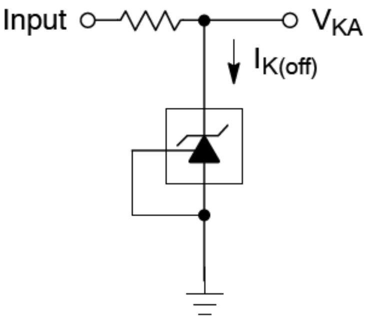


Figure 3: Off-State Current

APPLICATION INFORMATION

When The TS432AI/432BI is used as a shunt regulator, there are two options for selection of C_L, are recommended for optional stability:

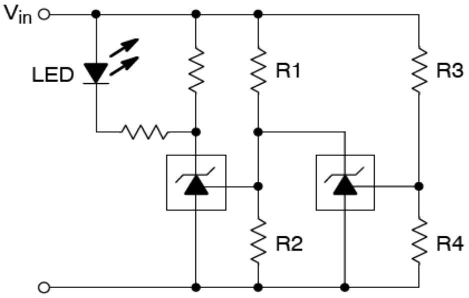
A) No load capacitance across the device, decouple at the load.

B) Large capacitance across the device, optional decoupling at the load.

The reason for this is that TS432AI/432BI exhibits instability with capacitances in the range of 10nF to 1µF (approx.) at light cathode current up to 3mA (typ). The device is less stable the lower the cathode voltage has been set for. Therefore while the device will be perfectly stable operating at a cathode current of 10mA (approx.) with a 0.1µF capacitor across it, it will oscillate transiently during start up as the cathode current passes through the instability region. Select a very low capacitance, or alternatively a high capacitance (10µF) will avoid this issue altogether. Since the user will probably wish to have local decoupling at the load anyway, the most cost effective method is to use no capacitance at all directly across the device. PCB trace/via resistance and inductance prevent the local load decoupling from causing the oscillation during the transient start up phase.

Note: if the TS432AI/432BI is located right at the load, so the load decoupling capacitor is directly across it, then this capacitor will have to be ≤1nF or ≥10µF.

APPLICATION EXAMPLE

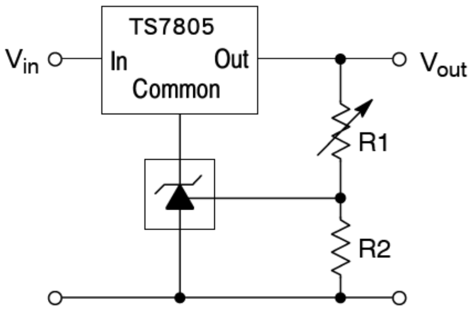


L.E.D. indicator is 'ON' when V_{in} is between the upper and lower limits,

$$\text{Lower limit} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

$$\text{Upper limit} = \left(1 + \frac{R3}{R4}\right) V_{ref}$$

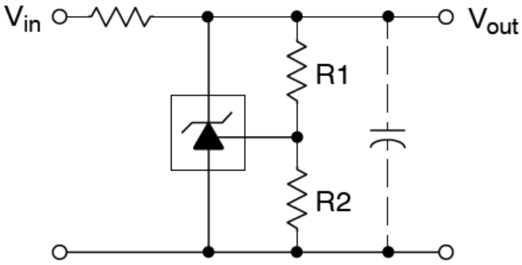
Figure 4: Voltage Monitor



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

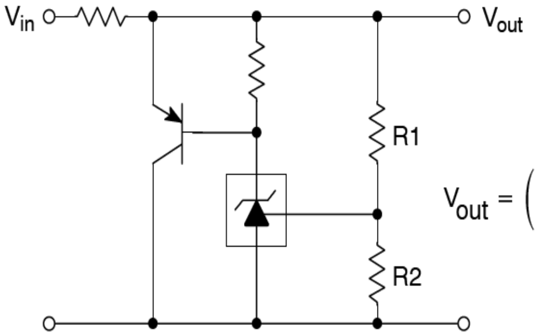
$$V_{out(min)} = V_{ref} + 5.0\text{ V}$$

Figure 5: Output Control for Three Terminal Fixed Regulator



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

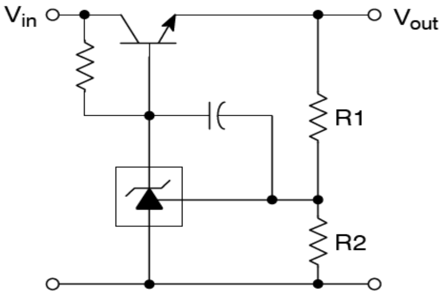
Figure 6: Shunt Regulator



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 7: High Current Shunt Regulator

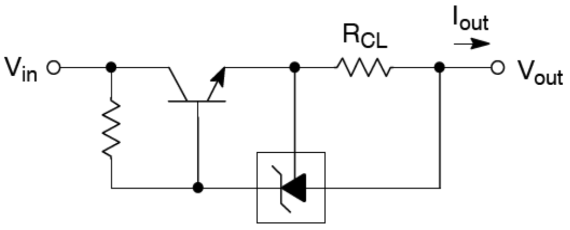
APPLICATION EXAMPLE (CONTINUE0



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

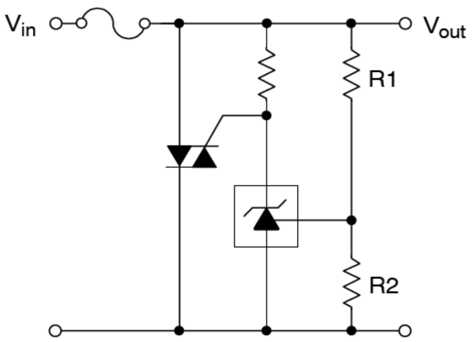
$$V_{out(min)} = V_{ref} + V_{be} \approx 2.0\ V$$

Figure 8: Series Pass Regulator



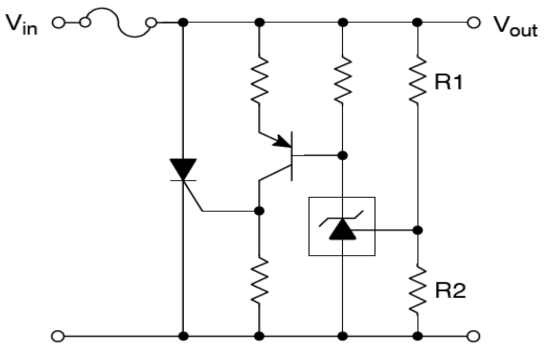
$$I_{out} = \frac{V_{ref}}{R_{CL}}$$

Figure 9: Constant Current Source



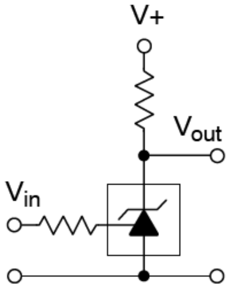
$$V_{out(trip)} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 10: TRIAC Crowbar



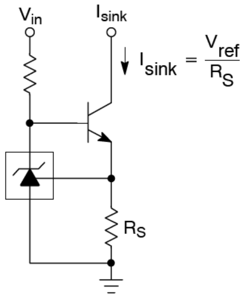
$$V_{out(trip)} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 11: SCR Crowbar



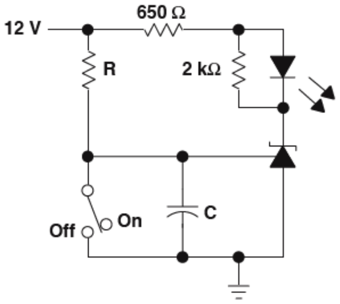
V_{IN}	V_{OUT}
$<V_{REF}$	V+
$>V_{REF}$	≈0.74V

Figure 12: Single-Supply Comparator with Temperature-Compensated Threshold



$$I_{sink} = \frac{V_{ref}}{R_S}$$

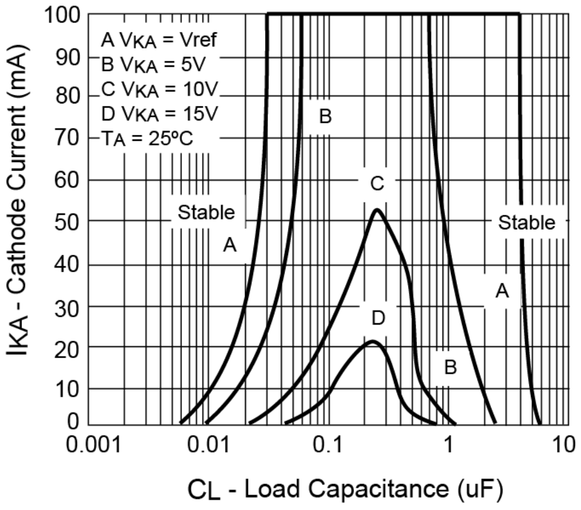
Figure 13: Constant Current Sink

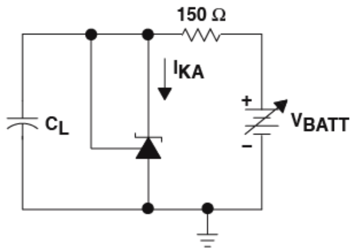


$$\text{Delay} = R \times C \times l_n\left(\frac{12\ V}{12\ V - V_{ref}}\right)$$

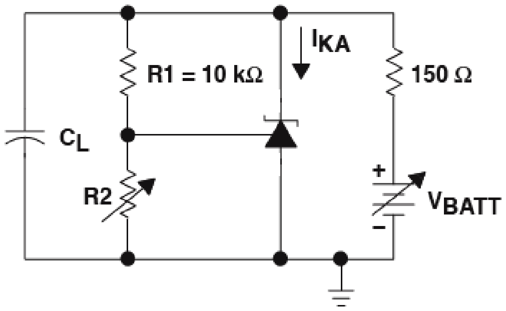
Figure 14: Delay Timer

TYPICAL PERFORMANCE CHARACTERISTICS





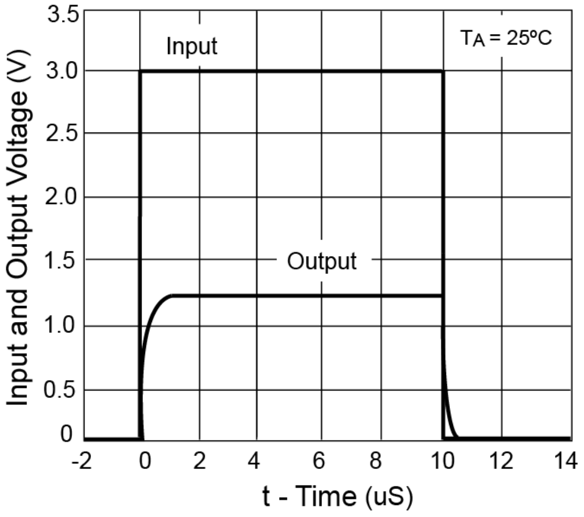
Test Circuit for Curve A

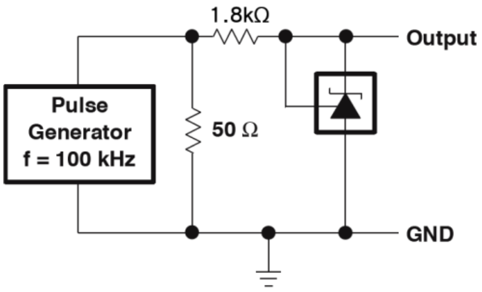


Test Circuit for Curve B, C and D

The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial VKA and IKA conditions with CL=0. VBATT and CL then were adjusted to determine the ranges of stability.

Figure 17: Stability Boundary Condition





Test Circuit for Pulse Response, Ik=1mA

Figure 18: Pulse Response

CHARACTERISTICS CURVES

(T_C = 25°C unless otherwise noted)

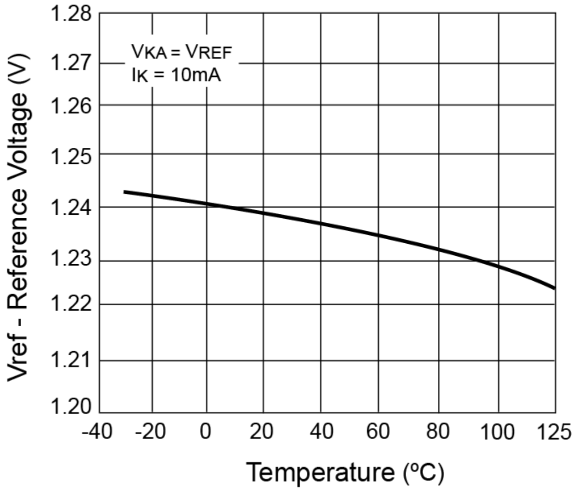


Figure 19: Reference Voltage vs. Temperature

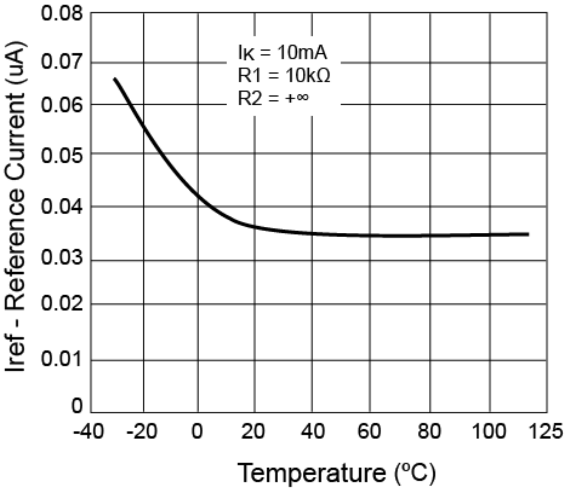


Figure 20: Reference Current vs. Temperature

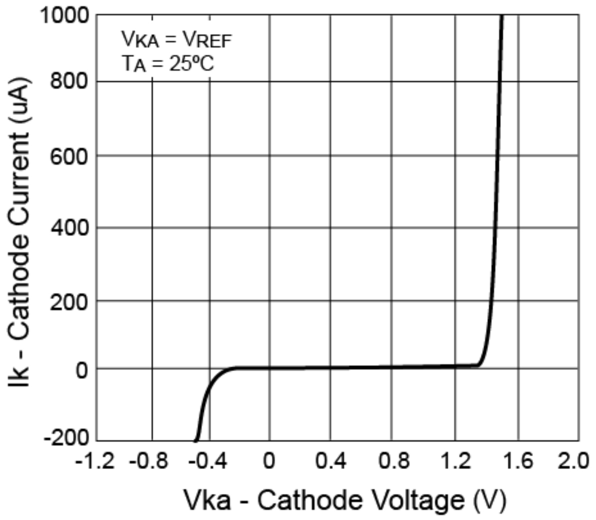
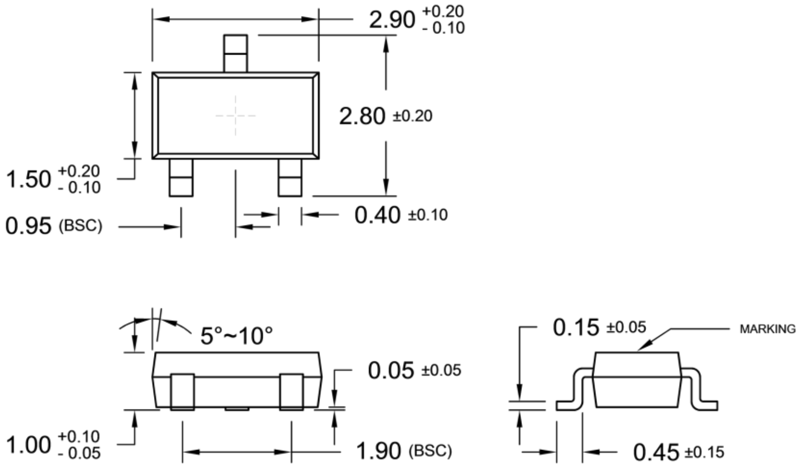


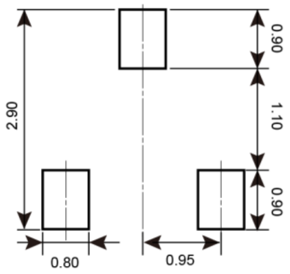
Figure 21: Cathode Current vs. Cathode Voltage

PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

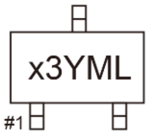
SOT-23



SUGGESTED PAD LAYOUT (Unit: Millimeters)



MARKING DIAGRAM



x = Device Code (**D** = TS432AI, **E** = TS432BI)
3 = SOT-23 package
Y = Year Code
M = Month Code for Halogen Free Product
    O =Jan **P** =Feb **Q** =Mar **R** =Apr
    S =May **T** =Jun **U** =Jul **V** =Aug
    W =Sep **X** =Oct **Y** =Nov **Z** =Dec
L = Lot Code (1~9, A~Z)

Notice