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EVAL-ADCMP396EBZ User Guide

UG-759

Evaluation Board for ADCMP396 Quad Comparator with Accurate Reference Output

FEATURES

Positive and negative voltage monitoring
LED indicated voltage output status
Test points for easy probing

PACKAGE CONTENTS

EVAL-ADCMP396EBZ evaluation board

EVALUATION BOARD DESCRIPTION

The EVAL-ADCMP396EBZ features accurate positive and negative voltage monitoring with 0.9% accuracy. The evaluation board uses LEDs to indicate an overvoltage or undervoltage event in both positive and negative voltage being monitored.

DEVICE DESCRIPTION

The ADCMP396 is a quad rail-to-rail input low power comparator suitable for general-purpose applications. The ADCMP396 consumes only 41.61 μA of supply current making it ideal for battery-powered systems.

The ADCMP396 has a common-mode input range of 200 mV beyond rails, a typical offset voltage of 1 mV across the full common-mode range, and an undervoltage lockout (UVLO) monitor. In addition, the design of the comparator allows a defined output state upon power-up, it generates a logic low output while the supply is still below the UVLO threshold.

The ADCMP396 incorporates a 1 V ± 0.9% buffered reference voltage over line, load, and temperature.

EVALUATION BOARD PHOTOGRAPH

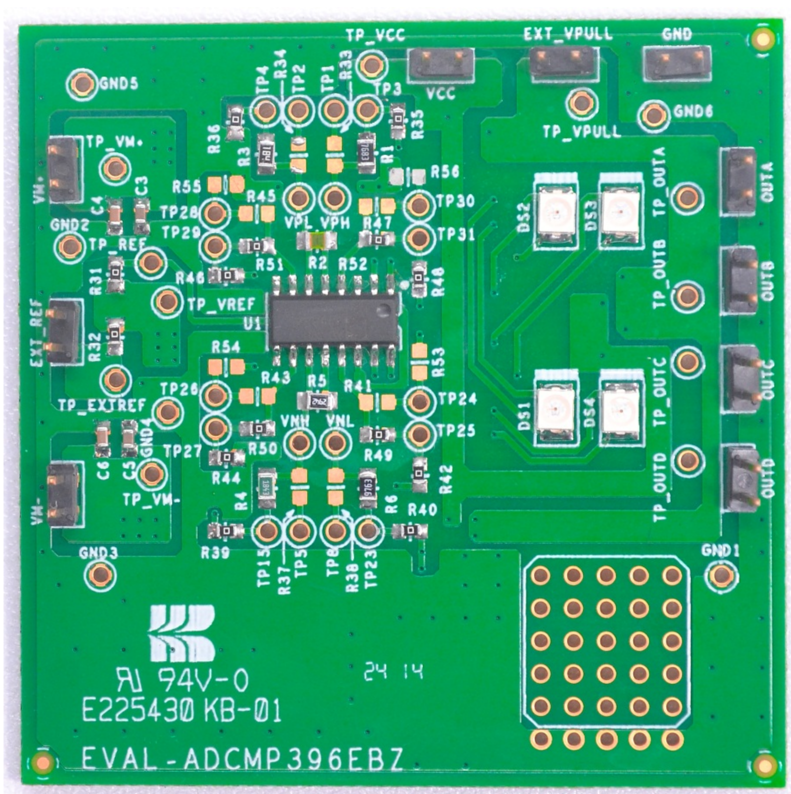

Figure 1.

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REVISION HISTORY

12/14—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POSITIVE AND NEGATIVE VOLTAGE MONITORING

When monitoring a positive supply, the desired nominal operating voltage for monitoring is denoted by V_M, I_M is the nominal current through the resistor divider, V_{OV} is the overvoltage trip point, and V_{UV} is the undervoltage trip point.

Figure 2 illustrates the positive voltage monitoring input connection. Three external resistors, R1, R2, and R3, divide the positive voltage for monitoring, V_{M+}, into high-side voltage, V_{PH}, and low-side voltage, V_{PL}.

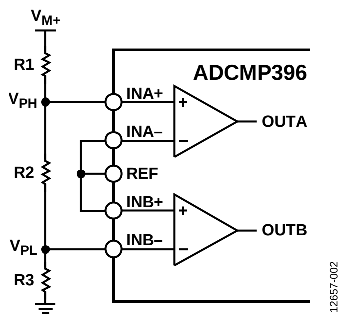

Figure 2. Positive Undervoltage/Overvoltage Monitoring Configuration

To trigger an overvoltage condition, the low-side voltage (in this case, V_{PL}) must exceed the V_{REF} threshold. The low-side voltage, V_{PL}, is given by Equation 1:

$$V_{PL} = V_{REF} = V_{OV+}\left(\frac{R3}{R1+R2+R3}\right) \quad (1)$$

where $R1+R2+R3=\frac{V_{M+}}{I_{M+}}$

Therefore, R3, which sets the desired trip point for the overvoltage monitor, is calculated using Equation 2:

$$R3=\frac{(V_{REF})(V_{M+})}{(V_{OV+})(I_{M+})} \quad (2)$$

To trigger the undervoltage condition, the high-side voltage, V_{PH}, must be less than the V_{REF} threshold. The high-side voltage, V_{PH}, is given by Equation 3:

$$V_{PH} = V_{REF} = V_{UV+}\left(\frac{R2+R3}{R1+R2+R3}\right) \quad (3)$$

Because R3 is already known, R2 can be expressed as follows:

$$R2=\frac{(V_{REF})(V_{M+})}{(V_{UV+})(I_{M+})}-R3 \quad (4)$$

When R2 and R3 are known, R1 is calculated using Equation 5:

$$R1=\frac{V_{M+}}{I_{M+}}-R2-R3 \quad (5)$$

If V_{M+}, I_{M+}, V_{OV+}, or V_{UV+} change, each step must be recalculated.

Figure 3 shows the circuit configuration for the negative supply voltage monitoring. To monitor a negative voltage, a reference voltage is required to connect to the end node of the voltage divider circuit, in this case REF.

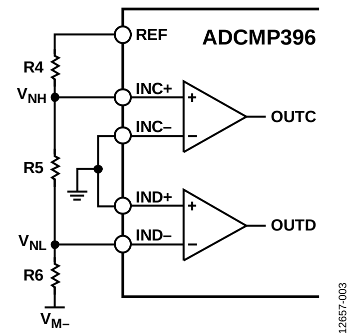

Figure 3. Negative Undervoltage/Overvoltage Monitoring Configuration

Equation 2, Equation 4, and Equation 5 need some minor modifications for use with negative voltage monitoring. The reference voltage, V_{REF}, is added to the overall voltage drop; it must therefore be subtracted from V_{M-}, V_{UV-}, and V_{OV-} before using each in negative voltage monitoring.

Three external resistors, R4, R5, and R6, divide the positive voltage for monitoring, V_{M-}, into the high-side voltage, V_{NH}, and low-side voltage, V_{NL}.

To trigger an overvoltage condition, the monitored voltage must be more negative than the nominal voltage, the high-side voltage (in this case, V_{NH}) must be more negative than ground. The high-side voltage, V_{NH}, is given by Equation 6:

$$V_{NH} = GND = \left[(V_{REF}-V_{OV-})\left(\frac{R5+R6}{R4+R5+R6}\right)\right]+V_{OV-} \quad (6)$$

where $R4+R5+R6=\frac{(V_{M-}-V_{REF})}{I_{M-}}$

Therefore, R4, which sets the desired trip point for the overvoltage monitor, is calculated using Equation 7:

$$R4=\frac{V_{REF}(V_{M-}-V_{REF})}{I_{M-}(V_{REF}-V_{OV-})} \quad (7)$$

To trigger an undervotlage condition, the monitored voltage must be more positive than the nominal voltage, the low-side voltage (in this case, V_{NL}) must be more positive than ground. Equation 8 gives the low-side voltage, V_{NL}:

$$V_{NL} = GND = \left[(V_{REF}-V_{UV-})\left(\frac{R6}{R4+R5+R6}\right)\right]+V_{UV-} \quad (8)$$

Because R4 is already known, R5 can be expressed as follows:

$$R5=\frac{V_{REF}(V_{M-}-V_{REF})}{I_{M-}(V_{REF}-V_{UV-})}-R4 \quad (9)$$

When R4 and R5 are known, R6 is calculated using the following formula:

$$R6=\frac{(V_{M-}-V_{REF})}{I_{M-}}-R5-R6 \quad (10)$$

POSITIVE AND NEGATIVE VOLTAGE MONITORING EXAMPLE

The EVAL-ADCMP396EBZ is designed to monitor 3.3 V ± 10% both in positive and negative polarities.

The nominal voltage for the EVAL-ADCMP396EBZ is 3.3 V and the nominal current through the resistor divider is 5 µA for positive voltage monitoring and −5 µA for negative voltage monitoring.

For the positive voltage monitoring, threshold V_{OV+} and V_{UV+} are 3.63 V and 2.97 V, respectively. The V_{REF} used is the 1 V reference of the ADCMP396. Use Equation 2 for R3.

$$R3 = \frac{(V_{REF})(V_{M+})}{(V_{OV+})(I_{M+})}$$

$$R3 = \frac{(1\ \text{V})(3.3\ \text{V})}{(3.63\ \text{V})(5\ \mu\text{A})}$$

$$R3 = 181.8\ \text{k}\Omega$$

Because R3 is already known, compute for R2 using Equation 4,

$$R2 = \frac{(V_{REF})(V_{M+})}{(V_{UV+})(I_{M+})} - R3$$

$$R2 = \frac{(1\ \text{V})(3.3\ \text{V})}{(2.97)(5\ \mu\text{A})} - 181.8\ \text{k}\Omega$$

$$R2 = 40.4\ \text{k}\Omega$$

When both R2 and R3 are known, compute for R1 using Equation 5,

$$R1 = \frac{V_{M+}}{I_{M+}} - R2 - R3$$

$$R1 = \frac{3.3\ \text{V}}{5\ \mu\text{A}} - 181.8\ \text{k}\Omega - 40.4\ \text{k}\Omega$$

$$R1 = 437.78\ \text{k}\Omega$$

For the negative voltage monitoring, thresholds for V_{OV-} and V_{UV-} are −3.63 V and −2.97 V, respectively. Negative voltage monitoring also uses the 1 V reference of the ADCMP396 as V_{REF}. Compute for R4 using Equation 7:

$$R4 = \frac{V_{REF}(V_{M-} - V_{REF})}{I_{M-}(V_{REF} - V_{OV-})}$$

$$R4 = \frac{1\ \text{V}(-3.3\ \text{V} - 1\ \text{V})}{-5\ \mu\text{A}(1\ \text{V} + 3.63\ \text{V})}$$

$$R4 = 185.8\ \text{k}\Omega$$

Because R4 is already known, compute for R5 using Equation 9,

$$R5 = \frac{V_{REF}(V_{M-} - V_{REF})}{I_{M-}(V_{REF} - V_{UV-})} - R4$$

$$R5 = \frac{1\ \text{V}(-3.3\ \text{V} - 1\ \text{V})}{-5\ \mu\text{A}(1\ \text{V} + 2.97\ \text{V})} - 185.8\ \text{k}\Omega$$

$$R5 = 30.9\ \text{k}\Omega$$

When both R4 and R5 are known, compute for R6 using Equation 10,

$$R6 = \frac{(V_{M-} - V_{REF})}{I_{M-}} - R5 - R6$$

$$R6 = \frac{(-3.3\ \text{V} - 1\ \text{V})}{-5\ \mu\text{A}} - 185.8\ \text{k}\Omega - 30.9\ \text{k}\Omega$$

$$R6 = 643.3\ \text{k}\Omega$$

Calculated resistor values are replaced with the following standard values:

$R1 = 432\ \text{k}\Omega$

$R2 = 40.2\ \text{k}\Omega$

$R3 = 180\ \text{k}\Omega$

$R4 = 184\ \text{k}\Omega$

$R5 = 29.4\ \text{k}\Omega$

$R6 = 634\ \text{k}\Omega$

Because the resistor values were changed, the actual overvoltage and undervoltage trip points are changed. The actual V_{OV} and V_{UV} thresholds can be computed by the following formulas:

$$R_{T+} = R1 + R2 + R3 \quad (11)$$

$$R_{T-} = R4 + R5 + R6 \quad (12)$$

$$V_{OV+} = \frac{V_{REF}(R_{T+})}{R3} \quad (13)$$

$$V_{OV+} = 3.623\ \text{V}$$

$$V_{UV+} = \frac{V_{REF}(R_{T+})}{(R2 + R3)} \quad (14)$$

$$V_{UV+} = 2.962\ \text{V}$$

$$V_{OV-} = \frac{-V_{REF}(R5 + R6)}{R4} \quad (15)$$

$$V_{OV-} = -3.605\ \text{V}$$

$$V_{UV-} = \frac{-V_{REF}(R6)}{R4 + R5} \quad (16)$$

$$V_{UV-} = -2.971\ \text{V}$$

The demo board uses LEDs to indicate if an overvoltage or an undervoltage scenario happened. Table 1 the truth table of the demo board light indication.

Table 1. Demo Board Light Indication Truth Table

Monitored Voltage	Fault	DS1	DS2	DS3	DS4
V_{M+}	V_{OV}				
	V_{UV}				
V_{M-}	V_{OV}				
	V_{UV}				

SWITCH, JUMPER, LED, AND CONNECTOR FUNCTIONS

Table 2. Pin Header Functions

Connector	Description
V_{CC}	Supply connector. Connect 2.3 V to 5.5 V.
EXT_VPULL	Input pin for the pull-up voltage.
EXT_VREF	Input pin for an external reference voltage.
VM+	Input pin for the positive voltage being monitored.
VM−	Input pin for the negative voltage being monitored.
OUTA	Output pin of Channel A.
OUTB	Output pin of Channel B.
OUTC	Output pin of Channel C.
OUTD	Output pin of Channel D.

Table 3. LED Functions

LED	Description
DS1	This LED used to indicate an undervoltage event in the positive voltage.
DS2	This LED used to indicate an overvoltage event in the positive voltage.
DS3	This LED used to indicate an overvoltage event in the negative voltage.
DS4	This LED used to indicate an undervoltage event in the negative voltage.

Table 4. Test Points

Test Point	Description
VPH	Positive high-side voltage.
VPL	Positive low-side voltage.
VNH	Negative high-side voltage.
VNL	Negative low-side voltage.
TP_REF	ADCMP396 reference test point.
TP_VREF	Reference voltage used for the resistor dividers.
TP_VPULL	External pull-up voltage.
TP_VCC	Supply voltage.
TP_VM+	Positive voltage.
TP_VM−	Negative voltage.
GND1	Ground.
GND2	Ground.
GND3	Ground.
GND4	Ground.
GND5	Ground.
GND6	Ground.
TP_OUTA	OUTA.
TP_OUTB	OUTB.
TP_OUTC	OUTC.
TP_OUTD	OUTD.

EVALUATION BOARD OVERVIEW

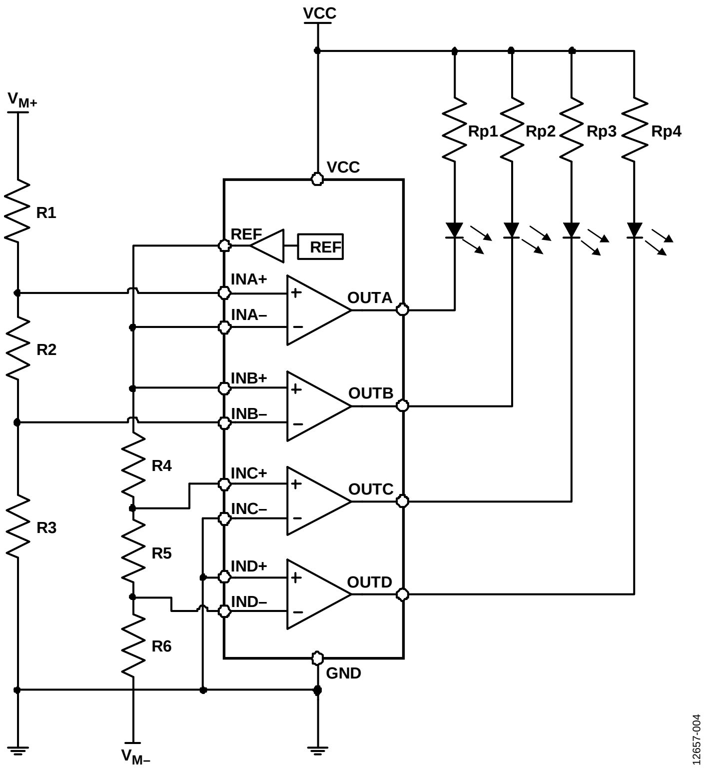

Figure 4. Evaluation Board Simplified Schematic

EVALUATION BOARD SCHEMATIC AND ARTWORK

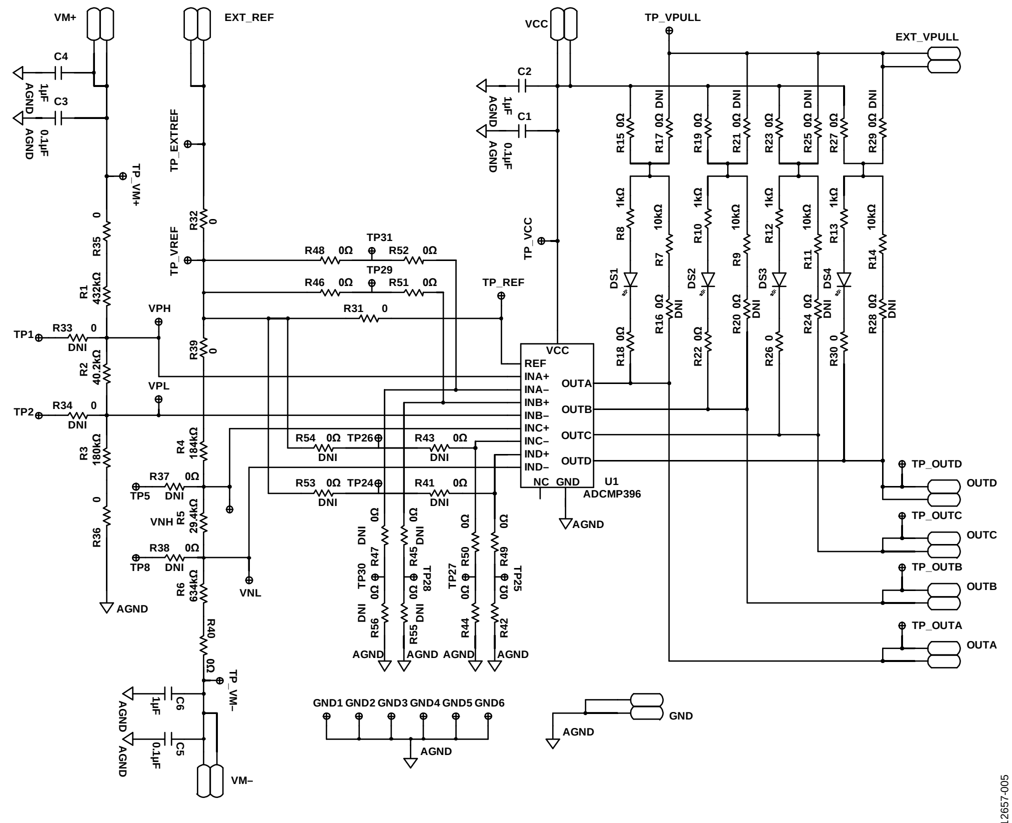

Figure 5. Evaluation Board Schematic

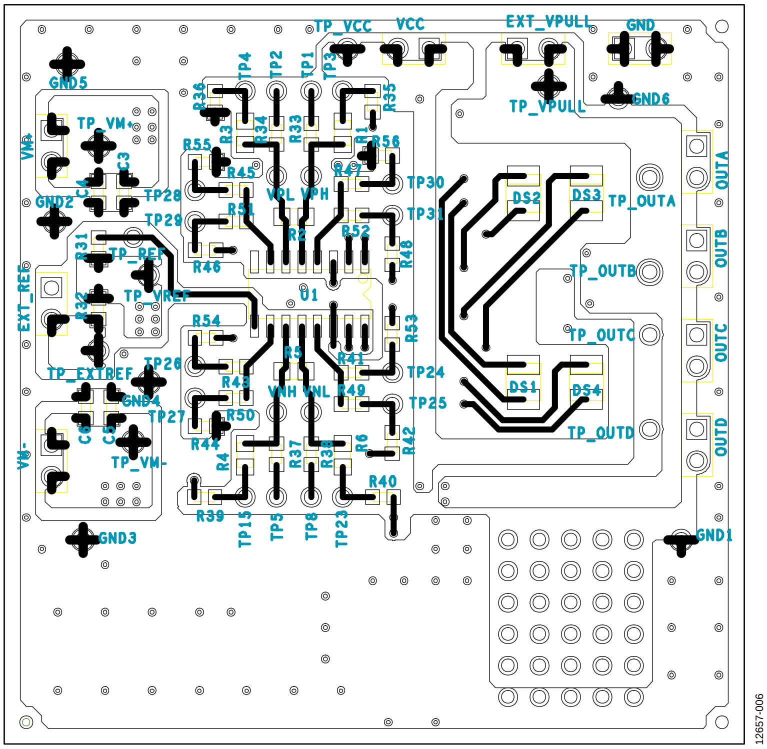

Figure 6. Evaluation Board Top Side Layout

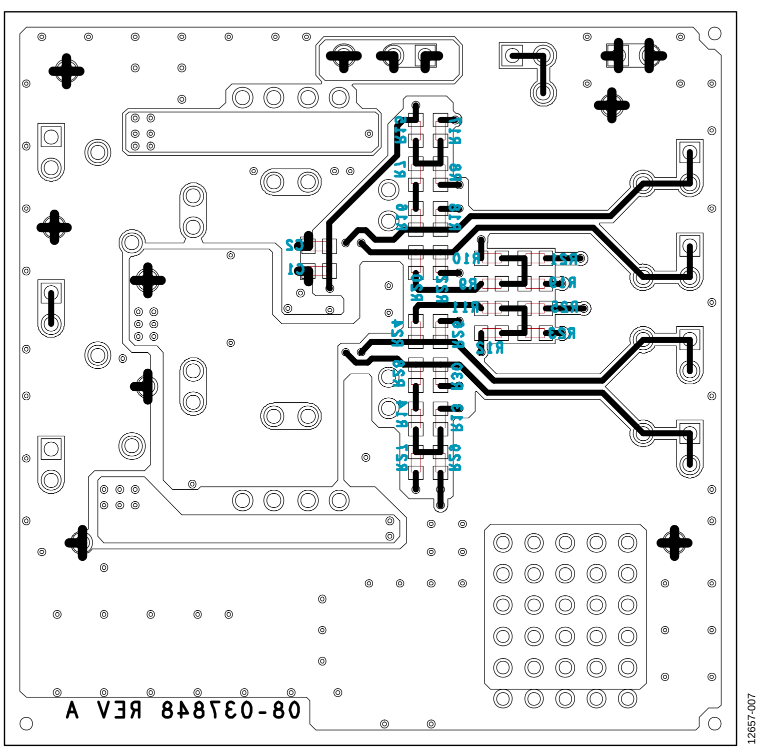

Figure 7. Evaluation Board Bottom Side Layout

ORDERING INFORMATION

BILL OF MATERIALS

Table 5.

Reference Designator	Part Description	Part Number
U1	Quad comparator with accurate reference output	ADCMP396ARZ
C1, C3, C5	Capacitor, 0.1 µF, 0603, 10%, 100 V	GCM188R72A104KA64D
C2, C4, C6	Capacitor, 1 µF, 0603, 10%, 100 V	GRM188R71A105KA61D
DS1 to DS4	LED, red	VLMS30J1L2-GS08
R1	Resistor, 432 kΩ, 0805	ERA-6AEB4323V
R2	Resistor, 40.2 kΩ, 0805	PAT0805E4022BST1
R3	Resistor, 180 kΩ, 0805	RC0805JR-07180KL
R4	Resistor, 184 kΩ, 0805	PAT0805E1843BST1
R5	Resistor, 29.4 kΩ, 0805	ERJ-6ENF2942
R6	Resistor, 634 kΩ, 0805	ERA-6AEB6343V
R7, R9, R11, R14	Resistor, 10 kΩ, 0603	ERA-3YEB103V
R8, R10, R12, R13	Resistor, 1 kΩ, 0603	ERJ-3EKF1001V
R15, R18, R19, R22, R23, R26, R27, R30, R31, R35, R36, R39, R40, R42, R44, R46, R48 to R52	Resistor, 0 Ω, 0603	ERJ-3GEY0R00V

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