



ICN2053

(16-Channel PWM Constant Current LED Sink Driver)

Description

The ICN2053 is a 16-channel PWM constant current sink LED driver for 1:32 time multiplexing applications. The constant-current value of all 16 channels is set by a single external resistor.

ICN2053 converts serial input data into the gray scale of each pixel by a 16-bit shift register. ICN2053 detects individual LED open errors without extra components. ICN2053 also integrated pre-charge circuit for ghosting reduction.

The ICN2053 exploits precise current regulation technology, with both channel-to-channel error and chip-to-chip error less than $\pm 2.0\%$.

Features

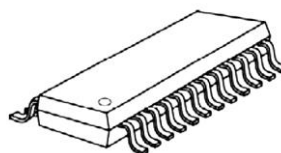
- ✧ 16 constant-current output channels
- ✧ Support time-multiplexing for 1~32 scans
- ✧ Output current setting range:
0.5~25mA×16@V_{DD}=5V constant current output
0.5~18mA×16@V_{DD}=4.2V constant current output
0.5~10mA×16@V_{DD}=3.3V constant current output
- ✧ Current accuracy
Between channel :< $\pm 2.0\%$ (Max.)
Between ICs :< $\pm 2.0\%$ (Max.)
- ✧ 8 bit current gain: 12.5%~200%
- ✧ Fast response of output current:
 \overline{OE} (min):20ns@V_{DD}=5V
- ✧ Data transfer frequency: f_{MAX}=35MHz(Max)
- ✧ Power supply voltage: V_{DD}=3.3~5V
- ✧ Operating Temperature: -40°C to +85°C
- ✧ Output current equation

$$I_{out} = \frac{9.23}{R_{EXT}}$$

- ✧ Pre-charge for ghosting reduction
- ✧ LED open detection
- ✧ Enhanced Circuit for Caterpillar Cancelling
- ✧ Low-gray scale enhancement
- ✧ Integrating LED protection circuit

Package

Shrink SOP



SSOP 24-150-0.635

Quad Flat No-Lead



BN: QFN24-4*4-0.5

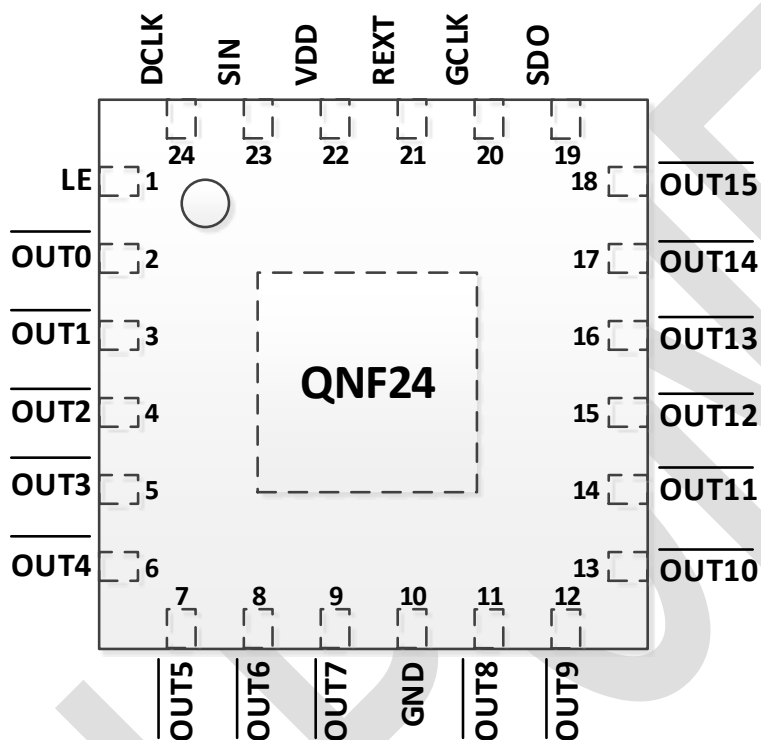
Quad Flat No-Lead



AN: QFN24-4*4-0.5

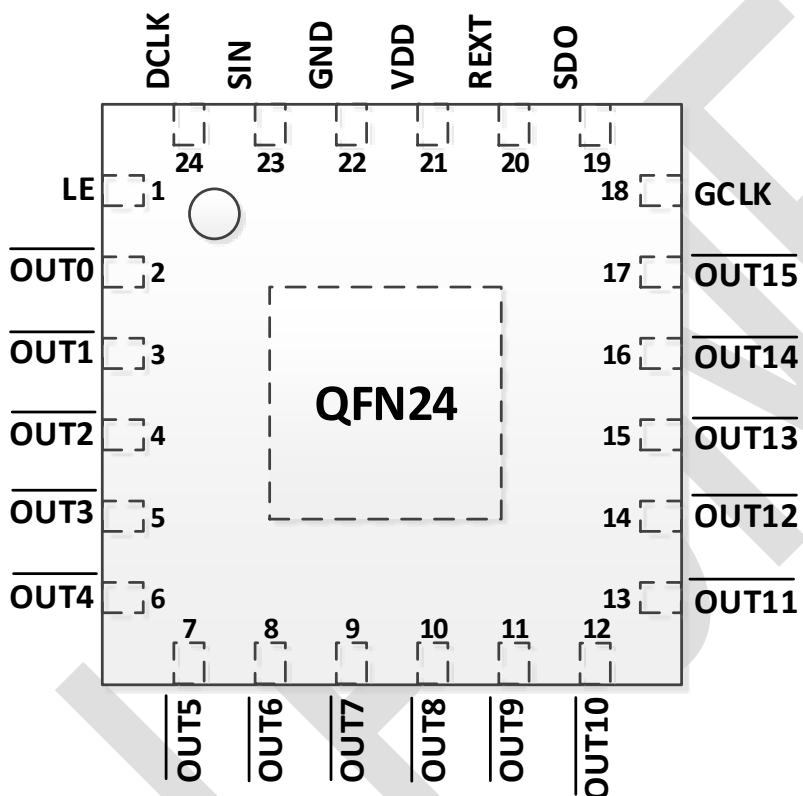
ICN2053

2 BN: QFN24-4*4-0.5



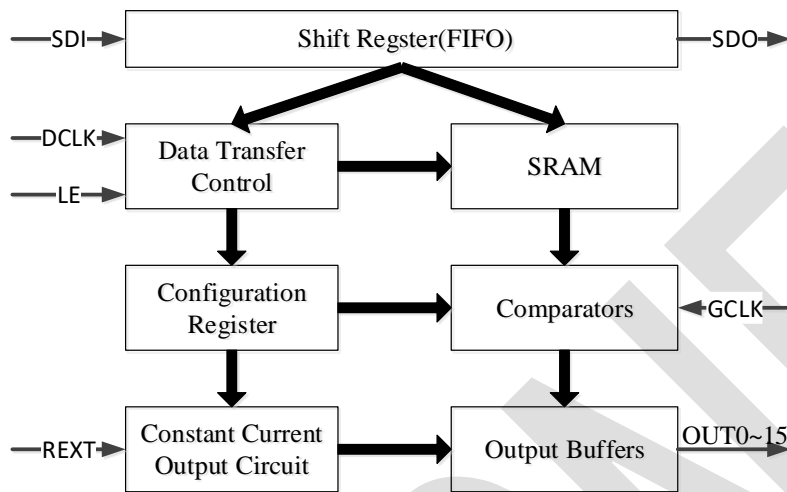
| ICN2053BN(QFN24) | | |
|------------------|--------------|---|
| Pin No. | Pin Name | Function |
| 1 | LE | Data transfer command input |
| 2~9,11~18 | OUT0 ~ OUT15 | Constant current output |
| 10 | GND | Power Ground |
| 19 | SDO | Serial data output |
| 20 | GCLK | The reference clock input pin for PWM gray scale control |
| 21 | REXT | Constant-current value setting .Connection to an external resistor to GND |
| 22 | VDD | Power-supply voltage |
| 23 | SIN | Serial data input |
| 24 | DCLK | Clock input terminal for data shift and command information |

3 AN: QFN24-4*4-0.5



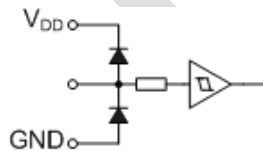
| ICN2053AN(QFN24) | | |
|------------------|--------------|---|
| Pin No. | Pin Name | Function |
| 1 | LE | Data transfer command input |
| 2~17 | OUT0 ~ OUT15 | Constant current output |
| 18 | GCLK | The reference clock input pin for PWM gray scale control |
| 19 | SDO | Serial data output |
| 20 | REXT | Constant-current value setting .Connection to an external resistor to GND |
| 21 | VDD | Power-supply voltage |
| 22 | GND | Power Ground |
| 23 | SIN | Serial data input |
| 24 | DCLK | Clock input terminal for data shift and command information |

ICN2053 Block Diagram

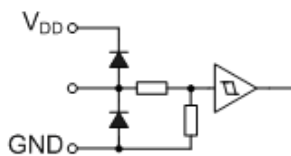


I/O Equivalent Circuits

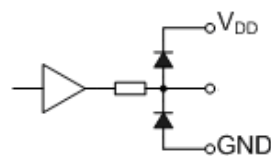
1. GCLK, SDI, LE



2. DCLK



3. SDO



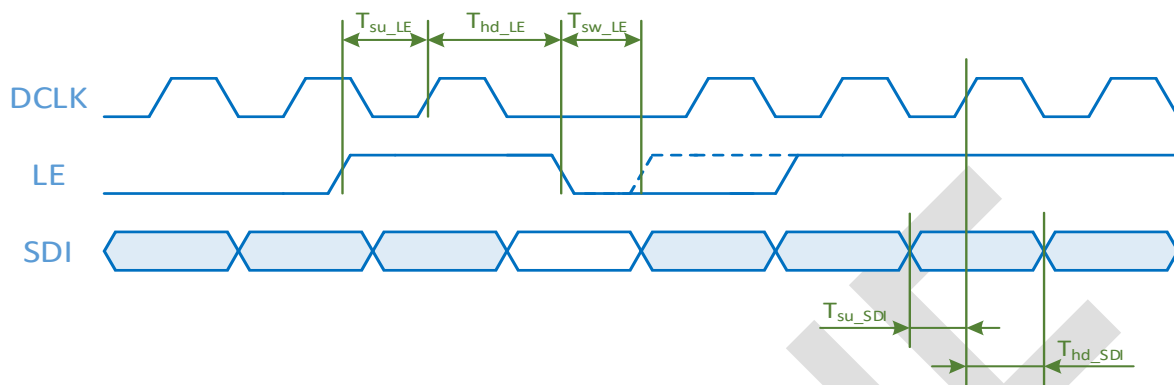
Control Command

| Command Name | Number of DCLK Rising Edge when LE is High | Description |
|--------------|--|---------------------------------|
| DATA_LATCH | 1 | Transfer Serial data to buffers |
| WR_DBG | 2 | Write Debug Register |
| VSYNC | 3 | Vertical Synchronal signal |
| WR_CFG1 | 4 | Write Configuration Register 1 |
| RD_CFG1 | 5 | Read Configuration Register 1 |
| WR_CFG2 | 6 | Write Configuration Register 2 |
| RD_CFG2 | 7 | Read Configuration Register 2 |
| WR_CFG3 | 8 | Write Configuration Register 3 |
| RD_CFG3 | 9 | Read Configuration Register 3 |
| WR_CFG4 | 10 | Write Configuration Register 4 |
| RD_CFG4 | 11 | Read Configuration Register 4 |
| EN_OP | 12 | Enable All Output Channels |
| DIS_OP | 13 | Disable All Output Channels |
| PRE_ACT | 14 | Pre-Active command |

Data Transfer Order

| Data Order | Line | Channel |
|------------|---------|--------------------|
| 1 | Line 1 | Channel 15 (OUT15) |
| 2 | | Channel 14 (OUT14) |
| | | |
| 16 | | Channel 0 (OUT0) |
| 17 | Line 2 | Channel 15 (OUT15) |
| 18 | | Channel 14 (OUT14) |
| | | |
| 32 | | Channel 0 (OUT0) |
| | | |
| 497 | Line 32 | Channel 15 (OUT15) |
| 498 | | Channel 14 (OUT14) |
| | | |
| 512 | | Channel 0 (OUT0) |

Timing Diagram



Maximum Rating ($T_a=25^\circ\text{C}$)

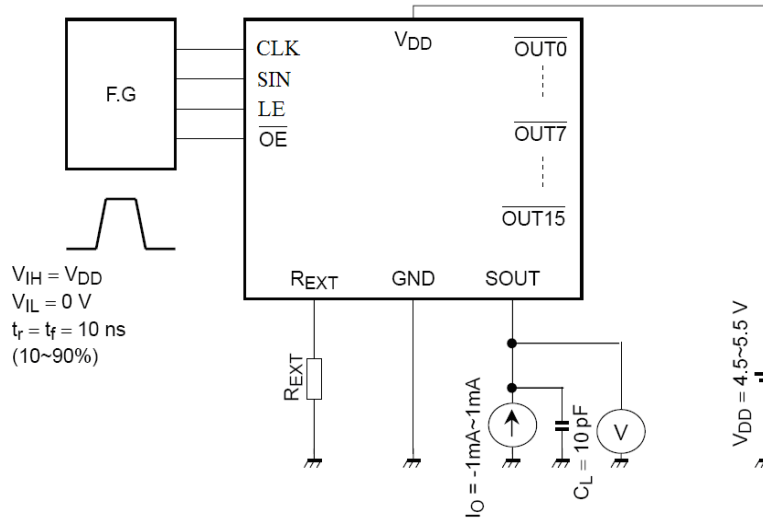
| Characteristics | | Symbol | Rating | Unit |
|-------------------------------------|---------|---------------|--------------------|------|
| Supply Voltage | | V_{DD} | 0~6.0 | V |
| Output Current | | I_o | 25 | mA |
| Input Voltage | | V_{IN} | -0.4~ $V_{DD}+0.4$ | V |
| Output voltage | | V_{OUT} | 11V | |
| Clock Frequency | | F_{CLK} | 35 | MHz |
| GND Terminal Current | | I_{GND} | +1000 | mA |
| Power Dissipation (On PCB, 25°C) | DN-type | P_D | 3.19 | W |
| Thermal Resistance | DN-type | $R_{th(j-a)}$ | 39.15 | °C/W |
| Operating Temperature | | T_{opr} | -40 ~ 85 | °C |
| Storage Temperature | | T_{stg} | -55 ~ 150 | °C |

Electrical Characteristics (Unless otherwise specified, $V_{DD}=4.5\sim 5.5\text{V}$, $T_a=25^\circ\text{C}$)

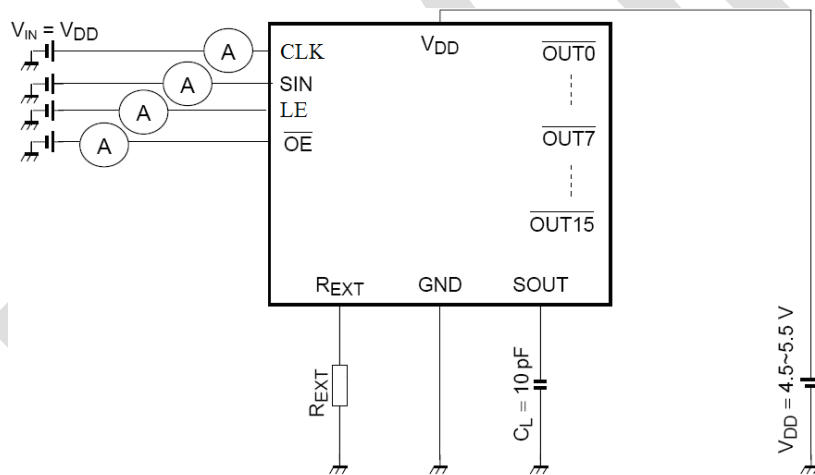
| Characteristics | Symbol | Test circuit | Test Conditions | Min | Typ | Max | Unit |
|--|--------------|--------------|--|--------------|--------------|-----------|------|
| High level logic output voltage | V_{OH} | 1 | $I_{OH}=-1\text{mA}$, SDO | $V_{DD}-0.4$ | - | V_{DD} | V |
| Low level logic output voltage | V_{OL} | 1 | $I_{OH}=+1\text{mA}$, SDO | - | - | 0.4 | V |
| High level logic input voltage | V_{IH} | | $0.7*V_{DD}$ | - | V_{DD} | V | |
| Low level logic input voltage | V_{IL} | 3 | GND | - | $0.3*V_{DD}$ | V | |
| High level logic input current | I_{IH} | 2 | $V_{IN}=V_{DD}$, SDI,CLK,LE,GCLK | - | - | 1 | μA |
| Low level logic input current | I_{IL} | 1 | $V_{IN}=\text{GND}$ SDI,CLK,LE,GCLK | -1 | - | - | μA |
| Power supply current | I_{DD1} | 4 | $R_{ext}=\text{Open}$, Out off | - | 4.5 | 6.0 | mA |
| | I_{DD2} | 4 | $R_{ext}=1.24\text{k}\Omega$, Out off | - | 6.0 | 7.0 | mA |
| Constant current error | ΔI_o | 5 | 0.5mA~25mA | - | ± 1.0 | ± 2.0 | % |
| Constant current power supply voltage regulation | $\%V_{DD}$ | 5 | $V_{DD}=4.5\sim 5.5\text{V}$, $R_{EXT}=3\text{k}\Omega$, $\overline{OUT0} \sim \overline{OUT15}$ | - | ± 0.1 | - | %/V |
| Constant current output voltage regulation | $\%V_{OUT}$ | 5 | $V_o=0.6\sim 3.0\text{V}$, $R_{EXT}=3\text{k}\Omega$, $\overline{OUT0} \sim \overline{OUT15}$ | - | ± 0.1 | | %/V |
| Pull-down resistor | R_{DOWN} | 2 | DCLK | 100 | 200 | 400 | kΩ |

Test Circuit

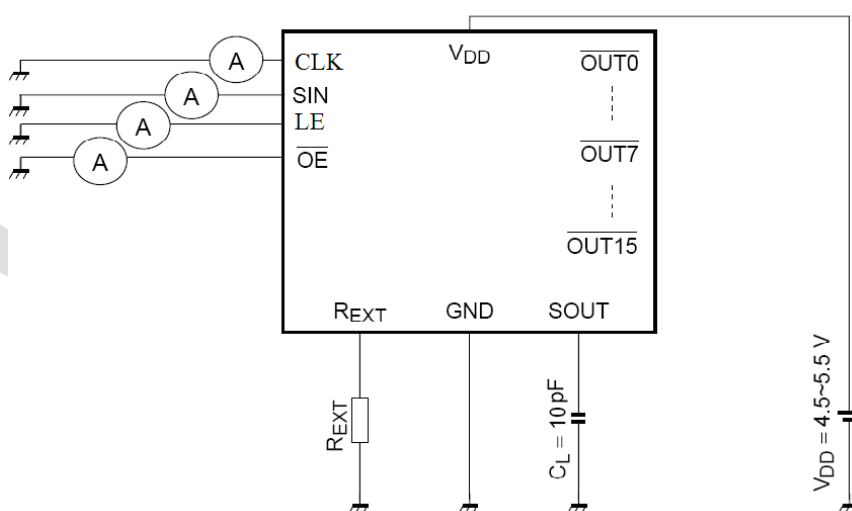
Test Circuit1: High level logic input voltage/Low level logic input voltage



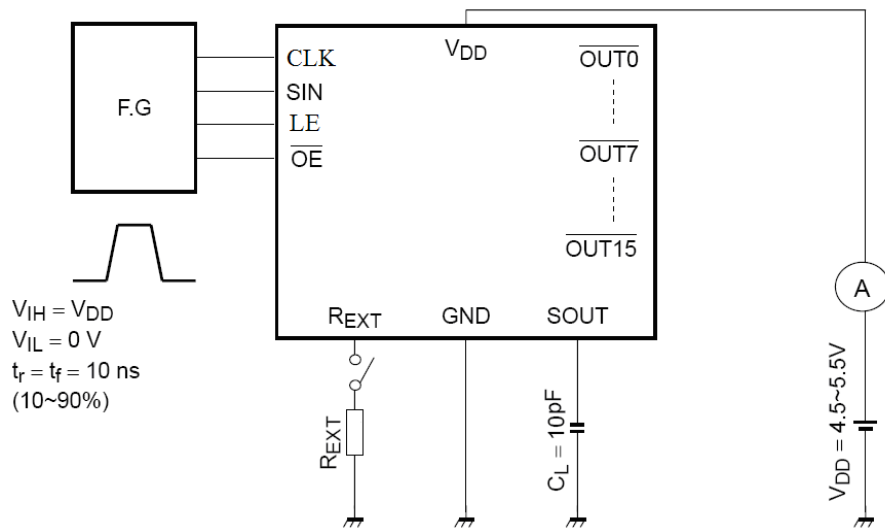
Test Circuit2: High level logic input current/Pull-down resistor



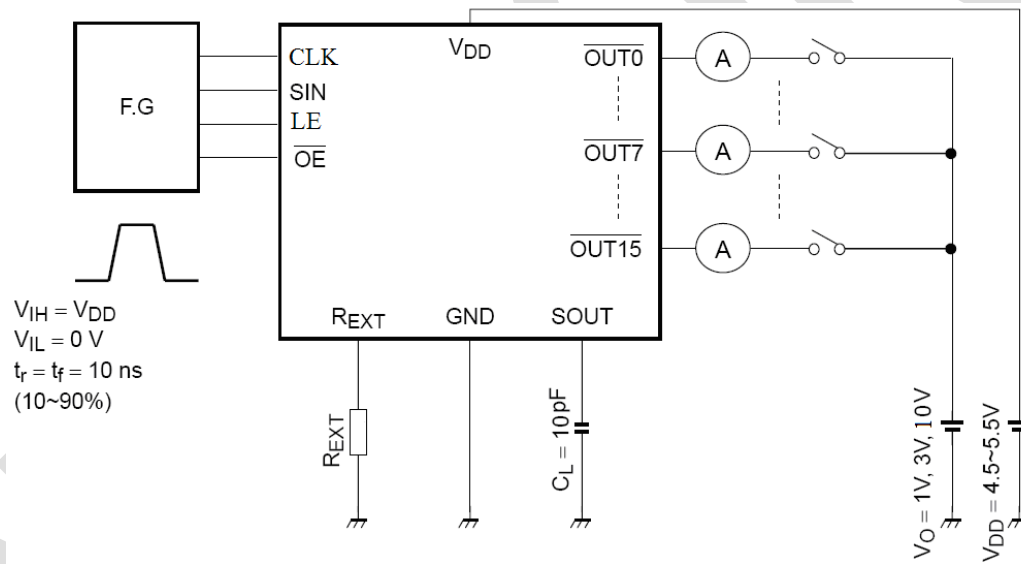
Test Circuit3: Low level logic input current/Pull-up resistor



Test Circuit4: Power supply current



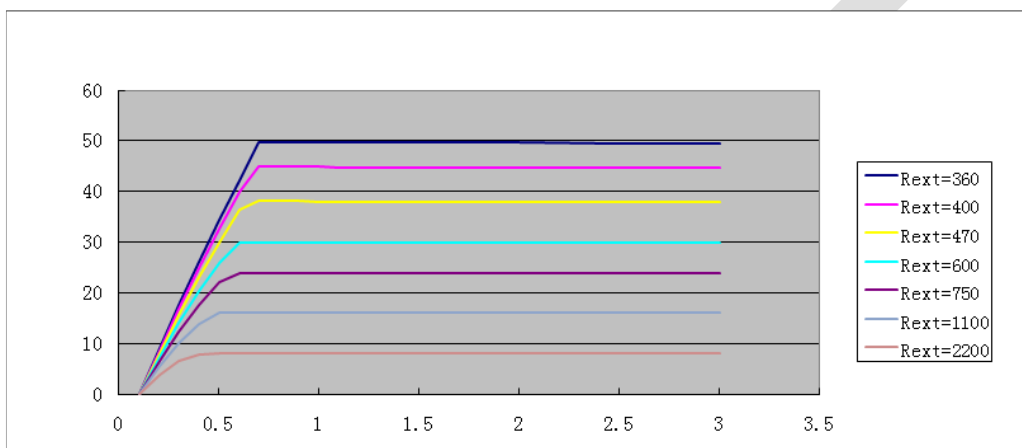
**Test Circuit5: Constant current output/Output OFF leak current/Constant current error
Constant current power supply voltage regulation/Constant current output voltage regulation**



Application Information

ICN2053 exploits precise current regulation technology, providing small channel-to-channel and IC-to-IC current variations.

- 1) The maximum current variation between channels is less than $\pm 2.0\%$, and that between ICs $< \pm 2.0\%$.
- 2) The current characteristic of output stage is flat. The output current can be kept constant regardless of the variations of LED forward voltage.



Setting Output Current

The output current (I_{out}) of ICN2053 is set by an external resistor, R_{ext}. The relationship between I_{out} and R_{ext} is :

$$V_{R-EXT}=1.232V, I_{gain}(\text{default})=200\%$$

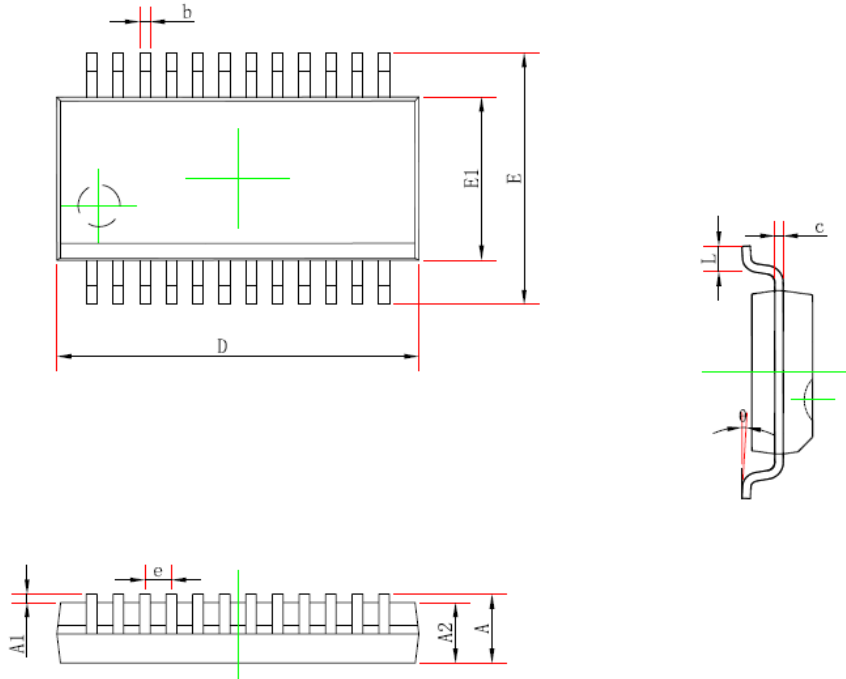
$$I_{out} = (V_{R-EXT} / R_{ext}) * 7.5$$

It is recommended that customers use the default value of $V_{R-EXT} = 2.464V$ for calculation.

Package Outline

(1) SSOP24-P-150-0.635

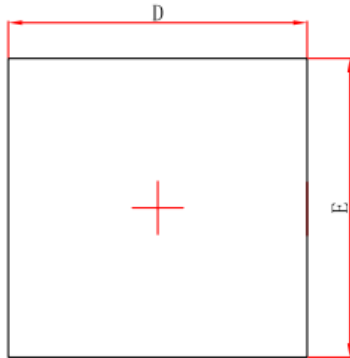
SSOP24 (150mil) PACKAGE OUTLINE DIMENSIONS



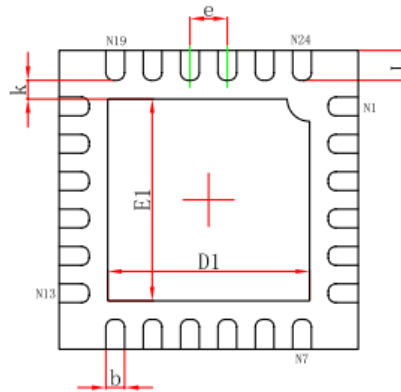
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | — | 1.750 | — | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.250 | — | 0.049 | — |
| b | 0.203 | 0.305 | 0.008 | 0.012 |
| c | 0.102 | 0.254 | 0.004 | 0.010 |
| D | 8.450 | 8.850 | 0.333 | 0.348 |
| E1 | 3.800 | 4.000 | 0.150 | 0.157 |
| E | 5.800 | 6.200 | 0.228 | 0.244 |
| e | 0.635 (BSC) | | 0.025 (BSC) | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

(2) QFN24-4*4-0.5

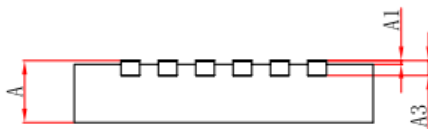
QFNWB4×4-24L (P0.50T0.75/0.85) PACKAGE OUTLINE DIMENSIONS



Top View



Bottom View



Side View

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------------|----------------------|-------------|
| | Min. | Max. | Min. | Max. |
| A | 0.700/0.800 | 0.800/0.900 | 0.028/0.031 | 0.031/0.035 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A3 | 0.203REF. | | 0.008REF. | |
| D | 3.924 | 4.076 | 0.154 | 0.160 |
| E | 3.924 | 4.076 | 0.154 | 0.160 |
| D1 | 2.600 | 2.800 | 0.102 | 0.110 |
| E1 | 2.600 | 2.800 | 0.102 | 0.110 |
| k | 0.200MIN. | | 0.008MIN. | |
| b | 0.200 | 0.300 | 0.008 | 0.012 |
| e | 0.500TYP. | | 0.020TYP. | |
| L | 0.324 | 0.476 | 0.013 | 0.019 |

Product Ordering Information

| Product number | Package (Pb-Free) | Weight (mg) |
|----------------|-------------------|-------------|
| ICN2053BP | SSOP24-0.635 | 130 |
| ICN2053BN | QFN24-4*4-0.5 | 38 |
| ICN2053AN | QFN24-4*4-0.5 | 38 |

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