DIO20874B

Micro-Power CMOS Input RRIO 1.4 V Open-Drain Output Comparator

Features

- Ultra-low power consumption:
  1.35 µA (typ) at V+ = 1.4 V
- Wide supply voltage range: 1.4 V to 5.5 V
- Propagation delay: 1.3 µs (typ) at V+ = 1.4 V
- Open-drain output sink current drive:
  25 mA (typ) at V+ = 5 V
- Rail-to-rail input
- -40°C to 85°C operating temperature range
- Available in the Green QFN3*3-16 Package

Applications

- RC timers
- Window detectors
- IR receiver
- Multivibrators
- Alarm and monitoring circuits

Descriptions

The DIO20874B is an ultra-low power comparator with a typical power supply current of 1.35 µA. It has the best-in-class power supply current versus propagation delay performance. The propagation delay is as low as 1.3 µs with 100 mV overdrive at 1.4 V supply.

Designed to operate over a wide range of supply voltages, from 1.4 V to 5.5 V, with guaranteed operation at 1.4 V, 2.5 V and 5.0 V, the DIO20874B is ideal for use in a variety of battery-powered applications. With rail-to-rail common mode voltage range, the DIO20874B is well suited for single-supply operation.

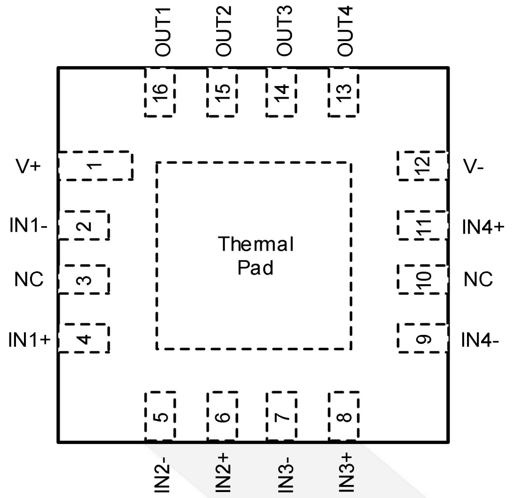
Featuring an open-drain output stage, the DIO20874B allows for operation with absolute minimum power consumption when driving any capacitive or resistive load.

The DIO20874B is available in the Green QFN3*3-16 package. The DIO20874B is ideal for the use in handheld electronics and mobile phone applications. It is rated over the -40°C to 85°C temperature range.

Ordering Information

Order Part Number	Top Marking	RoHS	T_A	Package	
DIO20874BCL16	DH7DB	Green	-40 to 85°C	QFN3*3-16	Tape & Reel, 5000

Pin Assignments



QFN3*3-16

Figure 1. Pin assignment (Top view)

Pin Description

Pin name	Description
OUT1	Output pin of the comparator1
OUT2	Output pin of the comparator 2
OUT3	Output pin of the comparator 3
OUT4	Output pin of the comparator 4
V+	Positive supply
V-	Negative supply
IN1+	Positive input pin of the comparator 1
IN1–	Negative input pin of the comparator 1
IN2+	Positive input pin of the comparator 2
IN2–	Negative input pin of the comparator 2
IN3+	Positive input pin of the comparator 3
IN3–	Negative input pin of the comparator 3
IN4+	Positive input pin of the comparator 4
IN4–	Negative input pin of the comparator 4
NC	No connection

Absolute Maximum Ratings

Stresses beyond those listed under the Absolute Maximum Rating table may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter		Rating	Unit
V_{CC}	Supply voltage (V+ – V-)		7.5	V
V_{IN}	Input voltage		(V-)-0.5 V to (V+)+0.5 V	V
V_D	Differential input voltage		±2.5 V	V
T_A	Operating temperature range		-40 to 85	°C
T_{STG}	Storage temperature range		-55 to 150	°C
T_J	Junction temperature		160	°C
T_L	Lead temperature range		260	°C
ESD	Electrostatic discharge	HBM, JEDEC: JESD22-A114	4000	V
		CDM, JEDEC: JESD22-C101	400	

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. DIOO does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Rating	Unit
V_{CC}	Supply voltage	1.4 to 5.5	V
T_A	Operating temperature range	-40 to 85	°C

Electrical Characteristics: V+ = 1.4 V

(At T_A = 25°C, V_+ = 1.4 V, V- = 0 V, V_{CM} = V_+/2 and V_O = V-, unless otherwise noted.)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply current	I_S	-40°C ≤ T_A ≤ 85°C, V_{CM} = 0.3 V		1.25		μA
		-40°C ≤ T_A ≤ 85°C , V_{CM} = 1.1 V		1.4		
Output swing high	V_{OH}	R_{PULL} = 5 kΩ		1.4		V
		R_{PULL} = 10 kΩ		1.4		
Output swing low	V_{OL}	R_{PULL} = 5 kΩ		62		mV
		R_{PULL} = 10 kΩ		31		
Output current	I_{OUT}	Sink		1.4		mA
Propagation delay (high to low)		Overdrive = 10 mV		2.6		μs
		Overdrive = 100 mV		0.92		
Propagation delay (low to high)		Overdrive = 10 mV		1.8		μs
		Overdrive = 100 mV		1.3		
Rise time(1)	t_{Rise}	Overdrive = 10 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		1		μs
		Overdrive = 100 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		1		
Fall time	t_{Fall}	Overdrive = 10 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		88		ns
		Overdrive = 100 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		87		

Note:
(1) Rise time depends on R_{PULL} and C_L.
(2) Specifications subject to change without notice.

Electrical Characteristics: V+ = 2.5 V

(At T_A = 25°C, V_+ = 2.5 V, V- = 0 V, V_{CM} = V_+/2 and V_O = V-, unless otherwise noted.)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply current	I_S	-40°C ≤ T_A ≤ 85°C, V_{CM} = 0.3 V		1.35		µA
		-40°C ≤ T_A ≤ 85°C , V_{CM} = 2.2 V		1.45		
Output swing high	V_{OH}	R_{PULL} = 5 kΩ		2.5		V
		R_{PULL} = 10 kΩ		2.5		
Output swing low	V_{OL}	R_{PULL} = 5 kΩ		52		mV
		R_{PULL} = 10 kΩ		26		
Output current	I_{OUT}	Sink		7.1		mA
Propagation delay (high to low)		Overdrive = 10 mV		2.4		µs
		Overdrive = 100 mV		0.8		
Propagation delay (low to high)		Overdrive = 10 mV		1.9		µs
		Overdrive = 100 mV		1.05		
Rise time[(1)]	t_{Rise}	Overdrive = 10 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		1		us
		Overdrive = 100 mV, C_L= 1 pF, R_{PULL} = 10 kΩ		1		
Fall time	t_{Fall}	Overdrive = 10 mV, C_L= 1 pF, R_{PULL} = 10 kΩ		50		ns
		Overdrive = 100 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		40		

Note:
(1) Rise time depends on R_{PULL} and C_L.
(2) Specifications subject to change without notice.

Electrical Characteristics: V+ = 5.0 V

(At T_A= 25°C, V_+= 5.0 V, V- = 0 V, V_{CM}= V_+/2 and V_O = V-, unless otherwise noted.)

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Supply current	I_S	-40°C ≤ T_A ≤ 85°C, V_{CM} = 0.3 V		1.45		μA
		-40°C ≤ T_A ≤ 85°C, V_{CM} = 4.7 V		1.55		
Output swing high	V_{OH}	R_{PULL} = 5 kΩ		5.0		V
		R_{PULL} = 10 kΩ		5.0		
Output swing low	V_{OL}	R_{PULL} = 5 kΩ		60		mV
		R_{PULL} = 10 kΩ		30		
Output current	I_{OUT}	Sink		24.3		mA
Propagation delay (high to low)		Overdrive = 10 mV		3.0		μs
		Overdrive = 100 mV		0.9		
Propagation delay (low to high)		Overdrive = 10 mV		2.7		μs
		Overdrive = 100 mV		1.1		
Rise time(1)	t_{Rise}	Overdrive = 10 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		1		μs
		Overdrive = 100 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		1		
Fall time	t_{Fall}	Overdrive = 10 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		43		ns
		Overdrive= 50 mV, C_L = 1 pF, R_{PULL} = 10 kΩ		25		

Note:
(1) Rise time depends on R_{PULL} and C_L.
(2) Specifications subject to change without notice.

Application Information

Hysteresis

If the applied differential input voltage is near the offset voltage of the comparator, the basic comparator configuration may oscillate or produce a noisy "chatter" output. This oscillation usually occurs when the input signal is moving very slowly across the switching threshold of the comparator.

Adding hysteresis or positive feedback can prevent the problem.

The hysteresis transfer curve is shown in Figure 2. This curve is a function of three components: V_{TH}, V_{OS}, and V_{HYST}:

- V_{TH} is the actual set voltage or threshold trip voltage.
- V_{OS} is the internal offset voltage between V_{IN+} and V_{IN-}. This voltage is added to V_{TH} to form the actual trip point at which the comparator must respond to change output states.
- V_{HYST} is the hysteresis (or trip window) that is designed to reduce comparator sensitivity to noise.

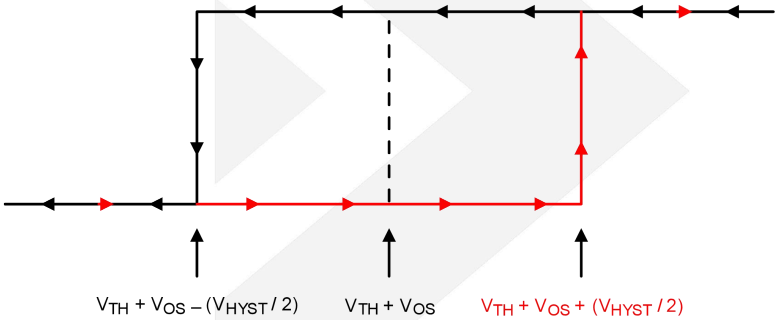


Figure 2. Hysteresis transfer curve

Inverting comparator with hysteresis

The inverting comparator with hysteresis requires a three-resistor network that is referenced to the comparator supply voltage (V_{CC}), as shown in Figure 3.

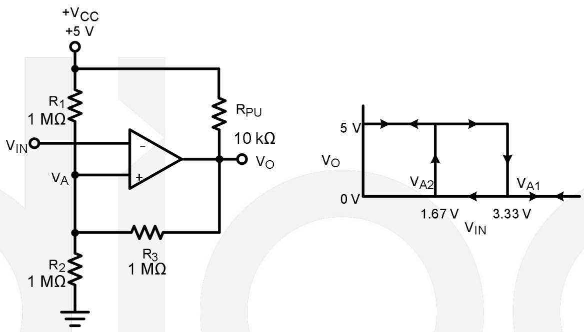


Figure 3. Inverting configuration with hysteresis

Figure 4 is the equivalent resistor networks when the output is high and low. Note that R_{PU} should be in series with R3 when the output is high. R_{PU} should be at least 10 times less than R3.

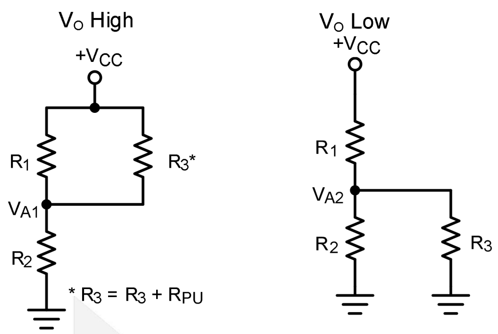


Figure 4. Inverting configuration resistor equivalent networks

When V_{IN} is less than V_A, the output voltage is high (for simplicity, assume V_O switches as high as V_{CC}). The three network resistors can be represented as R1 || R3 in series with R2, as shown in Figure 4.
Equation 1 below defines the high-to-low trip voltage (V_{A1}).

$$V_{A1} = V_{CC} \times \frac{R2}{(R1 \parallel R3) + R2} \quad (1)$$

When V_{IN} is greater than V_A, the output voltage is low. In this case, the three network resistors can be presented as R2 || R3 in series with R1, as shown in Equation 2.
Use Equation 2 to define the low to high trip voltage (V_{A2}).

$$V_{A2} = V_{CC} \times \frac{R2 \parallel R3}{R1 + (R2 \parallel R3)} \quad (2)$$

Equation 3 defines the total hysteresis provided by the network.

$$\Delta V_A = V_{A1} - V_{A2} \quad (3)$$

Non-inverting comparator with hysteresis

A non-inverting comparator with hysteresis requires a two-resistor network and a voltage reference (V_{REF}) at the inverting input, as shown in Figure 5.

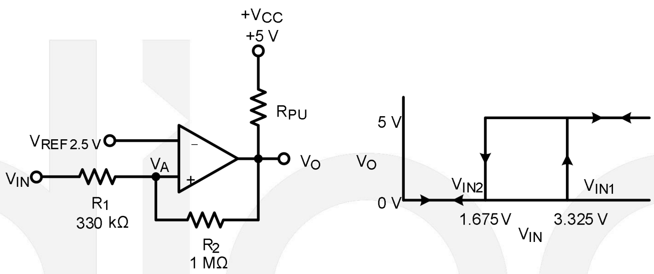


Figure 5. Non-inverting configuration with hysteresis

Figure 6 shows the equivalent resistor networks when the output is high and low. Note that R_{PU} should be in series with R2 when the output is high. R_{PU} should be at least 10 times less than R2.

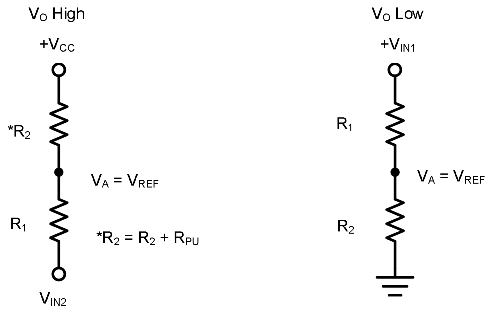


Figure 6. Non-Inverting configuration resistor networks

When V_{IN} is less than V_{REF}, the output is low. For the output to switch from low to high, V_{IN} must rise above the V_{IN1} threshold. Use Equation 4 to calculate V_{IN1}.

$$V_{IN1} = R1 \times \frac{V_{REF}}{R2} + V_{REF} \quad (4)$$

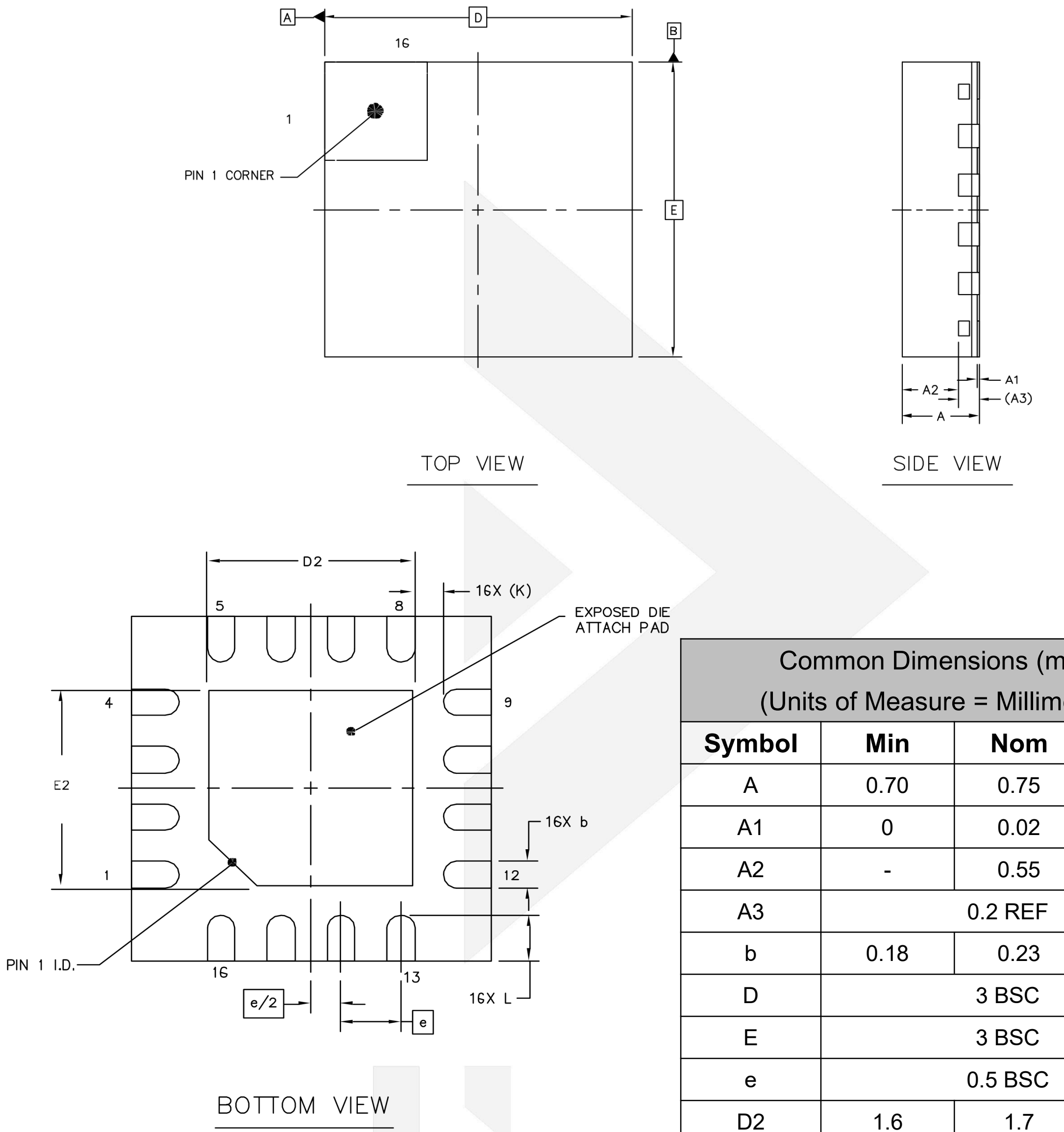
When V_{IN} is greater than V_{REF}, the output is high. For the comparator to switch back to a low state, V_{IN} must drop below V_{IN2}. Use Equation 5 to calculate V_{IN2}.

$$V_{IN2} = \frac{V_{REF} \times (R1 + R2) - V_{CC} \times R1}{R2} \quad (5)$$

The hysteresis of this circuit is the difference between V_{IN1} and V_{IN2}, as shown in Equation 6.

$$\Delta V_{IN} = V_{CC} \times \frac{R1}{R2} \quad (6)$$

Physical Dimensions: QFN3*3-16



Common Dimensions (mm) (Units of Measure = Millimeter)			
Symbol	Min	Nom	Max
A	0.70	0.75	0.80
A1	0	0.02	0.05
A2	-	0.55	-
A3	0.2 REF		
b	0.18	0.23	0.28
D	3 BSC		
E	3 BSC		
e	0.5 BSC		
D2	1.6	1.7	1.8
E2	1.6	1.7	1.8
L	0.3	0.4	0.5
K	0.2 MIN		

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