

# iC-WT

## INCREMENTAL ENCODER



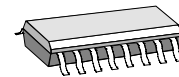
### FEATURES

- ◆ Differential scanning for track A and B
- ◆ Constant-light-evaluated scanning for the index track Z with adjustable relative threshold
- ◆ Photocurrent amplifier with high cut-off frequency
- ◆ Current comparators with hysteresis
- ◆ Index track Z selectable gated by tracks A and B
- ◆ Current-limited and short-circuit-proof push-pull outputs
- ◆ Outputs TTL compatible
- ◆ Adjustable LED current control for constant optical receiver power
- ◆ Integrated 50mA driver for the transmit LED
- ◆ LED current monitoring and error message upon violating the control range
- ◆ Low current consumption from single 5V power supply
- ◇ Option: enhanced temperature range -40..125°C

### APPLICATIONS

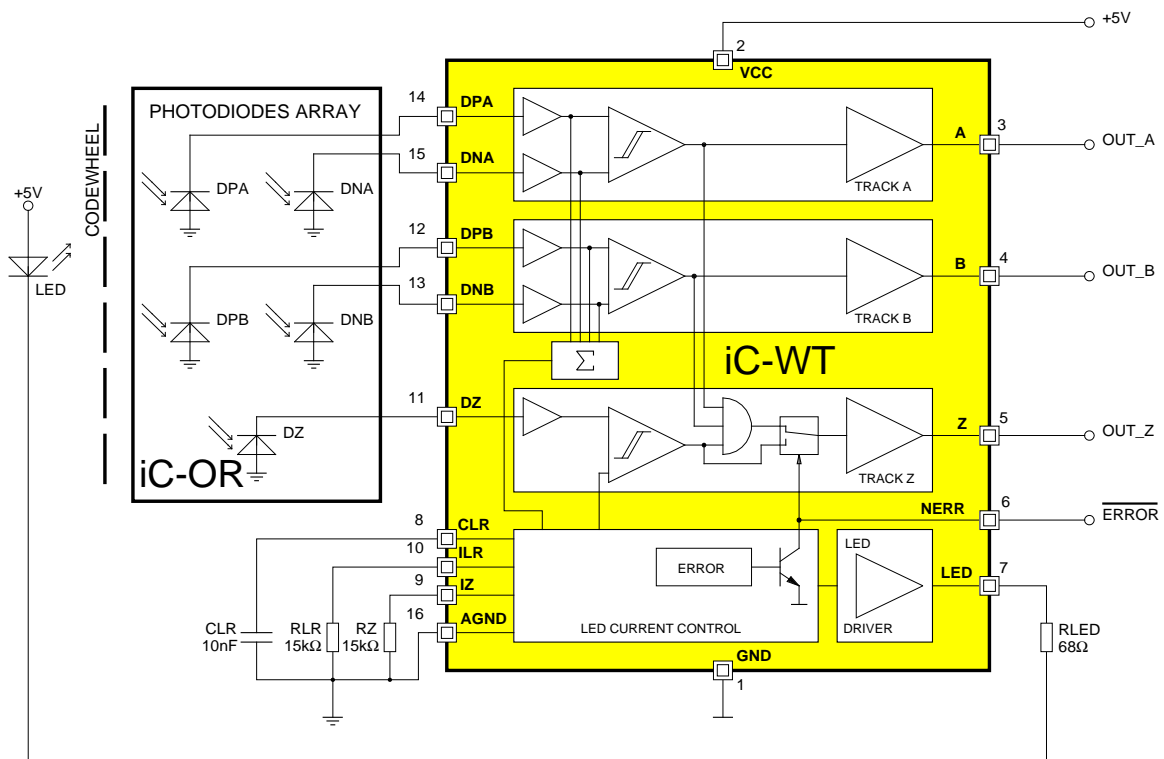
- ◆ Photocurrent evaluation for incremental linear or angular position measuring systems

### PACKAGES



SO16N

### BLOCK DIAGRAM



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Rev A0

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### DESCRIPTION

The device iC-WT is an evaluator IC for optical increment linear and rotary motion sensors, e.g. glass scales or shaft encoders.

A photodiodes array supplies the input signals for the monolithically integrated amplifiers, comparators and the TTL compatible push-pull output drivers. Two tracks, A and B, are evaluated differentially, the index track Z as a constant light.

An integrated LED current control with driver stage enables the direct connection of a transmit LED with series resistor and ensures a constant optical receive power. Two external resistors are used to set the relative index track comparator threshold and to determine the receive photocurrents.

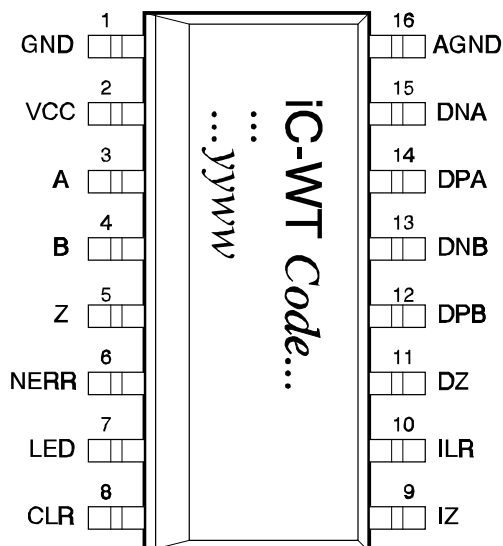
The internally available logical AND operation of index track Z to tracks A and B can be switched off for adjustment.

A monitor circuit triggers an error message when the LED current control range is violated. The fault output designed as an open collector is low active and simultaneously functions as an input to turn off the AND operation of the index track.

All connections are protected against damage due to ESD. The outputs are short-circuit proof.

### PACKAGES SO16N to JEDEC Standard

#### PIN CONFIGURATION SO16N (top view)



#### PIN FUNCTIONS

No. Name Function

No.	Name	Function
1	GND	Ground
2	VCC	+5V Supply Voltage
3	A	Track A TTL Output
4	B	Track B TTL Output
5	Z	Track Z TTL Output
6	NERR	Fault Output / AND Gate Disable
7	LED	Cathode LED
8	CLR	Capacitor for LED Current Control
9	IZ	Threshold for Index Track
10	ILR	Current Control Adjust
11	DZ	Cathode Photodiode Index Track Z
12	DPB	Cathode Photodiode Track B+
13	DNB	Cathode Photodiode Track B-
14	DPA	Cathode Photodiode Track A+
15	DNA	Cathode Photodiode Track A-
16	AGND	Common Anode for all photodiodes, connected to GND internally

### ABSOLUTE MAXIMUM RATINGS

Values beyond which damage may occur; device operation is not guaranteed.

Item	Symbol	Parameter	Conditions	Fig.			Unit
					Min.	Max.	
G001	VCC	Supply Voltage			0	7	V
G002	I(DPx) I(DNx)	Current in Inputs DPA, DNA, DPB, DNB			-1	1	mA
G003	V(A,B,Z)	Voltage at Outputs A, B, Z			0	VCC	
G004	I(A,B,Z)	Current in Outputs A, B, Z	$V(A,B,Z) < 0V$ or $V(A,B,Z) > VCC$		-4	4	mA
G005	I(DZ)	Current in Input DZ			-1	1	mA
G006	I(ILR) I(IZ)	Current in ILR, IZ			-6	1	mA
G007	I(CLR)	Current in CLR			-1	1	mA
G008	I(LED)	Current in LED	$V(LED) > VCC$		-1	1	mA
G009	I(LED)	Current in LED	$V(LED) \leq VCC$		-1	60	mA
G010	V(NERR)	Voltage at NERR			0	VCC	
G011	I(NERR)	Current in NERR	$V(NERR) < 0$ or $V(NERR) > VCC$		-4	4	mA
TG1	Tj	Junction Temperature			-30	130	°C
TG2	Ts	Storage Temperature			-30	130	°C

### THERMAL DATA

Operating Conditions: VCC= 5V ±10%

Item	Symbol	Parameter	Conditions	Fig.				Unit
					Min.	Typ.	Max.	
T1	Ta	Operating Ambient Temperature Range (extended temperature range on request)			-25		125	°C
T2	Rthja	Thermal Resistance Chip to Ambient	SMD mounting, without special cooling				125	K/W

All voltages are referenced to ground unless otherwise noted.

All currents into the device pins are positive; all currents out of the device pins are negative.

### ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC= 5V ±10%, Tj= -25..125°C, unless otherwise noted

Item	Symbol	Parameter	Conditions	Tj °C	Fig.				Unit
						Min.	Typ.	Max.	
<b>Total Device</b>									
001	VCC	Permissible Supply Voltage				4.5		5.5	V
002	I(VCC)	Supply Current in VCC, Outputs A, B, Z hi	closed LED control: R(ILR/AGND)= 15kΩ, I(LED)≈ 3mA, NERR= hi; I(A,B,Z)= 0, R(RZ/AGND)= 15kΩ, I(DZ,DPx)= -400nA, I(DNx)= -40..0nA, (x= A,B)					10	mA
003	I(VCC)	Supply Current in VCC, Outputs A, B, Z lo	closed LED control: R(ILR/AGND)= 15kΩ, I(LED)≈ 3mA, NERR= hi; I(A,B,Z)= 0, R(RZ/AGND)= 15kΩ, I(DZ,DPx)= -40..0nA I(DNx)= -400nA	27			5.5	12	mA mA
004	fo	Cut-off Frequency for Tracks A and B	sinusoidal waveform, I(DPx)= -20..-400nA, I(DNx)= -400..-20nA			500			kHz
005	fo	Cut-off Frequency for Index Track Z	rectangular waveform, I(DZ)= -20..-400nA, threshold 200nA			250			kHz
006	Δtp()	Propagation Delay Deviation track vs.track at A, B, Z						100	ns
<b>Differential Photocurrent Amplifier, Track A and B</b>									
101	I(DPx) I(DNx)	Permissible Sensor Current at DPA, DNA, DPB, DNB				-600		0	nA
102	CM(P/N)	Common Mode DPA vs. DNA, DPB vs. DNB				0.85	1	1.15	
<b>Comparator, Track A and B</b>									
201	Hys	Hysteresis referred to $[I(DPx) + I(DNx)] / 2$	I(DPx,DNx)= -400..0nA			15	20	25	%
<b>Photocurrent Amplifier, Index Track Z</b>									
401	I(DZ)	Permissible Sensor Current at DZ				-600		0	nA
<b>Comparator, Index Track Z</b>									
801	Hys	Hysteresis referred to I(DZ)	I(DZ)= -400..0nA			7	10	13	%
<b>Push-Pull Outputs A, B, Z</b>									
301	Vs()hi	Saturation Voltage hi	Vs()hi= VB-V(); I()= -400μA	-25 27 70 125			0.9 0.8 0.75 0.7	1.1 1.0 0.9 0.9	V V V V
302	Vs()hi	Saturation Voltage hi	Vs()hi= VB-V(); I()= -1.6mA	-25 27 70 125			1.2 1.1 1.05 1.05	1.5 1.4 1.3 1.3	V V V V
303	Vs()lo	Saturation Voltage lo	I()= 0.8mA					0.4	V
304	Vs()lo	Saturation Voltage lo	I()= 1.6mA					0.5	V
305	Isc()hi	Short-Circuit Current hi	V()= 0V..2.8V	27		-8	-3.5	-1.7	mA mA

### ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC= 5V ±10%, Tj= -25..125°C, unless otherwise noted

Item	Symbol	Parameter	Conditions	Tj °C	Fig.				Unit
						Min.	Typ.	Max.	
<b>Push-Pull Outputs A, B, Z (continued)</b>									
306	Isc()lo	Short-Circuit Current lo	V() = 1V..VCC	27		2	6	13	mA mA
307	Vc()hi	Clamp Voltage hi	Vc()hi= V()-VCC; I() = 4mA			0.4		1.5	V
308	Vc()lo	Clamp Voltage lo	I() =-4mA			-1.5		-0.4	V
<b>LED Current Control, pins CLR, ILR, IZ, LED</b>									
601	ISUM	Permissible Total Sensor Current at DPA, DNA, DPB, DNB	ISUM= I(DPA)+I(DNA) +I(DPB) +I(DNB);			-1500		-50	nA
602	I(LED)	Permissible Driver Current in LED				0.1		50	mA
603	Vs(LED)	Saturation Voltage lo at LED	I(LED)= 50mA, I(ILR)> 5µA, ISUM= 0	27		0.4	0.8	1.2	V V
604	V(ILR) V(IZ)	Voltage at ILR, IZ	I(ILR,IZ)= -150..-5µA			1.15	1.22	1.28	V
606	Isc(ILR) Isc(IZ)	Short-Circuit Current in ILR, IZ	V(ILR)= 0, V(IZ)= 0	27		-5	-2.4		mA mA
607	CR(ILR)	Current Ratio I(ILR)/ISUM	closed LED control, ISUM= -800..-50nA			80	100	125	
608	CR(IZ)	Current Ratio I(IZ)/I(DZ)	closed LED control, I(DZ)= -400..-10nA			320	400	500	
609	Vc()hi	Clamp Voltage hi at LED, CLR, ILR, IZ	VCC= 0V, I() = 1mA			0.4		1.0	V
610	Vc()lo	Clamp Voltage lo at LED, CLR, ILR, IZ	VCC= 0V, I() =-1mA			-1.0		-0.4	V
<b>Error Detection, AND Gate Select, Input/Output NERR</b>									
501	R(NERR)	Internal Pull-Up Resistor				20	30	45	kΩ
502	Vt()Gate	AND Gate Turn-Off Threshold	Gate disabled if V(NERR)< 0.4V	27		0.4	0.5	1	V V
701	Vs()lo	Saturation Voltage lo	I(NERR)= 1.6mA	27			0.15	0.4	V V
702	Vs()lo	Saturation Voltage lo	I(NERR)= 5mA	27			0.25	0.8	V V
703	Isc()lo	Short-Circuit Current lo	V(NERR)= 2V..VCC	27		5	15	30	mA mA
704	Vc()hi	Clamp Voltage hi	Vc()hi= V(NERR)-VCC; NERR=hi, I(NERR)= 4mA			0.4		1.5	V
705	Vc()lo	Clamp Voltage lo	NERR=lo, I(NERR)=-4mA			-1.5		-0.4	V

## APPLICATIONS INFORMATION

Figure 1 illustrates the layout of the entire electronic system of an incremental rotary encoder. The devices iC-OR (photodiodes array), iC-WT (incremental encoder) and iC-WE (line driver) from iC-Haus are used.

The rotary encoder requires the supply voltages  $VCC = +5V$  and  $VB = +5V$  to  $+30V$  (line driver) and supplies the conditioned signals of tracks A and B and index track Z at the outputs. It's possible to transmit these signals over directly connected lines of 100m length. The system's upper cut-off frequency is 500kHz for track A/B. Internal monitoring functions are available for the chip temperature of the line driver, for the supply voltages and for the LED current control. The ERROR port provides an error message signal which can be logically linked to other, external error signals by simple connection.

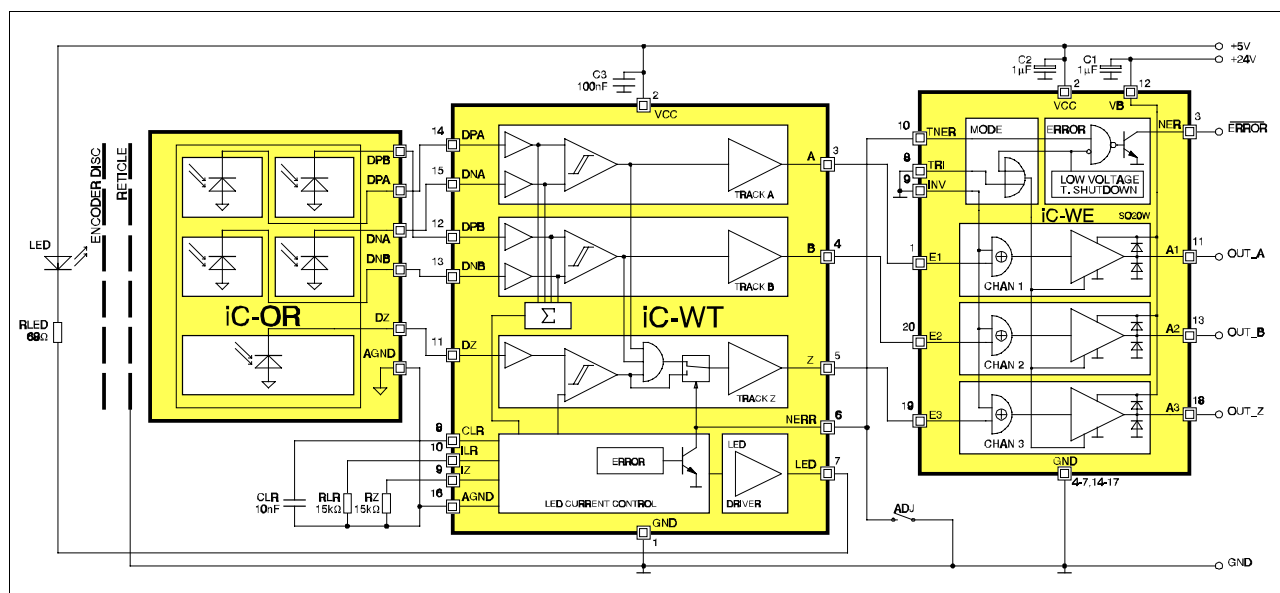


Fig. 1: Incremental rotary encoder

## DESCRIPTION OF FUNCTIONS

The *photodiodes array* iC-OR comprises two diodes each for tracks A and B (differential evaluation) and one diode for track Z (index pulse for constant-light evaluation) in the layout typical for an incremental encoder. A reference diode is not required since the threshold for the index signal is generated from the signals of tracks A and B. It is also possible to use the iC-Haus device iC-WS or the Siemens device KOM 2100.

The *incremental encoder* iC-WT evaluates the currents of the photodiodes and generates TTL-compatible information. The zero pulse is logically linked to the tracks A and B with an AND operation. This operation can be cancelled for adjustment purposes by applying a low level to the error message output NERR (combined input and output).

An integrated transmit-current drive circuit makes the adjustment to a constant summation photoelectric current at inputs A/B which is specified as the reference current at ILR by means of the external resistor RLR. The external capacitor CLR stabilizes this adjustment. Using a further reference current at IZ which is set with RZ it is possible to specify the constant-light evaluation threshold for the zero pulse at a controlled and, consequently, constant illuminance. With identical geometries and homogeneous illumination of all photodiodes, ILR and IZ can operate on a common resistor.

The resistor RLED limits the maximum possible current through the LED. The transmit-current control features an error detector which sets the output NERR to LOW (open collector) when the permissible working area is exited. The error message detector is activated, for example, in case of a defect of the LED, when the code discs are dirty or steamed, or in the case of excessive influence of lights from an external source.

The *line driver iC-WE* possesses short-circuit-proof push-pull output stages for the tracks A, B and Z. The drivers typically supply 300mA at  $V_B = 24V$  and are internally adapted for a characteristic impedance of  $75\Omega$ . The outputs can be inverted via input INV (active-high). Consequently, when two line drivers are used, a balanced activation of the line is also possible. Tri-state switching of the output stages is possible to support bus systems (input TRI). An error detector monitors the chip temperature as well as the supply voltages VCC and VB. In the event of a fault, the open-collector output NER is switched low and the output stages are switched to high impedance to prevent destruction. The error signal of the incremental encoder iC-WT can be switched through to the output NER via the error input TNER.

## DIMENSIONING

### Adjusting the LED current control

Since the photodiodes DPA to DNA and DPB to DNB have anti-phase illumination, the following applies for the control parameter  $I_{SUM}$  as a function of the photocurrent peak value  $I_{ph,max}$  of a photodiode:

$$I_{SUM} = I(DPA) + I(DNA) + I(DPB) + I(DNB) = 2 \times I_{ph,max}$$

Multiplied by the current transmission factor of the LED current control CR(ILR), the current to be set at ILR is (see electrical characteristics, No.607):

$$I_{ILR} = I_{SUM} \times CR(ILR) = 2 \times I_{ph,max} \times CR(ILR)$$

This current can be set with a resistor  $R_{LR}$  connected to AGND. Due to the reference voltage  $V(ILR)$  being applied to pin ILR, this produces:

$$R_{LR} = \frac{V(ILR)}{I(ILR)} = \frac{V(ILR)}{2 \times I_{ph,max} \times CR(ILR)}$$

**Example:** As a setpoint, the photodiodes should be illuminated so brightly that it conducts a photocurrent  $I_{ph,max} = 400nA$  at a maximum. With the electrical characteristics No.604 for  $V(ILR)$  and No.607 for  $CR(ILR)$  the result is:

$$R_{LR} = \frac{1.22}{2 \times 400nA \times 100} = 15.25k\Omega$$

### Adjusting the index track comparator threshold

The comparator threshold for the index signal is defined via a further reference current. The photocurrent  $I_{ph,max}$  is also obtained as the maximum for the photodiode DZ in the event of homogeneous illumination and same photodiodes for track A/B and track Z. The maximum signal-to-noise ratio is attained with the constant-light evaluation threshold:

$$I_{th} = \frac{I_{ph,max}}{2}$$

Analogue to the calculation of  $R_{LR}$ , it follows that:

$$I_{IZ} = I_{th} \times CR(IZ)$$

$$R_Z = \frac{V(IZ)}{I(IZ)} = \frac{V(IZ)}{I_{th} \times CR(IZ)}$$

**Example:** As a setpoint, the threshold  $I_{th}$  should be 200nA. With the electrical characteristics No.604 for  $V(IZ)$  and No.608 for  $CR(IZ)$  the result is:

$$R_Z = \frac{1.22V}{200nA \times 400} = 15.25k\Omega$$

If the current from ILR is the same as the current from IZ, a common resistor with the value  $R_{LR,Z} = R_{LR} / 2 = R_Z / 2$  can be utilized (in the example,  $15.25 \text{ k}\Omega / 2 = 7.625 \text{ k}\Omega$ ). ILR is connected directly to IZ.

### Limiting the current for the transmit LED

The resistance  $R_{LED}$  limits the maximum current through the LED. It is calculated with the minimum forward voltage  $V_{fw,min}$  of the LED used for illumination, the minimum saturation voltage of the LED pin  $Vs(LED)_{min}$  (electrical characteristics No.603) and the permissible transmit current for the driver output  $I(LED)_{max}$  (electrical characteristics No.602):

$$R_{LED} = \frac{VCC_{max} - V_{fw,min} - Vs(LED)_{min}}{I(LED)_{max}}$$

**Example:**  $R_{LED} = (5.5V - 1.2V - 0.4V) / 50mA = 78\Omega$

The lowest value for the current limiting is obtained by inserting the maximum saturation voltage of the LED pin  $Vs(LED)_{max}$  and the maximum LED forward voltage  $V_{fw,max}$ :

$$I(LED)_{lim} \geq \frac{VCC_{min} - V_{fw,max} - Vs(LED)_{max}}{R_{LED}}$$

**Example:**  $I(LED)_{lim} = (4.5V - 1.5V - 1.2) / 78\Omega \approx 19mA$

The limiting value inserted for the saturation voltage  $Vs(LED)_{max}$  of 1.2V is not achieved by currents under 50mA. The real minimum value for current limiting is therefore a little higher.

### Capacitor at CLR

The value of capacitor  $C_{LR}$  is not critical. The bottom of the permissible value range is restricted by the stability of control. The following applies:

$$C_{LR,min} = \frac{1nF \times 15k\Omega}{R_{LR}}$$

Upwardly, the value is limited by the dead time  $\tau$  of the LED current control after switching on the supply voltage:

$$C_{LR,max} = \frac{0.25 \times \tau}{R_{LR}}$$

**Example:**  $\tau = 100ms$ ,  $R_{LR} = 15k\Omega$ :  $C_{LR,max} = (0.25 \times 100ms) / 15k\Omega \approx 1.5\mu F$

## PRINTED CIRCUIT BOARD LAYOUT

The following aspects should be noted when creating the PCB layout:

- Short connections between photodiodes array and iC-WT to minimize couplings and interference on the small photocurrents.
- Short-circuit the anodes of the photodiodes to pin AGND of the iC-WT. The connection to GND is made exclusively inside the chip.
- Switch  $R_{LR}$ ,  $R_Z$ ,  $C_{LR}$  to AGND too.
- Do not run the printed conductors of the outputs of iC-WT and iC-WE in the vicinity of the connections between photodiodes array and iC-WT or decouple by means of a GND conductor between them.
- Connecting point of a metal reticle for the photodiodes array is GND on the iC-WT.



## DEMO BOARD

The demonstration board provides a survey over the properties of the iC-WT simply and easily. The encoder IC is already connected to the necessary external components. In addition, the board contains subunits which can be utilized to have measurements performed - even without a rotary encoder. Figures 2 to 4 show the wiring as well as the top and bottom layout of the test PCB.

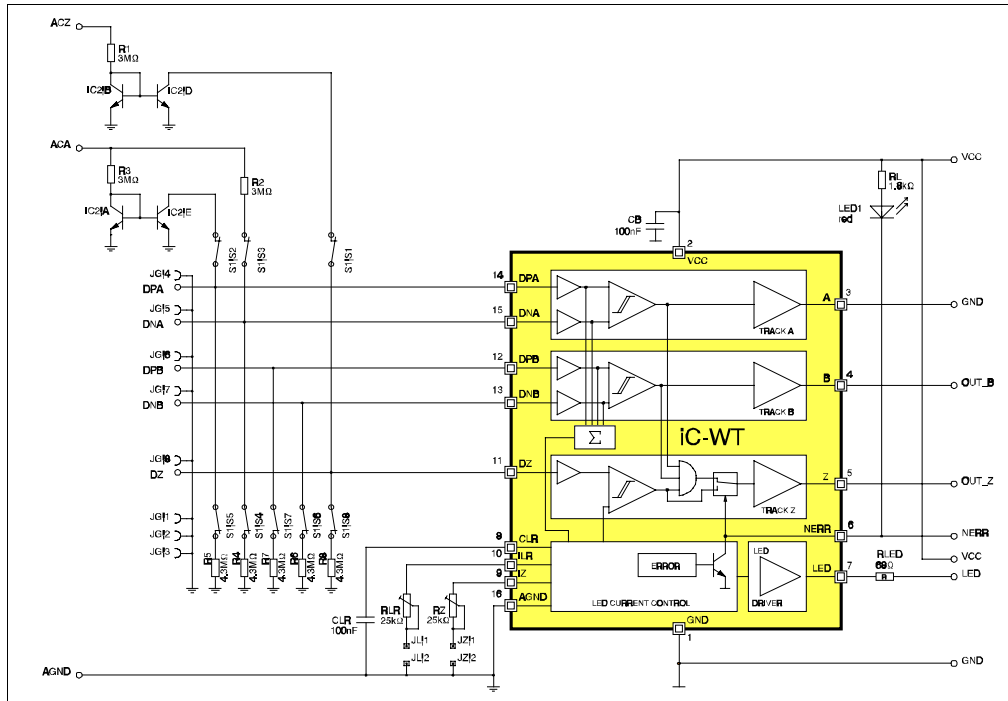


Fig. 2: Schematic diagram of the Demo Board

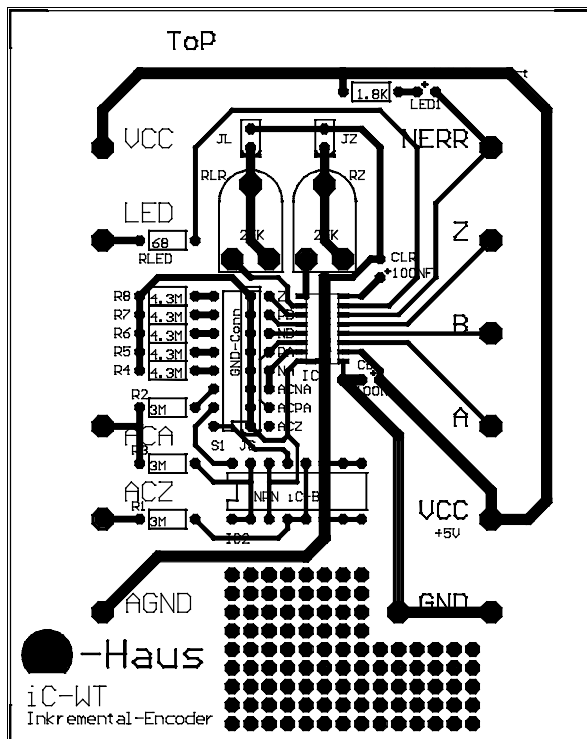


Fig. 3: Demo Board (components side)

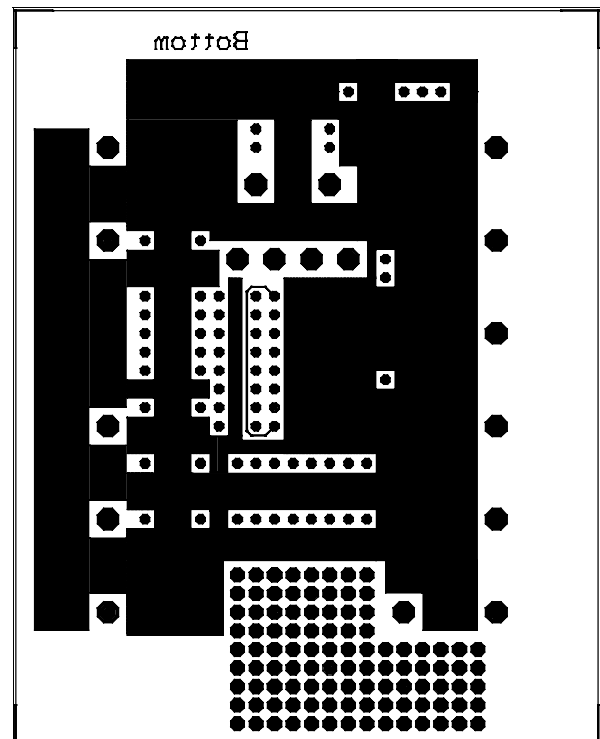


Fig. 4: Demo Board (solder dip side)

### MEASUREMENTS WITH THE DEMO BOARD

The iC-WT can be examined at three different levels:

1. Static wiring of the sensor inputs with constant currents (using DIP switches)
2. Dynamic wiring of the sensor inputs using function generator and current mirror circuit
3. Dynamic wiring of the sensor inputs using a rotary encoder with photodiodes array

A regulated power supply of +5V dc must be applied between VCC and GND for all measurements. Since the iC-WT operates with very low sensor currents, the work surface should possess an insulated screen (e.g. a single sided copper-clad plate) which is connected to GND. AGND is pulled down to GND inside the iC-WT and should not be interconnected externally. The transmit LED of the rotary encoder can be connected between LED and VCC. For the visual check in case of measurements without rotary encoder a colored LED is recommended.

#### 1.1 Static function of A, B and Z

Shut off the AND operation of index signal Z with A and B by connecting the combined input/output NERR to ground; the red control LED will light up. The two trimming potentiometers should be in the middle position initially, the DIP switches opened.

Closing a DIP switch of No.4 to No.8 connects the corresponding sensor input to AGND via a resistor (R4 to R8). Since each input is at constant (but temperature-dependent!) voltage potential  $V(T)$ , a constant current results of the magnitude:

$$I = V(T) / R.$$

The result at room temperature is about:

$$I = 1.8V / 4.3M\Omega = 420nA$$

This current is supposed to simulate the photocurrent of an illuminated photodiode. An open switch simulates a diode which is not illuminated ( $I = 0$ ).

The tracks A and B are evaluated differentially. The corresponding output is high (low) when current is only flowing from the P(ositive) (N(egative)) input. If the two inputs are conducting no current or the same current, the output remains in its old state due to hysteresis.

Track Z is compared to a current threshold set using the trimmer RZ. If the input current is higher, the output Z is high. The current flowing from IZ is specified with RZ:

$$I_{IZ} = V(IZ) / RZ$$

The current threshold set is obtained with the aid of the current transmission factor  $CR(IZ)$  as:

$$I_{th} = V(IZ) / (CR(IZ) \times RZ)$$

When the trimmer is at the middle setting, the following applies:

$$I_{th} = 1.22V / (400 \times 12.5k\Omega) = 244nA$$

The resistance value set with RZ can be measured after removing the jumper JZ.

#### 1.2 LED current control and error output

The function of the current control can be checked with an LED connected between LED and VCC. The voltage at NERR is displayed by the red LED on the demo board. It lights up when NERR is active, i.e. low.

The setpoint of the receive power is set at pin ILR by using trimmer RLR. The resistance value can be measured after removing the jumper JLR. The receive power is defined as the sum of the currents at the input pins DPA, DNA, DPB and DNB. The setpoint  $I_{SUM}$  is:

$$I_{SUM} = V(ILR) / (RLR \times CR(LR))$$

or:

$$RLR = V(ILR) / (I_{SUM} \times CR(LR))$$

If two of the DIP switches No.4 to No.7 are closed, the actual value of  $I_{SUM}$  is:

$$I_{SUM} = 2 \times 420\text{nA} = 840\text{nA},$$

Correspondingly, for the resistance RLR:

$$RLR = 1.22\text{V} / (840\text{nA} \times 100) = 14.5\text{k}\Omega$$

If the resistance set with the trimmer RLR is smaller, the result is a setpoint which is larger than the actual value. The control attempts to compensate for this by increasing the transmit LED current. Since the control loop is not closed, the control moves to the top stop and the transmit LED lights up brightly.

If the resistance set with the trimmer RLR is smaller, the result is a setpoint smaller than the actual value. The control attempts to compensate for this by reducing the transmit LED current. Since the control loop is not closed, the control moves to the bottom stop and the transmit LED is extinguished.

Between these extremes is a linear range in which the transmit LED is operated with a current proportional to the control difference. In this range the output NERR is moved to VCC potential via a pull-up resistor inside the IC and the error display is not lit. If the control is at a stop, NERR is low and the error LED is lit.

### 1.3 AND-operation of index track Z with A and B

The measuring set-up is identical to the one in 1.2. The LED current control is set as the normal operating condition such that it operates in the linear range, i.e. NERR is high. The AND-operation of index track Z with A and B is now activated. With RZ at the middle setting the output Z can only be switch high via DIP switch No.8 if A and B are also high (DIP switches No.5 and 7 closed, 4 and 6 open). If A or B or both are low, the high state of Z is only advanced to its output if the combined input/output NERR is connected to GND (AND gate disabled). This situation also exists if an error condition of the LED current control exists. In actual operation this situation is insignificant, since the condition of tracks A and B are undefined anyway in the event of an error.

### 2.1 Dynamic activation

To check the dynamic operation, inputs must be stimulated with a function generator. Tracks A and B are identical in construction, so only A and Z have to be studied. The signal is injected for track A at the Demo Board via pin ACA. A function generator connected between ACA and AGND should generate a delta or sinusoidal signal of variable frequency. DIP switches No.2 and 3 are closed, and No.4 and 5 are opened. Via R3 the ACA signal reaches a current mirror consisting of two NPN transistors, IC2A and IC2E, which prepare the input signal for the differential activation.

With  $V_{ACA}$  as the input voltage, the following applies for the current through R3 and consequently the current from DPA:

$$I_{DPA} = (V_{ACA} - V_{BE}) / R3$$

The result for the current from DNA is:

$$I_{DNA} = (V_{DNA} - V_{ACA}) / R2$$

With  $R2 = R3$ , the input currents assume the same value for a symmetrical activation via  $V_{ACA}$  as the medium voltage between  $V_{DNA}$  and  $V_{BE}$ :

$$V_{ACA} = (V_{DNA} + V_{BE}) / 2 \approx 1.16\text{V}$$

$$I_{DPA} = \{(V_{DNA} + V_{BE}) / 2 - V_{BE}\} / R3$$

$$= \{V_{DNA} / 2 - V_{BE} / 2\} / R3$$

$$= \{1.8\text{V} / 2 - 0.52\text{V} / 2\} / 3\text{M}\Omega$$

$$= 213\text{nA}$$

$$I_{DNA} = \{V_{DNA} - (V_{DNA} + V_{BE}) / 2\} / R2$$

$$= \{V_{DNA} / 2 - V_{BE} / 2\} / R2$$

$$= \{1.8\text{V} / 2 - 0.52\text{V} / 2\} / 3\text{M}\Omega$$

$$= 213\text{nA}$$

Modulating ACA around its mean value functions like a linear differential activation of the inputs DPA and DNA. The modulation limits are  $V_{BE}$  and  $B_{DNA}$ . An appropriate rectangular signal can be picked off at output A with an oscilloscope. For a pulse duty factor of 1:1 it may be necessary to readjust the temperature-dependent medium voltage at ACA. In addition, at high frequencies over 200kHz the parasitic capacities of the test circuit affect the activation and thus the output signal.

Index track Z can be measured by closed DIP switch No.1 and opening No.8. The signal is injected via ACZ, R1 and the 1:1 current mirror IC2B, IC2D. The specifications for track A apply appropriately. The comparison threshold is set at RZ (no differential activation). If the AND operation is activated, outputs A and B must be high in order for output Z to switch.

### 3.1 Activation with rotary encoder

The demonstration board can be activated by a rotary encoder with a photodiodes array. The connection between encoder and Demo Board can be made using a shielded cable. After the DIP switch is removed, the plug supplied can be installed. Figures 5 and 6 show the connection.

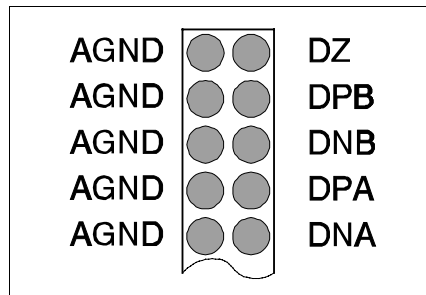


Fig. 5: Connector configuration

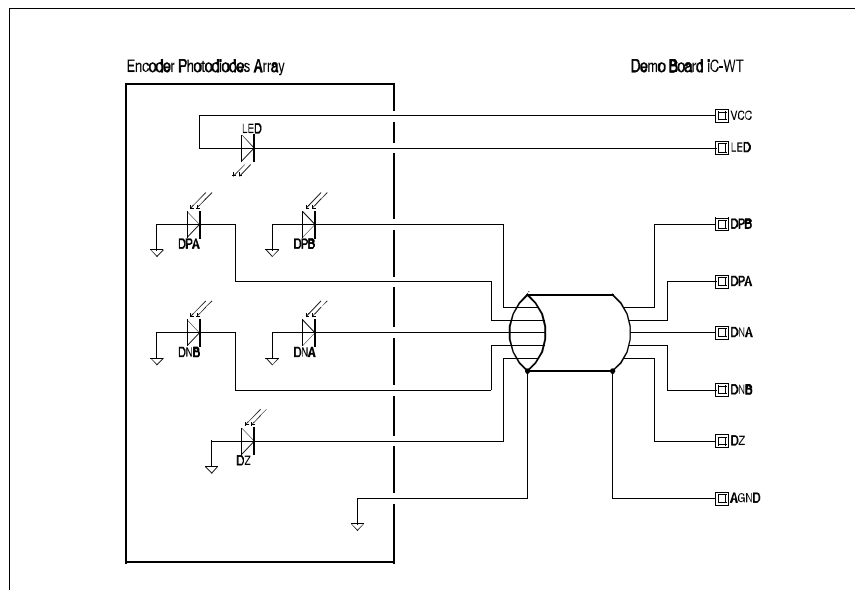


Fig. 6: Connecting a photodiodes array

**ORDERING INFORMATION**

Type	Package	Order designation
iC-WT WT Demo Board	SO16N	iC-WT-SO16N WT Demo Board

For information about prices, terms of delivery, options for other case types, etc., please contact:

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