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BROADCOM®

Data Sheet

ACNW3410

3 Amp Output Current IGBT Gate Drive Optocoupler with 100 kV/µs Noise Immunity

Description

The Broadcom® ACNW3410 contains an LED, which is optically coupled to an integrated circuit with a power output stage. This optocoupler is ideally suited for driving IGBTs and power MOSFETs used in motor control inverter applications. The 100 kV/µs noise immunity prevent erroneous drive in noisy industrial environment. The voltage and high peak output current supplied by this optocoupler make it ideally suited for driving IGBT directly. The ACNW3410 has the highest insulation voltage of V_{IORM} = 1414 V_{peak} in the IEC/ EN/DIN EN 60747-5-5.

CAUTION! It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation that may be induced by ESD.

Features

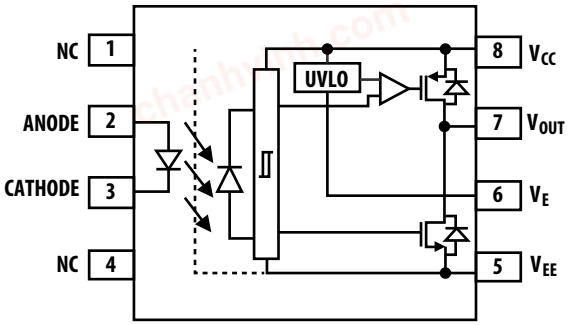
- 3.0 A maximum peak output current
- Rail-to-rail output voltage
- UVLO with V_E reference for negative power supply
- 150 ns maximum propagation delay
- 90 ns maximum propagation delay difference
- LED current input with hysteresis
- 100 kV/µs minimum Common Mode Rejection (CMR) at V_{CM} = 1500V
- I_{CC} = 5.0 mA maximum supply current
- Under Voltage Lock-Out Protection (UVLO) with Hysteresis
- Wide Operating V_{CC} Range: 15V to 30V
- Industrial Temperature Range: –40°C to 105°C
- Safety Approval
  - UL Recognized 5000 V_{RMS} for 1min.
  - CSA
  - IEC/EN/DIN EN 60747-5-5 V_{IORM} = 1414 V_{peak}

Applications

- IGBT/MOSFET gate drive
- AC and brushless DC motor drives
- Renewable energy inverters
- Industrial inverters
- Switching power supplies

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Figure 1: Functional Diagram



Design Notes: A 1-µF bypass capacitor must be connected between pins V_{CC} and V_{EE}.

Table 1: Truth Table – ACNW3410

LED	V_{CC} – V_E "POSITIVE GOING" (that is, TURN-ON)	V_{CC} – V_E "NEGATIVE GOING" (that is, TURN-OFF)	VO
OFF	0 V to 30 V	0V to 30V	LOW
ON	0 V to 11.9 V	0V to 10.9V	LOW
ON	11.9 V - to 13.2 V	10.9V to 12.2V	TRANSITION
ON	13.2 V – to 30 V	12.2V to 30V	HIGH

Ordering Information

ACNW3410 is UL Recognized with 5000 V_{RMS} for 1 minute per UL1577.

Table 2: Ordering Information

Part Number	Option	Package	Gull Wing Surface Mount	Tape and Reel	IEC/EN/DIN EN 60747-5-5	Quantity
	RoHS Compliant					
ACNW3410	-000E	400mil DIP-8			X	42 per tube
	-300E		X		X	42 per tube
	-500E		X	X	X	750 per reel

To order, choose a part number from the part number column and combine with the desired option from the option column to form an order entry.

Example 1:

ACNW3410-500E to order product of 400-mil DIP Gull Wing Surface Mount package in Tape and Reel packaging with IEC/EN/DIN EN 60747-5-5 Safety Approval in RoHS compliant.

Example 2:

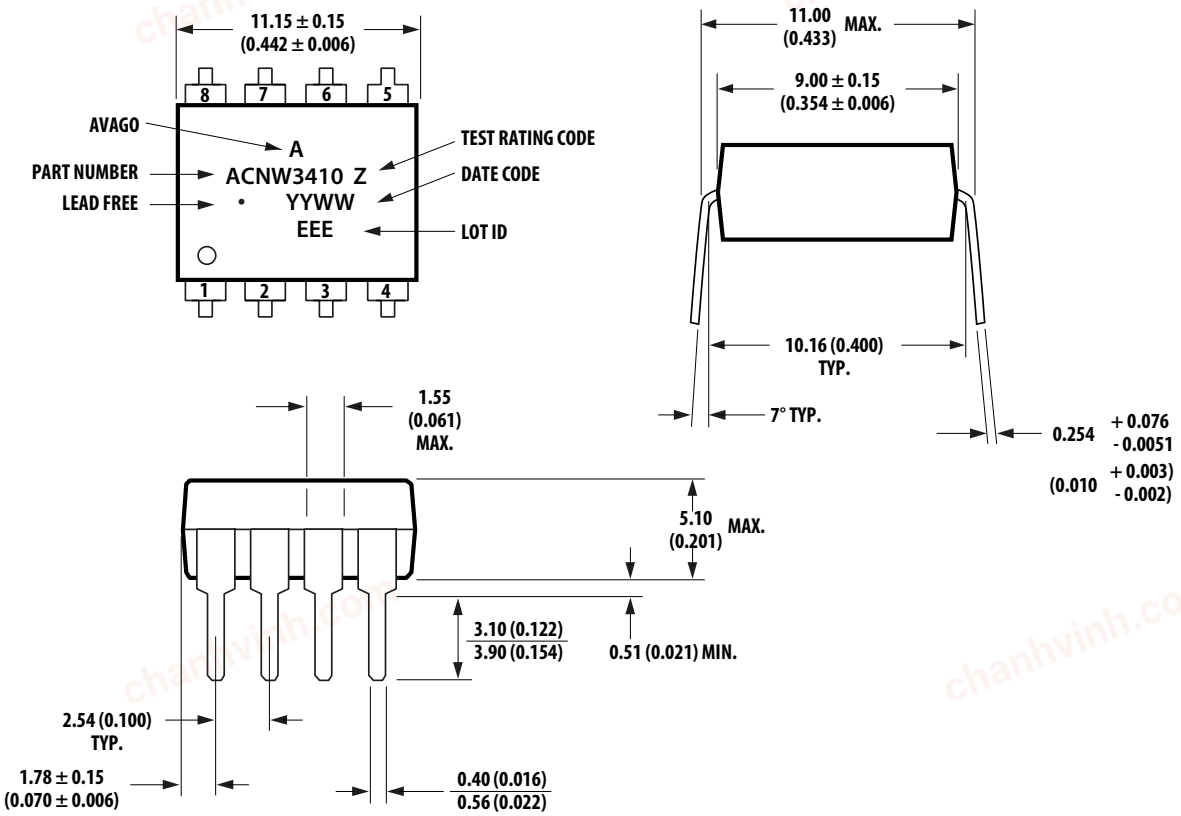
ACNW3410-000E to order product of 400mil DIP package in Tube packaging and RoHS compliant.

Option data sheets are available. Contact your Broadcom sales representative or authorized distributor for information.

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Package Outline Drawings

Figure 2: ACNW3410 Outline Drawing (8-pin Wide Body Package/400-mil DIP)

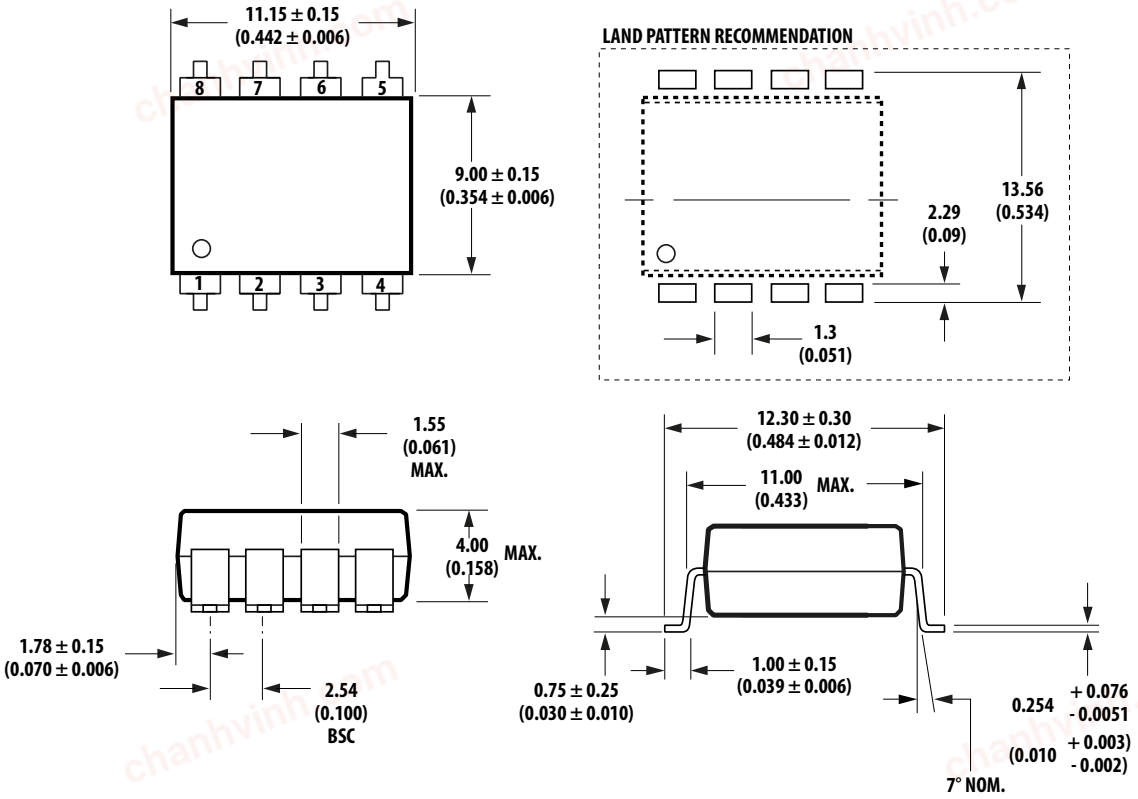


Dimensions in millimeters (inches).

NOTE: Floating Lead Protrusion is 0.25 mm (10 mils) maximum.

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Figure 3: ACNW3410 Gull Wing Surface Mount Option 300 Outline Drawing



Dimensions in millimeters (inches).

Lead coplanarity = 0.10 mm (0.004 inches).

NOTE: Floating lead protrusion is 0.25 mm (10 mils) maximum.

Recommended Pb-Free IR Profile

Recommended reflow condition as per JEDEC Standard, J-STD-020 (latest revision). Non-halide flux should be used.

Regulatory Information

The ACNW3410 is approved by the following organizations.

Table 3: Regulatory Information

UL	Recognized under UL 1577, component recognition program up to V_{ISO} = 5000 V_{RMS}, File E55361
CSA	CSA Component Acceptance Notice #5, File CA 88324
IEC/EN/DIN EN 60747-5-5	Maximum Working Insulation Voltage V_{IORM} = 1414 V_{peak}

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EC/EN/DIN EN 60747-5-5 Insulation Characteristics

Table 4: IEC/EN/DIN EN 60747-5-5 Insulation Characteristics (see Note 1)

Description	Symbol	Characteristic	Unit
Installation classification per DIN VDE 0110/39, Table 1			
For rated mains voltage ≤ 600 V_{RMS}		I – IV	
For rated mains voltage ≤ 1000 V_{RMS}		I – III	
Climatic Classification		40/105/21	
Pollution Degree (DIN VDE 0110/39)		2	
Maximum Working Insulation Voltage	V_{IORM}	1414	V_{peak}
Input to Output Test Voltage, Method b (see Note 1) V_{IORM} x 1.875=V_{PR}, 100% Production Test with t_m=1 sec, Partial discharge < 5 pC	V_{PR}	2652	V_{peak}
Input to Output Test Voltage, Method a (see Note 1) V_{IORM} × 1.6=V_{PR}, Type and Sample Test, t_m=10 sec, Partial discharge < 5 pC	V_{PR}	2262	V_{peak}
Highest Allowable Overvoltage (see Note 1) (Transient Overvoltage tini = 60 sec)	V_{IOTM}	8000	V_{peak}
Safety-limiting values – maximum values allowed in the event of a failure.			
Case Temperature	T_S	150	°C
Input Current	$I_{S, INPUT}$	400	mA
Output Power	$P_{S, OUTPUT}$	800	mW
Insulation Resistance at T_S, V_{IO} = 500 V	R_S	$>10^9$	Ω

NOTE:

1. Refer to IEC/EN/DIN EN 60747-5-5 Optoisolator Safety Standard section of the *Broadcom Regulatory Guide to Isolation Circuits*, AV02-2041EN, for a detailed description of Method a and Method b partial discharge test profiles.
2. These optocouplers are suitable for “safe electrical isolation” only within the safety limit data. Maintenance of the safety data shall be ensured by means of protective circuits. Surface mount classification is Class A in accordance with CECC 00802.

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Insulation and Safety Related Specifications

Table 5: Insulation and Safety Related Specifications

Parameter	Symbol	ACNW3410	Units	Conditions
Minimum External Air Gap (Clearance)	L(101)	9.6	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (Creepage)	L(102)	10.0	mm	Measured from input terminals to output terminals, shortest distance path along body.
Minimum Internal Plastic Gap (Internal Clearance)		1.0	mm	Through insulation distance conductor to conductor, usually the straight line distance thickness between the emitter and detector.
Tracking Resistance (Comparative Tracking Index)	CTI	> 200	V	DIN IEC 112/VDE 0303 Part 1
Isolation Group		IIIa		Material Group (DIN VDE 0110, 1/89, Table 1)

NOTE: All Broadcom data sheets report the creepage and clearance inherent to the optocoupler component itself. These dimensions are needed as a starting point for the equipment designer when determining the circuit insulation requirements. However, once mounted on a printed circuit board, minimum creepage and clearance requirements must be met as specified for individual equipment standards. For creepage, the shortest distance path along the surface of a printed circuit board between the solder fillets of the input and output leads must be considered (the recommended land pattern does not necessarily meet the minimum creepage of the device). There are recommended techniques, such as grooves and ribs, that may be used on a printed circuit board to achieve desired creepage and clearances. Creepage and clearance distances will also change depending on factors, such as pollution degree and insulation level.

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Absolute Maximum Ratings

Table 6: Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Note
Storage Temperature	T_S	–55	125	°C	
Operating Temperature	T_A	–40	105	°C	
Average Input Current	$I_{F(AVG)}$	—	25	mA	a
Peak Transient Input Current (<1 ms pulse width, 300pps)	$I_{F(TRAN)}$	—	1	A	
Reverse Input Voltage	V_R	—	5	V	
“High” Peak Output Current	$I_{OH(PEAK)}$	—	3.0	A	b
“Low” Peak Output Current	$I_{OL(PEAK)}$	—	3.0	A	b
Total Output Supply Voltage	$(V_{CC} – V_{EE})$	–0.5	35	V	
Negative Output Supply Voltage	$(V_E – V_{EE})$	–0.5	15	V	
Positive Output Supply Voltage	$(V_{CC} – V_E)$	–0.5	$35 – (V_E – V_{EE})$	V	
Output Voltage	$V_{O(PEAK)}$	–0.5	V_{CC}	V	
Output IC Power Dissipation	P_O	—	800	mW	c
Total Power Dissipation	P_T	—	850	mW	d

a. Derate linearly above 70°C free-air temperature at a rate of 0.3 mA/°C.

b. Maximum pulse width = 10 µs. This value is intended to allow for component tolerances for designs with I_O peak minimum = 2.5A. See Application Information for additional details on limiting I_{OH} peak.

c. Derate linearly above 85°C free-air temperature at a rate of 20 mW/°C.

d. Derate linearly above 85°C free-air temperature at a rate of 21.25 mW/°C. The maximum LED junction temperature should not exceed 125°C.

Recommended Operating Conditions

Table 7: Recommended Operating Conditions

Parameter	Symbol	Min	Max.	Units	Note
Operating Temperature	T_A	–40	105	°C	
Output Supply Voltage	$(V_{CC} – V_{EE})$	15	30	V	
Negative Output Supply Voltage	$(V_E – V_{EE})$	0	15	V	
Positive Output Supply Voltage	$(V_{CC} – V_E)$	15	$30 – (V_E – V_{EE})$	V	
Input Current (ON)	$I_{F(ON)}$	8	12	mA	
Input Voltage (OFF)	$V_{F(OFF)}$	–3.6	0.5	V	

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Electrical Specifications (DC)

All typical values are at T_A = 25°C, $V_{CC} – V_E$ = 15V, $V_E – V_{EE}$ = 15V. All minimum and maximum specifications are at recommended operating conditions (T_A = –40°C to 105°C, $I_{F(ON)}$ = 8 mA to 12 mA, $V_{F(OFF)}$ = –3.6V to 0.5V, $V_{CC} – V_E$ = 15V, $V_E – V_{EE}$ = 15V), unless otherwise noted.

Table 8: Electrical Specifications (DC)

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
High Level Peak Output Current	I_{OH}	–2.5	—	—	A	$V_{CC} – V_O$ = 15		a
Low Level Peak Output Current	I_{OL}	2.5	—	—	A	$V_O – V_{EE}$ =15		a
High Output Transistor RDS(ON)	$R_{DS,OH}$	0.5	1.5	3.0	Ω	I_{OH} = 2.5 A	6	b
Low Output Transistor RDS(ON)	$R_{DS,OL}$	0.2	0.9	1.8	Ω	I_{OL} = –2.5 A	7	b
High Level Output Voltage	V_{OH}	V_{CC} – 0.3	V_{CC} – 0.12	—	V	I_O = –100 mA	4	c, d
High Level Output Voltage	V_{OH}	—	V_{CC}	—	V	I_O = 0 mA , I_F = 10 mA		
Low Level Output Voltage	V_{OL}	—	0.09	0.25	V	I_O = 100 mA	5	
High Level Output Supply Current (V_{CC})	I_{CCH}	—	3	5	mA	I_F = 10 mA	8	
Low Level Output Supply Current (V_{CC})	I_{CCL}	—	3	5	mA	V_F = 0V	8	
V_E High Level Output Supply Current	I_{EH}	–1.3	–0.9	—	mA	I_F = 10 mA	9	
V_E Low Level Output Supply Current	I_{EL}	–1.0	–0.7	—	mA	V_F = 0V	9	
Threshold Input Current Low to High	I_{FLH}	0.50	2.5	6	mA	V_O > 5 V	10, 11	
Threshold Input Voltage High to Low	V_{FHL}	0.5	—	—	V			
Input Forward Voltage	V_F	1.20	1.45	1.85	V	I_F = 10 mA		
Temperature Coefficient of Input Forward Voltage	$\Delta V_F/\Delta T_A$	—	–1.5	—	mV/°C	I_F = 10 mA		
Input Reverse Breakdown Voltage	BV_R	5	—	—	V	I_R = 100 mA		
Input Capacitance	C_{IN}	—	23	—	pF	f = 1 MHz, V_F = 0 V		
UVLO Threshold	V_{UVLO+}	11.9	12.6	13.2	V	V_O > 5 V, I_F = 10 mA		
	V_{UVLO-}	10.9	11.6	12.2				
UVLO Hysteresis	$UVLO_{HYS}$	—	1.0	—	V			

a. Maximum pulse width = 10 ms.

b. Output is sourced at –2.5A/2.5A with a maximum pulse width = 10 µs.

c. In this test, V_{OH} is measured with a dc load current. When driving capacitive loads, V_{OH} will approach V_{CC} as I_{OH} approaches zero amps.

d. Maximum pulse width = 1 ms.

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Switching Specifications (AC)

All typical values are at T_A = 25°C, $V_{CC} – V_E$ = 15V, $V_E – V_{EE}$ = 15V. All minimum and maximum specifications are at recommended operating conditions (T_A = –40°C to 105°C, $I_{F(ON)}$ = 8 mA to 12 mA, $V_{F(OFF)}$ = –3.6V to 0.5V, $V_{CC} – V_E$ = 15V, $V_E – V_{EE}$ = 15V), unless otherwise noted.

Table 9: Switching Specifications (AC)

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Propagation Delay Time to High Output Level	t_{PLH}	50	75	150	ns	R_G = 10 Ω, C_G = 25 nF, f = 10 kHz, Duty Cycle = 50%, I_F = 10 mA,	12, 13, 16	
Propagation Delay Time to Low Output Level	t_{PHL}	50	68	150	ns			
Pulse Width Distortion	PWD			80	ns		16	a
Propagation Delay Difference Between Any Two Parts	PDD ($t_{PHL} – t_{PLH}$)	–90		90	ns		16	b
Propagation Delay Skew	t_{PSK}			80	ns		16	c
Rise Time	t_R		20	50	ns		14, 16	
Fall Time	t_F		10	30	ns			
Output High Level Common Mode Transient Immunity	$\|CM_H\|$	100			kV/µs	T_A = 25°C, I_F = 10 mA, V_{CM} = 1500V	17	d, e
Output Low Level Common Mode Transient Immunity	$\|CM_L\|$	100			kV/µ	T_A = 25°C, V_F = 0V, V_{CM} = 1500V		d, f

a. Pulse Width Distortion (PWD) is defined as $|t_{PHL} – t_{PLH}|$ for any given device.

b. The difference between $t_{PH}L$ and t_{PLH} between any two ACNW3410 parts under the same test condition.

c. t_{PSK} is equal to the worst case difference in t_{PHL} or t_{PLH} that will be seen between units at any given temperature and specified test conditions.

d. Pin 1 and 4 need to be connected to LED common. Split resistor network in the ratio 1:1 with 178Ω at the anode and 178Ω at the cathode.

e. Common mode transient immunity in the high state is the maximum tolerable dV_{CM}/dt of the common mode pulse, V_{CM}, to assure that the output will remain in the high state (that is, V_O > 15.0V).

f. Common mode transient immunity in a low state is the maximum tolerable dV_{CM}/dt of the common mode pulse, V_{CM}, to assure that the output will remain in a low state (that is, V_O < 1.0V).

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Package Characteristics

All typical values are at T_A = 25°C. All minimum/maximum specifications are at recommended operating conditions, unless otherwise noted.

Table 10: Package Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Input-Output Momentary Withstand Voltage[a]	V_{ISO}	5000	—	—	V_{RMS}	RH < 50%, t = 1 min., T_A = 25°C		b, c
Input-Output Resistance	R_{I-O}	—	10^{12}	—	Ω	V_{I-O} = 500 V_{DC}		c
Input-Output Capacitance	C_{I-O}	—	0.5	—	pF	f = 1 MHz		
LED-to-Ambient Thermal Resistance	R_{11}	—	139	—	°C/W	Thermal Model in Application Information		d
LED-to-Detector Thermal Resistance	R_{12}	—	25.3	—				
Detector-to-LED Thermal Resistance	R_{21}	—	40.2	—				
Detector-to-Ambient Thermal Resistance	R_{22}	—	87.5	—				

a. The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating. For the continuous voltage rating, refer to your equipment level safety specification or Broadcom Application Note 1074, *Optocoupler Input-Output Endurance Voltage*.

b. In accordance with UL1577, each optocoupler is proof tested by applying an insulation test voltage ≥ 6000 V_{RMS} for 1 second (leakage detection current limit, I_{I-O} ≤ 5 µA).

c. The device is considered to be a two-terminal device: pins 1, 2, 3, and 4 shorted together and pins 5, 6, 7, and 8 shorted together.

d. The device was mounted on a high conductivity test board as per JEDEC 51-7.

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Figure 4: V_{OH} vs. Temperature

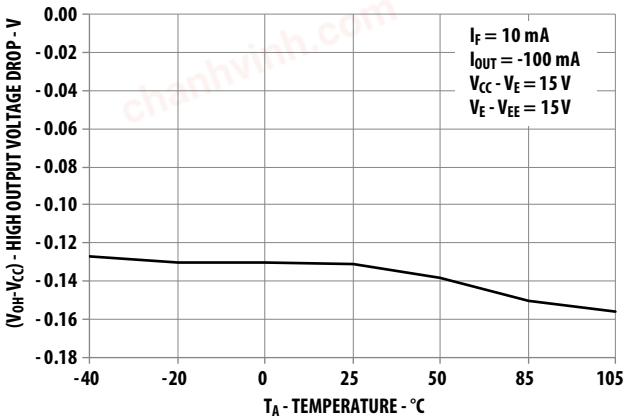


Figure 5: V_{OL} vs. Temperature

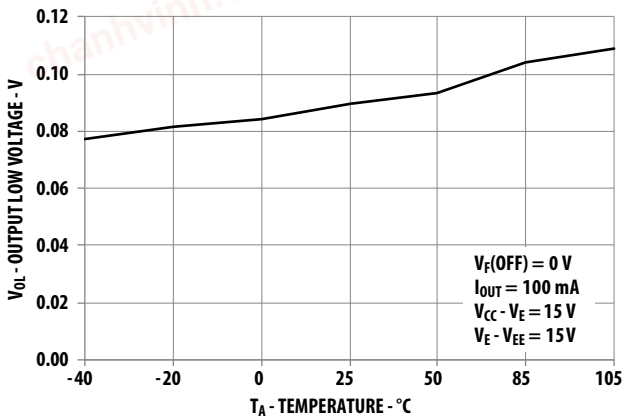


Figure 6: $R_{DS,OH}$ vs. Temperature

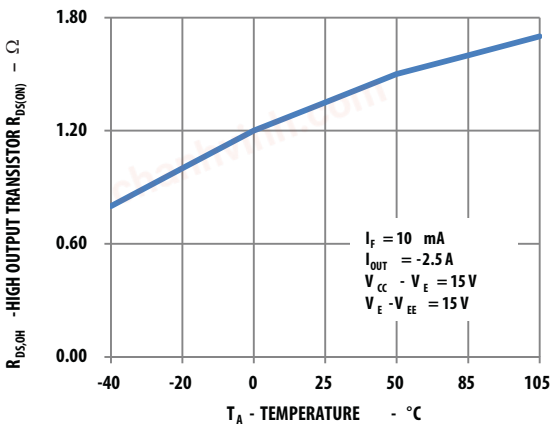


Figure 7: $R_{DS,OL}$ vs. Temperature

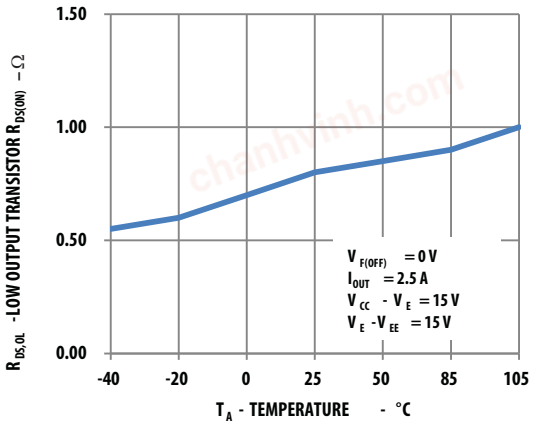


Figure 8: I_{CC} vs. Temperature

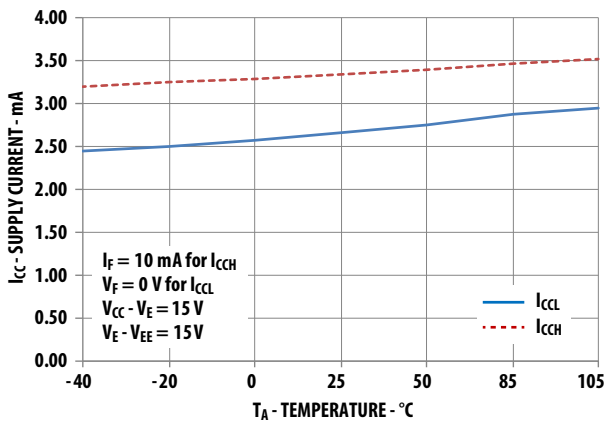
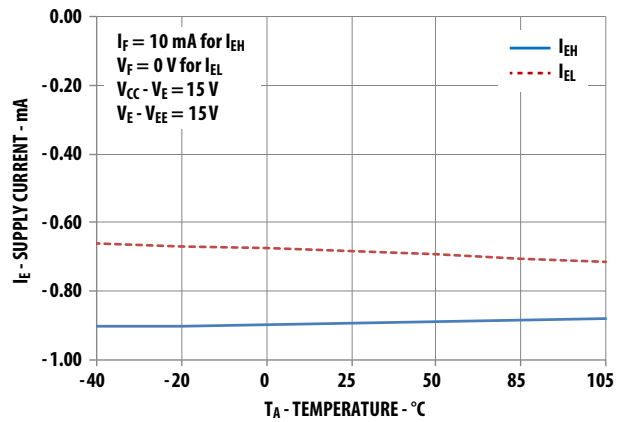


Figure 9: I_E vs. Temperature



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Figure 10: I_{FLH} Hysteresis

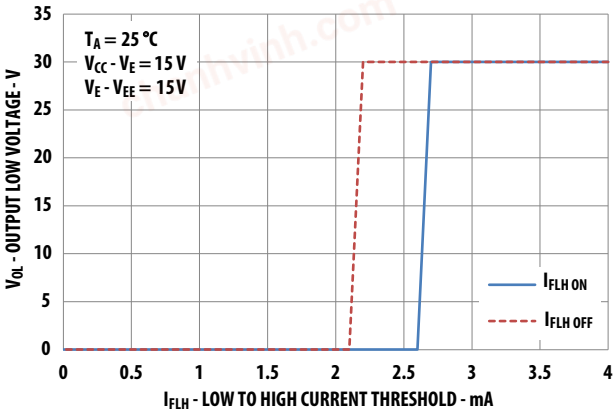


Figure 11: I_{FLH} vs. Temperature

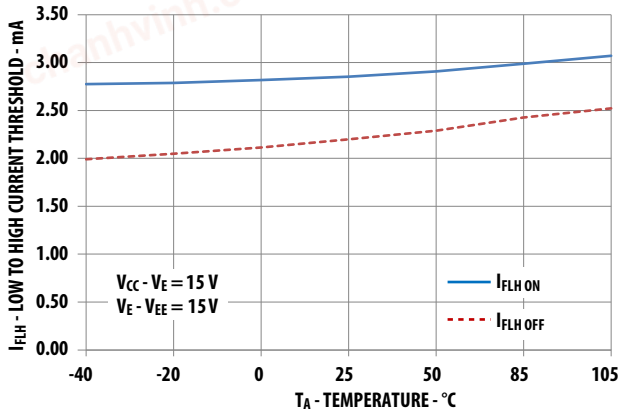


Figure 12: Propagation Delay vs. I_F

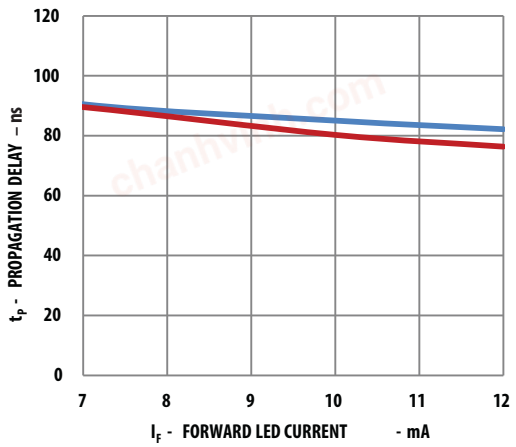


Figure 13: Propagation Delay vs. Temperature

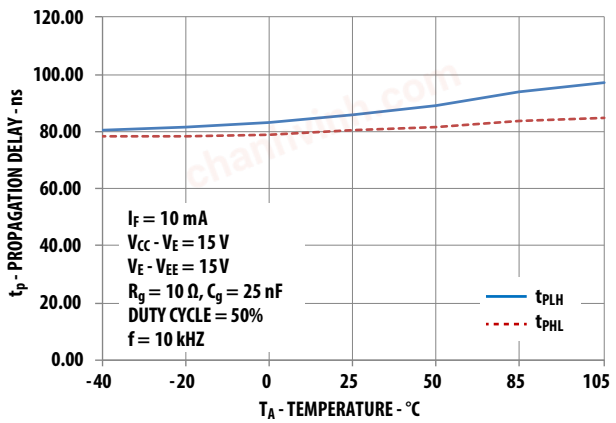


Figure 14: Rise and Fall Time vs. Temperature

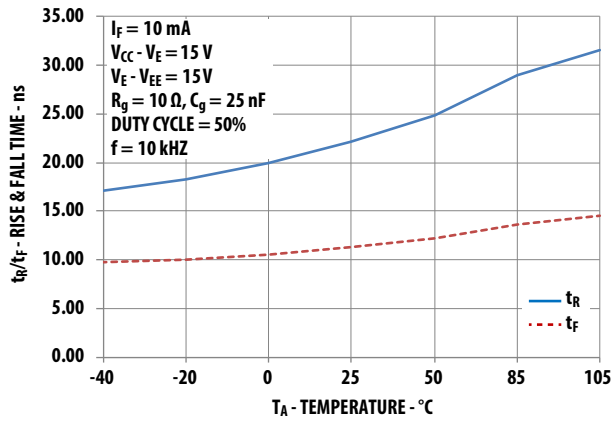
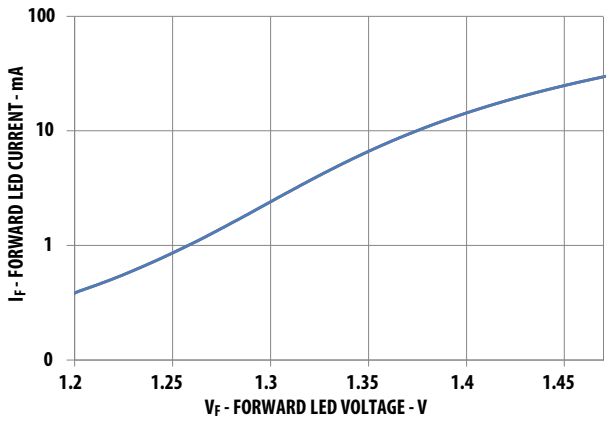


Figure 15: Input Current vs. Forward Voltage



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Figure 16: t_{PLH}, t_{PHL}, PWD PDD, t_{PSK}, t_r, and t_f Test Circuit and Waveforms

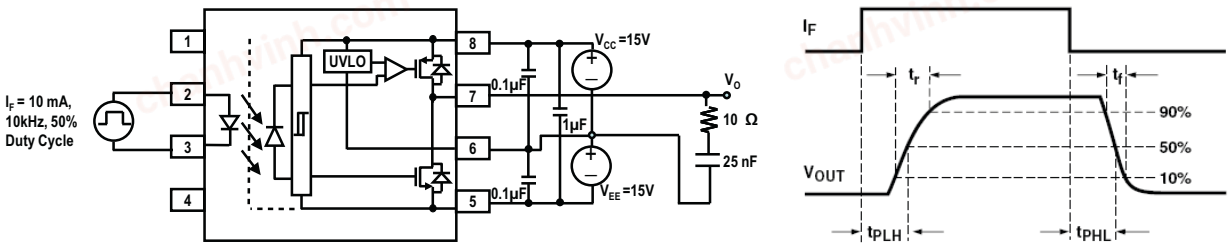
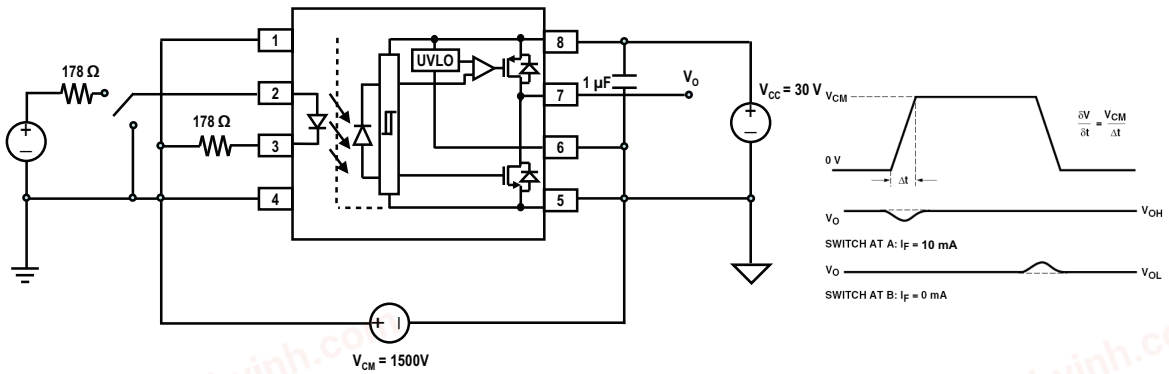


Figure 17: CMR Test Circuit with Split Resistors Network and Waveforms



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Application Information

Product Overview Description

The ACNW3410 is an optically isolated power output stage capable of driving IGBT or power MOSFET. Based on BCDMOS technology, this gate drive optocoupler delivers higher peak output current, better rail-to-rail output voltage performance and faster speed than the previous generation products.

The high peak output current and short propagation delay are needed for fast IGBT switching to reduce dead time and improve system overall efficiency. Rail-to-rail output voltage ensures that the MOSFET's gate voltage is driven to the optimum intended level with no power loss across the MOSFET. This helps the designer lower the system power which is suitable for bootstrap power supply operation.

The ACNW3410 has a V_E pin that allows of use negative power supply without affecting the UVLO monitoring the positive power supply. It has very high CMR (common mode rejection) rating which allows the microcontroller and the MOSFET to operate at very large common mode noise found in industrial motor drives and other power switching applications. The input is driven by direct LED current and has a hysteresis that prevents output oscillation if insufficient LED driving current is applied. This eliminates the need of additional Schmitt trigger circuit at the input LED.

Recommended Application Circuit

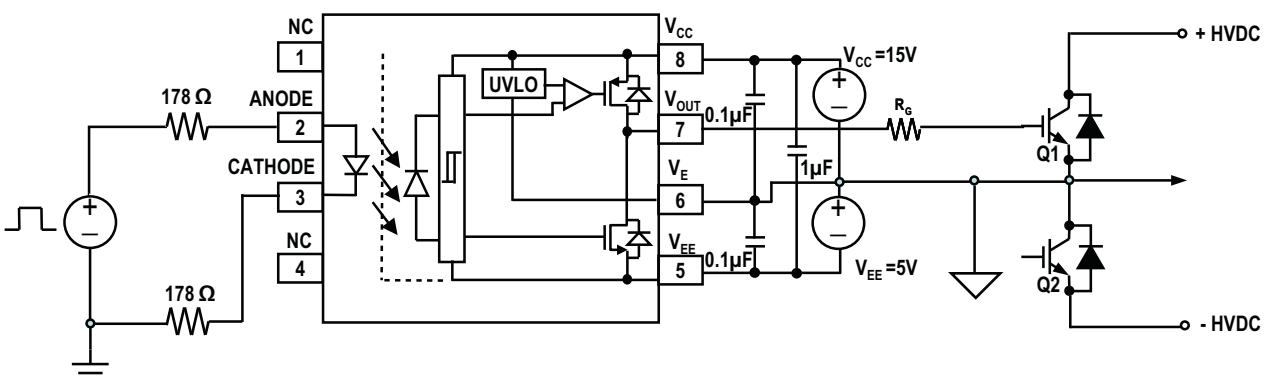
The recommended application circuit shown in the following figure illustrates a typical gate drive implementation using the ACNW3410.

The supply bypass capacitors provide the large transient currents necessary during a switching transition. Because of the transient nature of the charging currents, a low current (5.0 mA) power supply will be enough to power the device. The split resistors (in the ratio of 1:1) across the LED will provide a high CMR response by providing a balanced resistance network across the LED. Connect pin 1 and pin 4 to LED common.

The gate resistor R_G serves to limit gate charge current and controls the IGBT switching times.

In PC board design, care should be taken to avoid routing the IGBT's collector or emitter traces close to the ACNW3410 input as this can result in unwanted coupling of transient signals into ACNW3410 and degrade performance.

Figure 18: Recommended Application Circuit with Split Resistors LED Drive



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Thermal Model for ACNW3410 400mil DIP-8 Package Optocoupler

Definitions:

R_{11}: Junction to Ambient Thermal Resistance of LED due to heating of LED

R_{12}: Junction to Ambient Thermal Resistance of LED due to heating of Detector (Output IC)

R_{21}: Junction to Ambient Thermal Resistance of Detector (Output IC) due to heating of LED.

R_{22}: Junction to Ambient Thermal Resistance of Detector (Output IC) due to heating of Detector (Output IC).

P_1: Power dissipation of LED (W).

P_2: Power dissipation of Detector / Output IC (W).

T_1: Junction temperature of LED (C).

T_2: Junction temperature of Detector (C).

T_A: Ambient temperature.

Ambient Temperature: Junction to Ambient Thermal Resistances were measured approximately 1.25 cm above the optocoupler at ~23°C in still air.

Thermal Resistance	°C/W
R_{11}	139
R_{12}	25.3
R_{21}	40.2
R_{22}	87.5

This thermal model assumes that an 8-pin single-channel plastic package optocoupler is soldered into a 7.62 cm × 7.62 cm printed circuit board (PCB) per JEDEC standards. The temperature at the LED and Detector junctions of the optocoupler can be calculated using the following equations.

$T_1 = (R_{11} \times P_1 + R_{12} \times P_2) + T_A$ -- (1)

$T_2 = (R_{21} \times P_1 + R_{22} \times P_2) + T_A$ -- (2)

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