Application Note 951-1

Applications for Low-Input Current, High-Gain Optocouplers

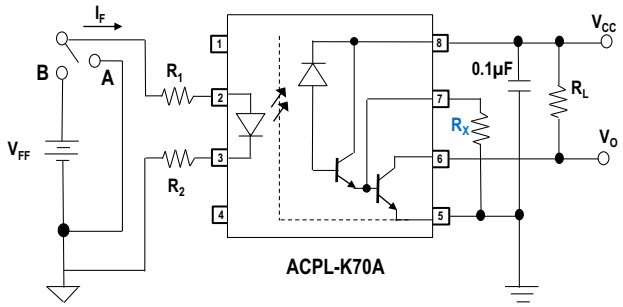
Introduction

Optically coupled isolators are useful in applications where large common mode signals are encountered. Some examples include line receivers, logic isolation, power lines, medical equipment, and telephone lines. This application note provides examples for the HCPL-0700/0701/0730/0731,6N138/9, and ACPL-K70A/K73A series high current transfer ratio (CTR) couplers in each of these areas.

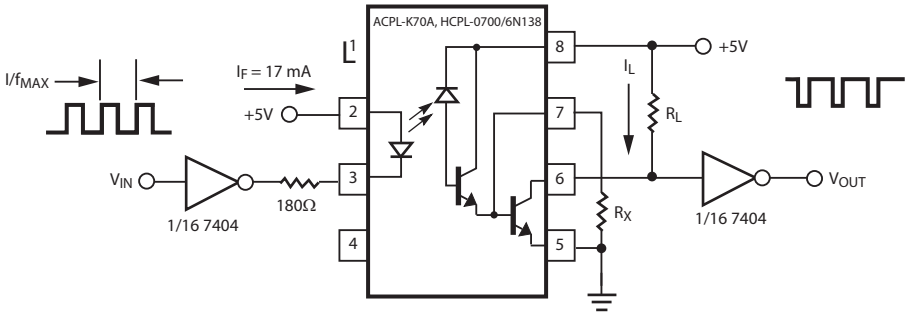
The Broadcom® HCPL-0700/0701/0730/0731,6N138/9 series couplers contain a high-gain, high-speed photodetector that provides a minimum current transfer ratio (CTR) of 300% at input currents of 1.6 mA for the HCPL-0700/0730, 6N138, ACPL-K70A and 400% at 0.5 mA for the HCPL-0701/0731, 6N139, ACPL-K70A. HCPL-070A/073A, and the newly released ACPL-K70A/K73A provides a minimum CTR of 800% at lower input current of 0.04 mA.The HCPL-0700/0701, 6N138/9, ACPL-K70A are single-channel devices, while the HCPL-0730/0731, ACPL-K73A are two-channel equivalent devices. HCPL-07xx and ACL-K70A/K73A use the SO8 package and the Stretched SO8 package format, respectively. The excellent low-input current CTR enables these devices to be used in applications where low power consumption is required and those applications that do not provide sufficient input current for other couplers. Separate pin connections for the photodiode and output transistor permit high-speed operation and TTL-compatible output. An external resistor or capacitor at the base can be added to make a gain-bandwidth (gain speed tradeoff) or input current threshold adjustment. The base lead can also be used for feedback.

Gain/Speed Trade Off

- Obtain maximum speed at required gain
- Use the same device for multiple applications



Rx (Ω)	IF (mA)	CTR (%)	R_L (Ω)	t_{PHL} (µs)	t_{PLH} (µs)
NONE	0.5	3500	4700	3.5	50
10,000	0.5	2813	4700	11.2	2.95

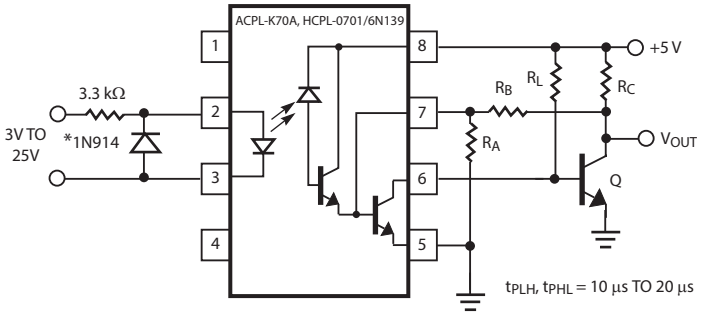


R_X (Ω)	R_L (Ω)	I_L (mA)	f_{MAX} (kHz)
NONE	100	46	250
820	1000	4.6	650

f_{MAX} IS THE FREQUENCY AT WHICH A 50% DUTY FACTOR AT THE INPUT IS DEGENERATED TO 10% OR 90% DUTY FACTOR AT THE OUTPUT.

RS-232C Compatible Line Receiver

- 2500V, 60-Hz common mode rejection
- Allows use of low-cost line
- Full 40-kB/s data rate for line lengths up to 5000 ft.
- Hysteresis for increased noise immunity



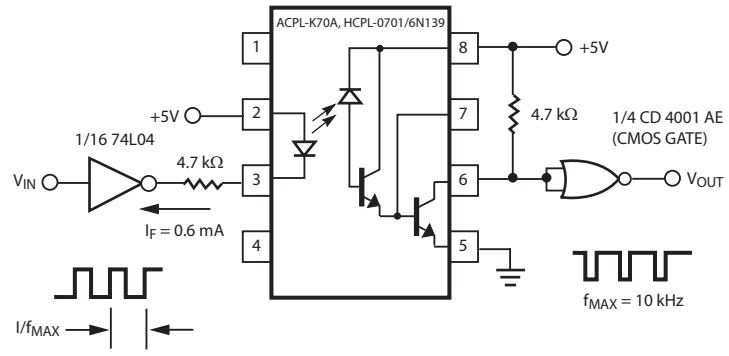
*ANTIPARALLEL DIODE IS NEEDED ONLY IF REVERSE LINE VOLTAGE EXCEEDS 15V (TO PREVENT HIGH REVERSE VOLTAGE FROM CAUSING POWER DISSIPATION IN EXCESS OF INPUT DIODE MAXIMUM RATING).

R_A	R_B	R_C	R_L	Q
680 kΩ	1.5 MΩ	1.8 kΩ	15 kΩ	2N3904

REMOVE R_A AND R_B FOR NO HYSTERESIS

Low Power Interface

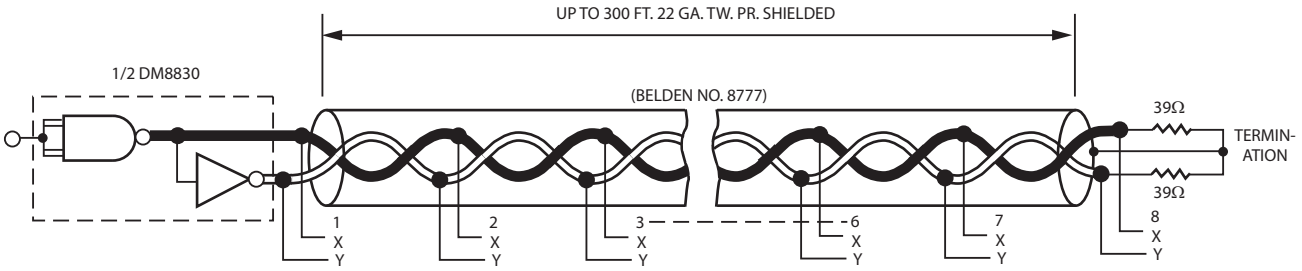
- Operation at I_F ³ 0.5 mA
- 10 kHz f_{MAX}
- Low power consumption



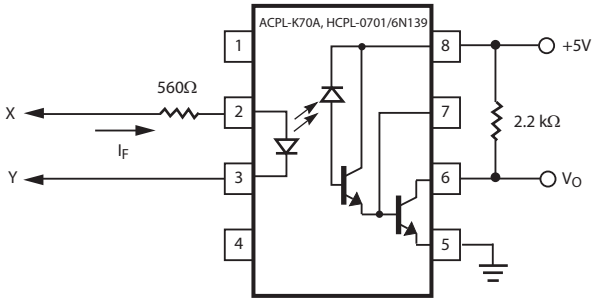
f_{MAX} IS THE FREQUENCY AT WHICH A 50% DUTY FACTOR AT THE INPUT IS DEGENERATED TO 10% OR 90% DUTY FACTOR AT THE OUTPUT.

Line Receiver for Party Line

- One to eight receivers can be used with circuit shown
- Uses conventional IC line driver
- Total line length 1 ft to 300 ft
- Typical data rate: 180 kB/s (t_{PHL}, t_{PLH} = 3 μs)
- Allows use of low-cost line



ISOLATOR LOADS MAY BE DISTRIBUTED RANDOMLY ALONG THE LENGTH OF THE LINE, OR ALL MAY BE LUMPED AT THE END. I_F FOR 1 AND 8 ISOLATOR LOADS WOULD BE 2.7 AND 1.8 mA RESPECTIVELY.

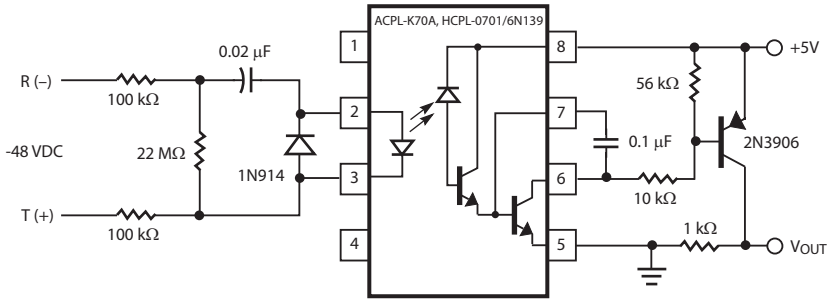


PROPAGATION DELAY: t_{PHL}, t_{PLH} = 0.5 μs TO 5 μs

OUTPUT GROUNDS MAY ALL BE ELECTRICALLY SEPARATED

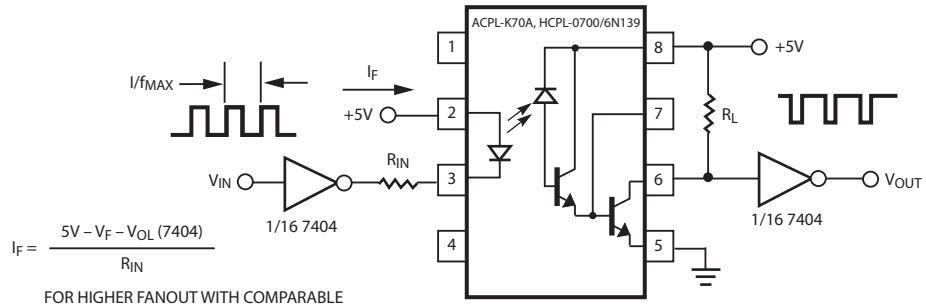
Telephone Ring Detector

- Discriminates between ring and dial signals
- Minimal line loading
- 2500V insulation from the telephone line
- Small size
- Integrator included



TTL-to-TTL Interface

- Direct input and output compatibility
- Adjustable data rate
- High fan-out



$$I_F = \frac{5V - V_F - V_{OL}\ (7404)}{R_{IN}}$$

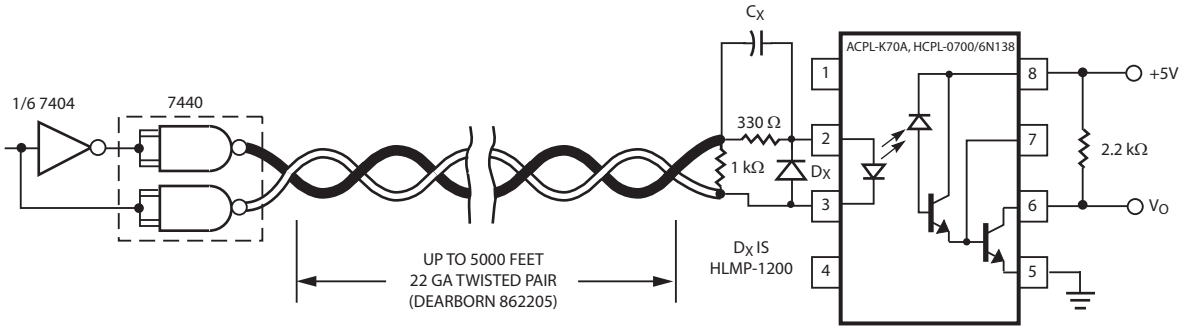
FOR HIGHER FANOUT WITH COMPARABLE DATA RATES USE SMALLER VALUES OF R_{IN}

R_L (Ω)	R_{IN} (Ω)	I_F (mA)	f_{MAX} (kHz)
2200	1800	1.7	40
270	390	8	125
100	180	17	250

f_{MAX} IS THE FREQUENCY AT WHICH A 50% DUTY FACTOR AT THE INPUT IS DEGENERATED TO 10% OR 90% DUTY FACTOR AT THE OUTPUT.

1 ft. to 5000 ft. Line Receiver

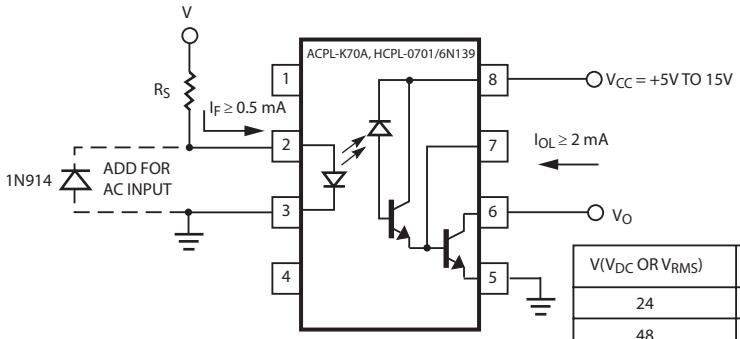
- Drive with standard TTL buffer gate
- 2500V, 60-Hz common mode rejection
- Allows use of low-cost line
- 40-kB/s data rate
- TTL-compatible output



PROPAGATION DELAY: WITHOUT C_X, D_X, t_{PLH} = 2 TO 5 µs; t_{PHL} = 25 µs
WITH D_X, $C_X \geq 0.002$ µF, t_{PLH} = 2 µs; t_{PHL} = 7 µs

High Voltage Status Indicator

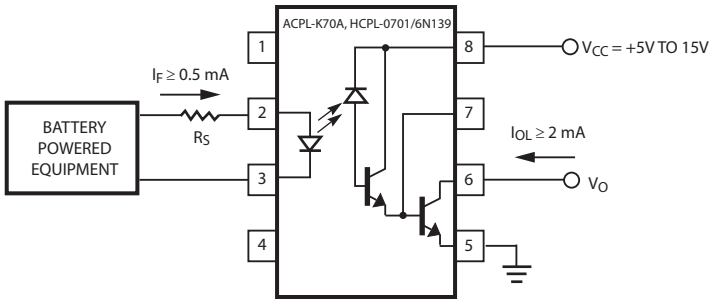
- Low power consumption
- TTL-compatible output
- High speed
- Use for power turn-on anticipation circuit, 117V line monitor or other high-voltage sensing



V(V_{DC} OR V_{RMS})	R_S	V • I_F (mW)
24	47 kΩ	11
48	100 kΩ	22
117	220 kΩ	62
230	470 kΩ	113

0.0.0.0.1 Medical Equipment Isolation

- Low power consumption
- 2500V, 60-Hz isolation
- Digital or analog operation



Conventional Darlington

- No bias supply required
- Base lead available for gain/bandwidth adjust
- Data rates of 2 kB/s