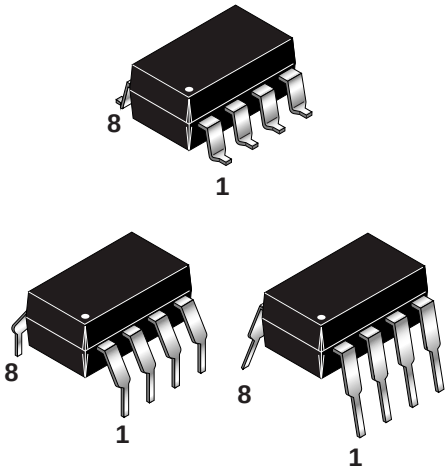
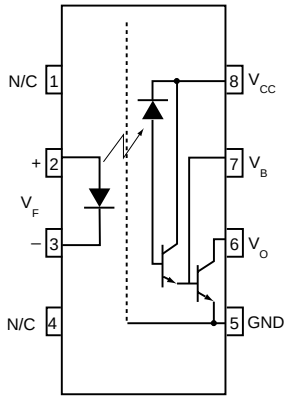
LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

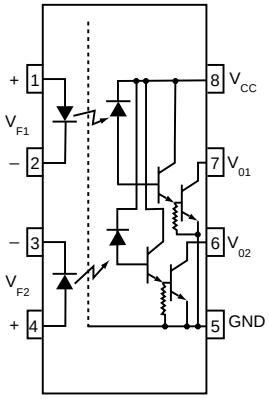
PACKAGE



SCHEMATIC



6N138 / 6N139



HCPL-2730 / HCPL-2731

DESCRIPTION

The 6N138/9 and HCPL-2730/HCPL-2731 optocouplers consist of an AlGaAs LED optically coupled to a high gain split darlington photodetector.

The split darlington configuration separating the input photodiode and the first stage gain from the output transistor permits lower output saturation voltage and higher speed operation than possible with conventional darlington phototransistor optocoupler. In the dual channel devices, HCPL-2730/HCPL2731, an integrated emitter - base resistor provides superior stability over temperature.

The combination of a very low input current of 0.5 mA and a high current transfer ratio of 2000% makes this family particularly useful for input interface to MOS, CMOS, LSTTL and EIA RS232C, while output compatibility is ensured to CMOS as well as high fan-out TTL requirements. An internal noise shield provides exceptional common mode rejection of 10 kV/µs.

FEATURES

- Low current - 0.5 mA
- Superior CTR-2000%
- Superior CMR-10 kV/µs
- CTR guaranteed 0-70°C
- U.L. recognized (File # E90700)
- VDE recognized (File # 120915) Ordering option V, e.g., 6N138V
- Dual Channel - HCPL-2730
- HCPL-2731

APPLICATIONS

- Digital logic ground isolation
- Telephone ring detector
- EIA-RS-232C line receiver
- High common mode noise line receiver
- µP bus isolation
- Current loop receiver

LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise specified)

Parameter		Symbol	Value	Units
Storage Temperature		T_{STG}	-55 to +125	°C
Operating Temperature		T_{OPR}	-40 to +85	°C
Lead Solder Temperature (Wave solder only. See recommended reflow profile graph for SMD mounting)		T_{SOL}	260 for 10 sec	°C
EMITTER				
DC/Average Forward Input Current	Each Channel	I_F (avg)	20	mA
Peak Forward Input Current (50% duty cycle, 1 ms P.W.)	Each Channel	I_F (pk)	40	mA
Peak Transient Input Current - (≤1 µs P.W., 300 pps)		I_F (trans)	1.0	A
Reverse Input Voltage	Each Channel	V_R	5	V
Input Power Dissipation	Each Channel	P_D	35	mW
DETECTOR				
Average Output Current	Each Channel	I_O (avg)	60	mA
Emitter-Base Reverse Voltage	(6N138 and 6N139)	V_{ER}	0.5	V
Supply Voltage, Output Voltage	(6N138, HCPL-2730)	V_{CC}, V_O	-0.5 to 7	V
	(6N139, HCPL-2731)		-0.5 to 18	
Output Power Dissipation	Each Channel	P_O	100	mW

ELECTRICAL CHARACTERISTICS (T_A = 0 to 70°C Unless otherwise specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

Parameter	Test Conditions	Symbol	Device	Min	Typ**	Max	Unit
EMITTER	T_A =25°C	V_F	All		1.30	1.7	V
Input Forward Voltage	Each channel (I_F = 1.6 mA)					1.75	
Input Reverse Breakdown Voltage	(T_A = 25°C, I_R = 10 µA)	BV_R	All	5.0	20		V
	Each Channel						
Temperature coefficient of forward voltage	(I_F = 1.6 mA)	($\Delta V_F/\Delta T_A$)	All		-1.8		mV/°C
DETECTOR							
Logic high output current	(I_F = 0 mA, V_O = V_{CC} = 18 V)	I_{OH}	6N139		0.01	100	µA
	Each Channel		HCPL-2731				
	(I_F = 0 mA, V_O = V_{CC} = 7 V)		6N138		0.01	250	
	Each Channel		HCPL-2730				
Logic low supply	(I_F = 1.6 mA, V_O = Open) (V_{CC} = 18 V)	I_{CCL}	6N138 6N139		0.4	1.5	mA
	(I_{F1} = I_{F2} = 1.6 mA, V_{CC} = 18 V)		HCPL-2731		1.3	3	
	(V_{O1} - V_{O2} = Open, V_{CC} = 7 V		HCPL-2730				
Logic high supply	(I_F = 0 mA, V_O = Open, V_{CC} = 18 V)	I_{CCH}	6N135 6N136		0.05	10	µA
	(I_{F1} = I_{F2} = 0 mA, V_{CC} = 18 V)		HCPL-2731		0.10	20	
	(V_{O1} - V_{O2} = Open, V_{CC} = 7 V		HCPL-2730				

** All Typicals at T_A = 25°C

LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

TRANSFER CHARACTERISTICS (T_A = 0 to 70°C Unless otherwise specified)

Parameter	Test Conditions	Symbol	Device	Min	Typ**	Max	Unit
COUPLED	(I_F = 0.5 mA, V_O = 0.4 V, V_{CC} = 4.5 V)	CTR	6N139	400	1100		%
	Each Channel		HCPL-2731		3500		
Current transfer ratio (Note 1, 2)	(I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V)		6N139	500	1300		%
	Each Channel		HCPL-2731		2500		
	(I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V)		6N138	300	1300		%
	Each Channel		HCPL-2730		2500		
Logic low output voltage output voltage (Note 2)	(I_F = 0.5 mA, I_O = 2 mA, V_{CC} = 4.5 V)	V_{OL}	6N139		0.08	0.4	V
	(I_F = 1.6 mA, I_O = 8 mA, V_{CC} = 4.5 V)		6N139		0.01	0.4	
	Each Channel		HCPL-2731				
	(I_F = 0.5 mA, I_O = 15 mA, V_{CC} = 4.5 V)		6N139		0.13	0.4	
	Each Channel		HCPL-2731				
	(I_F = 12 mA, I_O = 24 mA, V_{CC} = 4.5 V)		6N139		0.20	0.4	
	Each Channel		HCPL-2731				
	(I_F = 1.6 mA, I_O = 4.8 mA, V_{CC} = 4.5 V)		6N138		0.10	0.4	
	Each Channel		HCPL-2730				

** All Typicals at T_A = 25°C

LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

SWITCHING CHARACTERISTICS (T_A = 0 to 70°C unless otherwise specified., V_{CC} = 5 V)

Parameter	Test Conditions	Symbol	Device	Min	Typ**	Max	Unit
Propagation delay time to logic low (Note 2) (Fig. 22)	(R_L = 4.7 kΩ, I_F = 0.5 mA)	T_{PHL}	6N139			30	µs
	T_A = 25°C				4	25	
	(R_L = 4.7 kΩ, I_F = 0.5 mA)		HCPL-2731			120	
	Each Channel T_A = 25°C				3	100	
	(R_L = 270 Ω, I_F = 12 mA)		6N139			2	
	T_A = 25°C				0.2	1	
	(R_L = 270 Ω, I_F = 12 mA)		HCPL-2730			3	
	Each Channel T_A = 25°C		HCPL-2731		0.3	2	
	(R_L = 2.2 kΩ, I_F = 1.6 mA)		6N138			15	
	T_A = 25°C				1.5	10	
	(R_L = 2.2 kΩ, I_F = 1.6 mA)		HCPL-2731 HCPL-2730			25	
	Each Channel T_A = 25°C				1	20	
Propagation delay time to logic high (Note 2) (Fig. 22)	(R_L = 4.7 kΩ, I_F = 0.5 mA)	T_{PLH}	6N139			90	µs
	Each Channel		HCPL-2731				
	(R_L = 4.7 kΩ, I_F = 0.5 mA) T_A = 25°C		6N139		12	60	
	Each Channel		HCPL-2731		22		
	(R_L = 270 Ω, I_F = 12 mA)		6N139			10	
	T_A = 25°C				1.3	7	
	(R_L = 270 Ω, I_F = 12 mA) Each Channel		HCPL-2730 HCPL-2731			15	
	T_A = 25°C				5	10	
	(R_L = 2.2 kΩ, I_F = 1.6 mA)		6N138			50	
	Each Channel		HCPL-2730/1				
	(R_L = 2.2 kΩ, I_F = 1.6 mA) T_A = 25°C		6N138		7	35	
	Each Channel		HCPL-2730/1		16		
Common mode transient immunity at logic high	(I_F = 0 mA, $\|V_{CM}\|$ = 10 V_{P-P}) T_A = 25°C, (R_L = 2.2 kΩ) (Note 3) (Fig. 23)	$\|CM_H\|$	6N138 6N139	1,000	10,000		V/µs
	Each Channel		HCPL-2730 HCPL-2731				
Common mode transient immunity at logic low	(I_F = 1.6 mA, $\|V_{CM}\|$ = 10 V_{P-P}, R_L = 2.2 kΩ) T_A = 25°C, (Note 3) (Fig. 23)	$\|CM_L\|$	6N138 6N139	1,000	10,000		V/µs
	Each Channel		HCPL-2730 HCPL-2731				

** All Typicals at T_A = 25°C

LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

ISOLATION CHARACTERISTICS (T_A = 0 to 70°C Unless otherwise specified)

Characteristics	Test Conditions	Symbol	Min	Typ**	Max	Unit
Input-output insulation leakage current	(Relative humidity = 45%) (T_A = 25°C, t = 5 s) (V_{I-O} = 3000 VDC) (Note 8)	I_{I-O}			1.0	µA
Withstand insulation test voltage	(RH ≤ 50%, T_A = 25°C) (Note 4) (t = 1 min.)	V_{ISO}	2500			V_{RMS}
Resistance (input to output)	(Note 4) (V_{I-O} = 500 VDC)	R_{I-O}		10^{12}		Ω
Capacitance (input to output)	(Note 4, 5) (f = 1 MHz)	C_{I-O}		0.6		pF
Input-Input Insulation leakage current	(RH ≤ 45%, V_{I-I} = 500 VDC) (Note 6) t = 5 s, (HCPL-2730/2731 only)	I_{I-I}		0.005		µA
Input-Input Resistance	(V_{I-I} = 500 VDC) (Note 6) (HCPL-2730/2731 only)	R_{I-I}		10^{11}		Ω
Input-Input Capacitance	(f = 1 MHz) (Note 6) (HCPL-2730/2731 only)	C_{I-I}		0.03		pF

** All Typicals at T_A = 25°C

Notes

1. Current Transfer Ratio is defined as a ratio of output collector current, I_O, to the forward LED input current, I_F, times 100%.
2. Pin 7 open. (6N138 and 6N139 only)
3. Common mode transient immunity in logic high level is the maximum tolerable (positive) dV_{cm}/dt on the leading edge of the common mode pulse signal V_{CM}, to assure that the output will remain in a logic high state (i.e., V_O>2.0 V). Common mode transient immunity in logic low level is the maximum tolerable (negative) dV_{cm}/dt on the trailing edge of the common mode pulse signal, V_{CM}, to assure that the output will remain in a logic low state (i.e., V_O<0.8 V).
4. Device is considered a two terminal device: Pins 1, 2, 3 and 4 are shorted together and Pins 5, 6, 7 and 8 are shorted together.
5. For dual channel devices, C_{I-O} is measured by shorting pins 1 and 2 or pins 3 and 4 together and pins 5 through 8 shorted together.
6. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.

LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified)

Current Limiting Resistor Calculations

R_1 (Non-Invert) = $\frac{V_{DD1} - V_{DF} - V_{OL1}}{I_F}$

R_1 (Invert) = $\frac{V_{DD1} - V_{OH1} - V_{DF}}{I_F}$

$R_2 = \frac{V_{DD2} - = V_{OLX} (@\ I_L - I_2)}{I_L}$

Where:

V_{DD1} - Input Supply Voltage

V_{DD2} - Output Supply Voltage

V_{DF} - Diode Forward Voltage

V_{OL1} - Logic "0" Voltage of Driver

V_{OH1} - Logic "1" Voltage of Driver

I_F - Diode Forward Current

V_{OLX} - Saturation Voltage of Output Transistor

I_L - Load Current Through Resistor R2

I_2 - Input Current of Output Gate

INPUT		R1 (V)	OUTPUT						
			CMOS @ 5 V	CMOS @ 10 V	74XX	74LXX	74SXX	74LSXX	74HXX
			R2 (V)	R2 (V)	R2 (V)	R2 (V)	R2 (V)	R2 (V)	R2 (V)
CMOS @ 5 V	NON-INV.	2000	1000	2200	750	1000	1000	1000	560
	INV.	510							
CMOS @ 10 V	NON-INV.	5100							
	INV.	4700							
74XX	NON-INV.	2200							
	INV.	180							
74LXX	NON-INV.	1800							
	INV.	100							
74SXX	NON-INV.	2000							
	INV.	360							
74LSXX	NON-INV.	2000							
	INV.	180							
74HXX	NON-INV.	2000							
	INV.	180							

Fig. 1 Resistor Values for Logic Interface

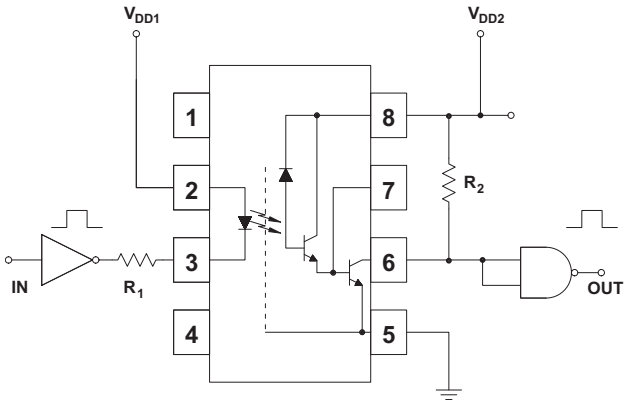


Fig. 2 Non-Inverting Logic Interface

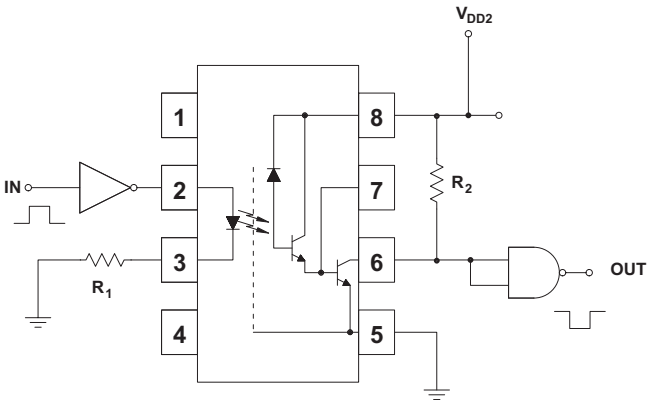


Fig. 3 Inverting Logic Interface

Fig. 4 LED Forward Current vs. Forward Voltage

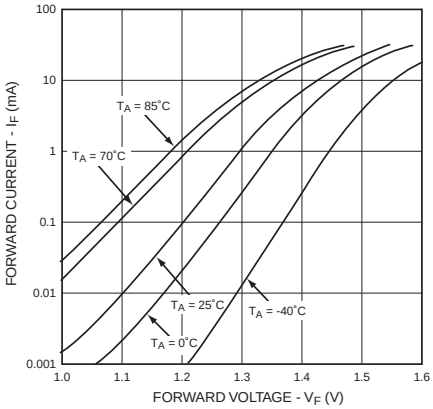


Fig. 5 LED Forward Voltage vs. Temperature

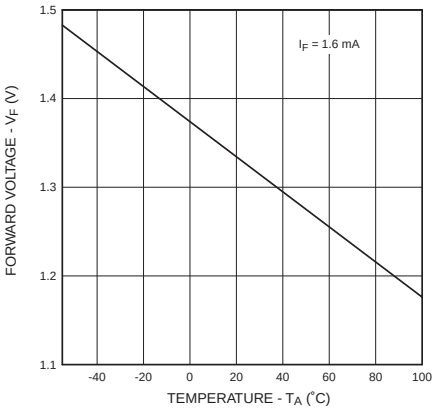


Fig. 6 Non-saturated Rise and Fall Times vs. Load Resistance (6N138 / 6N139 Only)

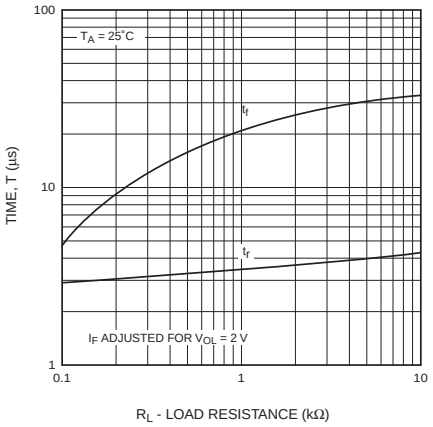


Fig. 7 Non-saturated Rise and Fall Times vs. Load Resistance (HCPL-2730 / HCPL-2731 Only)

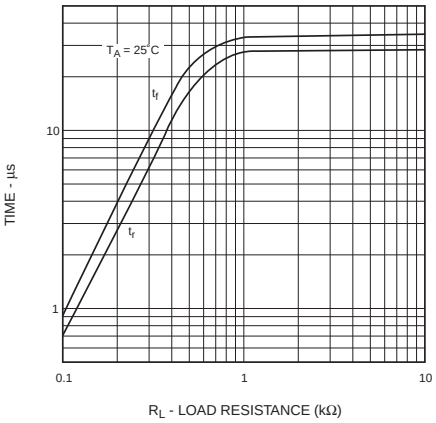


Fig. 8 Propagation Delay To Logic Low vs. Base-Emitter Resistance (HCPL-2730 / HCPL-2731 Only)

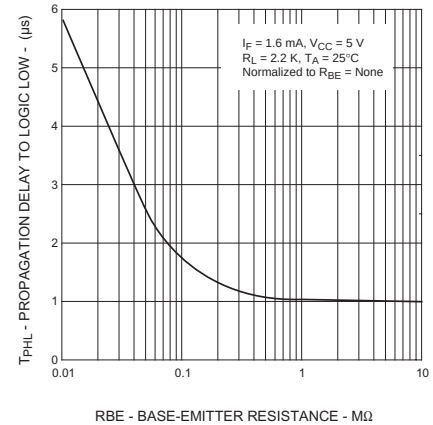


Fig. 9 Current Transfer Ratio vs. Forward Current (6N138 / 6N139 Only)

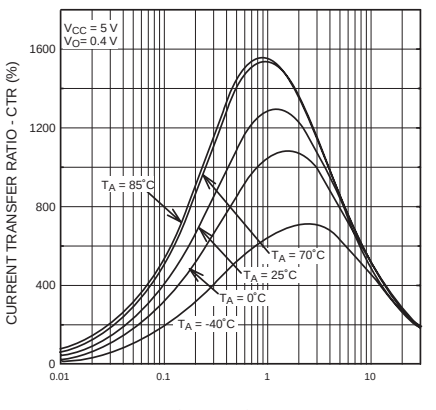


Fig. 10 Current Transfer Ratio vs. Base-Emitter Resistance (6N138 / 6N139 Only)

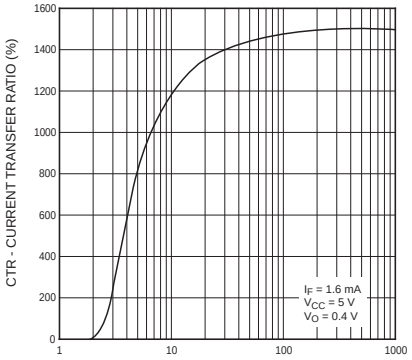


Fig. 11 Current Transfer Ratio vs. Forward Current (HCPL-2730 / HCPL-2731 Only)

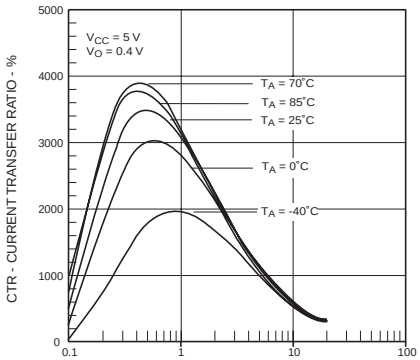


Fig. 12 Output Current vs Output Voltage (6N138 / 6N139 Only)

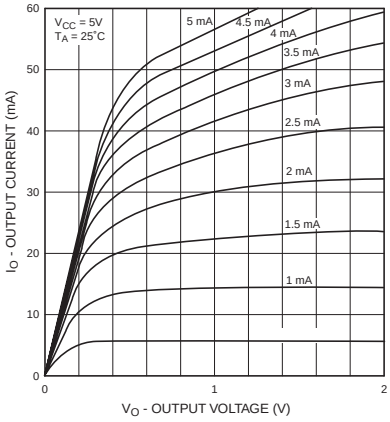


Fig. 13 Output Current vs Output Voltage (HCPL-2730 / HCPL-2731 Only)

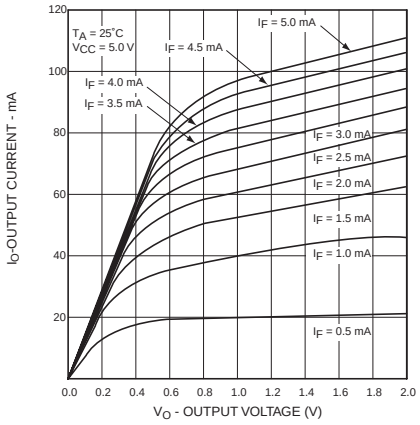


Fig. 14 Output Current vs. Input Diode Forward Current (6N138 / 6N139 Only)

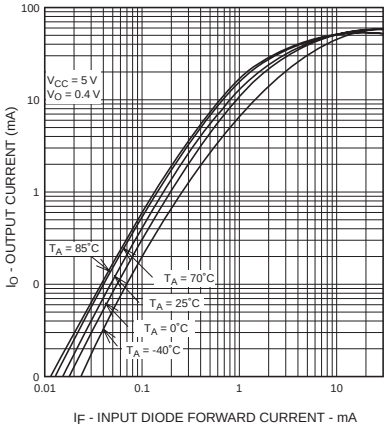


Fig. 15 Output Current vs Input Diode Forward Current (HCPL-2730 / HCPL-2731 Only)

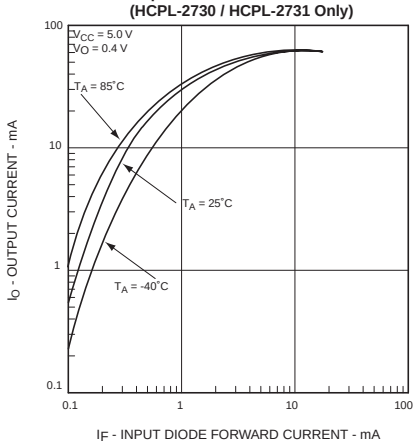


Fig. 16 Logic Low Supply Current vs. Input Diode Forward Current (6N138 / 6N139 Only)

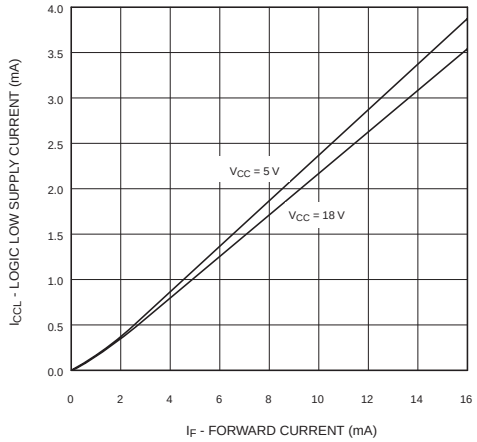


Fig. 17 Logic Low Supply Current vs. Input Diode Forward Current (HCPL-2730 / HCPL-2731 Only)

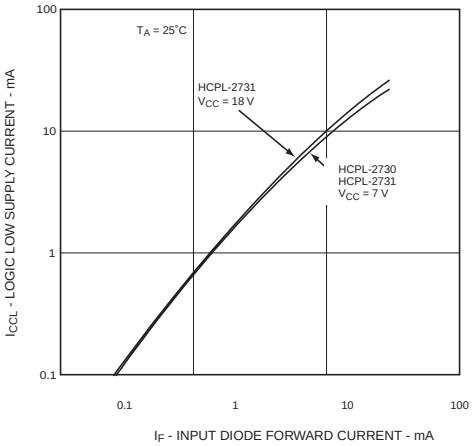


Fig. 18 Propagation Delay vs. Input Diode Forward Current (6N138 / 6N139 Only)

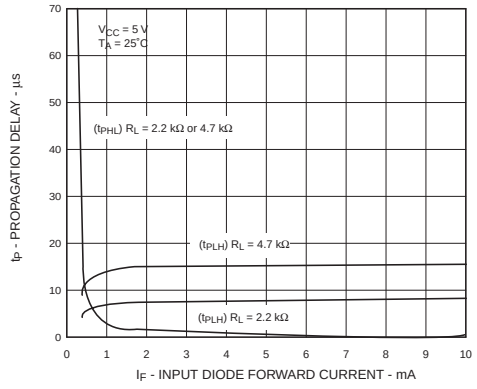


Fig. 19 Propagation Delay vs. Input Diode Forward Current (HCPL-2730 / HCPL-2731 Only)

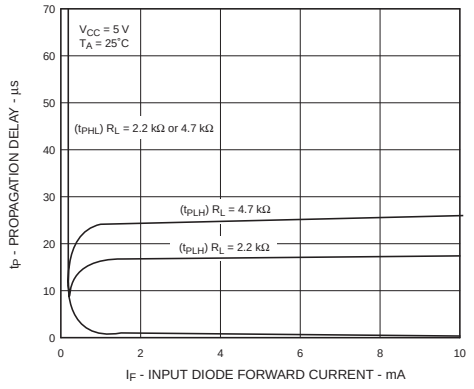


Fig. 20 Propagation Delay to Logic Low vs. Pulse Period (6N138 / 6N139 Only)

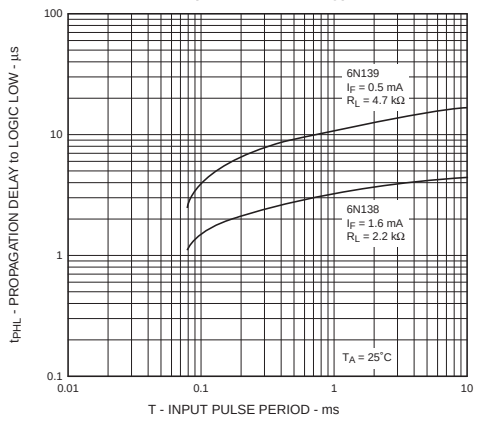


Fig. 21 Propagation Delay to Logic Low vs. Pulse Period (HCPL-2730 / HCPL-2731 Only)

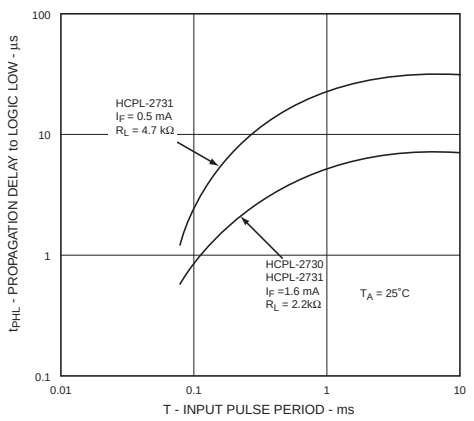


Fig. 22 Propagation Delay vs. Temperature (6N138 / 6N139 Only)

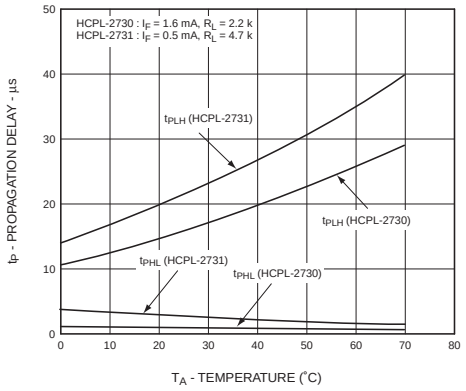
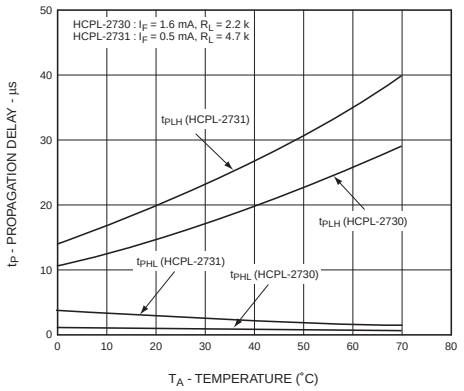


Fig. 23 Propagation Delay vs. Temperature (HCPL-2730 / HCPL-2731 Only)



LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

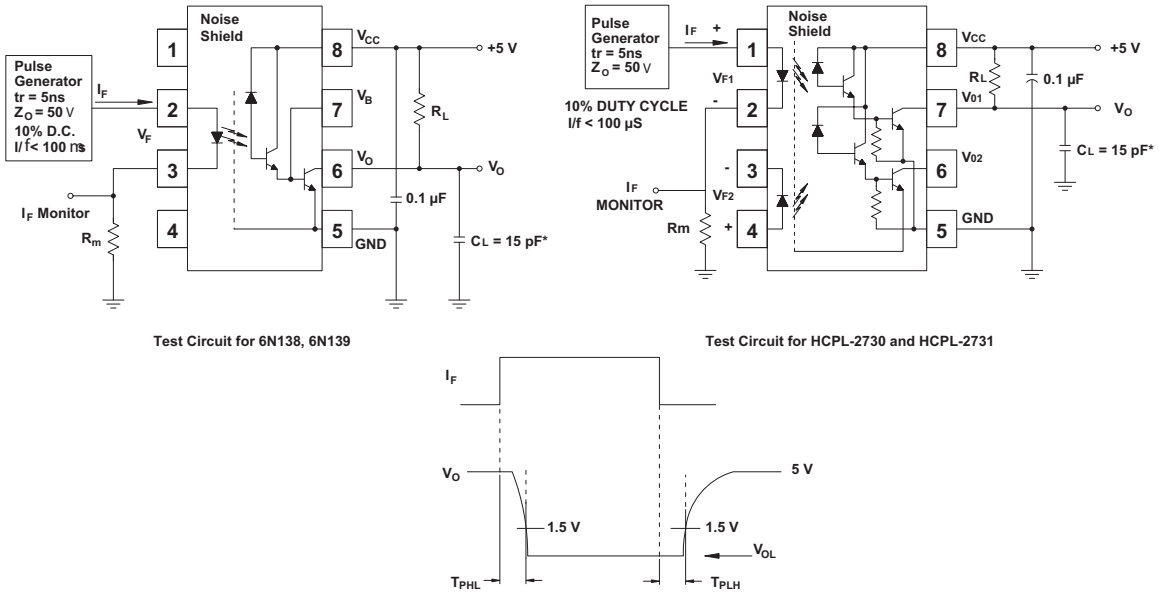


Fig. 22 Switching Time Test Circuit

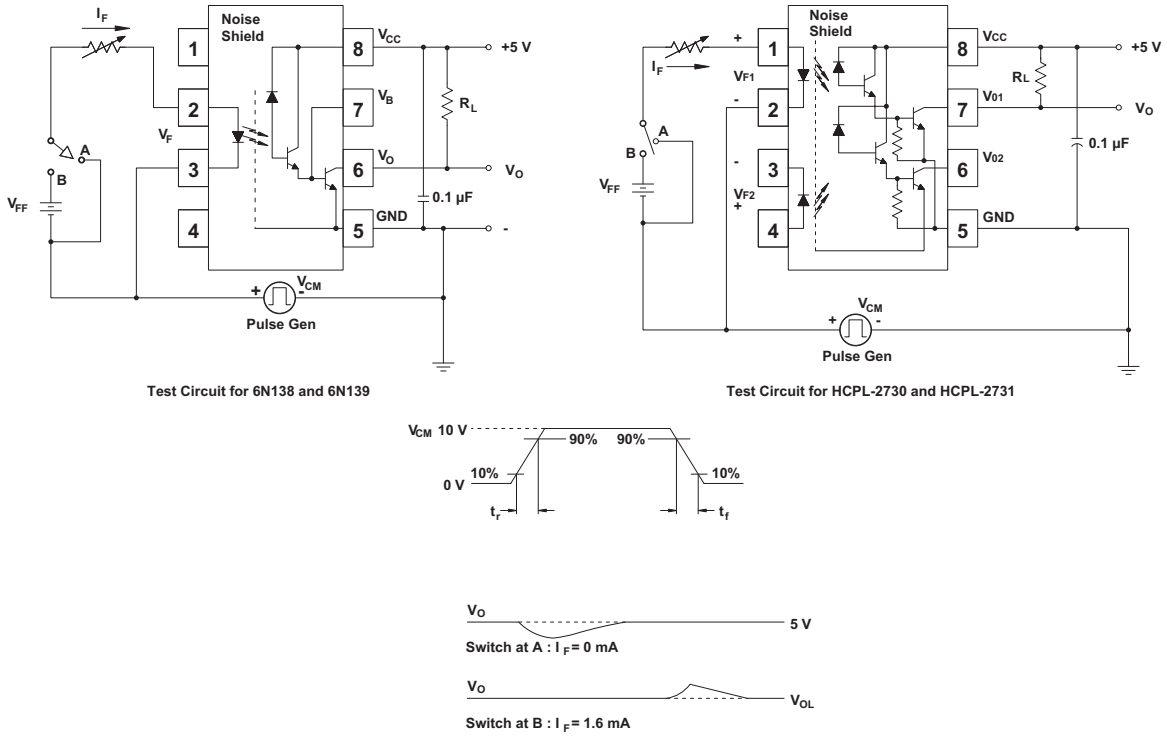
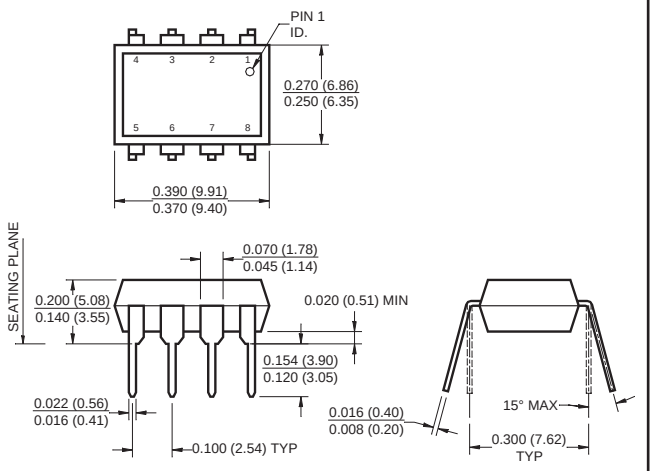


Fig. 23 Common Mode Immunity Test Circuit

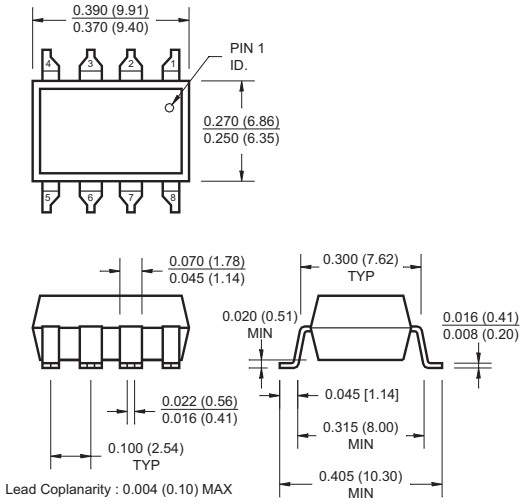
LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

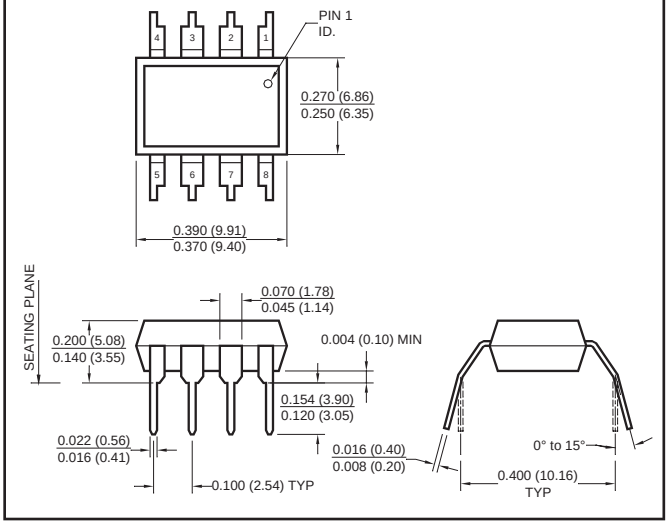
Package Dimensions (Through Hole)



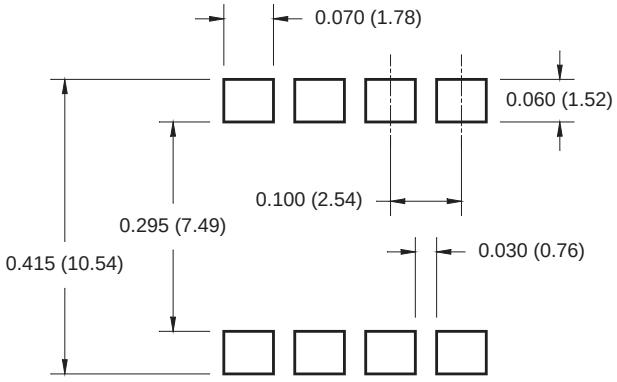
Package Dimensions (Surface Mount)



Package Dimensions (0.4"Lead Spacing)



Recommended Pad Layout for Surface Mount Leadform



NOTE
All dimensions are in inches (millimeters)

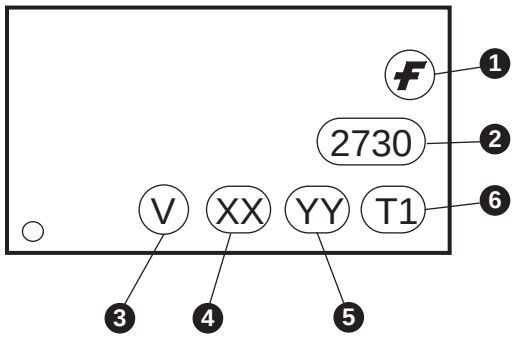
LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

ORDERING INFORMATION

Option	Example Part Number	Description
S	6n135S	Surface Mount Lead Bend
SD	6n135SD	Surface Mount; Tape and reel
T	6n135T	0.4" Lead Spacing
U	6n135U	VDE0884
TV	6n135TV	VDE0884; 0.4" lead spacing
SV	6n135SV	VDE0884; surface mount
SDV	6n135SDV	VDE0884; surface mount; tape and reel

MARKING INFORMATION

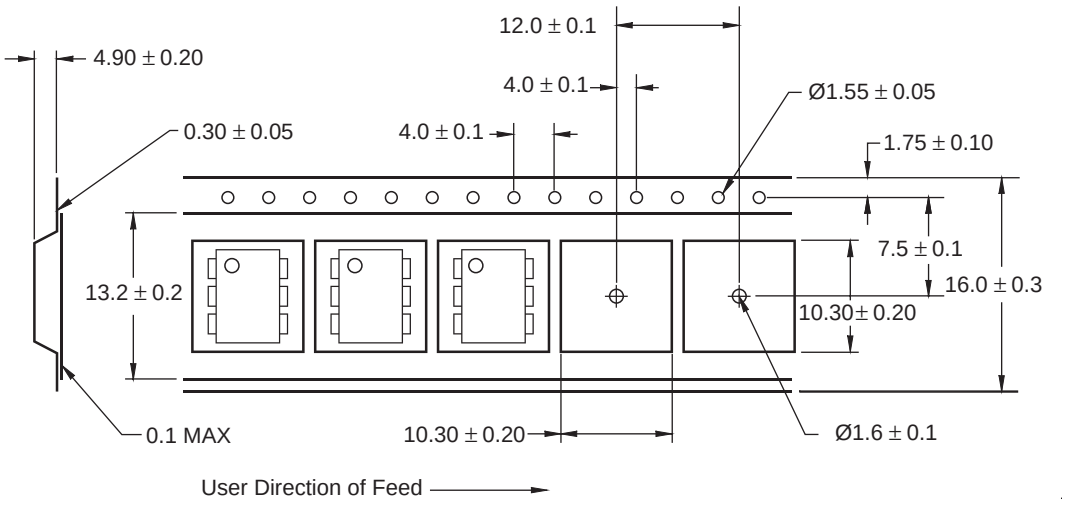


Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	Two digit year code, e.g., '03'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

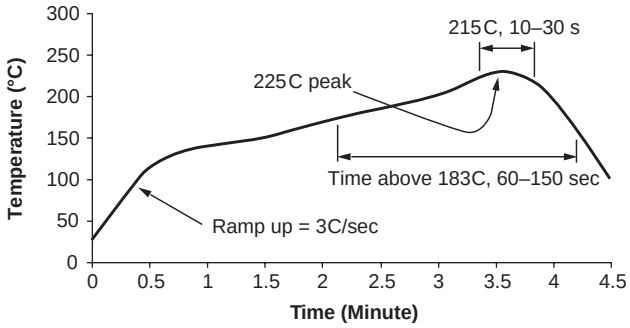
LOW INPUT CURRENT HIGH GAIN SPLIT DARLINGTON OPTOCOUPLERS

SINGLE-CHANNEL: 6N138 6N139
DUAL-CHANNEL: HCPL-2730 HCPL-2731

Tape Specifications



Reflow Profile



- Peak reflow temperature: 225C (package surface temperature)
- Time of temperature higher than 183C for 60–150 seconds
- One time soldering reflow is recommended

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ActiveArray™	FASTr™	LittleFET™	PowerEdge™	SuperFET™
Bottomless™	FPS™	MICROCOUPLER™	PowerSaver™	SuperSOT™-3
CoolFET™	FRFET™	MicroFET™	PowerTrench®	SuperSOT™-6
CROSSVOLT™	GlobalOptoisolator™	MicroPak™	QFET®	SuperSOT™-8
DOME™	GTO™	MICROWIRE™	QS™	SyncFET™
EcoSPARK™	HiSeC™	MSX™	QT Optoelectronics™	TinyLogic®
E^2CMOS™	I^2C™	MSXPro™	Quiet Series™	TINYOPTO™
EnSigna™	*i-Lo*™	OCX™	RapidConfigure™	TruTranslation™
FACT™	ImpliedDisconnect™	OCXPro™	RapidConnect™	UHC™
FACT Quiet Series™		OPTOLOGIC®	µSerDes™	UltraFET®
Across the board. Around the world.™		OPTOPLANAR™	SILENT SWITCHER®	VCX™
The Power Franchise®		PACMAN™	SMART START™	
Programmable Active Droop™		POP™	SPM™	

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.