5 MBd Digital Optocouplers Targeting Low-Power/Low-Supply Voltage Applications

White Paper

Introduction

Digital optocouplers in an electrical system provide high voltage insulation and noise rejection for data transmission. A high quality insulation barrier in the optocoupler is needed to provide outstanding reliability and durability for signal isolation.

In addition to insulation and noise rejection capabilities, Avago's new 5 MBd digital optocouplers, ACPL-M21L/021L/024L/W21L/K24L, the ACPL-x2xL family offers significant improvement in power saving and efficiency for power-conscious applications. Lower system power consumption is now a requirement for many electronics applications ranging from industrial, medical, power control system, communications, etc.. These new digital optocouplers consume 80% less power compared to conventional 5 MBd digital optocouplers in the market.

Table 1 shows a selection of key technical specifications.

Table 1. Key technical specifications of ACPL-x2xL

Parameter	Specification
Propagation Delay	250ns (max)
Propagation Delay Skew	220ns (max)
Pulse Width Distortion	200ns (max)
LED Input Current	1.6 to 6 mA
IDD Supply Current	1.1mA (max)
Common Mode Noise Rejection	25 kV/µs @ V_{CM} = 1000V
Supply voltage	2.5 to 5.5V
Temperature Range	–40 to 105°C
Continuous Working Voltage, V_{IORM}	567Vpeak / 1140Vpeak
Isolation Voltage, V_{ISO}	3750Vrms / 5000Vrms

Key Features and Specifications

The ACPL-x2xL digital optocouplers are newly designed optocouplers with CMOS outputs for low power consumptions. They are designed for various applications such as computer peripheral interfaces, microprocessors system interfaces, high speed line receiver, power control system, etc. Device performance is guaranteed over a wide temperature range from –40 to 105°C, making them ideal for industrial applications.

The key features of ACPL-x2xL digital optocoupler family are as follow:

- Low LED input current allows direct drive from CMOS outputs without the need for an external buffer (refer to Figure 1)
- Low supply current and supply voltage for low power consumption
- 25 kV/µs static common mode rejection - no compromise on noise immunity!
- Schmitt Trigger input for better noise immunity
- IEC60747-5-5 certification for reinforced insulation with continuous working voltages at 567Vpeak and transient voltages of 6kVpeak for ACPL-M21L/021L/024L and continuous working voltages at 1140Vpeak and transient voltages of 8kVpeak for ACPL-W21L/K24L

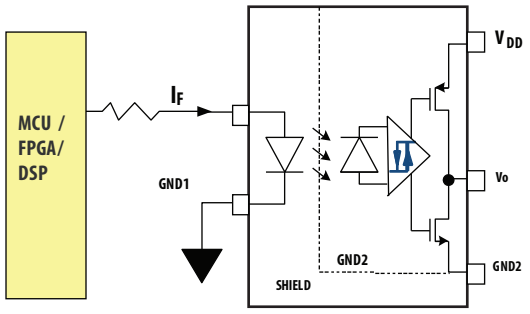


Figure 1. ACPL-M21L directly driven from MCU / FPGA / DSP without external buffer

Low Power Consumption

The advantage of the new 5MBd digital optocoupler family is the feature of low power consumption. The new ACPL-x2xL family of optocouplers consume less than 10mW of power without compromising signal isolation capability. With minimum input drive current of 1.6mA, maximum supply current of 1.1mA and a low supply voltage of 3.3V, the new 5MBd digital optocouplers reduce power consumption by as much as 80% as compared to the conventional 5MBd digital optocouplers and other isolators in the market.

Figure 2 shows the new 5MBd digital optocouplers having the lowest power among the other 5MBd digital optocouplers in the market.

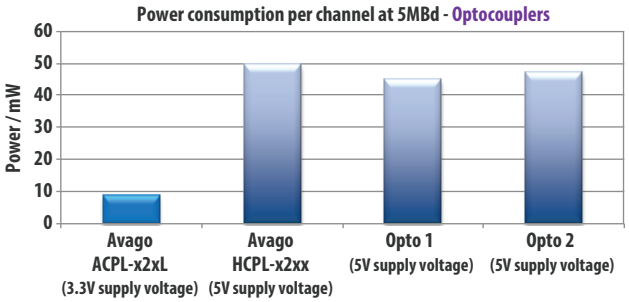


Figure 2. Power consumption comparison : ACPL-x2xL to conventional 5MBd optcouplers in the market

Better Performance and Improved Features

The new ACPL-x2xL family of optocouplers offered upgraded performance and improved features as compared to the HCPL-x2xx conventional optocouplers in low voltage logic applications (see Table 2). The upgraded ACPL-x2xL family of optocouplers include performances such as low supply current, low LED input current, low supply voltage, higher CMR and wider temperature range. The new 5MBd digital optocouplers are used with low voltage logic applications (2.5V/3.3V/5V supply voltage).

Optocoupler CMR Performance

Common mode noise can be a significant problem in data communication applications, especially in industrial environments where electric motors, sensors and programmable logic controllers are connected together.

An internal proprietary Faraday shield which is an effective planar metal tracks around the output receiver provides ESD protection and decouples the input side and output side of the optocouplers. This unique package design also minimizes the input to output capacitance. These two factors minimize the effects of common-mode noise and thus achieving high common mode transient immunity of >25kV/us @Vcm = 1000V.

The "split resistor" input LED drive configuration shown in Figure 3 above balances the impedance across the anode and cathode of the LED which further improves the CMR performance. A common mode noise voltage rise on the LED is symmetrical and therefore cannot switch the LED on. The series connected LED and current limiting resistor form a low pass filter that helps to filter noise transients.

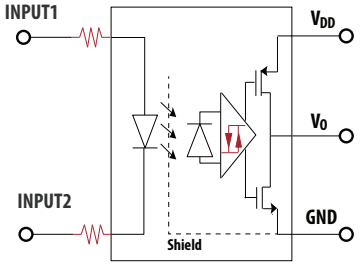


Figure 3. Typical high-CMR drive circuit configuration

Table 2. ACPL-x2xL Comparison to HCPL-x2xx

Type	Conventional Avago 5MBd Parts (Package)	New Product	Package / Configuration	Advantage for Upgrading to New Product	Upgraded Features
5MBd Digital Optocouplers	HCPL-0201/0211 (SO8)	ACPL-M21L	SO5 Single Channel	Smaller footprint	• ≥ 80% power consumption saving • Low forward current ($I_F \geq 1.6$ mA min) • Low supply current ($I_{DD} \leq 1.1$mA) • Wide temperature range (-40 °C to 105 °C) • Low supply voltage (2.5 V to 5.5 V). • Excellent CMR performance 25kV/µs @ Vcm 1000 V --- Part specific (ACPL-W21L/K24L) : • Offer higher working insulation voltage 1140Vpk, isolation voltage 5000Vrms with smaller footprint and with wider Creepage/Clearance (8mm/8mm)
		ACPL-021L	SO8 Single Channel	Same footprint (Direct drop in)	
	HCPL-2231/2232 (300mil DIP8)	ACPL-024L	SO8 Dual Channel	Smaller footprint	
	HCPL-2219/2200 /2201/2211 HCPL-2202/2212 (300mil DIP8)	ACPL-W21L	SSO6 Single Channel	Smaller footprint	
	HCPL-2231/2232 (300mil DIP8)	ACPL-K24L	SSO8 Dual Channel	Smaller footprint	

LED Reliability

The quality of the LED used in an optocoupler is an important factor for determining the life time of the product. Avago produces high reliability LEDs for optocouplers at its in-house facility. The infrared, AlGaAs LED used in the ACPL-x2xL provides excellent stability over both temperature and time. As shown in Figure 4, LED degradation is minimal after the lifetime of 30 years. This is based on the typical LED driving current of 2.2mA at a temperature of 100 °C.

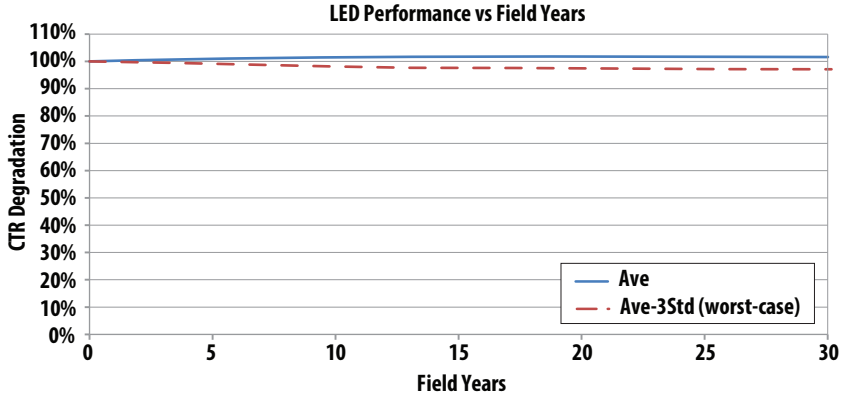


Figure 4. CTR degradation over field years.

CANBus / Serial Data Transmission Applications

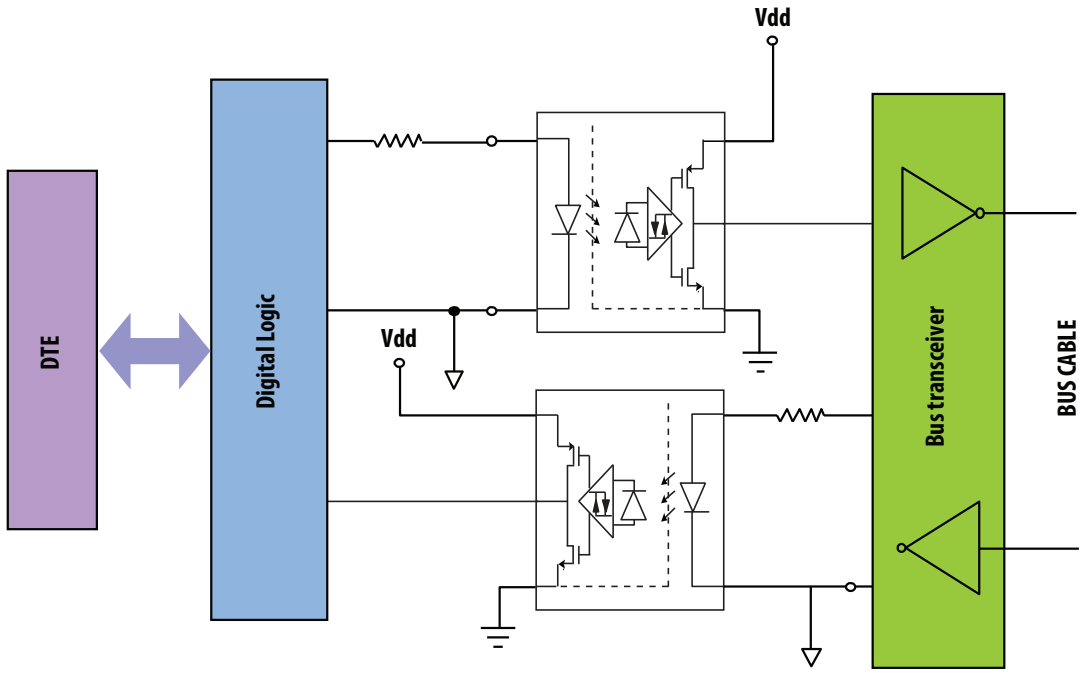


Figure 5. Optocouplers provide isolation between MCU and CAN bus transceiver

Digital optocouplers can be used to isolate I/O networking communication ports ranging from CANbus, RS-485, RS-232 and I2C applications. In Figure 5, the digital optocouplers are placed between the transceiver and the bus interface so as to isolate transient/burst interference and also to transmit data between the bus transceiver and the controller.

5MBd Digital Optocouplers with 2.5V Low Supply Voltage

Industrial equipments are moving towards low supply voltage, low power consumption for energy saving and efficiency. The new 5MBd digital optocouplers are compatible with the newer generation MCU/FPGA 2.5V Logic. These optocouplers not only work with 3.3V and 5V mixed-voltage operation but they are also design with 2.5V LVCMOS logic level compatibility. Operating at lower power consumption with supply voltage at 2.5V without compromising on propagation delays and isolation performances is the main advantage of using these optocouplers. These optocouplers guarantee the AC and DC electrical performances with lower supply voltage of 2.5V over the industrial temperature range. ACPL-x2xL option parts supporting 2.5V supply voltage are available.

Application Example (Evaluation Board available)

Schematic for the CANBus Evaluation board is shown in Figure 6. The design of this application example is for CAN bus isolations using ACPL-M21L.

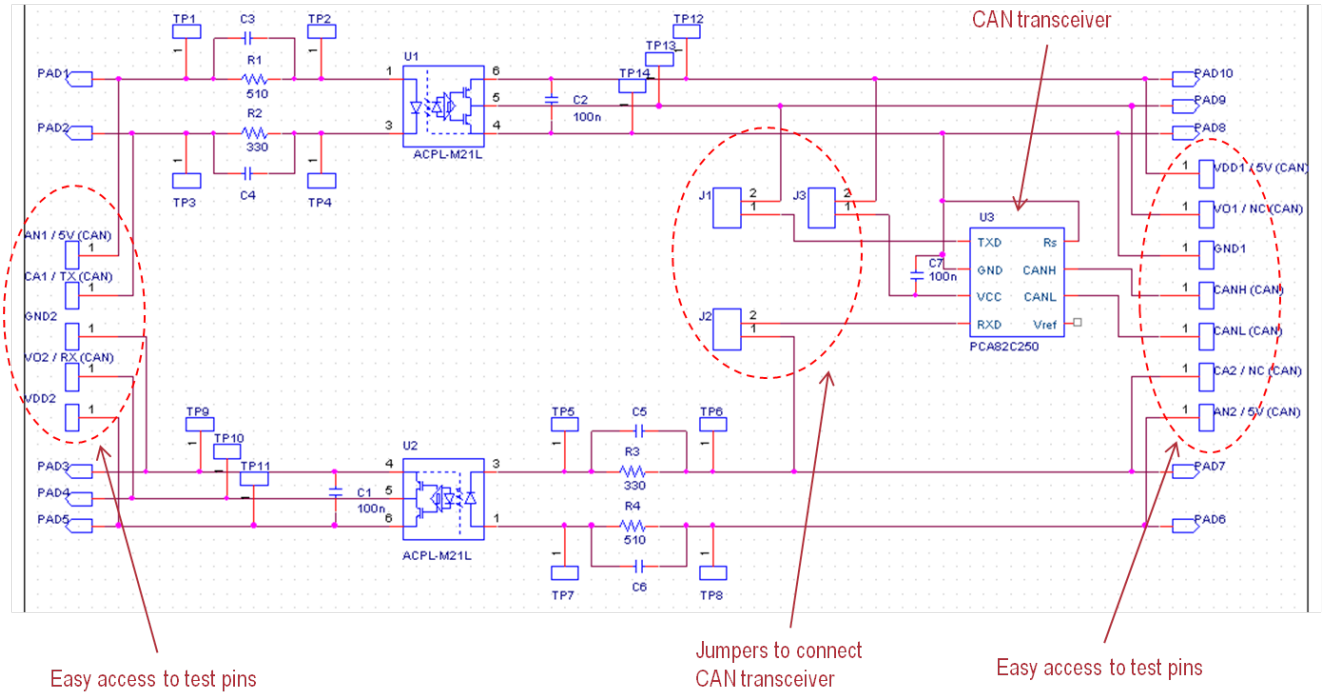


Figure 6. ACPL-M21L CANBus Evaluation Board Schematic

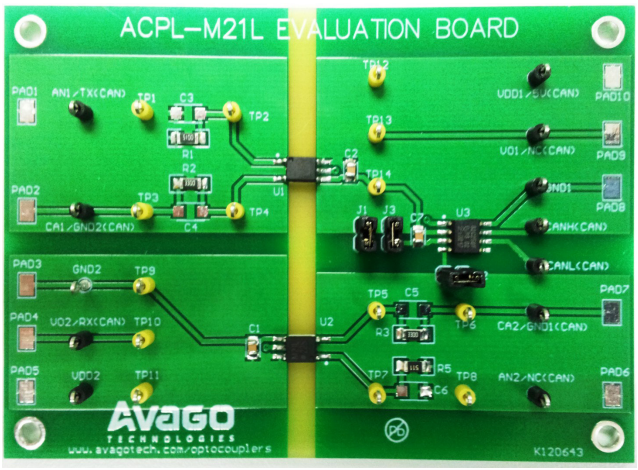


Figure 7. ACPL-M21L CANbus evaluation board

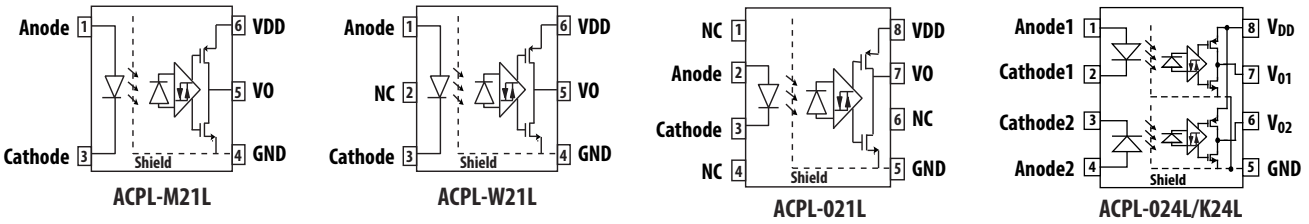
Product Offering

Table 3 and Figure 8 below show the various package options and the pin configurations available. All devices are RoHS-6 compliant.

Table 3. ACPL-x2xL package options

Part No.	Package Type	No. of Channels	UL1577, 1 min (Vpeak)	IEC 60747-5-5, Max. Working Voltage (Vpeak)	Clearance (mm)	Creepage (mm)
ACPL-M21L	SO-5	1	3750	567*	5.0	5.0
ACPL-021L	SO-8	1	3750	567*	4.9	4.8
ACPL-024L	SO-8	2	3750	567*	4.9	4.8
ACPL-W21L	SSO-6	1	5000	1140*	8	8
ACPL-K24L	SSO-8	2	5000	1140*	8	8

Notes:
* - Applicable for ACPL-M21L/021L/024L/W21L/K24L series with IEC 60747-5-5 Option, -x60E.



TRUTH TABLE (POSITIVE LOGIC)

LED	VO
ON	HIGH
OFF	LOW

A 0.1 µF bypass capacitor must be connected between pins Vdd and GND

Figure 8. ACPL-x2xL pins configuration

References

1. Digital Optocouplers for Ultra Low Power and High Noise Rejection, Roy Tan, Application Note AV02-2674EN - January 20, 2011.
2. Optimizing High-Voltage Common Mode Rejection Performance of the APCL-x6xL Ultra-Low Power Optocouplers, White Paper AV02-3053EN - July 19, 2011.
3. ACPL-M21L, ACPL-021L and ACPL-024L Low Power, 5 MBd Digital CMOS Optocoupler, Datasheets AV02-3462EN, Avago Technologies. May 15, 2012.
4. Digital Optocouplers Deliver Low Power Consumption and High Isolation for Automotive Applications, Avago Technologies, AV02-3220EN Nov 17, 2012.

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

AV02-4340EN - December 24, 2013