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Optoelectronics Group

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History of Fairchild's Optoelectronics Group

- 1969: Part of Monsanto Electronic Materials Group
- 1979: Acquired by General Instrument Corporation
  - Acquired Fairchild Semiconductor's Optoelectronics Group
- 1990: Acquired by Recovery Equity Investor's, L.P.
  - 1990: Initially named Quality Technologies
  - 1991: Acquired Harris Semiconductor Optoelectronics Division
  - 1992: Acquired Philips Semiconductor Optoelectronics Business
  - 1995: Changed name to QT Optoelectronics
  - 1998: Acquired Motorola Semiconductor Optocoupler Business
- 2000: Acquired by Fairchild Semiconductor
  - 2001: Becomes Optoelectronics Group of Fairchild Semiconductor

2006 Outlook for Fairchild Optoelectronics Group

- Divested LED and Display businesses to Everlight Electronics Company Ltd (as of Jan 3rd, 2006)

- Fairchild will continue to aggressively market optocoupler and infrared products lines, as these products are more closely related and complementary to Fairchild's core Power Franchise® business. Fairchild will continue to invest in the future growth of these products:
  - Ongoing optocoupler programs to improve package robustness under RoHS compliancy (for all packages to meet 260 deg C reflow profiles)
  - Focusing optocoupler development to address the growing industrial/motor control and white goods market segments (Mosfet/IGBT gate drive optocouplers, snubberless triac drivers, high speed optocouplers)
  - Promote Fairchild's patented coplanar packaging technology (Optoplanar™) which allows for superior common mode transient immunity over all optocoupler competitors. For our high performance couplers, this 30% improvement gives us a best in class Common Mode Rejection (CMR) rating

Optoelectronics Product Lines

Optocouplers

➢Transistor, Darlington, OPTOLOGIC™, Power, High-speed and complex function devices

➢Broad range of package platforms: 4-pin MFP, 4, 6, & 8-pin DIP and SOIC-8, Microcoupler (BGA)

➢Over 300 UL, CSA and VDE approved products

➢Target Applications

- Cell phones
- Telephone/fax
- Factory automation
- Switch Mode Power Supplies
- Printers
- Notebooks PCs
- Set top box
- Appliances

Infrared

➢Light emitting diodes, photosensors, transmissive and reflective opto sensors

➢Over 200 Standard and custom devices to meet specific customer requirements

➢Target Applications

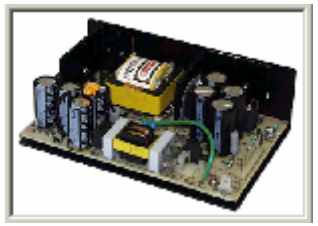
- Print media sensing devices
- Position sensors
- Optical encoders
- Smoke detectors
- Remote control
- VCR/DVD, joysticks
- Steering control
- Rain sensors
- Ignition, Alarms
- Optical encoders
- Vending machines

Optocoupler Competitors

- Avago Technologies (formerly HP, Agilent)
- Toshiba
- Sharp
- Vishay (includes former Temic, Siemens, Infineon lines)
- NEC/CEL
- Lite-On

Markets Served by FSC Optocouplers

Power Conversion



End Products

- SMPS, Adaptors, Chargers

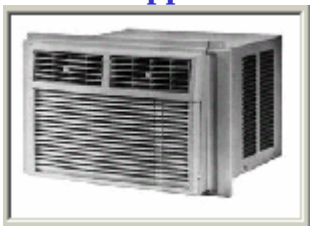
OPG Focus

- 4-Pin MFP / DIP, 6-Pin DIP, MICROCOUPLER

Product Development Focus

- CTR customization
- Performance enhancements

Home Appliances



End Products

- Air Cond, washers, water heaters

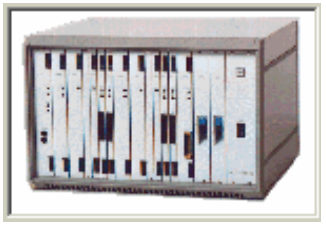
OPG Focus

- 6-pin DIP RP/ZC Phototriac
- 4-Pin MFP / DIP, 6-Pin DIP Phototransistors

Product Development Focus

- 4-Pin MFP Phototriac
- Packaging and performance enhancements

Telecommunication



End Products

- Telephony Switching Systems

OPG Focus

- SOIC-8 Phototransistors
- High Speed Couplers
- Photovoltaic SSR

Product Development Focus

- Packaging and performance enhancements

Office Equipment

End Products

- Printers/Scanners/Copier/Fax

OPG Focus

- 6-Pin DIP RP/ZC Phototriac

Product Development Focus

- 4-pin MFP Phototriac

End Products

- Instrumentation/Process Control

OPG Focus

- High speed Couplers

Product Development Focus

- 8-Pin SOIC / DIP
- 5-Pin MFP high speed transistor/logic

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Optocoupler Market

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Optocoupler Market Growth

Optocoupler TAM is expected to grow at a CAGR of 4.4% over the next 5 years (source – WSTS)

Optocoupler TAM ($M):

2005	2006	2007	2008	2009
922	961	1037	1090	1144

Optocoupler Market Growth

Optocoupler TAM ($M) by application:

Application	2005	2006	2007	2008	2009
Power Supplies	125	125	130	130	130
Telecom Switches	75	75	80	85	85
White Goods	200	215	230	240	250
Industrial Process Control / Instrumentation	300	310	330	340	350
Other	222	236	267	295	329
Total TAM	922	961	1037	1090	1144

Optocoupler Market Growth

Optocoupler SAM ($M) by application:

Application	2005	2006	2007	2008	2009
Power Supplies	95	100	110	110	110
Telecom Switches	40	40	45	50	50
White Goods	100	125	140	150	170
Industrial Process Control / Instrumentation	175	185	210	250	270
Other	125	150	175	210	220
Total SAM	535	600	680	770	820

Optocoupler Market Growth

Optocoupler SOM ($M) by application:

Application	2005	2006	2007	2008	2009
Power Supplies	9	8	7	7	6
Telecom Switches	8	9	10	11	11
White Goods	10	12	15	16	18
Industrial Process Control / Instrumentation	9	12	17	20	25
Other	15	16	16	18	20
Total SOM	51 (9.5%)	59 (9.8%)	70 (10.3%)	80 (10.4%)	95 (11.6%)

Optocoupler Market Growth

Optocoupler TAM ($M) by Product Type:

Product Type	2005	2006	2007	2008	2009
High Performance	250	260	275	285	290
Triacs	75	78	81	84	87

Optocoupler Market Growth

Optocoupler SAM ($M) by Product Type:

Product Type	2005	2006	2007	2008	2009
High Performance	150	175	190	210	220
Triacs	60	77	80	83	86

Optocoupler Market Growth

Optocoupler SOM ($M) by Product Type:

Product Type	2005	2006	2007	2008	2009
High Performance	9 (6%)	11 (6.3%)	13 (6.8%)	16 (7.6%)	20 (9.1%)
Triacs	14 (23.3%)	18 (23.4%)	20 (25%)	22 (26.5%)	23 (26.7%)

Optocoupler Market Conditions

Commodity Couplers – Phototransistor

Market	Application	Status
Telecom	Modems	Declining
Power Supply	Feedback	Stable
Industrial Automation	Interface	Strong

Function Specific Couplers - TRIAC, High Speed Logic Interface

Market	Application	Status
Industrial Automation	Data Comm	Strong
Automotive	Power Control	Growing
White Goods	Motion Control	Growing

Optocoupler Market & Technology Trends

The market segments that are growing are requiring high speed/high gain optocouplers capable of fast switching and eliminating ground loop noise, whilst still providing isolation between primary and secondary circuitry. With factory automation equipment and appliances becoming more complex, there is a high demand for components that:

1) Can consume less power and,
2) Offered in smaller packages

New optocouplers need to meet a 3.3V (vs. 5V) supply voltage specification reducing power consumption by 33%,and be available in smaller packages to optimize mounting density.

Optocouplers - Product Strategy

Capitalize on the best in class CMR performance of the Optoplanar™ structure, and focus development of products to serve applications ranging from high end power supplies and motor control circuits to data communications and digital logic interface circuits.

- High Speed Couplers:
  - 3.3 Volt
  - Enhanced CMR
  - Temperature stability

- Integrated Solutions:
  - Error Amplifier + Coupler
  - Synchronous rectification Mosfet Driver + Coupler
  - Integrated Gate Drive Coupler

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High Performance Optocouplers

- 15Mb CMOS Optocouplers

- New 3.3V and 5V High Speed Transistor & Logic Optocouplers

- IGBT/MOSFET Gate Drive Optocouplers

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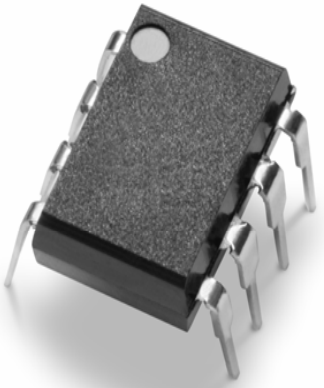
High Performance Optocouplers – package styles



8-PIN DIP BLACK

5-PIN MFP

8-PIN SOP

8-PIN DIP WHITE

High Performance Optocouplers – typical applications

- Industrial
  - Process controllers
  - Test instrumentation
  - Factory automation
- Computers
  - Isolated RS232 ports
  - Print head controller
  - MIDI instruments
- Telecommunications
  - Telephone switching networks
  - High performance modems

High Performance Optocouplers – what is Common Mode Transient Immunity?

Common mode transient immunity is a measure of the component's ability to reject unwanted noise and retain the integrity of the desired signal. It is specified in the data sheet in terms of 'common mode rejection' from low to high states (CM_L) and high to low states (CM_H).

High Performance Optocouplers – what affects Common Mode Immunity?

The ability of the device to reject unwanted noise is affected by three aspects of the design of the device:

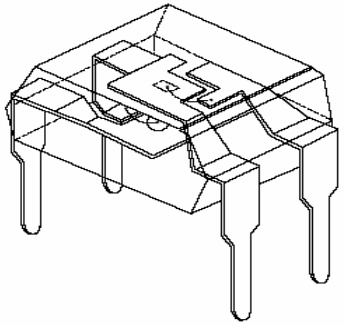
- Package capacitance (coupled from input to output)
- Detector chip capacitance
- Shielding the amplifier (from surface charges)
  i.e. charges that collect on the surface of the die

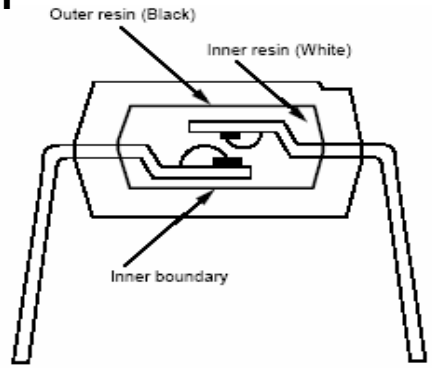
High Performance Optocouplers – package capacitance

Package capacitance is determined by many factors including the spacing of the leadframes for the emitter and detector chips and the internal configuration of those leadframes. Fairchild's coplanar package construction allows for the increase of the input-output spacing and to configure the two leadframes in such a way that reduces parallel surface area between them. This results in a >30% reduction in capacitance vs. the over-under package construction Agilent utilizes.

Optocoupler Constructions

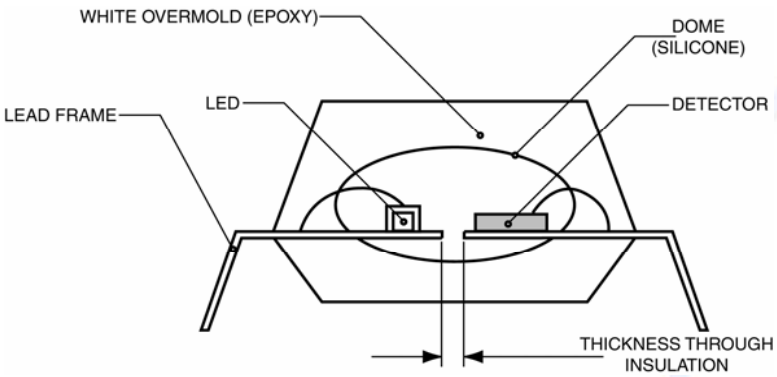
Over-Under Double Molding Construction





The drawing on the right shows the optocoupler in a light-tight epoxy resin housing, and a light-sensitive element with light-transmittable epoxy resin medium between them. A light signal emitted by the LED is transferred to the photosensitive detector via the internal resin medium. Both the housing resin and the internal resin have the same expansion coefficient. Namely, the optocoupler elements are molded twice with epoxy resin - this structure is referred to as a double molding structure

Coplanar Construction



Advantages

•Fixed isolation gap (thickness through insulation). So a consistent high input to output isolation voltage

• High Common Mode Noise Rejection (CMR). This construction eliminates the capacitive charge buildup that occurs in the over-under construction.

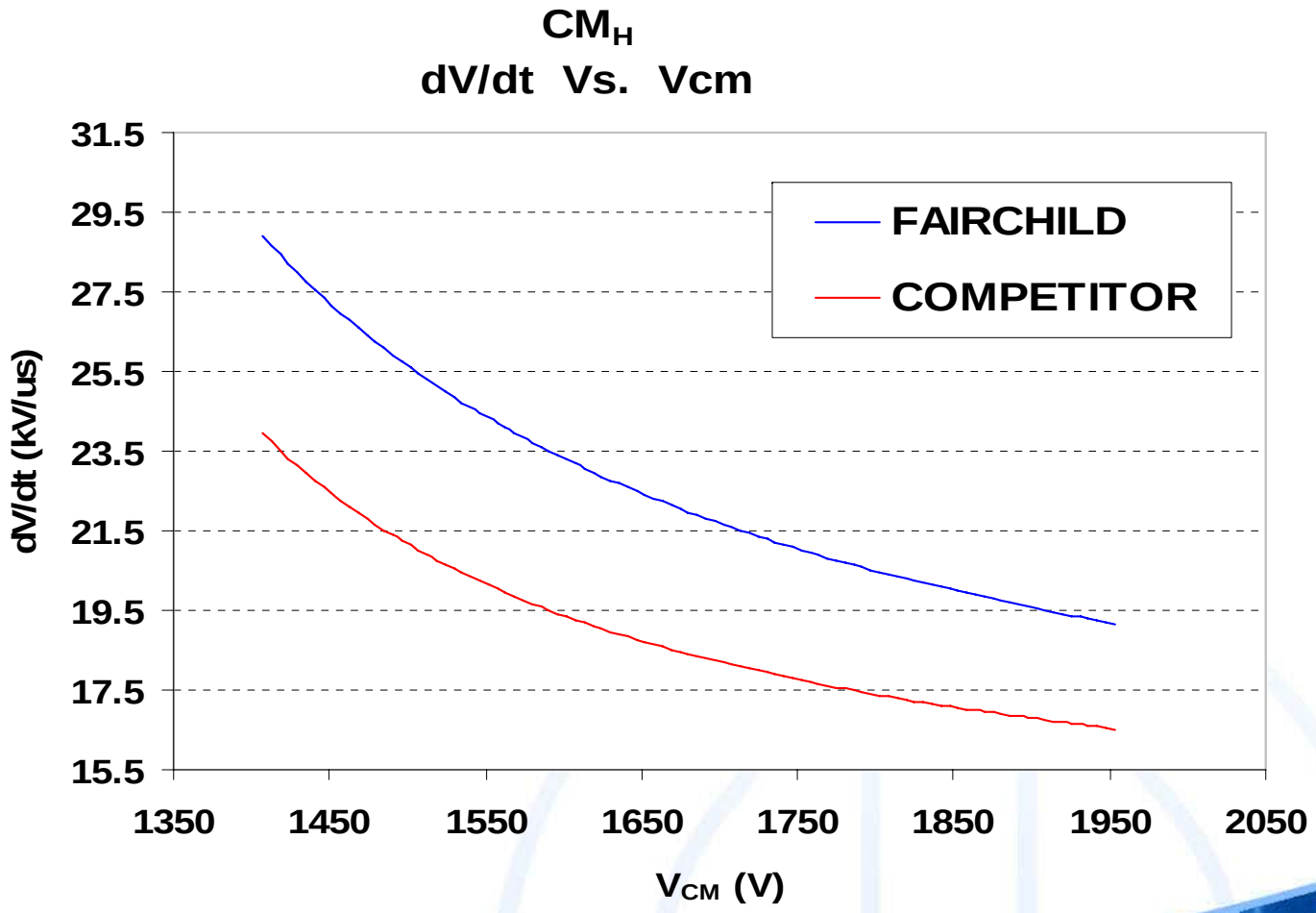
High Performance Optocouplers – detector chip capacitance

The detector chip capacitance has been reduced by decreasing the size of the chip through more efficient layout and improved light output of the LED source. In addition, a proprietary shielding method for the amplifier results in several orders of magnitude improvement over the shielding technique utilized in older generation high performance optocouplers. The shield is optically transmissive yet electrically conductive and acts to shunt surface charges to ground and eliminates the potential for latch-up.

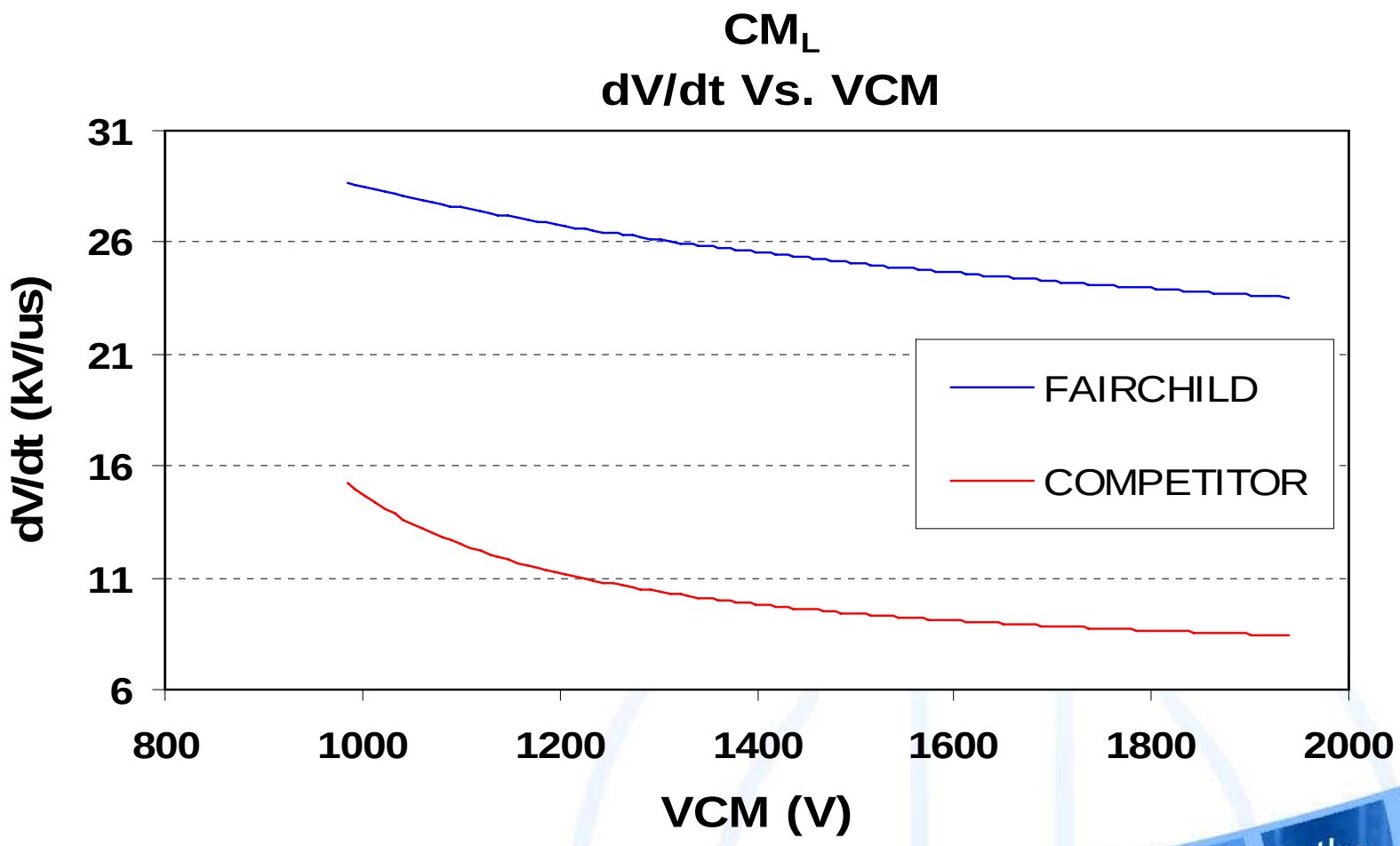
High Performance Optocouplers – competitive advantage

Fairchild's new high performance optocouplers have a superior common mode transient immunity advantage over the market leader, Agilent. This 30% improvement vs. the competition is achieved through our coplanar packaging technology and proprietary shielding of the silicon detector chip.

High Performance Optocouplers – common mode high comparison



High Performance Optocouplers – common mode low comparison



High Performance Optocouplers – recent releases

- Extension of existing 5V 8-pin DIP portfolio in 5-pin MFP and dual channel 8-pin SOP packages. These smaller packages optimize mounting density.

- Addition of 3.3V versions in single channel and dual channel 8-pin SOP and single channel 8-pin DIP. The 3.3V supply voltage specification reduces power consumption by 33%.

High Performance Optocouplers – 5V high-speed transistor output

- 5-Pin MFP: Full pitch on input side/Half pitch on output side
- Smallest high speed optocoupler available in the market
- 1Mbit/s Transistor Output
- Available FSIDs:
  - FODM452 (1MBit/s data rate)
  - FODM453 (1MBit/s data rate, 15kV/us CMR)

High Performance Optocouplers – 5V high-speed transistor output

Part Number	CTR@ 16 mA I_F (%)		V_{OL} (V)	I_{CCL} (µA)	t_{PHL}/t_{PLH} (µs)	CMR (kV/µs) CM_H/CM_L	V_{ISO} AC_{RMS}(V)
	min	max	max	max	max	min	1 minute
FODM452	20	50	0.4	200	0.8/0.8	5/5	3750
FODM453	20	50	0.4	200	0.8/0.8	15/15	3750

High Performance Optocouplers – 5V dual channel high-speed transistor & high-gain darlington outputs

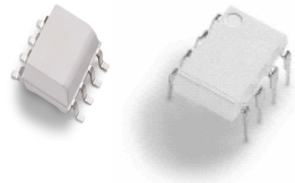
- 8-Pin SOIC: Two isolated channels in one compact surface mount package
- Provides optimum channel density vs. mounting space.
- Available FSIDs:
  - HCPL0453 (1MBit/s, no base connection)
  - HCPL0530 (1MBit/s)
  - HCPL0531 (1MBit/s, 1 kV/us CMR)
  - HCPL0534 (1MBit/s, 15 kV/us CMR)
  - HCPL0730 (300%-5000% CTR range)
  - HCPL0731 (500%-5000% CTR range)

High Performance Optocouplers – 5V dual channel high-speed transistor & high-gain darlington outputs

Part Number	CTR@ *1.6mA I_F ,16mA I_F (%)		V_{OL}(V)	I_{CCL} (µA)	CMR (kV/µS)	T_{PHL}/T_{PLH} (µS)	V_{ISO} (RMS) (V) 1 minute
	Min	Max	Max	Max	Min	Max	
HCPL0453	19	50	0.4	200	15	0.8/0.8	2500
HCPL0530	7	50	0.5	400	1	1.5/1.5	2500
HCPL0531	19	50	0.5	400	1	1.5/1.5	2500
HCPL0534	19	50	0.5	400	15	1.5/1.5	2500
HCPL0730*	300	5000	0.4	3	1	30/90	2500
HCPL0731*	500	5000	0.4	3	1	30/90	2500

HCPL04XX, HCPL05XX – 1Mbit/s High Speed Transistor Output Optocoupler
HCPL07XX - High Gain Split Photodarlington Output Optocoupler

High Performance Optocouplers – 3.3V high-speed transistor & high-gain darlington outputs



- 3.3V supply voltage reduces power consumption by 33% vs. 5V devices
- Dual channel 8-pin SOP version provides optimum channel density vs mounting space.
- Guaranteed 5kV/us minimum CMR rating for all devices
- Available FSIDs:
  - Single channel SOP: FOD050L (Transistor), FOD070L (Darlington)
  - Dual channel SOP: FOD053L (Transistor), FOD073L (Darlington)
  - Single channel DIP: FOD250L (Transistor), FOD270L (Darlington)

High Performance Optocouplers
– 3.3V high-speed transistor & high-gain darlington outputs

Part Number	CTR@ *1.6mA I_F, 16mA I_F (%)		V_{OL} (V)	I_{CCL} (µA)	CMR (kV/µS)	T_{PHL}/T_{PLH} (µS)	V_{ISO} (RMS) (V) 1 minute
	Min	Max	Max	Max	Min	Max	
FOD050L	15	50	0.3	200	5	1/1	2500
FOD053L	15	50	0.3	400	5	1/1	2500
FOD250L	15	50	0.3	200	5	1/1	5000
FOD070L*	400	5000	0.3	150	1	30/90	2500
FOD073L*	400	5000	0.3	300	1	30/90	2500
FOD270L*	400	7000	0.3	150	1	30/90	5000

High Performance Optocouplers
– 5V dual channel high-speed logic output

- Two isolated channels in one 8-pin SOP package provides optimum channel density vs mounting space.
- Provides optimum channel density vs. mounting space
- Available FSIDs:
  - HCPL0630 (10 MBit/s)
  - HCPL0631 (10 MBit/s, 5 kV/us CMR)
  - HCPL0661 (10 MBit/s, 25 kV/us CMR)

High Performance Optocouplers – 5V dual channel high-speed logic output

Part Number	I_{FT} (mA)	V_{OL} (V)	I_{CCH} (mA)	I_{CCL} (mA)	CMR (kV/µS)	T_{PHL}/T_{PLH} (nS)	V_{ISO} AC (RMS)
	Max	Max	Max	Max	Min	Max	
HCPL0630	5	0.6	15	21	-	75/75	2.5kV
HCPL0631	5	0.6	15	21	5	75/75	2.5kV
HCPL0661	5	0.6	15	21	25	75/75	2.5kV

High Performance Optocouplers – 3.3V high-speed logic outputs

- 3.3V supply voltage reduces power consumption by 33% vs 5V devices
- Dual channel SO8 version provides optimum channel density vs mounting space.
- Guaranteed 25 kV/us minimum CMR rating for all devices
- Available FSIDs:
  - Single channel SO8: FOD060L
  - Dual channel SO8: FOD063L
  - Single channel DIP: FOD260L

High Performance Optocouplers – 3.3V high-speed logic outputs

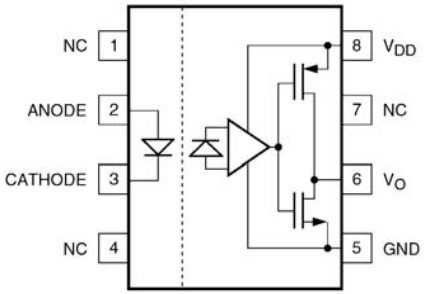
Part number	I_{FT} (mA)	V_{OL} (V)	I_{CCH} (mA)	I_{CCL} (mA)	CMR (kV/µS)	T_{PHL}/ T_{PLH} (µS)	V_{ISO} AC (RMS)
	Max	Max	Max	Max	Min	Max	
FOD060L	5	0.6	7	10	25	75/90	2.5kV
FOD063L	5	0.6	10	15	25	75/90	2.5kV
FOD260L	5	0.6	7	10	25	75/90	5kV

High Performance Optocouplers
– 15 MBaud CMOS Logic Optocouplers

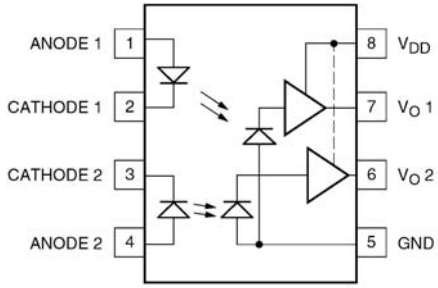
Product Features:

- Low power CMOS logic with push-pull output
- 15 MBaud bandwidth capability
  - 30 ns maximum pulse width distortion
  - 40 ns maximum propogation delay skew
- Excellent common mode rejection rating - (>50kV/us typical at 2000V common mode
- Guaranteed performance from -40°C to +100°C
- Compact 8-pin SOIC package
  - Single channel (FOD0708)
  - Dual channel (FOD0738)
- Double protection certification (UL) at 2500V(RMS) isolation rating
- Lead Free – Compatible with 260 °C reflow processes

High Performance Optocouplers
– 15 MBaud CMOS Logic Optocouplers



FOD0708



FOD0738

Specifications guaranteed between -40˚C to +100˚C

Part Number	I_{FT} (mA) Max	V_{OL} (V) Max	CM_H/CM_L (kV/µs) Min	PWD (ns) Max	T_{PHL}/T_{PLH} (ns) Max	V_{ISO} AC (RMS)
FOD0708	8.2	0.1	25	30	60/60	2.5kV
FOD0738	8.2	0.1	25	30	60/60	2.5kV

High Performance Optocouplers – cross reference

Microsoft Excel Worksheet

High Performance Optocouplers – safety agency certification

- CSA approved
- UL approved
- VDE approved

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2006 Planned Optocoupler Releases

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High Performance Optocouplers
FOD3180 - 2A output current, high speed IGBT/MOSFET gate driver optocoupler

Target Applications: High frequency driving of power IGBT and MOSFETs used in Plasma Display Panels (PDPs), motor control inverter applications and high performance DC/DC converters

Key Features:

- 2A minimum peak output current
- High speed response: 200ns max propagation delay over temperature range
- 250kHz maximum switching speed
- 20ns typ pulse width distortion
- Wide V_{CC} operating range: 10V to 20V
- Under voltage lockout protection (UVLO) with hysteresis

Expected Launch Date: **June 2006**

Datasheet: Preliminary data sheet available

Industrial Process / Motor Control Roadmap

	2003	2004	2005/2006
Product	❖FOD07XL (3.3V) ❖FOD27XL (3.3V) ❖HCPL073X (5V) ❖FODM452 (5V) ❖FODM453 (5V) ❖FODM30XX	❖FOD05XL (3.3V) ❖FOD25XL (3.3V) ❖HCPL053X (5V)	❖FOD06XL (3.3V) ❖FOD26XL (3.3V) ❖HCPL063X (5V) ❖FODM611 (5V MFP) ❖FOD07X8 (5V CMOS) ❖FOD3180 ❖FOD410 ❖FOD41XX ❖FOD420 ❖FOD42XX
Description	❖High Gain Darlington ❖Random Phase Triac	❖High Speed Transistor ❖Snubberless Triacs	❖High Speed Logic ❖Gate Driver ❖Snubberless Triacs
Package	❖SOIC-8 (Single Ch.) ❖8-Pin DIP (Dual Ch.I) ❖SOIC-8 (Dual Ch.) ❖5-Pin MFP ❖4-Pin MFP	❖SOIC-8 (Single Ch.) ❖8-Pin DIP (Dual Ch.) ❖SOIC-8 (Dual Ch.)	❖SOIC-8 (Single Ch.) ❖8-Pin DIP (Dual Ch.) ❖5-Pin MFP ❖SOIC-8 (Dual Ch.) ❖8-Pin DIP ❖6-Pin DIP

Appliances Roadmap

	2003	2005	2006	2007
Product	❖FODM30XX	❖FOD410 ❖FOD41XX ❖FOD420 ❖FOD42XX	❖FOD3180	❖FOD3120
Description	❖Random Phase Triac	❖Snubberless Triacs	❖20V Gate Driver	❖30V Gate Driver
Package	❖4-pin MFP (Full Pitch)	❖6-pin DIP	❖8-pin DIP	❖8-pin DIP

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Typical Applications

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High Speed Optocoupler

High speed couplers are used to transfer communication data and control signal from one voltage potential to another voltage potential. The voltage potential will have two different ground references

Example -

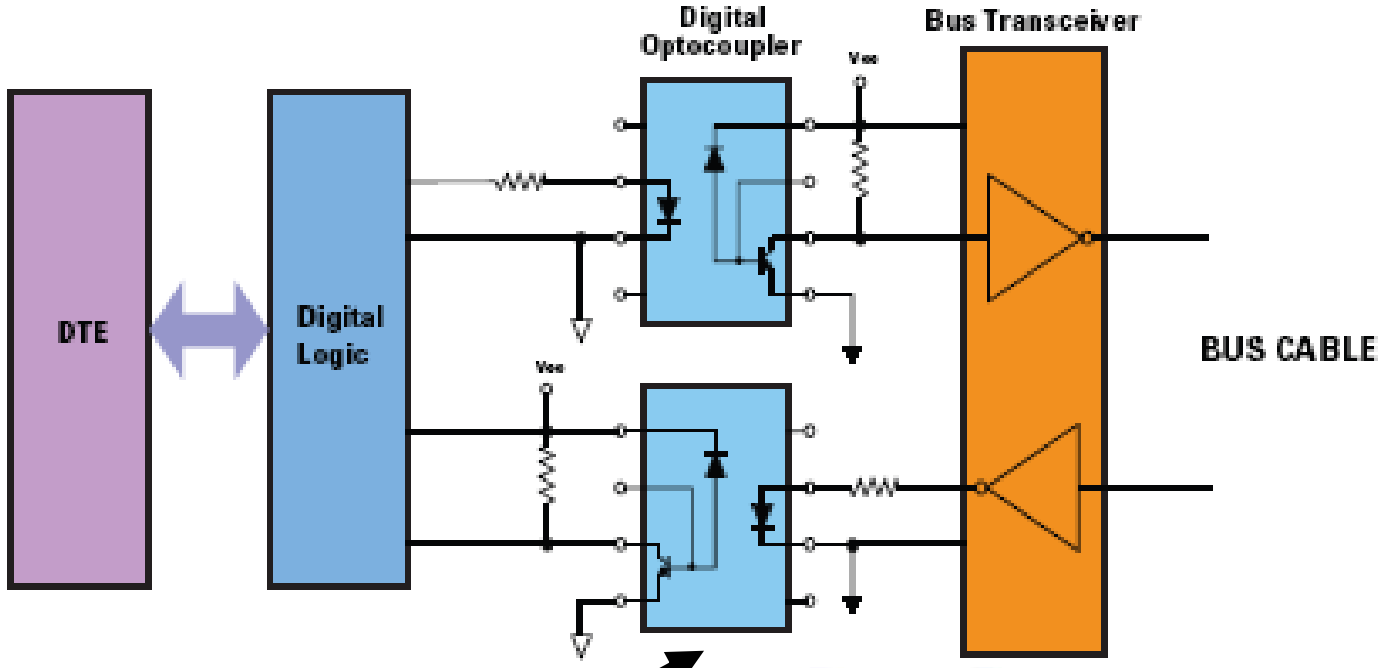
From low voltage potential, example 3V - 5V at input and high voltage potential 480Vac at the output

The input and output is isolated by a non electrical connection

Features of the High Speed Coupler vs. Standard Coupler

- High data rate from 50KHz until 10 MHz
- Low input driving current 500uA to 5mA
- Transient Shield (CMR – Common Mode Rejection) 1kV/us to 10KV/us (Fairchild Optocouplers have the highest CMR in the industry)
- Pulse Width Distortion is low. Maximum 40ns
- Pulse Width Skew for dual channel high speed coupler

Serial Bus Interface Isolation



Recommended FSC Optocouplers:

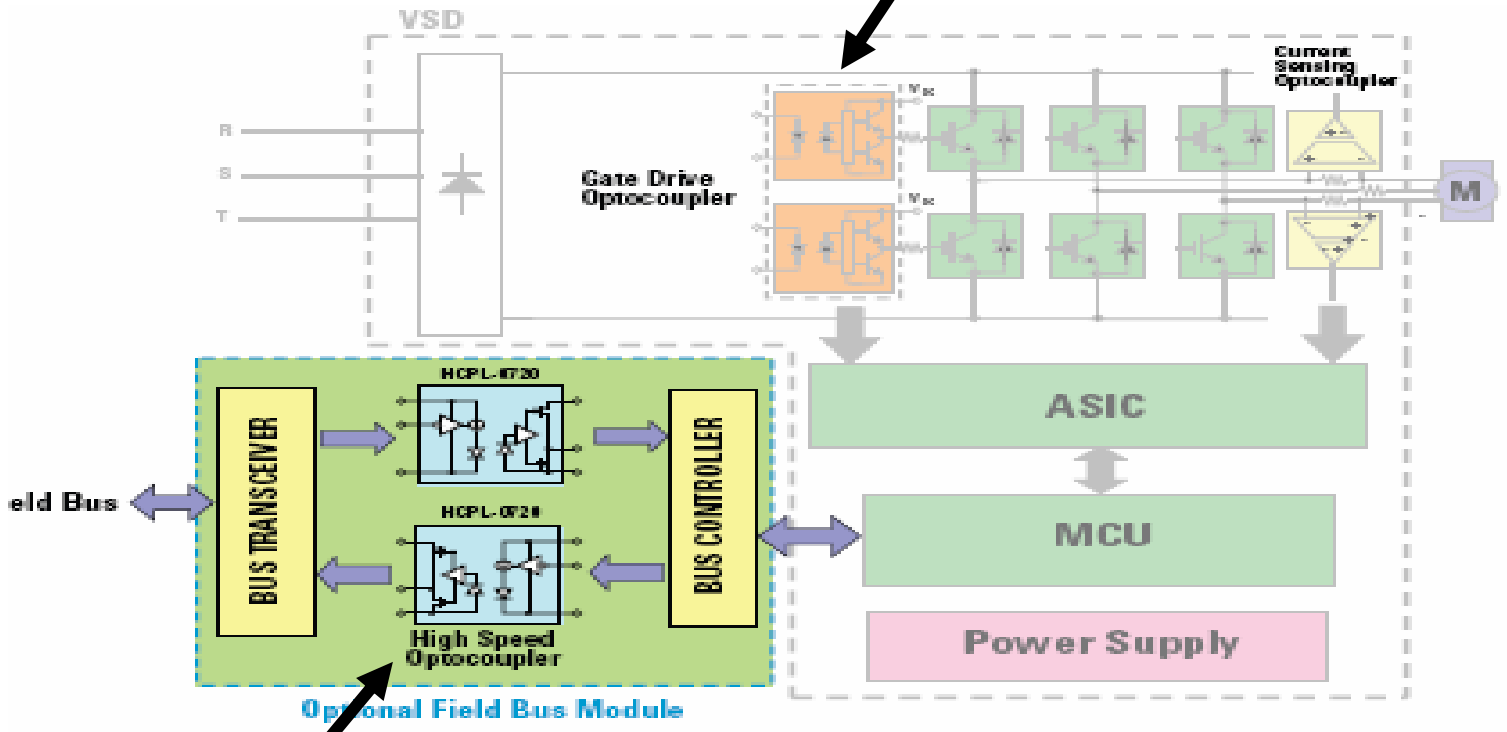
8-pin DIP: 6N135, 6N136, HCPL2503, FOD250L

8-pin SOP: HCPL0500, HCPL0501, FOD050L

Variable speed drive with network card

Recommended FSC Optocouplers:

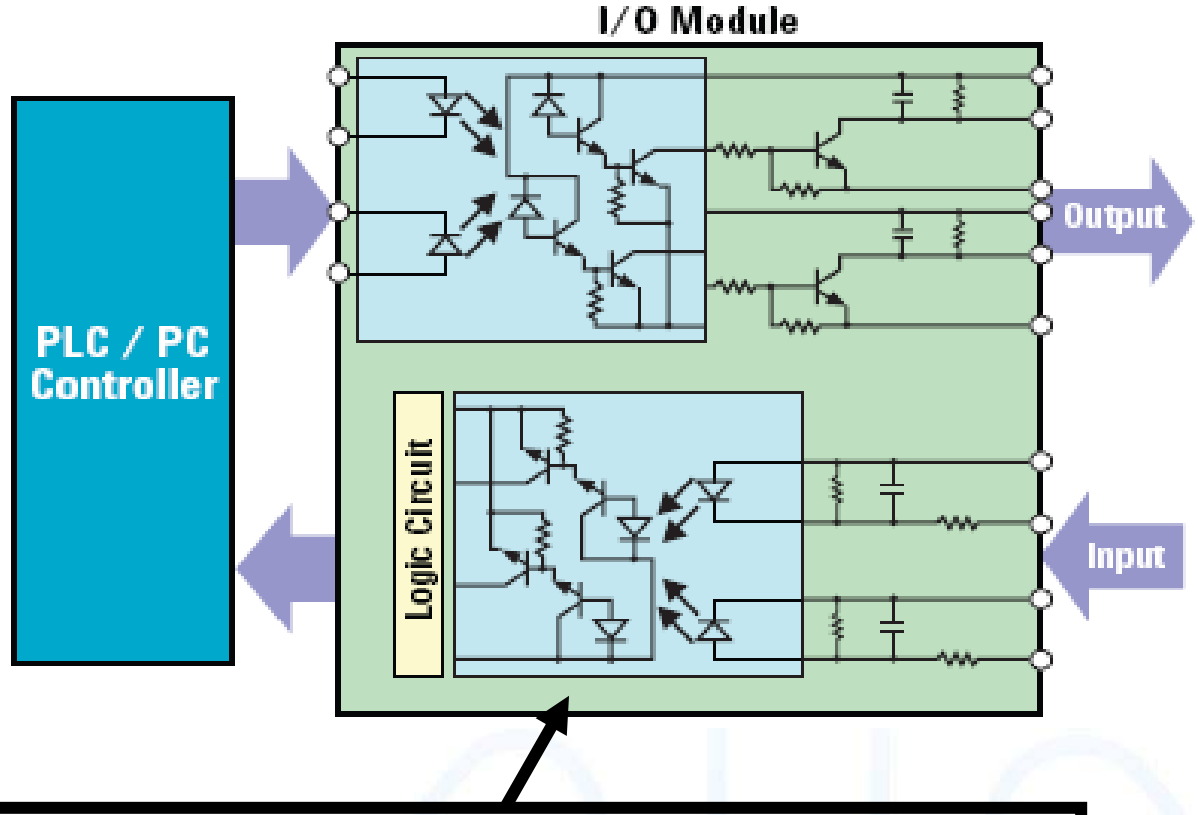
8-pin DIP: FOD250, FOD3180 (June 2006 release)



Recommended FSC Optocoupler:

8-pin DIP: FOD0710 (Sept 2006 release)

Digital I/O module in PLC or industrial PC

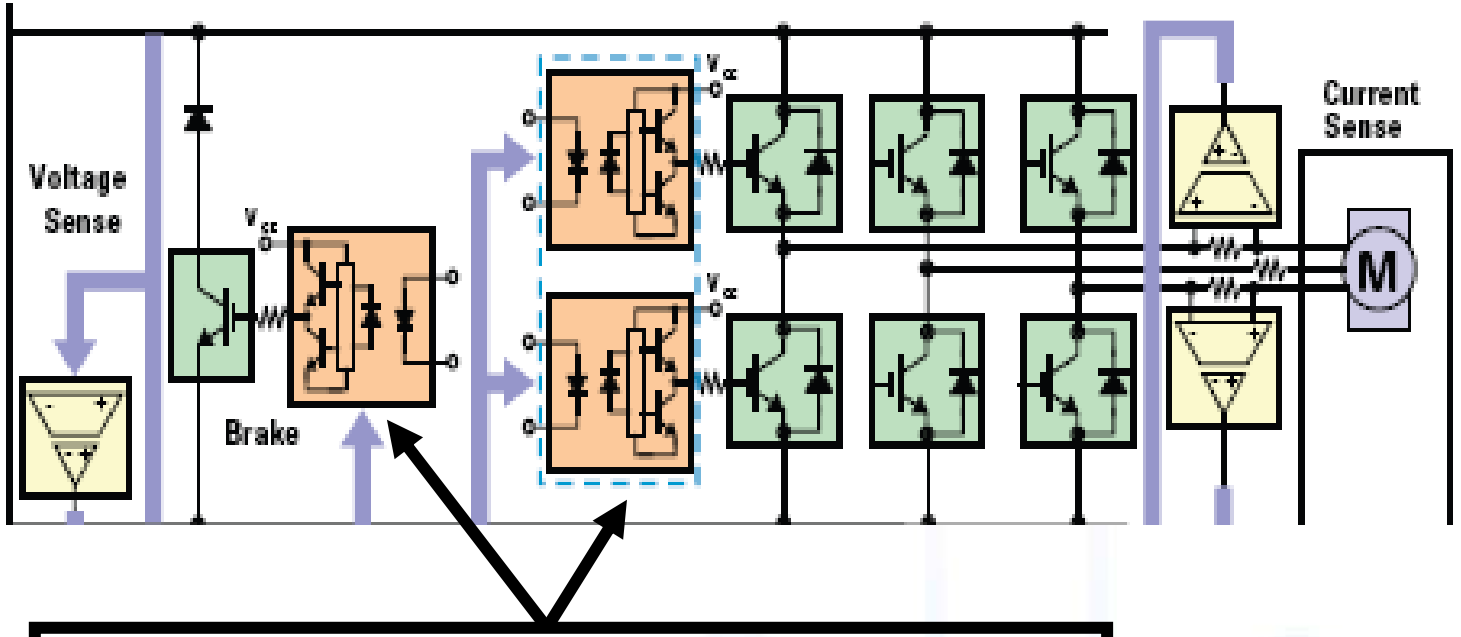


Recommended FSC Optocouplers:

8-pin DIP: HCPL2730, HCPL2731

8-pin SOP: HCPL0730, HCPL0731, FOD073L

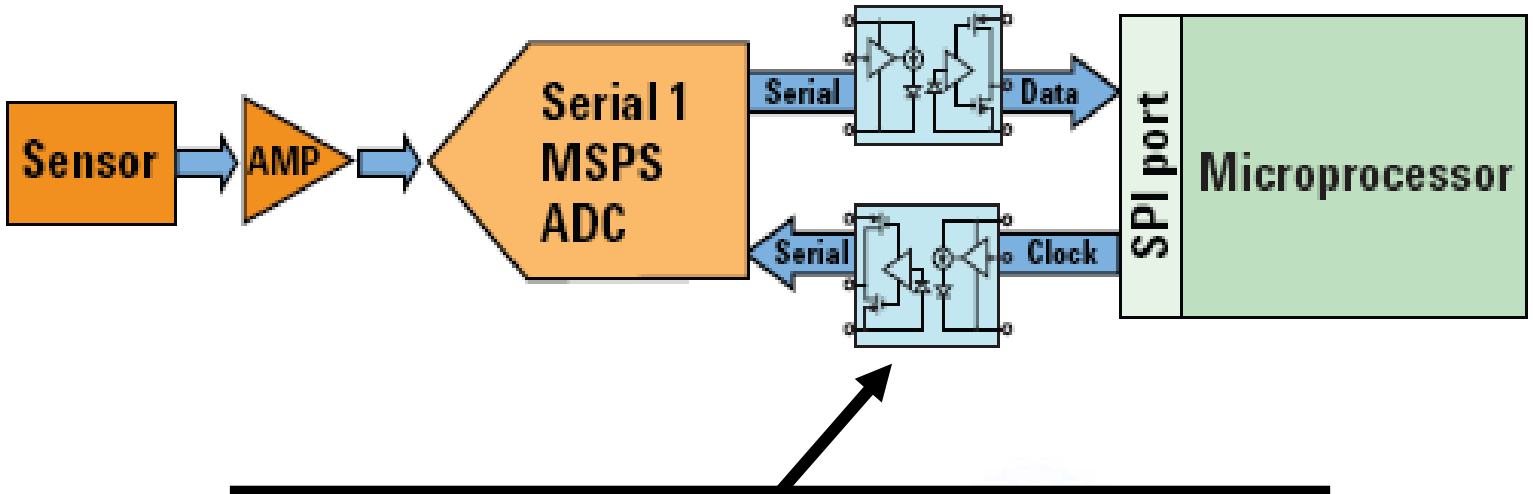
Industrial USB block diagram



Recommended FSC Optocouplers:

8-pin DIP: FOD250, FOD3180 (June 2006 release)

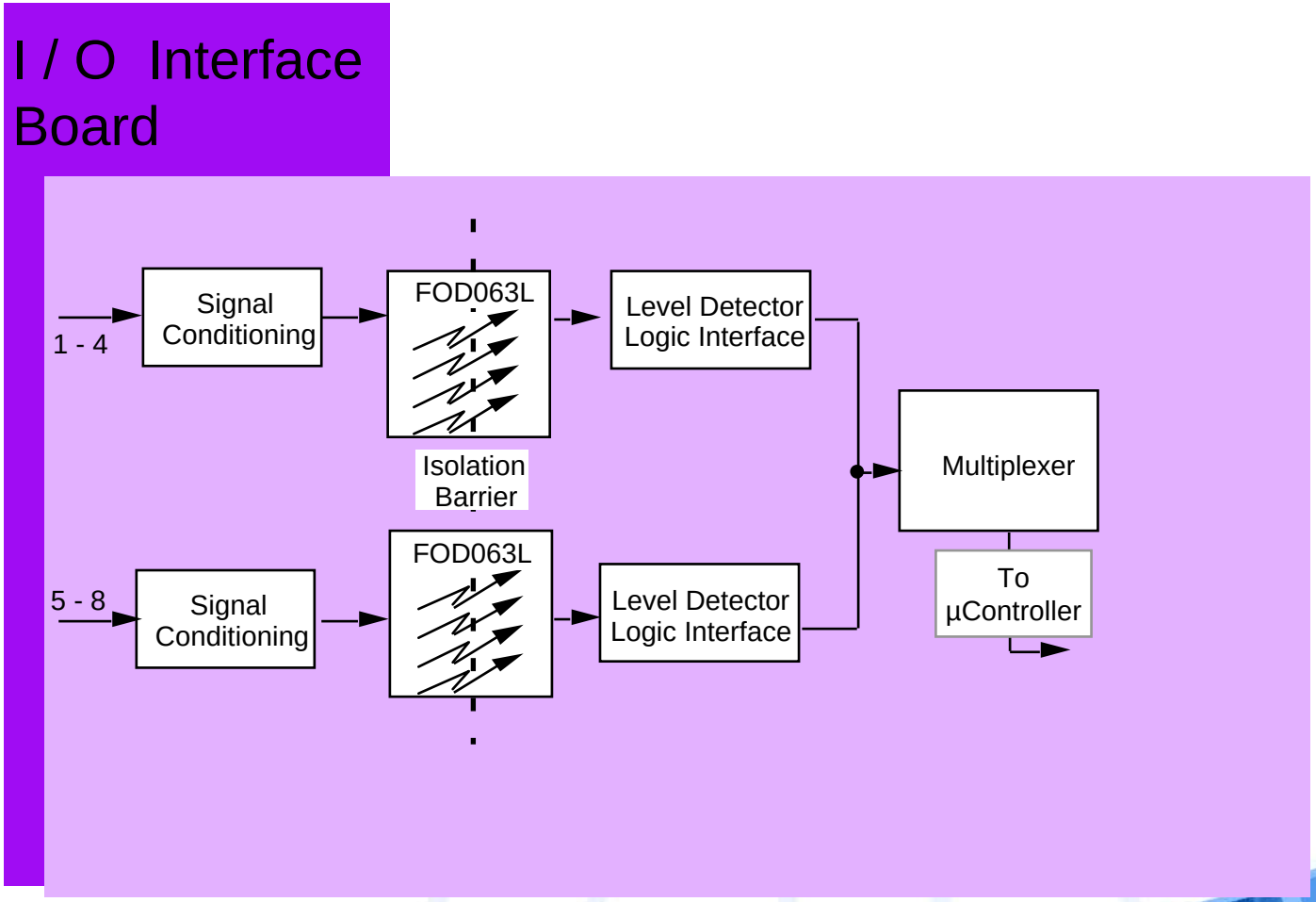
Parallel A/D Conversion isolation block diagram



Recommended FSC Optocoupler:

8-pin DIP: FOD0710 (Sept 2006 release)

Controller Input



Process Controller - Outputs