Optocouplers, Linear Opto-Isolators, Error Amplifiers and Applications

June 5, 2013
### Single and Dual Optocouplers

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Minimum Breakdown Voltage (V&lt;sub&gt;p&lt;/sub&gt;)</th>
<th>Nominal Current Transfer Ratio (%)</th>
<th>Maximum Saturation Voltage (V)</th>
<th>Maximum Input Control Current (mA)</th>
<th>Minimum Isolation Voltage (V&lt;sub&gt;min&lt;/sub&gt;)</th>
<th>Package Type</th>
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<td>3750</td>
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CPC1301, CPC1303 Optocouplers
5kV_{rms} Input/Output Isolation

Features
- 5000V_{rms} Input/Output isolation
- High Current Transfer Ratio (CTR)
- 4-pin DIP package (through hole and surface mount versions)
- Two different through hole versions with 7.62mm and 10.16mm I/O pin pitch available

Applications
- Data Communication Interface with Remote/Smart Meters
- The combination of low input current, high current transfer ratio, high output voltage capability, and 5kV_{rms} isolation rating make these optos ideal for many industrial applications including remote meters.
• Low cost optocouplers are used in:
  
  ○ Any application requiring isolation

  ○ Telecom-specific applications include:
    - Ringing detection for telephone DAAs
    - Loop current detection
    - Current sensing
    - Tip/ring circuits
    - Telecom switching
Ring and Off-Hook Detection in Telephone Data Access Arrangement

Off-Hook Detection

Ring Detection
Some Direct Inward Dialing (DID) systems use loop reverse battery signaling so there is a need for loop detection.
Linear Opto-Isolators

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Servo Gain K1 (Min / Max)</th>
<th>Forward Gain K2 (Min / Max)</th>
<th>Transfer Gain K3 (Min / Max)</th>
<th>Input Control Current (mA)</th>
<th>Isolation Voltage (V_{mkr})</th>
<th>Package Type</th>
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<td>0.004 / 0.03</td>
<td>0.668 / 1.179</td>
<td>2 - 10</td>
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<td>2 - 10</td>
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<td>0.733 / 1.072</td>
<td>2 - 10</td>
<td>3750</td>
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K3 Sorted Bins

<table>
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<tr>
<th>Bin</th>
<th>Voltage Range</th>
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<tr>
<td>Bin C</td>
<td>0.668 - 0.732</td>
</tr>
<tr>
<td>Bin D</td>
<td>0.733 - 0.805</td>
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<tr>
<td>Bin E</td>
<td>0.806 - 0.886</td>
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<tr>
<td>Bin F</td>
<td>0.887 - 0.974</td>
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<tr>
<td>Bin G</td>
<td>0.975 - 1.072</td>
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<tr>
<td>Bin H</td>
<td>1.073 - 1.179</td>
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Linear Optocouplers feature an LED and **two matched photodiodes** to provide **linear signal processing** over an isolation barrier.
The LOC117 linear optocoupler (featuring an LED and two matched photodiodes) is a ‘binned’ version of the LOC111.

The binning test is performed on the transfer gain operating bands:

Bin F = 0.887 Min. - 0.974 Max. Transfer Gain  
Bin G = 0.975 Min. - 1.072 Max. Transfer Gain

Benefit: Gives customer maximum flexibility to use one part number for a specified range of transfer gain
Photoconductive Mode

- Bandwidth 200kHz
- Linearity 8 bit D/A converter with +/- 1 LSB error
- There is Dark Current due to voltage Vcc across diode (25nA max)
- Use this mode if speed is more important than precision
- Lower capacitance = higher speed due to Vcc effect on PN junction

Figure 1. Isolation Amplifier (Photoconductive Operation)

Figure 2A. Photoconductive Amplitude Response
Photovoltaic Mode

- Bandwidth 40kHz
- Linearity 12 to 14 bit D/A converter with +/- 1 LSB error
- No Dark Current
- Use this mode where precision is more important than speed
- Lack of Dark Current eliminates entire error term
- Lower noise makes smaller measurements possible
- The Linear output makes calculations trivial
ECG Design Example

Selected ECG Design Considerations and Challenges:

- Cardiac Signals for adults are approximately 1mV to 5mV in magnitude
- Bandwidth 0.005 to 100Hz
- Noise problems such as residual electrode voltages
- Power line 50/60 Hz noise
- Protection against high defibrillation voltages 1500V to 5000V
- Electrical isolation from the power line and the earth ground
EKG Electrical Isolation

Transformer Isolation

- Transformers are inherently high AC frequency devices
- Modulation and demodulation needed

Optical Isolation

- Optical signal is modulated in proportion to the electric signal and transmitted to the detector
- Pulse code modulated
Linear Optocoupler Solution:

- Photovoltaic Mode provides excellent low voltage measurement and excellent linearity
- Bandwidth up to 40kHz
- CMRR is 130dB eliminates power line 50/60 Hz noise
- Protection against high defibrillation voltages (3750Vrms)
- Electrical isolation from the power line and the earth ground
ECG Block Diagram
Variable-Speed Motor Controller Monitoring

Design Considerations:

- Variable speed controllers regulate speed or torque of asynchronous motors.
- Typically operate in industrial environments and are exposed to high-energy over voltages (surges), phase failures, under voltage conditions and supplies with high levels of noise interference.

Linear Optocoupler Solution:

- LOC110 Provides 3750Vrms of Input to output Isolation
- High Common Mode Rejection Ratio CMRR = 130dB
- It is possible to get up to 12 bits of resolution
- Monitors line voltage and absence of phases
Variable-Speed Motor Controller

Monitoring Circuit

Monitors Line Voltage and Absence of Phases

Monitors Bus Voltage 600V

Figure 1
Isolated Pressure Transmitter

Design Considerations:

- Industrial controllers and data acquisition equipment require an isolated voltage to current loop converter to protect user and equipment from electric shock.
- Typically operate in industrial environments and are exposed to high common mode noise from high voltage switching power supplies.

Linear Optocoupler Solution:

- LOC112 Provides 3750Vrms of Input to output Isolation
- High Common Mode Rejection Ratio CMRR = 130dB
- Monitors Temperature/Pressure
Isolated Pressure Transmitter Block Diagram
Isolated 1V-10V to 4mA-20mA Converter Schematic

LOC112 Accepts Voltage from Pressure Transducer and transmits across barrier to XTR110 Voltage to Current Converter

XTR110 Converts Input Voltage to 4mA to 20mA Current
Optically Isolated Error Amplifiers

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Reference Voltage (%)</th>
<th>$V_{\text{REF}}$ Tolerance (%)</th>
<th>CTR K1 (%)</th>
<th>CTR K2 (%)</th>
<th>CTR Matching K3 (%)</th>
<th>Linearity (dB)</th>
<th>Isolation Voltage ($V_{\text{iso}}$)</th>
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<td>3750</td>
<td>8-Pin DIP, 8-Pin Surface Mount</td>
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Selected SMPS Design Considerations and Challenges:

- National and International safety agencies require power supply’s output to be isolated from AC mains.
- SMPS depend on feedback technique to maintain voltage regulation.
- More designers push SMPS to higher switching frequencies.
- Standard Optocouplers used in feedback are pushed to their operating BW limit.
Switch Mode Power Supply Feedback

- Feedback Winding Method
  - Requires signal rectification, filtering and possible signal scaling
  - Poor load regulation due to inadequate transformer winding

- Optical Isolation Method
  - Signal rectification, filtering and scaling eliminated
  - Excellent load regulation and temperature stability
The LIA120 Optically Isolated Reference Amplifier combines IXYS ICD linear optical coupler technology with an industry standard 431 type precision programmable shunt regulator to provide very linear high gain with excellent temperature stability for a total gain error of less than 2dB.

- Precision Voltage Reference
  - On board 431-type shunt regulator
  - Low voltage operation 2.7V
  - 1.240V ± 1% reference

- CTR Matching 15% (current trans. ratio)
- >70dB THD (total harmonic distortion)
- 70dB CMRR (common mode rejection ratio)
- 3,750Vrms isolation
- UL approval pending
- Used in Power Supply Feedback
Optically Isolated Error Amplifier

Integration of a precision voltage reference and inexpensive optocoupler in a single package

- Precision Voltage Reference
  - On board 431-type shunt regulator
  - Low voltage operation 2.74V
  - 1.240V ± 1% reference
  - New 1% references available
  - CTR 300% to 600%

- 3,750Vrms isolation

- BSI approval 8661 and 8662

- UL approval E90700

- CSA approval 1113643

- Competition: Fairchild FOD series Error Amplifiers
LIA130 in Power Supply Feedback

Example Application for the LIA130
High Speed
Digital
Optical Isolation
Optically Isolated, 
$\text{I}^2\text{C}$ Bus Repeater ICs

CPC5902

&

CPC5903
I²C Bus Overview

- “Inter-Integrated Circuits” or I²C bus
  - Popular serial protocol developed by Philips (NXP) in the early ’80s
  - 2 bus lines: Serial-Data (SDA), Serial-Clock (SCL)
  - Each device is software addressable by a unique address
  - Master/slave relationships for all components on the bus
  - 4 standard data rates: 100kbps, 400kbps, 1Mbps and 3.4Mbps
  - Open-drain signal pins
  - True multi-master bus providing arbitration and collision detection
Galvanic isolation is required for specific I²C Bus applications for safety and operational requirements:
- AC power mains
- Power supplies
- DC/DC Converter high-side monitoring
- Industrial
- Telephone lines
- Medical equipment
- Instrumentation
- Lighting controls
- Motor controls

Allows user to distribute I²C bus capacitance by using a repeater.
Current Implementation - Optical Isolation I²C Bus Applications

Requires **3 ICs** per I²C Bus port (ICs 1 thru 3 below)
- I²C Driver IC (1)
- Two Dual optocouplers for bidirectional signal processing (2) (3)
  - Serial Data
  - Serial Clock

**Consumes PC board space** per I²C Bus port
CPC5902 Optically Isolated Bus Repeater

- Optically isolates the I²C Bus
  - $3750V_{\text{rms}}$ minimum optical isolation barrier specification
  - UL, CSA, EN regulatory approvals
- I²C compatible
  - Serial Data and Serial Clock ports in a single package
  - Standard and Fast modes to 400kbps
- 2.7 to 5.5V supply range
- Package: 8-pin gull-wing surface-mount or DIP
Features

- Two bidirectional optocouplers in a single package
- Proven low cost optocoupler technology
- Excellent surge robustness 6kV peak for K.20 surge testing customers
- Minimal EMI/RFI issues
  - No impact on power controller or regulatory certification
- Supports direct static-state buffering without refresh
- Cost effective for most I²C applications running at standard or fast mode operation of 400kbps
- Supply voltage specification from $V_{dd}$ of 2.7V to 5.5V
- Passed UL E76270
- Preferred Isolator on Broadcom PoE reference designs due to cost and robustness
CPC5902 provides $3750V_{\text{rms}}$ isolation between host and PSE Controller for high surge robustness testing on RJ45 jacks.
CPC5903 Optically Isolated Bus Repeater

- I²C compatible
  - Bidirectional Serial Data and **Unidirectional** Serial Clock ports in a single package
  - Standard and Fast modes to 400kbps

- Optically isolates the I²C Bus
  - 3750V_{rms} minimum optical isolation barrier specification
  - UL, CSA, EN regulatory approvals

- 2.7 to 5.5V supply range
- Package: 8pin gull-wing surface-mount, 8pin DIP
Clare I²C Bus Repeaters and Competitive iCoupler Technology

Competitive silicon RF transformer solutions
- Higher speed technology - Mbps
  - Analog Devices ADuM1250 “iCoupler”
  - Silicon Labs Si8400, Si8600
- Monolithic silicon solution with internal generated clock required for transmission
- Internal clock creates EMI/RFI interference issues with power controllers
- Requires clock refresh for direct static-state buffering
- Supply voltage specification only from V_{dd} of 3.0V to 5.5V

Clare I²C Optically isolation Bus Repeaters
- Excellent surge robustness 6kV peak for K.20 surge testing customers
- Minimal EMI/RFI issues
  - No impact on power controller or regulatory certification
- Supports direct static-state buffering without refresh
- Proven optical technology with excellent reliability data
  - LEDs running at low current
- Cost effective for most I²C applications running at standard or fast mode operation of 400kbps
- Supply voltage specification from V_{dd} of 2.7V to 5.5V
Competitive silicon RF transformer solutions

- Data/clock signals are RF modulated over silicon transformers
- **Internal RF oscillator** creates EMI/RFI interference
  - EMI/RFI testing is costly and time consuming.
  - Special filtering and layout required to eliminate EMI/RFI
- Susceptible to latch up and ESD.
- Limited operating voltage of 3.0 – 5.5V
- ADu1250 and Si8400 not tested to $6kV_{pp}$ surge.
• **ISSUES:** Diploid emissions from internal RF oscillator on iCouplers
  - Between ground planes.
  - Higher current increases diploid effect.
  - Cylindrically radiated magnetic interference between board layers of the printed circuit board.

• **REQUIREMENTS:**
  - Several filter components
  - Special layout guidelines are required to minimize emissions across the PCB.
CPC5902/CPC5903 Summary

- New optical isolation I²C bus repeater IC’s from Clare
- Single package solution replacing 3 ICs
- Significant board space reduction
- Galvanic isolation of 3750V_{rms}
- Optical approach minimizes EMI
- Low current design
- Clare - long time supplier of reliable optically isolated products
- Released Product
Upcoming Isolation Products for Digital Circuits:
(prototypes ~ Sept 2013)

CPC5904/CPC5905
Optically Isolated I²C Bus Repeater
(faster CPC5902/CPC5903)
CPC5902 – Optically Isolated I2C Bus Repeater

**Strengths**
- limited output slew rate - no ring on long lines, low electromagnetic interference
- little or no undershoot - excellent pulse fidelity

**Weaknesses**
- limited output drive (3mA at B side, 6mA at A side)
- only guaranteed to 500kHz
- I/O levels not SMBUS compatible
CPC5904
Optically Isolated Bus Repeater IC

**Strengths**

- High speed (1 Msps guaranteed)
- sideA I/O Levels SMBUS/TTL/I2C compatible:
  - $2.7V < V_{dd} < 3.6V$, $I_{ol} = 4mA$
- Increased output drive:
  - (6mA sideB, 9mA sideA)
- does not require external LED resistors or buffers
- Lower cost

**Weaknesses**

- Fast slew rate - can undershoot

Q3 CY2013 Samples
CPC5904 and CPC5902
Switching Speed Comparison

CPC5902

1.8 Switching Specifications

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<th>Parameter</th>
<th>Conditions</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
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<tr>
<td>( I^2C ) Clock Frequency</td>
<td>( I_{SINKA}=6,mA, C_{LOADA}=400,pF ) ( I_{SINKB}=3,mA, C_{LOADB}=200,pF ) ( I_{SINKB}=6,mA, C_{LOADB}=400,pF ) (( V_{DDB} \geq 4.5,V ))</td>
<td>( f_{MAX} )</td>
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CPC5904

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<th>Typ</th>
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<td>( I^2C ) Clock Frequency</td>
<td>( I_{SINKA}=6,mA, C_{LOADA}=400,pF )</td>
<td>( f_{MAX} )</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>kHz</td>
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<td>1000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>kHz</td>
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</table>

- CPC5904 meets standard and fast mode performance with 2.7V supply
- CPC5904 offers 1MHz switching with reduced \( C_{LOADB} \) capacitance
New Isolation Products for Digital Circuits:

CPC5002
Dual High-Speed Open-Drain Optical Isolator

CPC5001
Single Channel, Each Direction, High-Speed Open-Drain Optical Isolator
CPC5002 Dual High Speed Digital Optical Isolator

CPC5002 Features
- Dual optics isolates 2 signals
- Operates 2.7V to 5.5V $V_{DD}$
- High Speed 10Mbps
- 1.5mA low LED drive current
- Lowest power optocoupler
- $3750V_{\text{rms}}$ isolation

Applications
- Isolated line receiver
- Isolated bus receiver
- Ground loop elimination circuit
- ADC/DAC digital noise isolation

Released
CPC5002 Features

- **Pin Compatible** with existing solutions:
  - Toshiba TLP2630, TLP2631
  - Avago HCPL263, HCPL063
  - NEC PS9821-2

- **High Speed** Low Power CMOS Construction
  - very high gain photocurrent comparator
  - competitors: power hungry bipolar processes
  - competitors: low gain
  - competitors: output slew rate depends upon input slew rate

- **Lowest LED Drive** current required:
  - 1.5mA per LED vs 7.5mA per LED

- **Lowest power supply current** for minimal power dissipation
  - low glitch 1.4mA vs (various, 3mA to 24mA)

- **Lowest power supply voltage**
  - CPC5002 is the only part specified to operate down to 2.7Vdd
CPC5001 Single-Channel, Each Direction, High Speed Digital Optical Isolator

CPC5001 Features
- Forward optic path
- Reverse optic path for feedback from load side
- Operates 2.7V to 5.5V $V_{DD}$
- High Speed 5Mbps
- Low power optocoupler
- 3750V$_{rms}$ isolation

Applications
- Isolated line receiver
- Isolated bus receiver
- Ground loop elimination circuit
- ADC/DAC digital noise isolation
Conclusion

• Clare core strengths
  ☐ High voltage wafer fab
  ☐ Isolation barrier expertise
  ☐ Multi-chip packaging
  ☐ Analog/power/mixed-signal design

• Active IC development program
  ☐ Telecom
  ☐ High voltage switching
  ☐ Self protecting SSRs
  ☐ Optical I²C bus repeaters
  ☐ High speed optoisolators

• Future products in new markets for optical bus and high speed optocouplers
An Introduction To Solid State Relay Technology
OptoMOS™ SSR Technology

Optical Isolation provides an internal isolation barrier between high voltage (output or load side) and the input side (control side)

1. Current passes through the input Light Emitting Diode (LED) which emits an infrared light.

2. The infrared light passes through the optical lightpath and shines on the surface of the Photovoltaic chip (PV).

3. The PV chip converts the infrared light to a voltage.

4. The voltage is transferred to the output MOSFET and turns them on/off.
Advantages over Traditional **Electro-Mechanical Relays (EMRs)**

- **Size and Space**
  - 25 - 60% area reduction, 50% height reduction

- **Electrical performance**
  - Immune to magnetic fields
  - No contact bounce
  - Logic, Intelligence & Protection
  - Significantly Lower Drive Current and 10x reduction in power

- **Reliability, durability and quality**
  - Higher solid state reliability, **long lifecycle**
  - Ideal in Shock and Vibration Environments

- **Manufacturing**
  - PCB Auto-insert
  - Reduced Assembly Costs
Relay Types

Types of Relays
SSRs and EMRs

- Form A
  - Normally open

- Form B
  - Normally closed

- Form C
  - Both form A and B
  - Break before make switching
**SCR vs. MOSFET Based Relays**

**SCR guidelines for use:**
- Best for rugged environments
- Only for AC Voltage applications
- More efficient (lower cost) for high current applications

**MOSFET based relay guidelines for use**
- Versatile range of voltage (30V-1200V)
- Works in AC and DC applications
- More stable operation in noisy environments
- Best value for low current applications
SSR Market Trends

FY10 SSR Revenue by Application

- Industrial High Power (>1A) 5%
- Industrial AC Line (SCR) 5%
- Industrial Signal 3%
- Industrial FET based (<1A) 17%
- Security 23%
- Telecom 39%
- Aerospace/Hi-Rel 3%

FY13 SSR Revenue by Application

- Industrial High Power >1A 11%
- Ind. Signal 3%
- Indust. AC line (SCR) 4%
- Industrial-FET based (<1A) 19%
- Ind. metering
- Hirel & aerosp 3%
- Linear opto 4%
- Security 18%
- Telecom 28%
OptoMOS™

Solid State Relays
Optocouplers
Linear Optocouplers (covered on Wednesday)
Discrete MOSFETs
IXYS Integrated Circuits Division
OptoMOS Applications
Solid State Relay Applications

Typical SSR Applications by Load Voltage

- **30 to 60V** – Security Market, Low voltage systems, Car battery systems
- **100 to 280V** – Industrial
- **300 to 400V** – Telecom (tip and ring voltage)
  Industrial, 110V AC power
- **>400V** – Industrial, Utility Metering, Fluid Pumps,
  110/220V AC power, Electric/Hybrid Vehicles

Security

CPE-Telephony

Gasoline Pumps

AC Power Meters

Central Office Telephony
Solid State Relays: Security Market

Security Applications: Passive infrared detectors, Door locks, Alarm panels, Door/window sensors

4 pin
- CPC1017N
- CPC1008N
- CPC1016N
- CPC1018N
- CPC1020N
- CPC1030N
- CPC1035N
- CPC1002N
- CPC1117N
- CPC1333G
- CPC1393GR

4 pin SIP
- CPC1217Y
- CPC1219Y

6 pin
- CPC1510GS
- LBA110S
- LBA127P
- LCA110S
- LCA712
- LCA717

8 pin
- CPC1317P
- CPC1335P
- CPC2317N
- LCC120S
- PAA150
Solid State Relays: Power Meter Market

Power Meter Applications measure:
- Active Power
- Reactive Power
- Tariff Switching (reduce usage during peak power times)
- Alarm Outputs
- Custom Controls
- Limit Power Consumption

4 pin
- CPC1390G
- CPC1393G
- CPC1394G

6 pin
- PLA192
- PLA193
- PLA194
- PLA143
- PLB190

8 pin
- PAA190
- PAA193
- PBA190

Power Relay
- CPC1983Y
- CPC1966Y
- CPC1968J
Solid State Relays: Gas and Chemical Pump Market

Gas and Fluid pumps applications:
- Triac driver
- Diagnostics

Optical Isolation offers “spark-less” switching vs. electro-mechanical relays.

4 pin DIP
- CPC1965G

4 pin SIP
- CPC1965Y

8 pin
- CPC1961G

Power Relay
- CPC1966Y/B
- CPC1998J
Solid State Relays: Telecom Market

Telecom Applications

- Telecommunications/Telecom Switching/ Tip/Ring Circuits
- Hook Switch
- Central Office switching
- Ground Start signaling

4 pin
- CPC1030N
- CPC1035N
- CPC1230N
- CPC1004N

6 pin
- LCB110
- LCB111
- PLB150S

8 pin
- LAA110S
- LAA110L
- LAA126S
- LBA110
- LBA110L
- PAA110

Special Function
- ITC117P
- ITC137P
- TS117P

Central Office Line Cards

VoIP Gateway with PSTN Interface
New Low Voltage Solid State Relays (SSR)

Ultra Low Resistance

For the Security Market, Low voltage systems, Battery systems
LCB717 and LCA717, 30V 1-Form-B and 1-Form-A, 6-Pin Package SSRs

Features
- Up to $2A_{\text{rms}}$ load current (AC)
- Up to 4A DC Configuration
- As low as 0.15 Ohm $R_{\text{ON}}$ (AC)
- As low as 0.04 Ohm $R_{\text{ON}}$ (DC)
- 6-pin surface mount & DIP packages
- 3750V$_{\text{rms}}$ isolation

Applications
- Security / Alarm Controls in series due to low on resistance (window break sensors)
- Low Voltage Battery (3.3V to 12V)
- Electromagnetic Relay (EMR) replacement
- Sensor Circuitry
- Industrial
**Features**

- 1 Normally open and 1 normally closed switch in single 8-pin package
- $1.0A_{\text{rms}}$ Load Current
- 0.6 Ohm $R_{\text{on}}$
- 60V, Form-A/B SSR
- $3750V_{\text{rms}}$ isolation
- Requires only 2mA of Input Control Current

**Applications**

- Industrial controls
- Instrumentation
- Security
  - REX (Request To Exit)
Market (e.g. Security Passive Infra-Red (PIR) Detectors)

- Traditionally the 2\textsuperscript{nd} largest market for IXYS ICD
- Sell to most of the large passive infra-red security manufacturers around the world
- CPC1017N 4-pin SOP Solid State Relay (SSR) is IXYS ICD’s most popular product
- IXYS ICD offers MANY SSR derivatives for this market
Passive Infra-Red (PIR) security system

- PIR sensor signal applied to microcontroller
- Microcontroller processes PIR signal and makes decision to drive solid state relay (SSR)
- SSR drives alarm in fault condition. Bidirectional structure allows switching of non-standard alarm wiring. SSR is immune to EMI/RFI vs. electromechanical relays (EMR)
New 300 to 400V Solid State Relays (SSR)

350V Hook switch relays for Customer Premise Equipment (CPE) Telephony
400V relays for CPE and Central Office (CO) Telephony
CPC1540 – SSR with Integrated Current Limiting and Thermal Shutdown

2nd Source to Vishay LH1540 (drop-in replacement)

Features

- 1-Form-A, normally open
- $350V_p$ blocking voltage
- 25 Ohm max. $R_{on}$
- Continuous load current
  - bi-directional operation 120mA
  - uni-directional operation 250mA
- Integrated current-limit protection
- Integrated thermal shutdown
- Reduces component count
Narrow-body 8-pin SOP: CPC2030N (1-Form-A) Dual Single Pole SSR

Features

- 8-pin SOP (small outline package)
- 350V Blocking Voltage
- 1500V_{rms} Input/Output Isolation
- UL, CSA, IEC/EN regulatory approvals

Applications

- Telecommunications (CPE)
- Security
- Instrumentation: Multiplexers, Data Acquisition, Electronic Switching, I/O Subsystems
- Industrial Controls
400V SSRs: CPC2025N & CPC2125N
Dual 8-pin Narrow-body SOP Package

Features
- Dual 1-Form-A and Dual 1-Form-B
- 400V load voltage offers improved margin for telephony applications
- 8-pin narrow-body SOP package
- 1500V\textsubscript{rms} isolation
- Panasonic Cross Reference:
  CPC2025N - AQW214S
  CPC2125N - AQW414S

Applications
- Telecom CPE and CO Equipment
- Industrial controls
PLB190 - 400V, 5kV_{rms} 1-Form-B SSR in a 6-Pin DIP Package

**Features**

- 400V – Highest Blocking Voltage 1-Form-B SSR
- 6-pin DIP package
- 5000V_{rms} isolation
- 130mA Load Current
- 25 Ohm max. R_{on}

**Applications**

- Telecommunications: Telecom Switching, Tip/Ring Circuits
- Instrumentation (Handheld)
- Medical Equipment — Patient/Equipment Isolation
- Industrial Controls
- Meters (Watt-Hour, Water, Gas)
New 600V+ Solid State Relays

Smart AC Power Meter
High Voltage Systems
Car Battery Charging Circuits
PLA192E, PLA193E 600V, 5kV_{rms} SSRs with Partial Discharge Testing

Features
- New E-suffix, 100% tested for partial discharge meeting standard: EN 60747-5-5 (VDE – EU Association)
- 600V Output Blocking Voltage
- 5000V_{rms} Input/Output isolation
- 22 / 50 Ohms max. R_{on}
- 150 / 100mA max. Load Current

Applications
- Meters (Watt-Hour, Water, Gas)
- Instrumentation
- Industrial controls

PLA192E Safety and Insulation Ratings

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Battery Isolation Monitor
Battery Isolation Monitor

- Electric motors on **Electric Vehicles** (EV) and **Hybrid Electric Vehicles** (HEV) are supplied from **high-voltage** (HV) battery stacks to allow efficient operation.

- Those battery stacks can typically involve 100+ cells, providing hundreds of volts.

- >50V can prove lethal to human beings.

- Safety isolation becomes a key concern since even lower voltages can damage electronic equipment.
Isolation Monitor Application Example

- The electronic circuit monitors the isolation current from the battery poles to ground

- Application requirements
  - 450V battery voltage
  - 2700Vp isolation test voltage
  - Robust to over voltage surges
  - 1mA operating load current
PLA171P 800V, Wide Output Pin Separation SSR

- **Features**
  - 800V min. Output Blocking Voltage over full –40° … +105° C operating temperature range
  - 6-pin Flatpack package (8-pin body)
  - 6.97mm Load Output Creepage Distance meeting pollution class 2 requirements
  - 50 Ohms/100mA load output rating
  - 5KVrms I/O Isolation

- **Applications**
  - HV-Battery Isolation Monitor on (H)EV cars
Competition

- **Aromat (Panasonic Electronic Works - PEW)**
  - Continues to be a strong competitor (AQV, AQW, AQY parts)
  - Many second source opportunities
  - Our new power SIP relays will match their products, i4-PAC™ relays move us ahead

- **Avago**
  - Many, many crosses

- **Coto**
  - New to SSR market, questionable quality, long time EMR supplier

- **Vishay** (previously Infineon, Siemens, Lucent)
  - Losing momentum in the market, obsoleting many parts
  - We continue to win business against Vishay and are aggressively pursuing their sockets (LHxxx parts)

- **SSO**
  - Losing market share

- **Omron, Crydom**
  - Limited competition in small signal relays, stronger in high current

- **Others**
  - NEC (CEL), Toshiba, IR, Cosmo
• **Product Catalog** has many new products (updated e-version on web site)

• New Solid State Relays (SSRs) and Applications by Load Voltage
  - **30V** – security and battery applications
  - **60V** – security, battery and industrial applications
  - **300 to 400V** – Many existing devices for telecom
  - **Greater than 400V** - for metering, power mains and industrial, thyristor battery charger application, battery monitoring

• **Power Relays**
  - (2 to 32A) 100 to 1000V
  - New package styles for higher power
    - Power SOIC
    - Super SIP

• **Long-term, top-rated, broad-line supplier** of SSR products
Optically Coupled I²C Bus Repeater

Features

- Low EM and RF Generation - No Internal Clock
- Bidirectionally Buffers Both I²C Signals
- Extends and Isolates I²C Interfaces
New Power Packages
New Power SOIC 5kV Isolation

Features
- Multiple pin configurations
- >12.5mm I/O creepage distance
- $5000\text{V}_{\text{rms}}$ Input/Output isolation
- 2.4W Package Power Dissipation

Benefits
- Low profile package
- output pin spacing allows usage in special environment
- Surface mount assembly

Applications
- Metering
- High Voltage Line Connection (Motors)
- Medical
- Automotive
New Power SOIC Block Diagrams

High Voltage

>7.75mm output
creepage distance

Bridge Configuration
New Power SOIC Block Diagrams

Two independent outputs

High output current
New SuperSIP Package

- **SuperSIP with “ST” (super thermal) suffix**
  - Improved creepage/clearance distances over i4PAC/ISOPlus264 (Input to Output (pin 2 to 3) is 0.400" [10.16mm])
  - Industry standard pin-out
  - Works with some standard style heat-sinks
Competition product:

Total volume of package = 0.68 in³

IXYS design: SuperSIP

Total volume of package = 0.18 in³

• IXYS ICD’s design takes up only about 1/3 of the PC board space as the competition!!

• We maintain the industry standard pin-out

• Same power, current and voltage ratings for a lower price with higher reliability

• Uses technology already employed in IXYS products
New Power Relays
Higher power packages with low thermal resistance

MOSFET Based
CPC1983YE - PowerSIP package

Features
- 600V Output Blocking Voltage
- 4000V_{rms} Input/Output isolation
- 6 Ohms max. on-resistance
- 500mA max. Load Current
- > 6mm input/output creepage
- > 4mm output creepage distance

Applications
- Meters with higher load current switching capability
CPC1706 – 60V 4A Load Current

Features

- $4A_{dc}$ Load Current
- Very low 0.09 Ohm on-resistance
- 60V, Form-A SSR
- 2500V$_{rms}$ isolation
- 4-Pin PowerSIP package

Applications

- Industrial
- Robotics
- Medical Equipment: Multiplexers, Data Acquisition, Electronic Switching, I/O Subsystems
- Instrumentation
- Home Appliances
CPC1968
500V-5A Switching Capability

Features

- isoPLUS-264 package
- $5A_{\text{DC}}$ Load Current
- 0.35 Ohm on-resistance
- 500V, Form-A Power Relay
- 2500V$_{\text{rms}}$ isolation
- UL 508 Recognized Component

Applications

- Industrial and Motor Controls
- Robotics
- Medical Equipment
- Instrumentation: Multiplexers, Data Acquisition, Electronic Switching, I/O Subsystems
- Transportation Equipment
- Aerospace/Defense
CPC1907B High Current
5kV_{rms} Output Isolation

**Features**
- \(5000V_{rms}\) Input to Output Isolation
- Load Current up to \(6A_{rms}\)
- \(60V_{P}\) Blocking Voltage
- \(0.06\) Ohms \(R_{on}\)
- 12.5mm External Creepage Distance
- 5mA Input LED Control Sensitivity

**Applications**
- Industrial controls
- High power switches for 12V, 24V powered systems
- Medical (5kV_{rms} isolation)
CPC1971BAH
Dual Form-A Relay with Common Contact

Features

- Power SOIC package
- 200mA_{rms} Load Current
- 800V, Form-A SSR
- 50 Ohm R_{on}
- 5000V_{rms} input/output isolation
- In Development

Applications

- Automotive, High-Voltage Circuitry
- Instrumentation: Multiplexers, Data Acquisition, Electronic Switching, I/O Subsystems
- Meters
- Medical Equipment – Patient/Equipment Isolation
- Industrial Controls
AC Power Switches

(SCR-Based)
AC Power Switches: SCR-Based Relays

- Utilize Dual Power SCRs (Thyristors) instead of MOSFETs
- Tightly controlled zero-cross circuitry ensures switching of AC loads with minimal switching noise
- Applications: Programmable Controls, Process Control, Power Control Panels, Remote Switching, Gas Pump Electronics, White goods (washing machines, dishwasher etc.)
What is an AC Relay?

AC Relay Types

- **SCR (Silicon Controlled Rectifier)**
  - High dV/dt immunity
  - Robust design
  - Snubber-less

- **Triac**
  - Lower Cost
  - Needs Snubber Circuit
  - Lower Commutating dV/dt
  - Lower dI/dt
Applications

Zero Cross
- Resistive loads
  - Heaters
- Single phase motor
- Lighting
- HVAC (Heating, Ventilation and Air Conditioning)
- Solenoids
- Lower EMI

Non-zero Cross
- Motors
  - Multi-Phase
  - Single Phase
- Transformer control
- Highly inductive loads
- Phase angle control
  - Lighting
  - Resistive Loads
2 Types of AC Relays

- **Zero Crossing**
  - Zero Volt Turn on
  - Synchronous
- Loads will only switch on around the zero crossing.

- **Non-Zero Cross**
  - Random Turn on
  - Instantaneous
  - Asynchronous
- Loads switch with control signal

- Both types only shut off at a zero current crossing
CPC1966Y AC-Power Relay

Features

- $3A_{\text{rms}}$ Load Current
- AC Operating Voltage $20-240V_{\text{rms}}$
- Blocking Voltage $600V_p$
- Tightly controlled zero-cross circuitry, ensuring low noise switching of AC loads, minimizing generation of transients
- $3750V_{\text{rms}}$ input to output isolation

Applications

- Motors
- Treadmills
- Remote Switching
- Gas Pumps
- Contactors
- Large Relays
- Solenoids
- Heaters
CPC1966B High Current 5\(kV_{rms}\) Output Isolation

**Features**

- 5000\(V_{rms}\) Input to Output Isolation
- Load Current up to 3\(A_{rms}\)
- 800\(V_p\) Blocking Voltage
- 12.5mm External Creepage Distance
- 5mA Input Control Sensitivity
- Zero-Cross Switching

**Applications**

- Meters with higher load current switching capability
- Motors
- Heaters
CPC1966Yx6 – Non Zero Cross AC Power Relay

Features

- $3 \text{ A}_{\text{rms}}$ Load Current
- $20\text{-}240\text{V}_{\text{rms}}$ Operating Voltage
- $600\text{V}_p$ Blocking Voltage
- Random turn on control circuitry enables precise control of the output waveform
- $3750\text{V}_{\text{rms}}$ of input/output isolation

Applications

- Programmable Control
- Process Control
- Power Control Panels
- Remote Switching
- Solenoids
- Motors
- Heaters
CPC1998J AC Power Relay

CPC1998J in the i4-PAC features:

- $5A_{\text{rms}}$ Load Current (free air)
- $20A_{\text{rms}}$ Load Current (5K/W heatsink)
- AC Operating Voltage 20-240$V_{\text{rms}}$
- On-State Voltage Drop 0.92$V_{\text{rms}}$ (at load current of $5A_{\text{rms}}$)
- Blocking Voltage $800V_P$
- Tightly controlled zero-cross circuitry, ensuring low noise switching of AC loads, minimizing generation of transients
- $2500V_{\text{rms}}$ of input to output isolation

Applications

- Motors
- Programmable Controls
- Process Control
- Power Control Panels
- Remote Switching
- Gas Pump Electronics
- Contactors
- Large Relays
- Solenoids
- Heaters
CPC40055ST – SuperSIP Current-Controlled AC Switch

Features
- Optical SCR Switch
- SuperSIP Thermal Package – (38.1 x 17.78) mm or (1.5 x 0.7) in.
- 66% smaller than the popular standard devices
- $5A_{\text{rms}}$ Load Current (without heatsink)
- 800V Blocking Voltage
- $2500V_{\text{rms}}$ Isolation Voltage
- 5mA Input Control Sensitivity
- UL508 Approval for multiple loads
  - Motor, Tungsten, Electric Ballast

Applications
- Power and Industrial Controls
- Motors
- Solenoids
- Instrumentation
- Controlling valves/actuators in automation and industrial systems
CPC44055ST – SuperSIP
Voltage-Controlled AC Switch

Features
- Optical SCR Switch
- Super SIP Thermal Package – (38.1 x 17.78) mm or (1.5 x 0.7) in.
- 66% smaller than the popular standard devices
- \(5A_{\text{rms}}\) Load Current (without heatsink)
- \(800V\) Blocking Voltage
- \(2500V_{\text{rms}}\) Isolation Voltage
- 9 to 16V Input Control Voltage
- UL508 Approval for multiple loads
  - Motor, Tungsten, Electric Ballast

Applications
- Power and Industrial Controls
- Motors
- Solenoids
- Instrumentation
- Controlling valves/actuators in automation and industrial systems