AC Relay Wildcard Users Guide

Introduction

This document describes how to use the AC Solid State Relay WildCard™ Module. It provides an overview of the hardware and software for the module as well as a schematic.

The AC Solid State Relay Module allows you to control up to four, 5 amp AC loads. You can stack up to eight AC Relay Modules on to the Module Carrier Board or you can mix and match any of the growing family of WildCard Modules. The following sections guide you through the AC Relay Module's hardware and software.

AC Relay Wildcard Specifications	
Channels	Four independent, optically isolated solid state AC relays
Voltage	Controls 12 to 280 VAC at 50 or 60 Hz
Current	Switches up to 5 amps
Isolation	Optically isolated to 4000 V rms
Switching Mode	Zero voltage switching
Turn On/Off Times	Max turn on/off time of ½ AC cycle
Connections	Easy-to-connect-to screw terminals

Hardware

Overview

The AC Relay Module was designed to allow easy control of AC loads. Each AC Relay provides:

- Control of 12 to 280 VAC loads operating at 47 to 63 Hz and up to 5 Amps.
- Optically isolated control to 4000 Vrms.
- Zero voltage switching.
- Max turn on/off time of ½ AC Cycle.

The next sections show you how to connect the AC Relay Module to the Module Carrier Board and how to configure the module for proper operation.

Connecting To The Module Carrier Board

To connect the AC Relay Module to the Module Carrier Board, follow these simple steps:

1. Connect the WildCard© Carrier Board to the QED Board as outlined in the WildCard© Carrier Board Users Guide".
2. With the power off, connect the Module Bus on the AC Relay Module to Module Port 0 or Module Port 1 on the Module Carrier Board. The corner mounting holes on the module should line up with the standoffs on the Module Carrier Board. The Module Bus on the AC Relay Module is located opposite from the screw terminals. The module ports are shown in Figure 1 of the "WildCard© Carrier Board Users Guide". CAUTION: The WildCard© Carrier Board does not have keyed connectors. Be sure to insert the module so that all pins are connected. The Module Carrier Board and the AC Relay Module can be permanently damaged if the connection is done incorrectly.

Selecting the Module Address

Once you have connected the AC Relay Module to the WildCard© Carrier, you must set the address of the module using jumper shunts across J1 and J2.

The Module Select Jumpers, labeled J1 and J2, select a 2-bit code that sets a unique address on the module port of the WildCard© Carrier Board. Each module port on the Module Carrier Board accommodates up to 4 modules. Module Port 0 on the WildCard© Carrier Board provides access to modules 0-3 while Module Port 1 provides access to modules 4-7. Two modules on the same port cannot have the same address (jumper settings). Table 1 shows the possible jumper settings and the corresponding addresses.

Module Port	Module Address	Installed Jumper Shunts
0	0	None
	1	J1
	2	J2
	3	J1 and J2
1	4	None
	5	J1
	6	J2
	7	J1 and J2

Table 1: Jumper Settings and Associated Addresses

Once you have connected and configured all of the hardware properly, you can use the software drivers to control AC loads.

Software

This section describes the software that enables you to control the AC Relay Module. We first start with a description of how modules are addressed, then move on to how the relays are controlled, and finally present you with example software that initializes and controls the relays.

Initializing the Module

Several bytes of memory on the QED board starting at $C000_H$ are used to communicate with the AC Relay Module. The page used for the memory's extended address corresponds to the module address. For example, to communicate with module 1 on the WildCard© Carrier Board, use the 6 byte memory block starting at address $C000_H$ on page 1.

The AC Relays on the AC Relay Module are controlled by a Xilinx CPLD (Complex Programmable Logic Device). The AC Relay control lines on the CPLD must be configured as outputs for proper operation (on power up, the control lines are initialized as inputs). To initialize the module, simply create a function that is defined as follows. Both C and FORTH versions are presented.

```
// C Code to initialize the AC Relay Module

#include <allqed.h>                 // Include QED header files

#define RELAY_CONTROL_LINES         1
#define DIRECTION_REGISTER          0xC005
```

```
#define RELAY_CONTROL_REGISTER      0xC000
#define ALL_RELAYS                  0xF

void Init_AC_Relay ( uchar module_number ) // Valid module numbers are 0-7
// Initializes the AC Relay Module by configuring the AC relay control lines
// of the CPLD to outputs.  The module number depends on the module select
// jumpers.  See Table 1 for the jumper settings and associated addresses.
{
  EXTENDED_ADDR module_addr;

  module_addr.page16 = module_number;
  module_addr.addr16 = RELAY_CONTROL_REGISTER;

  // Turn all relays off before initializing control lines to outputs.
  // Relays are active low (i.e. writing a 0 to the relay turns it on).
  StoreChar( ALL_RELAYS, module_addr.addr32 );

  module_addr.addr16 = DIRECTION_REGISTER;

  StoreChar( RELAY_CONTROL_LINES, module_addr.addr32);
}
```

```
\ Forth Code to initialize the AC Relay Module

HEX

4 USE.PAGE        \ Initialize the memory map.
15 WIDTH !        \ Avoid non-unique names.
ANEW ACR.CODE     \ Forget marker for easy re-loading.


1     CONSTANT    RELAY_CONTROL_LINES
F     CONSTANT    ALL_RELAYS
C005  CONSTANT    DIRECTION_REGISTER
C000  CONSTANT    RELAY_CONTROL_REGISTER

: Init_AC_Relay ( byte -- | byte = module num. Valid module numbers are 0-7 )
\ Initializes the AC Relay Module by configuring the AC relay control lines
\ of the CPLD to outputs.  The module number depends on the module select
\ jumpers.  See Table 1 for the jumper settings and associated addresses.
locals{ &module }

  \ Disconnect all relays before initializing control lines to outputs.
  \ Relays are active low (i.e. writing a 0 to the relay turns it on).
  ALL_RELAYS RELAY_CONTROL_REGISTER &module C!
  RELAY_CONTROL_LINES DIRECTION_REGISTER &module C!
;
```

Controlling A Relay

Once you have initialized the module, use `Control_AC_Relay` to turn on or off the relays and `Read_AC_Relay_Status` to read the status of all the relays. Note that the control lines are active low, which means that to turn a relay on, you have to write a 0 to the relay.

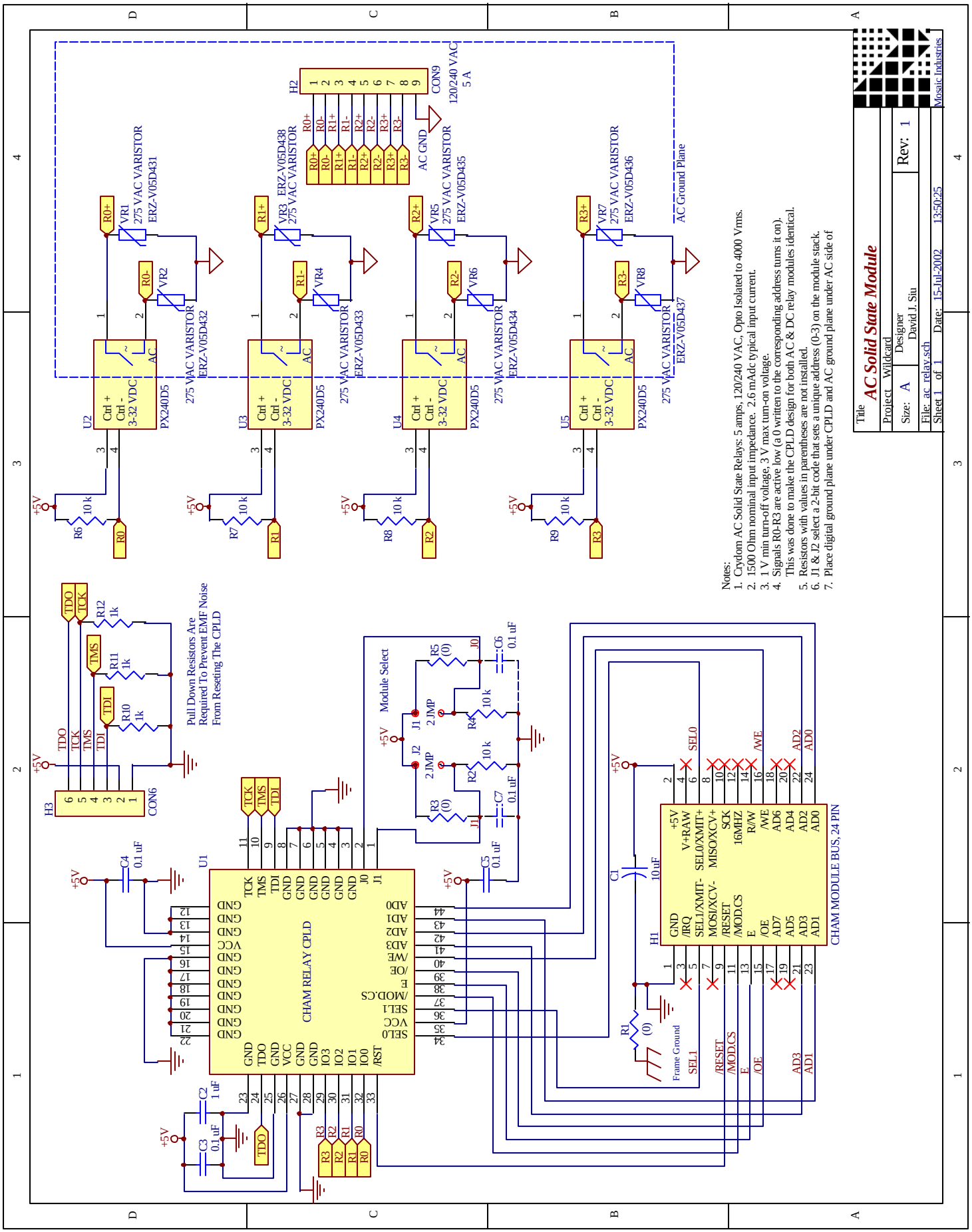
```
// C Code to control the AC Relay Module

// Relays are active low (i.e. writing a 0 to the relay turns it on).
#define RELAY_ON                    0
#define RELAY_OFF                   1

void Control_AC_Relay ( uchar module_number, uchar relay_num, uchar state )
// Sets the relay number to the appropriate state (on or off).
// Valid relay numbers are 0-3.  Valid module numbers are 0-7.
{
  EXTENDED_ADDR module_addr;

  module_addr.page16 = module_number;
  module_addr.addr16 = RELAY_CONTROL_REGISTER;

  if(state) // turn relay off
  {
    state = state << relay_num;
    SetBits( state, module_addr.addr32 );
  }
  else      // turn relay on
  {
    state = 1 << relay_num;
    ClearBits ( state, module_addr.addr32 );
  }
}

uchar Read_AC_Relay_Status ( uchar module_number )
// Reads the current state of the AC Relays.  Valid module numbers are 0-7.
// Returns a character whose least significant nibble represents the four
// relays.  For example, if 1 is returned (0001 in binary), then Relay 0 is
// off and the other relays are on.  If 12 is returned (1100 in binary),
// then relays 2 and 3 are off and 0 and 1 are on.  The four most significant
// bits do not matter.
{
  EXTENDED_ADDR module_addr;
  Char ac_relay_status;

  module_addr.page16 = module_number;
  module_addr.addr16 = RELAY_CONTROL_REGISTER;

  ac_relay_status = FetchChar( module_addr );

  return( ac_relay_status );
}
```

```
\ Forth Code to control the AC Relay Module

HEX

\ Relays are active low (i.e. writing a 0 to the relay turns it on).
0     CONSTANT    RELAY_ON
1     CONSTANT    RELAY_OFF

: Control_AC_Relay ( byte1\byte2\byte3 -- )
```

```
\ Sets the relay number to the appropriate state (on or off).
\ byte1 = Module Number.  Valid module numbers are 0-7.
\ byte2 = Relay Number.  Valid relay numbers are 0-3.
\ byte3 = Relay State.  Valid relay states are RELAY_ON or RELAY_OFF
locals{ &state &relay_num &module }

  &state
  IF                          \ turn relay off
    &state &relay_num SCALE
    RELAY_CONTROL_REGISTER &module SET.BITS
  ELSE                        \ turn relay on
    1 &relay_num SCALE
    RELAY_CONTROL_REGISTER &module CLEAR.BITS
  ENDIF
;

: Read_AC_Relay_Status ( byte -- | byte = module_number )
\ Reads the current state of the AC Relays.  Valid module numbers are 0-7.
\ Returns a character whose least significant nibble represents the four
\ relays.  For example, if 1 is returned (0001 in binary), then Relay 0 is
\ off and the other relays are on.  If 12 is returned (1100 in binary),
\ then relays 2 and 3 are off and 0 and 1 are on.  The four most significant
\ bits do not matter.

  RELAY_CONTROL_REGISTER SWAP C@
;
```

Conclusion

Now you are ready to start using your AC Relay Module. All of the software routines listed in this document are also on the distribution diskette that accompanies each module.


AC Solid State Module
Project Wildcard
Size: A
Designer David J. Siu
Rev: 1
File: ac_relay.sch
Sheet 1 of 1
Date: 15-Jul-2002
13:50:25
Mosaic Industries
Notes:
1. Crydom AC Solid State Relays: 5 amps, 120/240 VAC, Opto Isolated to 4000 Vrms.
2. 1500 Ohm nominal input impedance. 2.6 mAdc typical input current.
3. 1 V min turn-off voltage, 3 V max turn-on voltage.
4. Signals R0-R3 are active low (a 0 written to the corresponding address turns it on).
This was done to make the CPLD design for both AC & DC relay modules identical.
5. Resistors with values in parentheses are not installed.
6. J1 & J2 select a 2-bit code that sets a unique address (0-3) on the module stack.
7. Place digital ground plane under CPLD and AC ground plane under AC side of
AC Ground Plane
CHAM RELAY CPLD
CHAM MODULE BUS, 24 PIN
Module Select
Pull Down Resistors Are Required To Prevent EMF Noise From Reseting The CPLD
275 VAC VARISTOR ERZ-V05D431
275 VAC VARISTOR ERZ-V05D432
275 VAC VARISTOR ERZ-V05D433
275 VAC VARISTOR ERZ-V05D435
275 VAC VARISTOR ERZ-V05D436
275 VAC VARISTOR ERZ-V05D437
275 VAC VARISTOR ERZ-V05D438
PX240D5
CON9
120/240 VAC 5 A
CON6

Series PX, MPX

5Amp • 120/240 Vac - AC OUTPUT

- **Ultra High Surge Rating**
- **Random (R) and Zero Voltage Switching**
- **Wide Range Control**
- **Opto Isolated to 4000 Vrms**

Advanced features include exceptional steady state current, plus ultra-high surge ratings utilizing oversized inverse-parallel SCR chips, together with efficient thermal management for increase cycle life. Models are available to switch up to 280 Vrms with either zero-cross or random turn-on ("R") switching versions.

Manufactured in Crydom's ISO 9002 Certified facility for optimum product performance and reliability.

MODEL NUMBERS	DC CONTROL	PX240D5 MPX240D5	PX240D5R MPX240D5R
OUTPUT SPECIFICATIONS ①			
Operating Voltage (47-63 Hz) [Vrms]		12-280	12-280
Load Current Range [Arms]		.06-5.0	.06-5.0
Transient Overvoltage [Vpk]		600	600
Max. Surge Current, (16.6ms) [Apk]		250	250
Max. On-State Voltage Drop @ Rated Current [Vpk]		1.4	1.4
Maximum I^2t for Fusing, (8.3 msec.) [A^2sec]		260	260
Max. Off-State Leakage Current @ Rated Voltage [mArms]		4.0	4.0
Min. Off-State dv/dt @ Max. Rated Voltage [V/µsec] ②		500	500
Max. Turn-On Time ③		1/2 Cycle	0.02 msec
Max. Turn-Off Time		1/2 Cycle	1/2 Cycle
Power Factor (Min.) with Max. Load		0.5	0.5
INPUT SPECIFICATIONS ①			
Control Voltage Range		3-32 Vdc	
Max. Turn-On Voltage		3.0 Vdc	
Min. Turn-Off Voltage		1.0 Vdc	
Nominal Input Impedance		1500 Ohm	
Typical Input Current @ Nominal Voltage		2.6 mAdc	

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GENERAL NOTES

① All parameters at 25˚C unless otherwise specified.
② Off-State dv/dt test method per EIA/NARM standard RS-443, paragraph 13.11.1
③ Voltage applied for 1 minute.

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Crydom Corp, 2320 Paseo de las Americas, Ste. 201, San Diego, CA 92154
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Series PX, MPX

5Amp • 120/240 Vac - AC OUTPUT

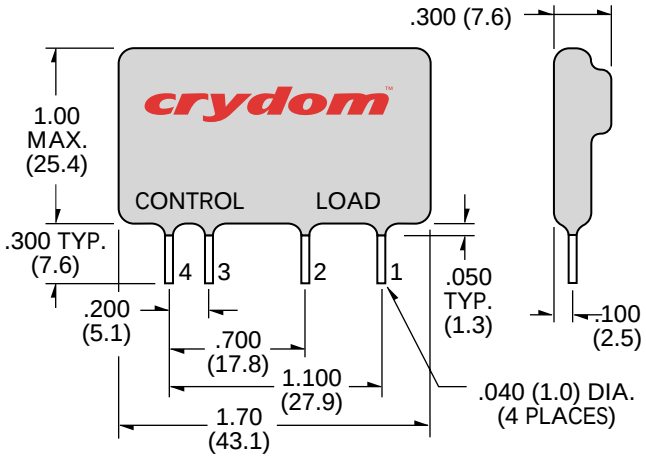
GENERAL SPECIFICATIONS

Dielectric Strength 50/60Hz Input/Output/Base	4000 Vrms
Insulation Resistance (Min.) @ 500 Vdc	10^9 Ohm
Max. Capacitance Input/Output	16 pF
Ambient Operating Temperature Range	-30 to 80˚C
Ambient Storage Temperature Range	-40 to 125˚C

MECHANICAL SPECIFICATIONS

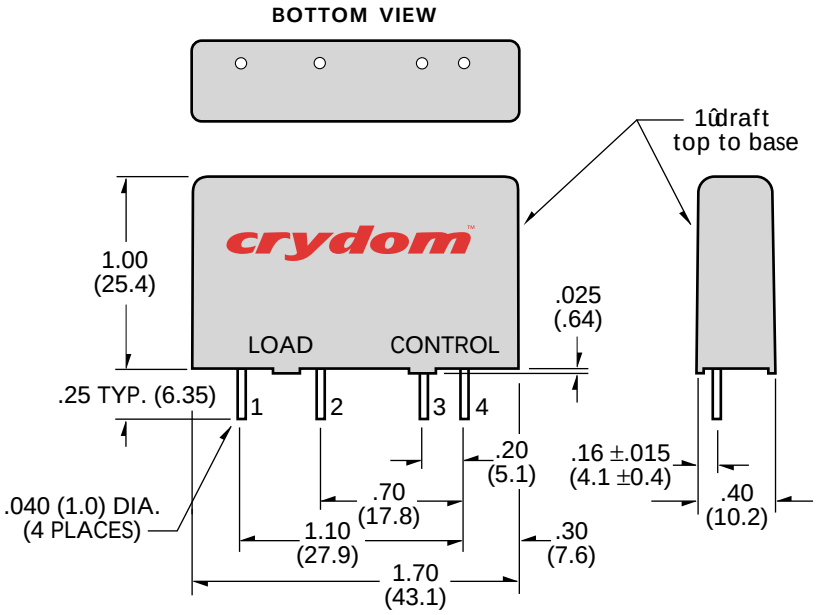
Weight: (typical)	0.4 oz. (11g)
Encapsulation:	Thermally Conductive Epoxy

PX PACKAGE



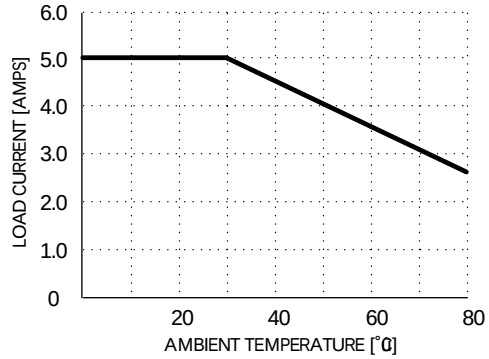
PIN 1: AC LOAD
PIN 2: AC LOAD
PIN 3: +DC CONTROL
PIN 4: -DC CONTROL

MPX PACKAGE



All dimensions are in inches (millimeters)

CURRENT DERATING CURVE



Max. Load Current vs. Temp.

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APPROVALS

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SERIES PX
Rev. 020504
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