DC Relay Wildcard Users Guide 1.0

Introduction

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

The DC Solid State Relay Module allows you to control up to three, 3 amp DC loads. You can stack up to eight DC 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 DC Relay Module's hardware and software.

DC Relay Wildcard Specifications	
Channels	Three independent, optically isolated solid state DC relays
Voltage	Controls 3 - 60 VDC
Current	Switches up to 3 A continuously, 12 A surge for 10 msec.
Isolation	Optically isolated to 2500 V rms
Maximum ON Voltage Drop	0.4 VDC
Maximum OFF Leakage Current	100 µA
Turn On/Off Times	Max turn on/off times of 50/300 µsec
Connections	Easy-to-connect-to screw terminals

Hardware

Overview

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

- Control of 3 to 30 VDC loads up to 3 amps.
- Max surge current of 12 amps for 10 ms.
- Optically isolated control to 2500 Vrms.
- Max turn on time of 50 us.
- Max turn off time of 300 us.
- Flyback and surge protection for inductive loads.

For more technical information, please consult the data sheet for the Crydom DMO063 at http://www.crydom.com/. The next section shows you how to connect the DC 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 DC Relay Module to the Module Carrier Board, follow these simple steps:

1. Connect the Module Carrier Board to the QED Board as outlined in the "Module Carrier Board Users Guide".
2. With the power off, connect the Module Bus on the DC 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 DC Relay Module is located opposite from the screw terminals. The module ports are shown in Figure 1 of the "Module Carrier Board Users Guide". CAUTION: The Module 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 DC Relay Module can be permanently damaged if the connection is done incorrectly.

Selecting the Module Address

Once you have connected the DC Relay Module to the Module Carrier Board, 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 Module Carrier Board. Each module port on the Module Carrier Board accommodates up to 4 modules. Module Port 0 on the Module 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 DC loads.

Software

This section describes the software that enables you to control the DC 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 DC 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 Module Carrier Board, use the 6 byte memory block starting at address $C000_H$ on page 1.

The DC Relays on the DC Relay Module are controlled by a Xilinx CPLD (Complex Programmable Logic Device). The DC 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 DC 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_DC_Relay ( uchar module_number ) // Valid module numbers are 0-7
// Initializes the DC Relay Module by configuring the DC 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 DC Relay Module

HEX

4 USE.PAGE        \ Initialize the memory map.
15 WIDTH !        \ Avoid non-unique names.
ANEW DCR.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_DC_Relay ( byte -- | byte = module num. Valid module numbers are 0-7 )
\ Initializes the DC Relay Module by configuring the DC 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_DC_Relay` to turn on or off the relays and `Read_DC_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.

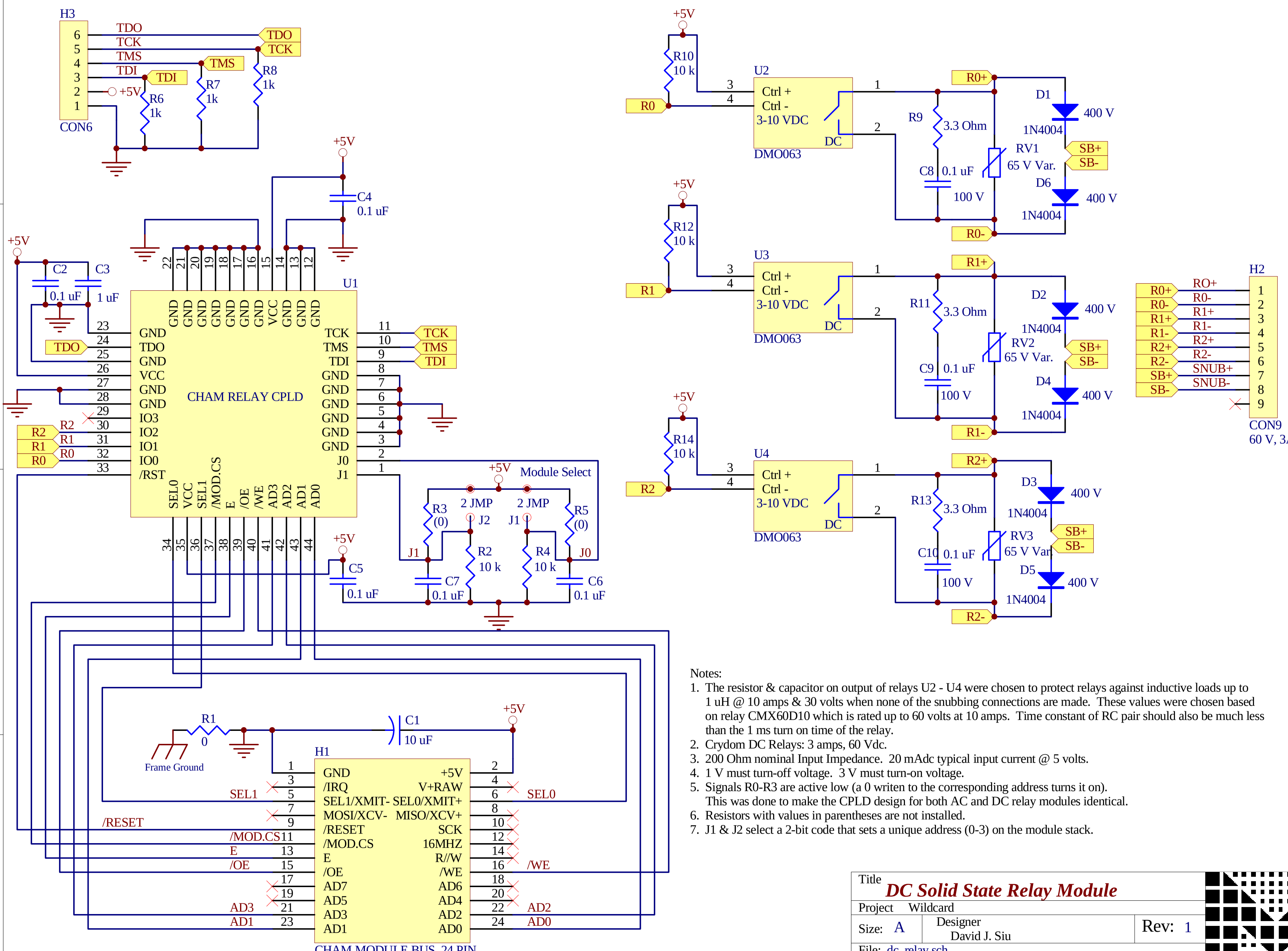
```
// C Code to control the DC Relay Module

// 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_DC_Relay ( uchar module_number, uchar relay_num, uchar state )
// Sets the relay number to the appropriate state (on or off).
// Valid relay numbers are 0-2.  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_DC_Relay_Status ( uchar module_number )
// Reads the current state of the DC Relays.  Valid module numbers are 0-7.
// Returns a character whose three least significant bits represents the
// three relays.  For example, if 1 is returned (001 in binary), then Relay 0
// is off and the other relays are on.  If 6 is returned (110 in binary),
// then relays 1 and 2 are off and 0 is on.  The five most significant bits
// do not matter.
{
  EXTENDED_ADDR module_addr;
  Char dc_relay_status;

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

  dc_relay_status = FetchChar( module_addr );

  return( dc_relay_status );
}
```

```
\ Forth Code to control the DC 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_DC_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 0-2.
\ 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_DC_Relay_Status ( byte -- | byte = module_number )
\ Reads the current state of the DC Relays.  Valid module numbers are 0-7.
\ Returns a character whose three least significant bits represents the
\ three relays.  For example, if 1 is returned (001 in binary), then Relay 0
\ is off and the other relays are on.  If 6 is returned (110 in binary),
\ then relays 1 and 2 are off and 0 is on.  The 5 most significant bits do
\ not matter.

  RELAY_CONTROL_REGISTER SWAP C@
;
```

Conclusion

Now you are ready to start using your DC Relay Module. All of the software routines listed in this document are also on the QED Demo and Driver diskette in the wildcards directory.



Notes:

1. The resistor & capacitor on output of relays U2 - U4 were chosen to protect relays against inductive loads up to 1 uH @ 10 amps & 30 volts when none of the snubbing connections are made. These values were chosen based on relay CMX60D10 which is rated up to 60 volts at 10 amps. Time constant of RC pair should also be much less than the 1 ms turn on time of the relay.
2. Crydom DC Relays: 3 amps, 60 Vdc.
3. 200 Ohm nominal Input Impedance. 20 mAdc typical input current @ 5 volts.
4. 1 V must turn-off voltage. 3 V must turn-on voltage.
5. Signals R0-R3 are active low (a 0 writen to the corresponding address turns it on). This was done to make the CPLD design for both AC and DC relay modules identical.
6. Resistors with values in parentheses are not installed.
7. J1 & J2 select a 2-bit code that sets a unique address (0-3) on the module stack.

Title	**DC Solid State Relay Module**
Project	Wildcard
Size: A	Designer David J. Siu
Rev:	1
File:	dc_relay.sch
Sheet 1 of 1	Date: 2-Jan-2003 16:36:15

Mosaic Industries

crydom™

Series DO, DMO

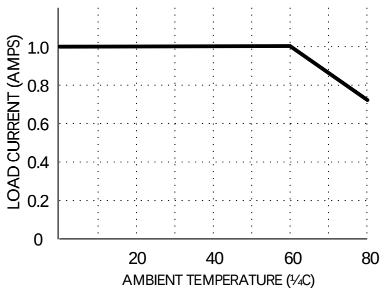
1-3.0Amp • 60 Vdc - DC OUTPUT MINI-SIP

- **Compact for High Density PCB Mount**
- **DC Control, DC Output**
- **Bipolar (DO) or MOSFET (DMO) Output**
- **3-10 Vdc Logic Compatible Input**
- **Crydom's Patented Design**

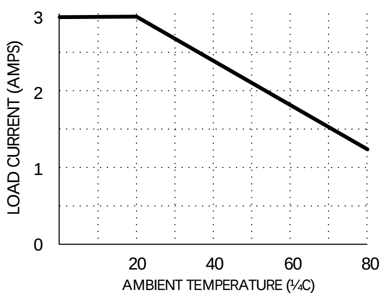
SPST-NO DC output relays in epoxy-coated packages utilize the popular .10" grid lead spacing. They are available with either bipolar transistor output (DO), or the DMO063 with MOSFET output rated at 3A/60 VDC.

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

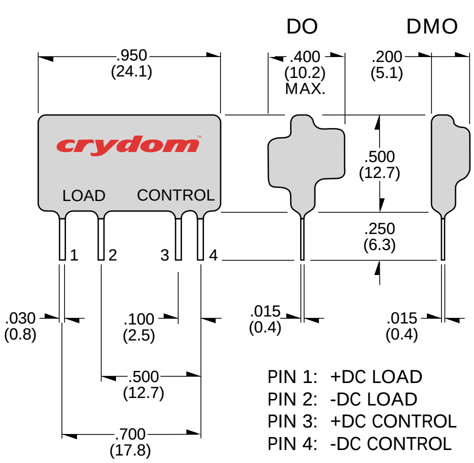
CURRENT DERATING CURVES



DO Max. Load Current vs. Temp.



DMO Max. Load Current vs. Temp.



MODEL NO.	DO061A④	DO061B④	DMO063④
INPUT SPECIFICATIONS ①			
Control Voltage Range	3.0-9.0 Vdc	1.7-9.0 Vdc	3.0-10.0 Vdc
Nominal Input Impedance	270 Ohm	270 Ohm	200 Ohm
Typical Input Current @ 5 Vdc	15 mAdc	15 mAdc	20 mAdc
Must Turn On Voltage	3.0 Vdc	1.7 Vdc	3.0 Vdc
Must Turn Off Voltage	1.0 Vdc	0.8 Vdc	1.0 Vdc
OUTPUT SPECIFICATIONS ①			
Operating Voltage Range	3-60 Vdc	3-60 Vdc	0-60 Vdc
Load Current Range	.02-1.0 Adc		0-3.0 Adc
Max. Surge Current	5.0 Adc (1 Sec)		12.0 Adc(10 ms)
Max.Off-State Leakage @ Rated Voltage	200 µAdc		100 µAdc
Max. On-State Voltage Drop @ Rated Current	1.5 Vdc		0.4 Vdc ②
Max.Turn-On Time	50 µsec	50 µsec	50 µsec
Max. Turn-Off TIme	50 µsec	150 µsec	300 µsec
GENERAL SPECIFICATIONS			
Dielectric Strength ③	4000 Vrms		2500 Vrms
Insulation Resistance (Min.) @ 500 Vdc ③	10^9 Ohm		10^9 Ohm
Max. Capacitance (Input/Output)	8.0 pF		8.0 pF
Ambient Operating Temperature Range	-30 to 80˚C		-30 to 80˚C
Ambient Storage Temperature Range	-30 to 125˚C		-30 to 125˚C
MECHANICAL SPECIFICATIONS			
Weight: (typical)	0.15 oz. (4.3 g)		
Encapsulation:	Thermally Conductive Epoxy		

GENERAL NOTES

① All parameters at 25˚C unless otherwise specified.
② Typical On-State Resistance = .13|
③ Dielectric and insulation resistance are measured between input and output.
④ Inductive loads should be diode suppressed.

For recommended applications and more information contact:
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