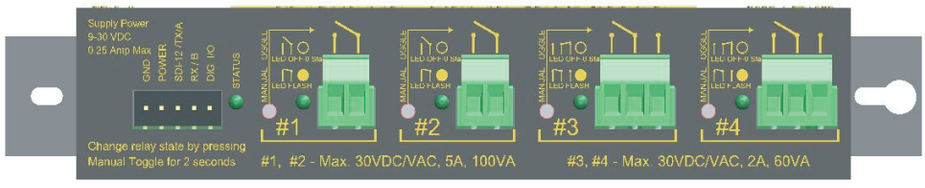
INSTRUCTION MANUAL

LR4
Four Channel Latching Relay Module

February 2009



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1. General Description

The LR4 Latching relay module utilizes latching relays that provide some unique characteristics as outlined:

- Low power consumption
  Once the control module changes the state of the relay by applying power to a coil, power can then be removed as the relay mechanically latches its state. Conventional relays require the power to be continuously present to hold a relay in one of its states.

- Relay state is Non-volatile
  Once a relay is set to a desired state the relay will remain in that state even if power is lost to the control module. The only way to change the state of a relay is to send a valid command that instructs the relay state to be changed or by using the manual toggle button.

2. Specifications

Supply Voltage		9-30 VDC
Power Consumption	Quiescent	< 2.0 mA
Power Consumption	Peak	< 250 mA
Operating Temperature		-40ºC to +60ºC
Relay Type		Latching
Communications Hardware		SDI-12
Protocol		SDI-12 Version 1.3
Digital I/O Input voltage		
	Maximum	+20 VDC
	Minimum	-12 VDC

3. Relay Details

Relay #1 and Relay #2

2 independent Form “a” (SPST) contacts.
Maximum Voltage Ratings: 30VDC/30VAC
Maximum Current: Not to exceed 100VA or 5 Amps

Relay #3 and Relay #4

2 independent Form “c” (SPDT) contacts
Maximum Voltage Ratings: 30VDC/30VAC,
Maximum Current: Not to exceed 60VA or 2 Amps

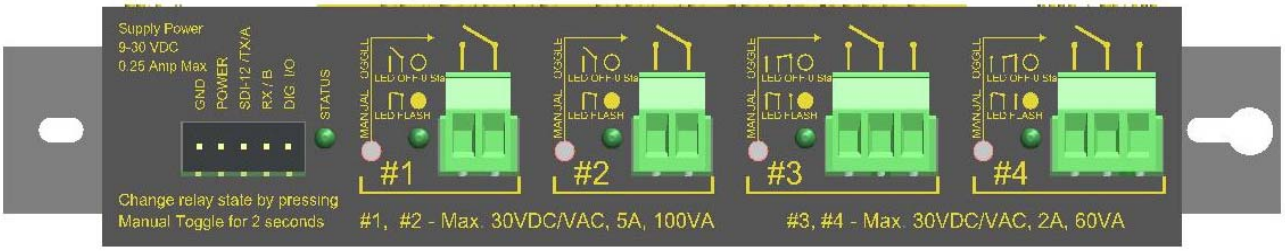

Figure 1: LR4 Module

4. Contact Details

There are 2 different contact types on the LR4. One type is referred to as a Form A and the second is referred to as a Form C. Relays #1 and #2 are type Form A and Relays #3 and #4 are type Form C. The following figures outline the differences:

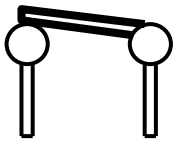

Figure 2: Form A - State = 1

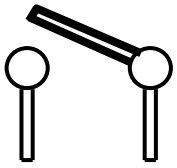

Figure 3: Form A - State = 0

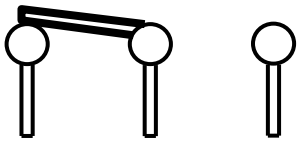

Figure 4: Form C - State = 1

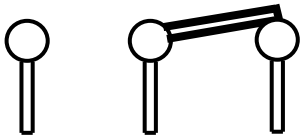

Figure 5: Form C - State = 0

5. Manual Toggle Control

There is one Manual Toggle push button for each relay. The state of a relay can be changed by pressing the corresponding button and holding it in place for 2 seconds. If a relay is in the 1 state the when a button is pressed the corresponding LED will turn on and 2 seconds later the user will see the LED go off once the relay has changed to the 0 state. In a quiet environment a click can also be heard when the relay changes state. Likewise if an LED is in the 0 state the corresponding LED will be off when a button is pressed and then turn on once the relay has gone to the 1 state. The button must be released and depressed again to change the state again.

To conserve power the indicating LEDs will flash briefly once every 5 seconds. A brief momentary push (less than 1 second) of any button will cause the control module to turn on any LED whose relay is in the 1 state for several seconds.

Only one button should be pressed at a single time. Once a relay is controlled manually the relay will remain in that state permanently until a command is communicated to change the relay state or the button is used to change the state.

6. LED Indicators

There are 5 LEDs on the control module. The main status LED will indicate a successful power up by turning on for one second. Rapid flashing for approximately 3 seconds indicates a power up problem. When the status LED is on, any of the contacts that are in the “1” state will also have its LED on.

In normal operation the status LED will briefly flash once every 5 seconds. Any contact in the 1-state will have its LED flash with the status LED. A brief button press can be used to activate the LEDs for a longer period of time to observe the relay states. The button press must be less than 1 second to avoid toggling any of the relays.

7. LR4 SDI-12 Wiring

It is recommended to power down your system before wiring the LR4.

LR4 Terminals SDI-12	Connection
GND	Power Ground and Shield
Power	Positive DC Power Source (9-30VDC)
SDI-12 /TX/A	Recorder/Reader SDI-12 Com port or control port
RX/B	Do not connect (For RS-232 and RS-485)
DIG I/O	Readable Digital Input port

7.1. *SDI-12 Addresses*

The LR4 can be set to one of ten addresses (0 to 9) which allows up to ten LR4 Modules to be connected to a single digital I/O channel (control port) of an SDI-12 datalogger.

The LR4 is shipped from the factory with the address set to 0. The address on the LR4 can be changed by sending an SDI-12 change address command. The change address command can be issued from most SDI-12 recorders. For some Campbell Scientific dataloggers the SDI-12 transparent mode will need to be entered to change the address.

When it is necessary to use more than one LR4, it is easiest to use a different control port for each LR4 instead of changing the address. If additional control ports are not available, then the address will need to be changed.

To change the address of an LR4 with the default address of 0 to the address of 1 the following command can be sent:

"0A1!"

Only one SDI-12 device should be connected when using the change address command.

7.2. *SDI-12 Commands*

The SDI-12 protocol has the ability to support various measurement commands. The LR4 supports the commands that are listed in the following table.

The different commands are entered as options in the SDI-12 recorder instruction. The major difference between the various measurement commands are the data values that are returned.

SDI-12 Extended commands are used to set a relay to a desired state.

SDI-12 Command	Command Function/Description	Values Returned
aM!	Status All 4 Relays - 0 or 1 State	R1, R2, R3, R4 (4 values)
aM1!	Status Relay #1 - 0 or 1 State	R1
aM2!	Status Relay #2 - 0 or 1 State	R2
aM3!	Status Relay #3 - 0 or 1 State	R3
aM4!	Status Relay #4 - 0 or 1 State	R4
aM5!	LR4 Supply Voltage	V_{Supply} (Volts)
aM6!	Not completed – Do not use	
aM7!	Not completed – Do not use	
aM8!	Dig. I/O input state – 0 or 1	Dig. I/O Input State
aM9!	Not completed – Do not use	
aMC! aMCn!	Same as aM!	
aC!	Concurrent Measurements Status All 4 Relays - 0 or 1 State	R1, R2, R3, R4 (4 values)
aCn!	Concurrent Measurements Same as M1 – M8	Output is the Same as M1 – M8
aCC! aCCn!	Concurrent Measurement Commands with Checksum. See aM and aM1- aM8	Output is the same as aM, aM1-aM8 Checksum is added
aD0!	Send Data	Dependent upon command Sent
aV!	Verification command	S1,S2,V,WD S1 = BootRom Signature S2 = Firmware Signature V = Supply Voltage Note1 WD = Watch Dog Errors
aI!	Send Identification	013CAMPBELL LR4 2.0SN *SN = Serial number (5 digits)*
?!	Address Query	a
aAb!	Change Address command	b is the new address
aXR;0,R1,R2,R3,R4 Extended command	Sets Values of All 4 Relays to either 0 or 1 state Where R1 is 0 or 1 for Relay #1 Where R2 is 0 or 1 for Relay #2 Where R3 is 0 or 1 for Relay #3 Where R4 is 0 or 1 for Relay #4	a Address is returned with a value of 1.
aXR;N,V! Extended command	Set the State of an Individual Relay. N is 1-4 corresponding to Relays #1 to #4, V is 0 or 1 state	a Address is returned with a value of 1.
aR0!	Same as aM!	Same as aM! command
aR1! to aR8	Same as aM1! to aM8!	Same as M commands

Where a = address of SDI-12 device.
Where n = numbers 1 to 9

7.3. *SDI-12 Programming Examples for CRBasic Datalogger*

The following are programming examples for CRBasic Dataloggers such as the CR800, CR850, CR1000, and CR3000.

7.3.1. Reading Relay Status Values

The SDI-12 “M” commands can be used to read the status of the LR4 relays. Alternatively to the SDI-12 “M” commands the LR4 also supports the “R” command. The SDI-12 “R” command is available to sensors that can respond immediately to a measurement request as the LR4 is capable of doing so. This can be advantageous in reducing the execution time for reading information back from the LR4.

```
'Programming line to Read the state of all 4 relays
with an M command
SDI12Recorder (RelayReadState(),1,0,"M!",1.0,0)

'Programming line  to Read the state of Relay #3 with
an M command
SDI12Recorder (RelayState_3,1,0,"M3!",1.0,0)

'Programming line to Read the state of all 4 relays
with an R command
SDI12Recorder (RelayReadState(),1,0,"R!",1.0,0)

'Programming line  to Read the state of Relay #3 with
an R command
SDI12Recorder (RelayState_3,1,0,"R3!",1.0,0)
```

7.3.2. Setting Relay Values

Relays on the LR4 can only be set in SDI-12 by using extended commands as follows:

```
'Set all four relays to the 0 state
SDI12Recorder (SetResult,1,0,"XR;0,0,0,0,0!",1.0,0)

'Set all four relays to the 1 state
SDI12Recorder (SetResult,1,0,"XR;0,1,1,1,1!",1.0,0)
```

```
'Set relay #3 to the 0 state
SDI12Recorder (SetResult,1,0,"XR;3,0!",1.0,0)

'Set relay #3 to the 1 state
SDI12Recorder (SetResult,1,0,"XR;3,1!",1.0,0)
```

7.3.3. CR200 Programming

The CR200 datalogger is similar to the CRBasic programming earlier in this section except for the following:

- The channel field does not exist
- The address field does not exist as the address is placed in the first digit of the command.
- The CR200 does not support setting all 4 relays in one command. The individual relay commands can only be used on the CR200.

```
'CR200 Set Relay #4 to State 1.
SDI12Recorder (RelayState_4, "0XR;4,1!", 1.0, 0)
```

7.4. *CR10X, CR23X Set Relay Example*

For the CR10X datalogger using instruction 68 after the P105 instruction is used to send the extended commands.

```
;A P68 following this P105 sends extended commands
;Use program control to set the Relay3Val variable to either 0 or 1
1:  SDI-12 Recorder (P105)
 1: 0       SDI-12 Address
 2: 0       Start Measurement (aM!) ;Leave at zero
 3: 1       Port
 4: 13      Loc [ Relay3Val ] ; This location contains the desired state value
 5: 1.0     Multiplier
 6: 0.0     Offset

2:  Extended Parameters 4 Digit (P68)
 1: 88      Option ;Decimal for Character 'X'
 2: 82      Option ;Decimal for Character 'R'
 3: 59      Option ;Decimal for Character ';'
 4: 51      Option ;Decimal for Character '3' (49 for#1, 50 for #2, and 52 for #4 )
 5: 44      Option ;Decimal for Character ','
 6: 128     Option ;Relay state value from input location
 7: 0000    Option
 8: 0000    Option
```

```
;Read the state of all 4 relays
3:  SDI-12 Recorder (P105)
 1: 0       SDI-12 Address
 2: 0       Start Measurement (aM!)
 3: 1       Port
 4: 1       Loc [ ReadRel1  ]
 5: 1.0     Multiplier
 6: 0.0     Offset
```

8. Relay Contact Life

The expected life of the relays under no load conditions is 50 million operations. Under load the life expectancy is reduced to 100,000 operations.

Inductive loads can further reduce the life expectancy of the relay contact. Proper signal conditioning (clamping diodes) should be considered for inductive loads.

9. Firmware Update Procedure

The firmware on the LR4 can be updated by using a terminal program such as Hyperterminal. The LR4 contains an internal female DB-9 connector to facilitate an RS-232 connection.

Firmware updates should only be performed at an appropriate workstation with static control procedures in place. Failure to follow the procedures may cause damage to the device.

- Ensure that the LR4 is completely disconnected.
- Remove the cover of the LR4 by removing the 2 Philips screws.
- Locate the Program mode jumper and move the Jumper from Run mode to Prog. mode as shown in Figure 6: LR4 Jumper Positions.
- Connect the LR4 to power and ground only (No other connections should be made otherwise it may interfere with programming).
- Once power is applied the status LED should remain on.
- Connect the computer to the RS-232 connector inside the LR4

- Setup Hyperterminal or the communications program that is being used as follows:
  - BAUD rate: 38400
  - Data Bits: 8
  - Parity: None
  - Stop Bits: 1
  - Flow control: XON/XOFF
  - 25ms line delay (under ASCII setup)
- From the Hyperterminal menu select Transfer -> Send Text File
- Select the new download text file and the transfer should begin.
- Initially the LED should remain constantly on. When data transfer begins the LED will flash rapidly with each line that is reprogrammed.
- Upon completion the LED will remain steadily on again.
- If there are any errors the LED will flash to indicate that an error occurred.
- If an error is indicated by a flashing LED, cycle power to the LR4 and attempt the reprogram process again.
- After the reprogramming is successful, disconnect the LR4 from the power supply.
- Move the jumper back from the Program position to the Run position.
- Re-assemble the device.
- Verify operation of the LR4.

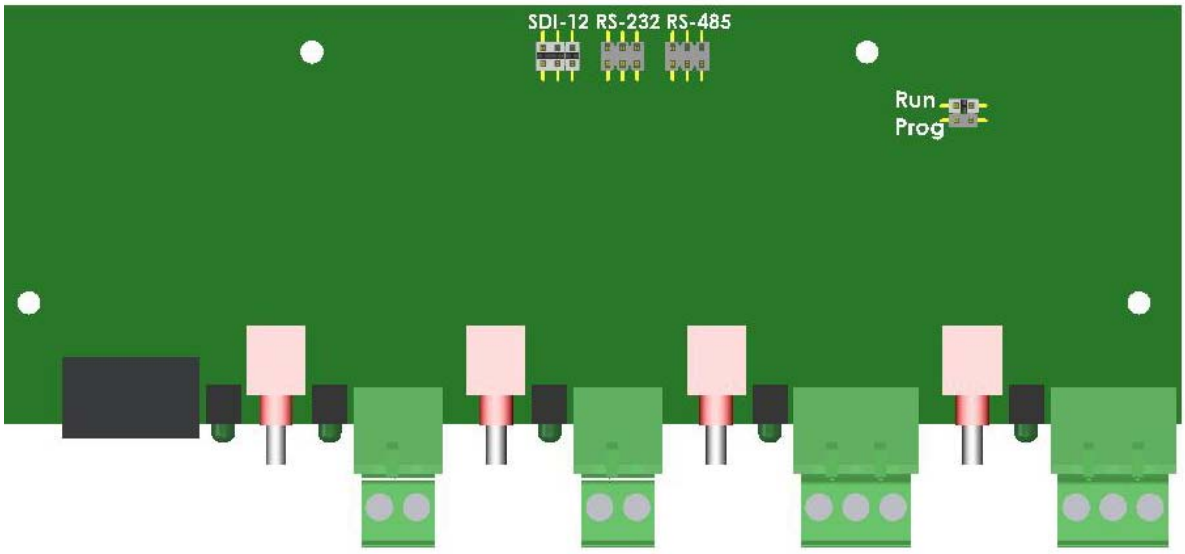

Figure 6: LR4 Jumper Positions

10. LR4 MODBUS Supplement

The LR4 can operate in a MODBUS mode. The 3 internal jumpers in the LR4 need to be moved from the SDI-12 position to either the RS-232 or the RS-485 position for MODBUS operation. By default the LR4 is shipped with the jumpers set for SDI-12 Operation. The jumpers must be moved prior to any connection with an RS-232 or an RS-485 device. See Figure 6: LR4 Jumper Positions to help locate the jumper positions on the PCB.

To move the internal jumpers:

- Ensure that the LR4 is completely disconnected
- Remove the cover of the LR4 by removing the 2 Philips screws.

10.1. *MODBUS BAUD Rate*

The default BAUD rate is 19200. Other BAUD rates are possible. Consult the factory if other BAUD rates are required.

10.2. *MODBUS Mode*

The LR4 supports RTU mode. ASCII mode is currently not implemented.

10.3. *MODBUS Address*

The default address assigned to the LR4 is 51. Other addresses can be assigned to the LR4 by writing the new desired address to register 9999. Once this is done the LR4 will only respond to the new address.

If the address is unknown then the broadcast address (0) can be used to set the address to a valid range (1 - 247).

10.4. *MODBUS Supported commands*

Read Holding Registers (0x03)
Write Single Register (0x06)
Write Multiple registers (0x10)

10.5. *MODBUS Operation*

All I/O on the LR4 module are treated as registers. The following are the register assignments for the LR4:
0001 – Relay #1
0002 – Relay #2
0003 – Relay #3
0004 – Relay #4
0005 – External I/O value (currently set as input only)
0006 – LR4 supply voltage value in mV. 12250 = 12.25 volts
0007 – Signature of the Boot ROM
0008 – Signature of the Operating Firmware
0009 – The Serial Number of the LR4
9999 – Can be written to in order to change the LR4's MODBUS address

10.6. *LR4 RS-232 Wiring for MODBUS*

It is recommended to power down your system before wiring the LR4.

LR4 Terminals RS-232	Connection
GND	Power Ground and Shield
Power	Positive DC Power Source (9-30VDC)
SDI-12 /TX/A	To MODBUS master RS-232 Receive (RS-485A)
RX/B	To MODBUS master RS-232 Transmit (RS-485B)
DIG I/O	Readable Digital Input port