Fermi National Accelerator Laboratory

Fermilab

Operation Readiness Clearance (ORC)
of
SpinQuest (E1039) Target lifter control system

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1 The block diagram of the complete target lifter system

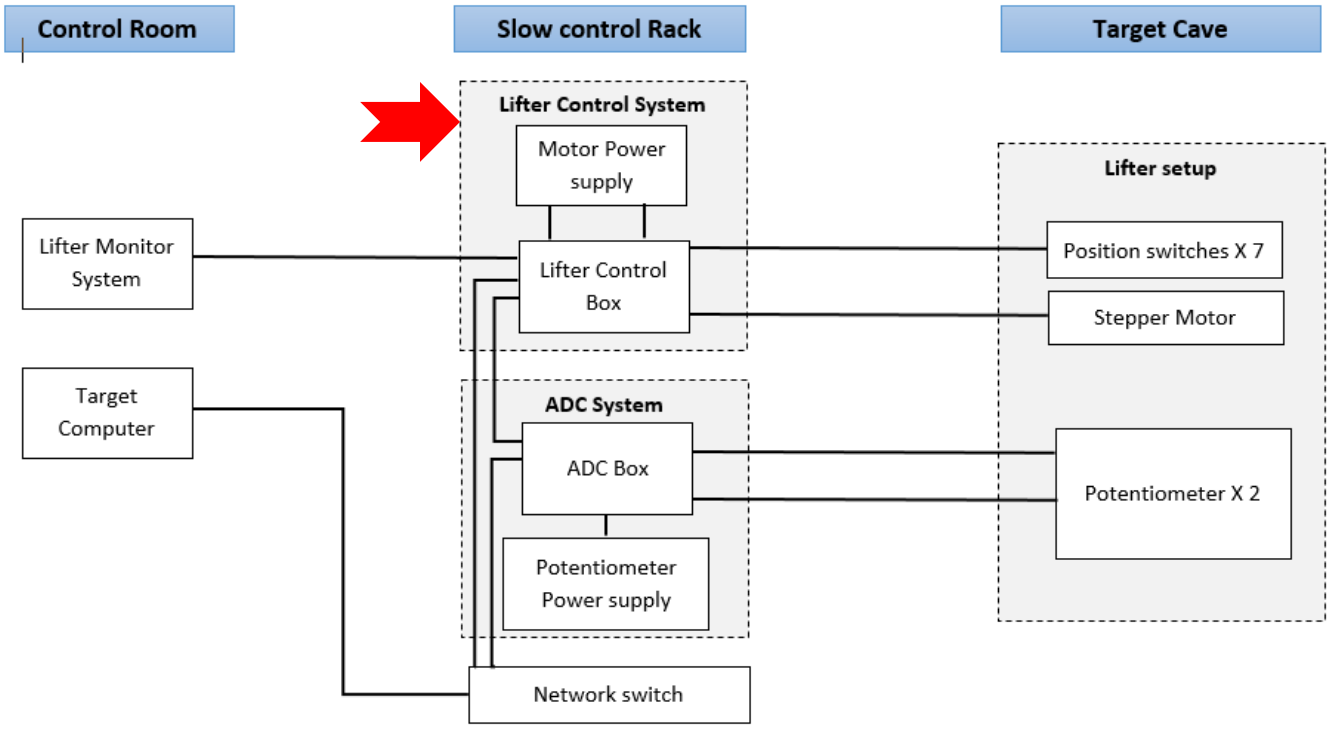


Figure 1 : The block diagram of the target lifter system

This ORC document discusses the lifter control system on the slow control rack

2 Lifter control system

The lifter control system consists of the motor control and power source electronics for the lifter setup. The setup is planned to place on the slow control rack.

3 The tasks of the Lifter control system

- Supply power and the control signals to the stepper motor of the target lifter system
- Connect the position switches of the lifter with the motor controller
- Send the status of the position switches to the lifter monitor system which is placed in the control room
- Power cycle the motor controller when required. The power cycle command will issue from the control room.

4 The components of the system

Table 1 : The components of the lifter control system

Qty	Item	Model
1	Moto controller	Applied Motion, STF-03D
1	Regenerating clamp	Applied Motion, RC880
2	4-Channel relay module	LIVISN, B07Z38SS6T
1	12V/110V relay	Omron Automation, G2R-1-T DC12
1	+/- 12 V Power Supply	Cosel USA, Inc., PBW15F-12-N
1	Motor Power supply	Applied Motion, PS150D24

The first five items of the above table are placed in a rack mountable metallic box. The motor power supply will be placed on the din railing of the slow control rack

5 The Front panel of the box

- ON/OFF Switch
- Red LED : 110 V indicator
- Orange LED : 24 V indicator
- Green LED : 12 V indicator

Figure 2: Front panel of the lifter control box

6 Back panel of the box

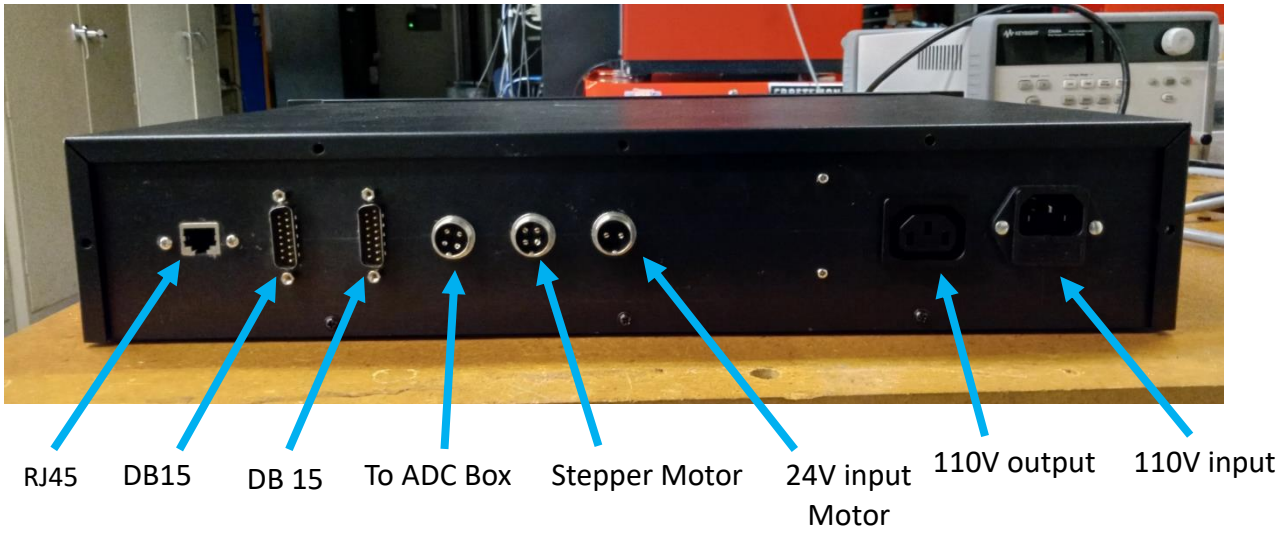


Figure 3 : Back panel of the box

7 Inside the box

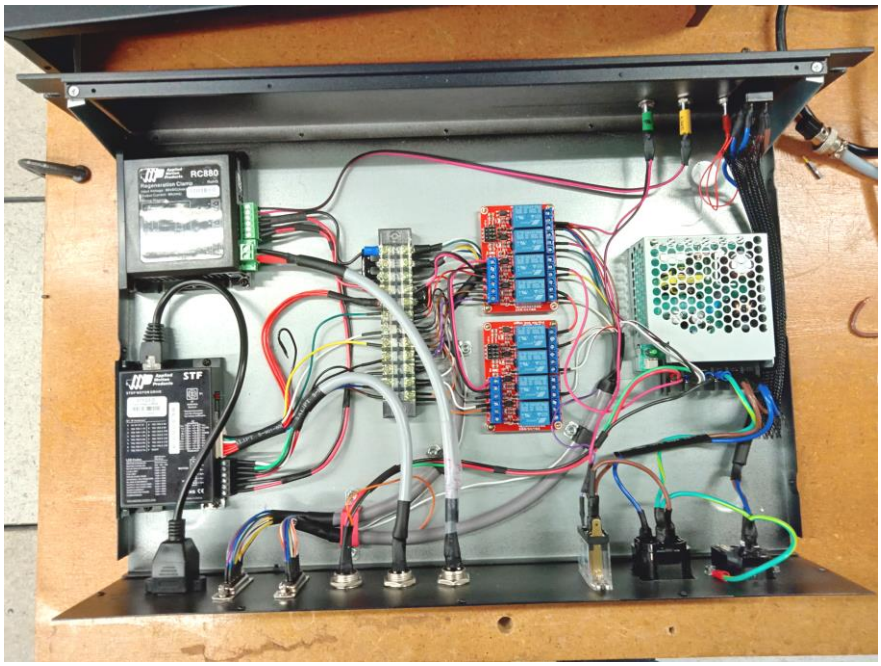


Figure 4 : components inside the box

8 The placement of the control box in the slow control rack

Figure 5 : Placement of the control box on the slow control rack

9 Placement of the motor power supply on the din rail of the slow control rack

Figure 6 : Placement of the motor power supply on the din rail

10 Included safety features

- 110 V ON/OFF switch
- 110V/5A glass fuse
- All the high voltage wires (110V) and terminals are properly covered
- All the connecting points, cables and the LED indicators are properly labeled

The complete wiring is attached separately.

11 Specifications

11.1 4 Channel Relay Module

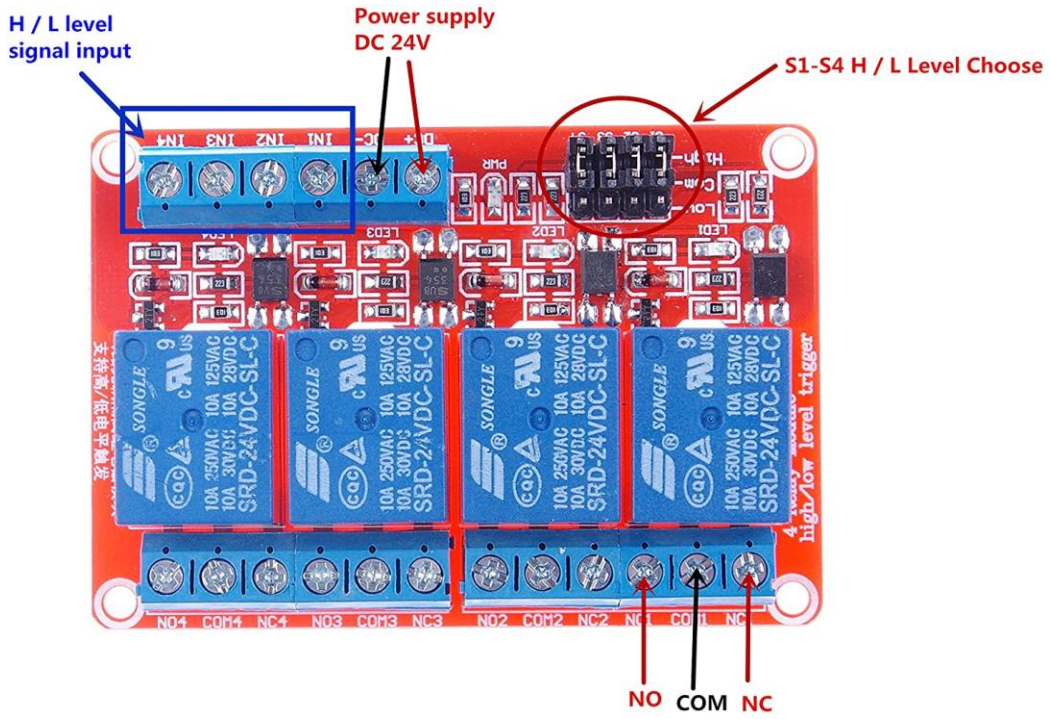


Figure 7 : 4 channel relay module

Table 2 : Sepectifatoions of the relay module

Model Number	B07Z38SS6T by LIVISN
Relay voltage and current rating	AC 250V/10A, DC 30V/10A
OPTOCOUPLER isolation	Yes
Module size	73mm * 50mm * 18.5mm (L * W * H)

11.2 Motor controller

Figure 8 : Stepper motor controller

Table 3 : Specifications of motor controller

Model Number:	STF03
Part Number:	STF03-R, STF03-C, STF03-D, STF03-IP, STF03-EC
Supply Voltage:	12-48 VDC
Supply Voltage Type:	DC
Control Modes:	Streaming Commands Q Programming CANopen EtherNet/IP Modbus RTU Modbus TCP EtherCAT
Output Current:	0.1-3.0 A/phase
Communication Ports:	RS-485 CANopen Ethernet EtherNet/IP EtherCAT Ethernet, dual-port
Encoder Feedback:	No
Step Resolution:	Full Half Microstepping Microstep Emulation
Idle Current Reduction:	0-90%
Setup Method:	Software setup
Digital Inputs:	8
Digital Outputs:	4
Dimensions:	3.9 x 2.4 x 0.9 inches
Weight:	5.5 oz
Operating Temperature Range:	0 to 70 °C

11.3 Regeneration Clamp

Figure 9 : Regenerating clamp

Table 4 : Specifications of the regenerating clamp

Electrical Specifications				
Parameter	Min.	Typ.	Max.	Unit
Power Supply voltage	-	-	80	VDC
Input Current (RMS)	-	-	15	Amps
Output Current (RMS)	7.0(max)/Channel, but no more than 15(max) total			Amps
Clamp circuit activation Voltage	1	1.3	1.6	V (Vout-Vin)
Clamp circuit inactivation Voltage	0.3	0.5	0.7	V (Vout-Vin)
Capacitance	-	3000	–	μF
Resistance	9.9	10	10.1	Ω
Continuous Power Dissipation	-	50	–	W
Peak Power Dissipation	-	800	–	W

Environmental Specifications	
Heat Sinking Method	Natural cooling or fan-forced cooling
Surrounding Air Conditions	Avoid dust, oily mist and corrosive air
Operating Temperature	0 - 40°C (32 - 104°F)
Maximum Ambient Humidity	90% non-condensing
Shock	5.9m/s² maximum
Storage Temperature	-10 - 70°C (14 - 158°F)

11.4 12 V Power Supply

Figure 10 : 12 V power supply module

Table 5 : Specfications of the 12 V power supply

	Model	PBW15F-12
Input	Voltage	100V
	Current	0.4
	Frequency	50/60 Hz
Output	Voltage	+/- 12 V
	Current	0.7 A
	Line Regulation [mV]	60max
	Load Regulation [mV]	600max
Protection	Over Current Protection	
	Over Voltage Protection	
	Operating Indication	LED
Others	Size	31 X 78 X 85mm
	Cooling Method	Convection

11.5 Motor Power supply

Figure 11 : Stepper motor power supply

Table 6 : Specifications of the motor power supply

MODEL		PS150D24
OUTPUT	DC VOLTAGE	24V
	RATED CURRENT	6.5A / 230VAC 5.2A / 115VAC
	CURRENT RANGE	0 ~ 6.5A / 230VAC 0 ~ 5.2A / 115VAC
	RATED POWER	156W / 230VAC 125W / 115VAC
	RIPPLE & NOISE (max.) Note.2	150mVp-p
	VOLTAGE ADJ. RANGE	24 ~ 28V
	VOLTAGE TOLERANCE Note.3	± 1.0%
	LINE REGULATION	± 0.5%
	LOAD REGULATION	± 1.0%
	SETUP, RISE TIME	1500ms, 60ms/230VAC 3000ms, 60ms/115VAC at full load
	HOLD UP TIME (Typ.)	16ms/230VAC 10ms/115VAC at full load
INPUT	VOLTAGE RANGE Note.6	90 ~ 264VAC 127 ~ 370VDC [DC input operation possible by connecting AC/L(+), AC/N(-)]
	FREQUENCY RANGE	47 ~ 63Hz
	EFFICIENCY (Typ.)	87%
	AC CURRENT (Typ.)	2.6A/115VAC 1.7A/230VAC
	INRUSH CURRENT (Typ.)	20A/115VAC 35A/230VAC
	LEAKAGE CURRENT	<1mA / 240VAC
PROTECTION	OVERLOAD Note.7	105 ~ 130% rated output power Protection type : Constant current limiting, recovers automatically after fault condition is removed / 230VAC
		105 ~ 150% rated output power Protection type : Constant current limiting, recovers automatically after fault condition is removed / 115VAC
	OVER VOLTAGE	29 ~ 33V
		Protection type : Shut down o/p voltage, re-power on to recover
	OVER TEMPERATURE	Shut down o/p voltage, re-power on to recover

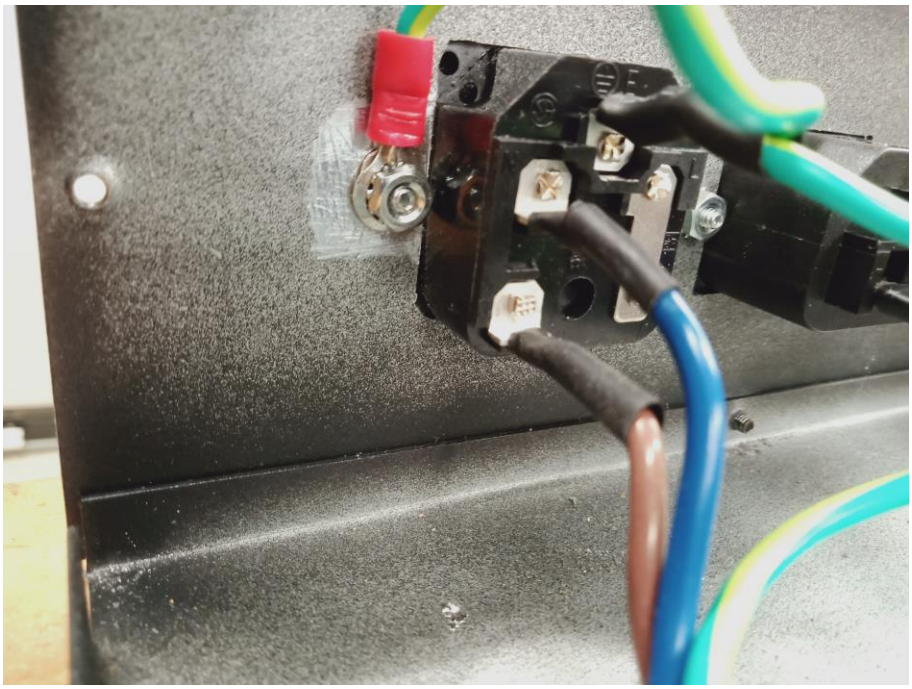
END

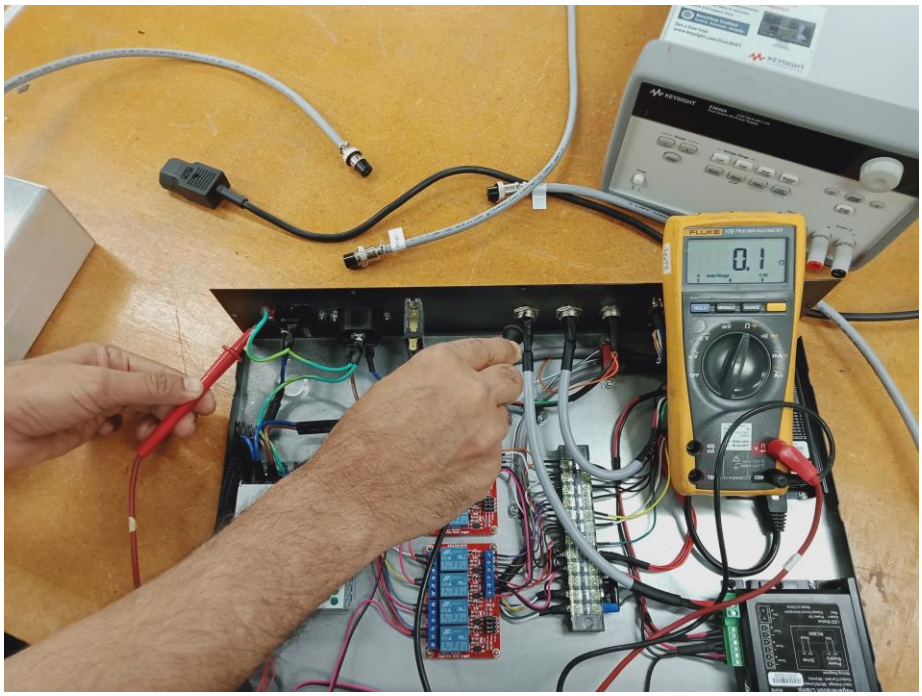
M2
RC880
Vin+
Vin-
Out1+
Out1-
Out2+
Out2-
Out3+
Out3-
24VDC
GND
18 AWG
Ethernet Port
V+
V-
A+
A-
B+
B-
M1
STF03-D
Motor Controller
X+
X1+
X2+
X3+
X4+
X5
X7
Shield
X1-
X2-
X3-
X4-
X6
XCOM
22 AWG
J1
Vin +
Vin -
2PIN_MALE
Motor PS input
J7
A+
A-
B-
B+
4PIN_MALE
TO STEPPER MOTOR
GND
+24VDC
J17
CONNECTING BAR
SW2_R
SW3_R
SW1_R
SW4_R
SW5_R
SW6_R
SW7_R
SW_B
SW1_B
SW7_B
SW2_B
SW3_B
SW4_B
SW5_B
SW6_B
J2
CONN-D15M
U1
4CH RELAY MODULE
U2
4CH RELAY MODULE
DC-
DC+
IN4
IN3
IN2
IN1
NO4
COM4
NC4
NO3
COM3
NC3
NO2
COM2
NC2
NO1
COM1
NC1
RE_7
RE_6
RE_5
RE_4
RE_3
RE_2
RE_1
+12V
U3
+/- 12V POWER MODULE
J15
3P CONNECTING BAR
RE_COM
-12V
RE_9COM
RE_9
RL1
G2R-14-DC12
SW1
SW-SPST
FU1
5 A
J9
POWER IN (MALE)
J11
POWER OUT(FEMALE)
RED LAMP
YELLOW LAMP
GREEN LAMP
J16
POT_OUT
4PIN_MALE
J4
Re_COM
EX_3
Re_7
EX_2
Re_6
EX_1
Re_5
Pot_GND
Re_4
Pot_OUT
Re_3
Re_9COM
Re_2
Re_9
Re_1
DB15 Male
Target/Lifter Control/02

FILE NAME:	Target Lifter System.DSN
DESIGN TITLE:	Power Supply Box
PATH:	
BY:	REV:
DATE:	5/20/2021
PAGE:	4 of 4
TIME:	9:02:25 AM

Following changes are done for the Lifter control box according comments from the ORC review committee.

1. The ground connection was improved by removing the cassis paint and placing a star washer between the ring terminal and the cassis.





2. AC inputs and outputs modules are labeled as 120 VAC and the values of the required fuse is labeled (5A).