
Trim Card Diagnostic and Replacement Procedure

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Estimated Time to Perform: 20 minutes

Procedure Overview

This procedure is used to guide accelerator operators and EES technicians through the process of diagnosing problems associated with magnet trim power supply cards, and when necessary, replacing defective trim cards that fail to respond to initial diagnostic troubleshooting processes.

The procedure is divided into the following sections:

Section 1.0 [Trim Card Diagnostic Process on page 3](#)

Section 2.0 [Trim Card Reseat/Swap Process on page 5.](#)

Hazard Analysis

Electrical Hazard

- The maximum output of each trim card is less than ± 30 volts to ground, up to 12 Amps, with a maximum of ~ 20 Amps under faulted conditions. Stored energy in the magnet could be as much as 100 joules.

Mechanical Hazard

- If the suspect trim card is located in the top two bays of the trim rack and you cannot comfortably reach this area, please use a step stool or ladder to remove the trim card. DO NOT pull down on the trim card as this can break the rails.

Falling Objects Hazard

- Ensure that the doors for adjacent trim bays are securely fastened in place and the door tab is engaged.

Sharp Objects Hazard

- Connectors, component leads, and other objects on a trim card can be sharp. Handle all trim cards with care.

Hot Objects Hazard

- The heat sink on a trim card that has been operating can be a heated surface. Avoid touching the heat sink on any trim card that has been operating recently.



Prerequisites

1. JLab technicians or MCC Operations personnel must have task-specific training and be approved by their supervisor to perform this procedure.
2. Minimum required personnel protective equipment (PPE):
 - Long pants
 - Closed-toe shoes
 - Safety glasses
 - Leather or mechanics gloves inspected to be in good condition



Procedure Steps

1.0 Trim Card Diagnostic Process

CAUTION: If at any time an **Alert! Card Found** pop-up message appears on a trim rack screen, this indicates that a trim card is present in a slot that should be empty. Immediately remove the trim card from the slot and report what occurred to the system expert.

9	MFBK20Z	1.348	1.345	On	
10	MBHK202H	-84.0	-83.9	N/A	
11	MBHK202V	-78.1	-72.3	N/A	
12	Alert! card found				
13	MDHK203H	-127.1	-116.9	N/A	
14	MBHK203V	-95.4	-95.3	N/A	
15	MFGK203	1.348	1.345	On	

1. Open the *Trim Rack XXX* screen (JMenu⇒System Expert⇒DC Power⇒Trim Magnet Racks⇒select faulted rack) (see [Figure 1-1](#), below), and determine what faults are present.

The screenshot shows the 'Trim Rack Screen - NL19B09' interface. It features a control panel on the left with buttons for 'Rack On', 'Rack Off', 'Master Reset', and 'Channel Reset'. The main area is a table with columns for Channel, Magnet, Setpoint, Readback, Keep on Loop, Mismatch, Off Loop, Out of Range, Voltage, Resistance, Card Type, and EXP. A red box highlights the table area, and arrows point to 'Demand Setpoint', 'Individual Channel Number', 'Trim Card Fault Indicators', and 'Expert Screens'. Navigation buttons for 'NEXT PAGE', 'BACK 1 PAGE', and '1ST PAGE' are on the left.

Channel	Magnet	Setpoint	Readback	Keep on Loop	Mismatch	Off Loop	Out of Range	Voltage	Resistance	Card Type	EXP
1	MQB1L15	-2.477	-2.473	On	Off						
2	MQS1L15	3.250	3.248	N/A							
3	MAT1L15V	0.000	0.000	N/A							
4											
5											
6	MQB1L16	2.374	2.372	On	Off						
7	MAT1L16H	0.000	-0.000	N/A							
8	MQS1L16	2.797	2.801	N/A							
9	MQB1L17	-2.696	-2.694	On	Off						
10	MQS1L17	2.747	2.745	N/A							
11	MAT1L17V	0.000	-0.000	N/A							
12											
13											
14	MQB1L18	2.608	2.610	On	Off						
15	MAT1L18H	-0.052	-0.052	N/A							
16	MQS1L18	2.827	2.827	N/A							
17	MQB1L19	-2.946	-2.947	On	Off						
18	MQS1L19	2.964	2.966	N/A							
19	MAT1L19V	0.399	0.398	N/A							
20											
21	MQS1L22	1.085	1.082	N/A							
22	MQB1L20	2.822	2.820	On	Off						
23	MAT1L20H	-0.433	-0.433	N/A							
24	MQS1L20	2.272	2.275	N/A							
25	MQB1L21	-3.144	-3.149	On	Off						
26	MQS1L21	2.771	2.769	N/A							
27	MAT1L21V	-0.099	-0.099	N/A							
28											
29											
30	MQB1L22	3.030	3.026	On	Off						
31	MAT1L22H	-0.095	-0.095	N/A							
32											

Figure 1-1: Trim Rack XXX Screen

2. Start an ELog entry or OPS-PR, and include a screen shot of the *Trim Rack XXX* screen (Figure 1-1) to capture all of the trim card fault data.

- Find the fault(s) in Table 1-1, below, and determine whether immediate attention should be considered (left column) or the repair can be delayed (right column). Is the fault a “Delayed Attention” fault?

Table 1-1: Trim Card Faults

Consider Immediate Attention	Delayed Attention (OPS-PR)
Mismatch (software-detected fault)	Voltage (software-detected alarm)
Off Loop (software-detected fault)	Resistance (software-detected alarm)
Out of Range (software-detected fault)	Polling Error (software-detected fault)
Card Type (software-detected fault)	Block Overheat (hardware-detected fault)
ADC Overrange (hardware-detected fault)	Framing Error (software-detected fault)
Board Overheat (hardware-detected fault)	Bad Address (software-detected fault)
READY (hardware-detected fault)	Message Length (software-detected fault)
No Response (software-detected fault)	Checksum Error (software-detected fault)

NO YES → A. For all “**Delayed Attention**” faults (right column in Table 1-1, above), generate an OPS-PR that includes the screen shot from [Step 2 on page 3](#). System experts will address the problem when time permits.

Go to [Step 4](#)

B. PROCEDURE COMPLETE.

- For all “**Consider Immediate Attention**” faults (left column in Table 1-1, above), in consultation with the Crew Chief, determine if the fault is affecting beam delivery such that the scheduled program is being compromised. If, for example, a Magnet Mismatch is not stopping beam delivery and the halls are happy with the beam quality, then continue delivering beam. Is the program being compromised?

YES NO → A. Document the fault with an OPS-PR that includes the screen shot from [Step 2 on page 3](#) and make sure the on-coming crew is aware of the fault. If an opportunistic maintenance period comes along, proceed to [Section 2.0, page 5](#) to reseal/swap the faulted trim card, coordinating with system experts if repair efforts might overlap.

- Is the fault a **Mismatch** or **Off Loop** fault?

NO YES → A. Do one of the following, depending on the fault type:

- Mismatch** – Perform a Demand Setpoint by clicking on the = button for the faulted trim card(s) on the *Trim Rack XXX* screen (see [Figure 1-1 on page 3](#)). Did this clear the fault?

Go to [Step 6](#)

NO YES → B. Complete the ELog entry, noting how the problem was corrected. Procedure complete.

Go to [Step 6](#)

- Off Loop** – Cycle the faulted trim card by toggling the **Keep on Loop** switch to OFF, then ON. Did the faulted trim card cycle through its hysteresis loop and return to the requested value?

NO YES → C. Complete the ELog entry, noting how the problem was corrected. Procedure complete.

Go to [Step 6](#)

- Proceed to [Section 2.0, page 5](#) to reseal/swap the faulted trim card.




2.0 Trim Card Reset/Swap Process

NOTE: In the following steps you will determine the trim card type/location, obtain a spare card, proceed to the service building, don the required PPE, then try to reseat the existing card before replacing it with the spare.

1. Print a copy of this procedure and take it with you as you complete the following steps.
2. Determine the type of trim card required as follows:

CAUTION: Ensure the replacement card type is correct. Trim cards are labeled on the front edge of the card. The replacement card label must match the **Trim Card Label** information on the EDM Expert screen (Figure 2-1, below). Grabbing the wrong card may delay the repair.

- a. On the *Trim Rack XXX* screen (see [Figure 1-1 on page 3](#)), click on the associated **Expert Screen** button  to open the expert screen (see Figure 2-1, below).

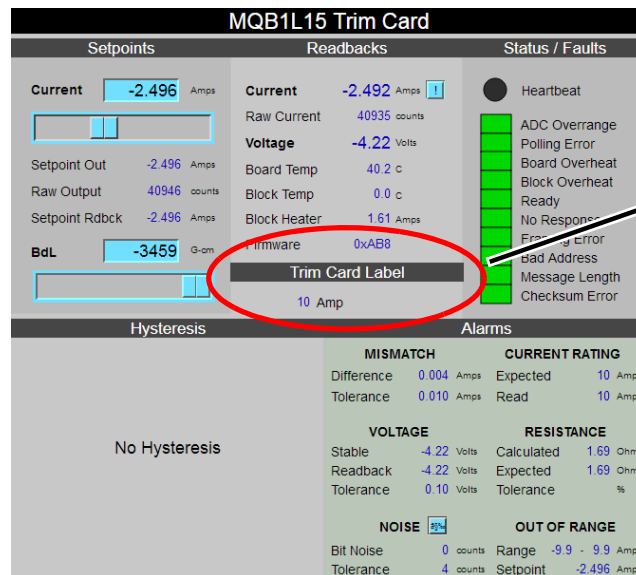


Figure 2-1: Trim Card Expert Screen

- b. Under **Trim Card Label** (see Figure 2-1, above), note the specified trim card type. **Write down the entire description**; it will be used to select the correct replacement trim card.
3. Using the magnet name, determine the physical location of the affected trim rack. The trim rack number indicates the service building where the trim rack resides; the channel assignment (see [Figure 1-1 on page 3](#)) indicates the position of the card within the trim rack. Write this down and take it with you.

EXAMPLE: Quadrupole magnet MQB1L15 resides on Channel 1 of trim rack NL19B09. The trim card for this magnet would be located in Slot 1 of rack NL19B09 in the North Linac service building.



4. Obtain a replacement trim card (denoted with a green tag) from the MCC Equipment Room (Room 105) in Building 85 as follows:

CAUTION: Ensure that the replacement trim card label exactly matches the **Trim Card Label** recorded in [Step b on page 5](#). Trim cards are labeled on the front edge (see [Figure 2-3](#), below). Grabbing the wrong card may delay the repair.

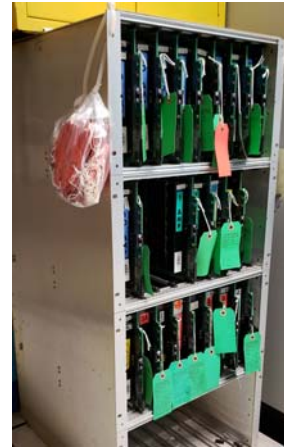


Figure 2-2: Spares Rack in MCC Equipment Room

- a. Locate the trim card spares rack in the MCC Equipment Room (see Figure 2-2).
 - b. Select a green-tagged card with a label that matches the **Trim Card Label** information recorded in [Step b on page 5](#).
5. Obtain and don the PPE specified in [Step 2 on page 2](#) before beginning work.
 6. Proceed to the front of the trim rack where the defective trim card is located.

NOTE: There are four trim card bays per rack with eight cards per bay (for a total of 32 separate trim card channels). Trim Channel 1 is the first slot of the top bay. Trim Channel 32 is the last slot of the lower right-most bay.

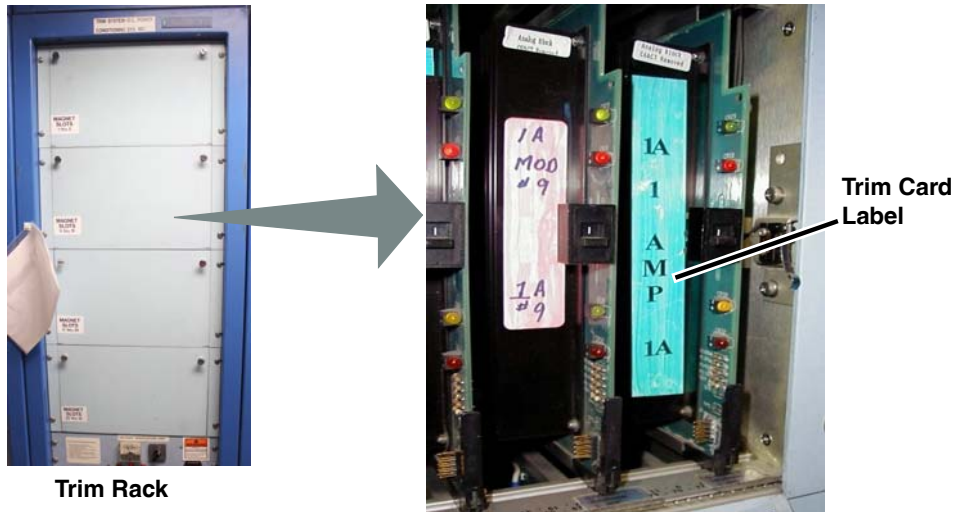


Figure 2-3: Trim Card Front Panel

7. **CAUTION:** Before opening the front panel of the trim bay, make sure that the front panels to the other trim bays in the rack are securely fastened in place.

NOTE: Opening the door may affect beam operations. Don't do this without first notifying the control room.

Open the door to the trim card bay by pushing the plastic tab off to the side and rotating the thumb screws so the arrows point down (see Figure 2-4).



Figure 2-4: Panel Retainers

CAUTION: Use a step stool or ladder to remove the trim card if you cannot comfortably reach the trim card bay. DO NOT pull down on the trim card as this can break the guide rails.

8. Locate the defective trim card by its channel assignment.
9. Before replacing the trim card, attempt to “revive” the existing card by reseating it as follows:

CAUTION: The heat sink on recently operated trim cards may be HOT, and the connector pins are SHARP (see [Figure 2-5](#), below). Protect yourself by wearing the required PPE (leather or mechanics gloves inspected to be in good condition).

CAUTION: If the hot swap switch on a trim card is in the “1” position when the trim card is inserted, electrical arcing will occur causing damage to the connector contacts on the card and to the connector at the back of the trim card slot.

- a. Move the hot swap switch on the card from the “1” position to the “0” position (see [Figure 2-4](#), below).

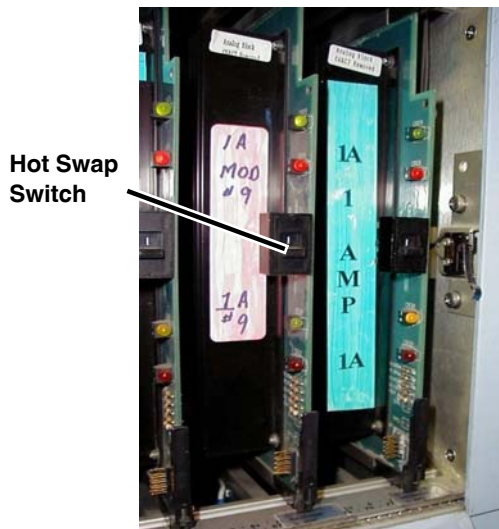


Figure 2-4: Hot Swap Switch

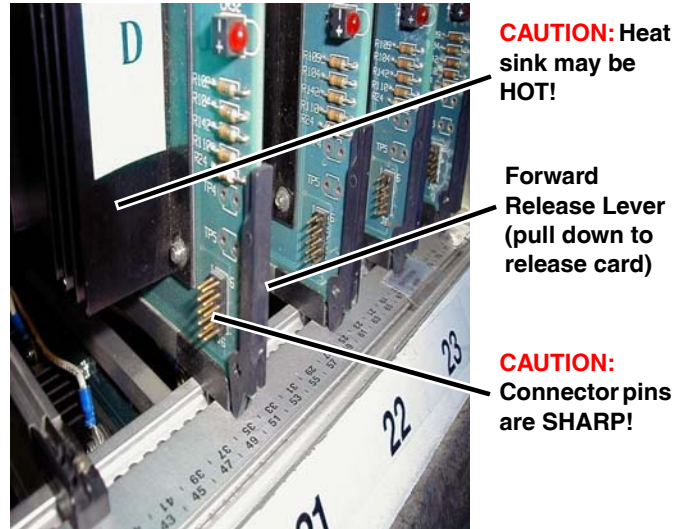


Figure 2-5: Forward Release Lever

- b. **Wait at least 20 seconds before proceeding to Step c, below.** This allows magnet current to bleed off and prevents other cards in the rack from going off loop when the card is removed.
- c. Locate the forward release lever at the **BOTTOM** front edge of the faulted trim card (see [Figure 2-5](#)).
- d. Grab the top of the forward release lever (see [Figure 2-5](#)), and pull it toward you. The trim card will move slightly toward you and come loose from its connector in the rear of the chassis.
- e. Return the forward release lever to the “up” position such that it is seated against the card (see [Figure 2-5](#)).

- f. Push the card back into the slot until you feel it seat comfortably into the connector at the rear of the slot.
- g. Verify that the front of the card lines up with the other trim cards in the chassis.
- h. Move the hot swap switch from the “0” position to the “1” position.

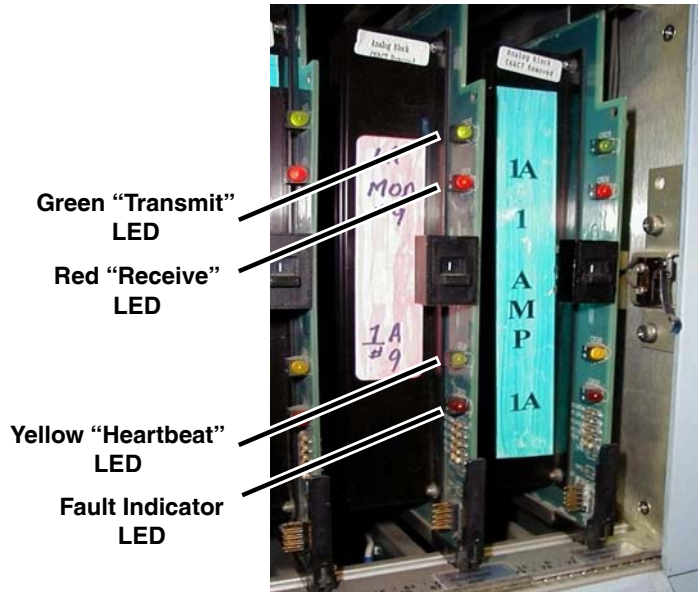


Figure 2-6: Trim Card LEDs

- i. Are the transmit, receive, and heartbeat LEDs (see [Figure 2-6](#)) on the front edge of the card now indicating proper function by blinking rapidly?

NOTE: The fault indicator LED, shown in [Figure 2-6](#), should *not* be illuminated if the trim card is functioning properly.

NO **YES** → **A.** Reseating the card worked! Skip to [Step 17 on page 9](#).

10. Repeat Steps a–d on [page 7](#), but this time gently slide the card completely out of the chassis so you can insert the replacement card (but this time you don’t need to wait 20 seconds before sliding out the card). LEAVE THE GREEN “SERVICE-ABLE” TAG ON THE NEW TRIM CARD FOR LATER REFERENCE.
11. Verify that the replacement trim card hot swap switch is in the “0” position and the forward release lever is in the “up” position.
12. Slide the replacement card partway into the guide rails at the top and bottom of the chassis so it slides easily.

NOTE: If one of the guide rails falls out, stop and contact EES DC Power.
13. Push the card into the slot until you feel it seat comfortably into the connector at the rear of the slot.
14. Verify that the front of the card lines up with the other trim cards in the chassis and the forward release level is in the “up” position such that it is seated against the card.
15. Move the hot swap switch from the “0” position to the “1” position.



16. Verify that the card is functioning properly by observing the yellow “heartbeat” LED, the green “transmit” LED, and the red “receive” LED (see [Figure 2-6 on page 8](#) for LED locations). Are they all illuminated?



Go to
[Step 17](#)

- A.** Reseat the trim card as follows:

- a. Move the hot swap switch from the “1” position to the “0” position (see [Figure 2-4 on page 6](#)).

NOTE: Since the card has not been supplying current to the magnet, you do not need to pause for 20 seconds to let magnet current bleed off.

- b. Grab the top of the forward release lever (see [Figure 2-5 on page 7](#)), and pull it toward you. The trim card will move slightly toward you and come loose from its connector in the rear of the chassis.
- c. Return the forward release lever to the “up” position such that it is seated against the card (see [Figure 2-5 on page 7](#)).
- d. Push the card into the connector until you feel it seat comfortably into the connector at the rear of the slot.
- e. Verify that the front of the card lines up with the other trim cards in the chassis.
- f. Move the hot swap switch from the “0” position to the “1” position.

- B.** Are the transmit, receive, and heartbeat LEDs on the front edge of the card now functioning properly?

NOTE: The fault indicator LED, shown in [Figure 2-6 on page 8](#), should not be illuminated if the trim card is functioning properly.



Go to
[Step 17](#)

- C.** Repeat [Step 10 on page 8](#) using a different “serviceable” trim card obtained from the MCC Equipment Room (Room 105) in Building 85.

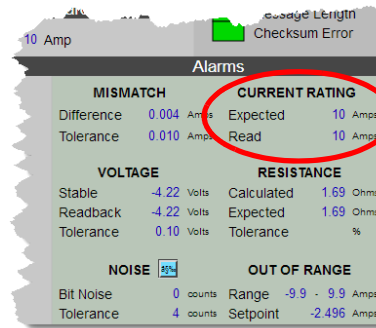
- D.** If the second trim card still does not operate properly, contact the system expert for further guidance.

17. Pause for two minutes while the operating temperature of the new trim card stabilizes.



18. Call the MCC, and under **Current Rating** on the *Trim Card Expert* screen for the magnet, have them compare the **Expected** and **Read** values (see Figure 2-7 to the right). Are these values the same?

NOTE: If the **Expected** and **Read** values don't match, both will be highlighted in **RED**, indicating a trim card fault.



“Expected” and “Read” values must match

Figure 2-7: Trim Card Expert Screen

- YES NO** → A. When the **Expected** and **Read** values don't match, the trim card is faulty and could damage the magnet. Return to [Step 2 on page 5](#) and repeat the replacement process with a different card from the spares supply, being very careful to match the **Trim Card Label** information on the *Trim Card Expert* screen with the label on the spare trim card. Attach a red “Defective” tag to the failed card. If a second trim card fails in the same fashion, contact the System Expert.

19. After the magnet's **Current** readback matches the **Set Value**, have the MCC cycle the magnet through hysteresis.
20. Close the front door to the trim bay and slide the plastic retainer tab back over the front panel.
21. Complete the ELog entry detailing which trim card was replaced. Ensure that the magnet name, trim rack number, and the card's channel assignment are included in the entry. Note the ELog entry number for use in the following step.
22. Complete and attach a red “Defective” tag to the defective trim card(s). Ensure that the ELog entry number noted in [Step 21](#), above, is also noted on the red “Defective” tag. Return the defective card(s) to trim card spares rack in the MCC Equipment Room (Room 105) in Building 85.
23. PROCEDURE COMPLETE.

