

# The Control System for Trim-Coil Relay-Selectors in J-PARC MR

Kenichi Sato<sup>A)</sup>, Susumu Igarashi<sup>A)</sup>, Norihiko Kamikubota<sup>A)</sup>, Susumu Yoshida<sup>B)</sup>, Noboru Yamamoto<sup>A)</sup> <sup>A)</sup> J-PARC, KEK & JAEA, Ibaraki-ken, <sup>B)</sup> Kanto Information Service (KIS), Accelerator Group, Ibaraki

## **Abstract**

## In J-PARC main ring, each of the main magnets (Bending, Quadrupole, Sextupole) has a trim-coil. The basic aim of trim-coil is to correct small deviation of each magnetic field. In addition, we have used them for other purposes, for example: (1) in Beam-Based-Alignment studies, (2) as flux monitors, and (3) to make a short-circuit to reduce ripples of magnetic field. At a moment, trim-coils can be used for only one purpose. We introduced relay-switches to change trim-coil connection to a device, which corresponds to the selected purpose. When we switch the purpose, we have to change 1,200 on-site relays manually, distributed in three buildings.

#### Conslusion

Thus, a control system for trim-coil relay-selectors have been developed in winter, 2014-2015. EPICS tools and environment are used to develop the system. The system comprises PLC I/O modules with controller running EPICS on Linux. The system will be in operation after March, 2015. By using the system, we expect much easier switching of relay-switches than before.

## **Overview of Trim-coil relay selector**

- **1. Trim-coils in MR main magnets** 
  - Bending:96 Quadrupole:216 sextupole:72

System development and configuration

- 1. PLC-module (YOKOGAWA)
  - **Consist of a CPU module and I/O modules.**

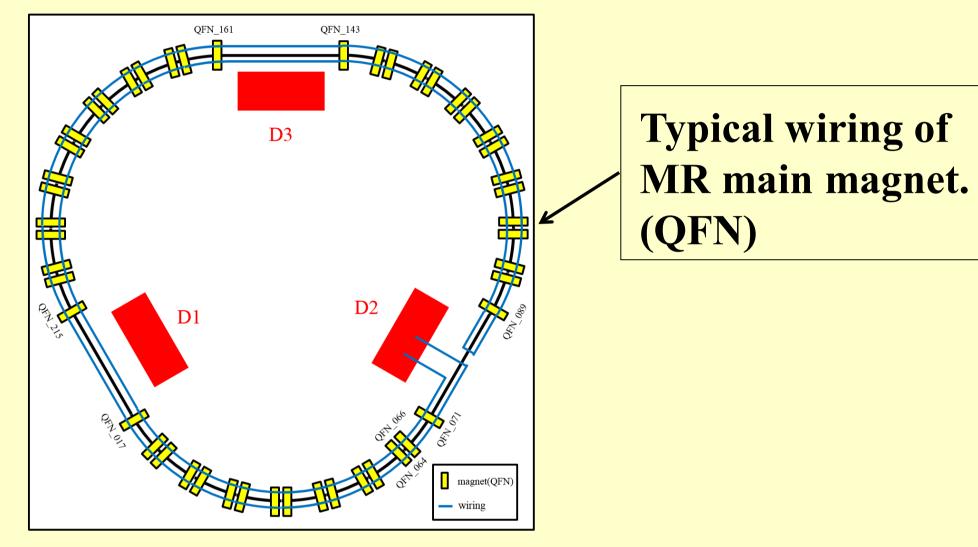
## **Control display development**

**Status of Trim-coil relay selector system** 

./status	trimcoil	_relay.ed	l (jkjt	olade	e44.mr.	jkcont)	
			<b>.</b>	<i>a</i> .			

Power rack1 rack2 rack3 Power rack1 rack2 rack3 Power rack1 rack2 rack3

- **3 power distribution buildings (D1,D2,D3)**
- 6(B) + 11(Q) + 3(S) families

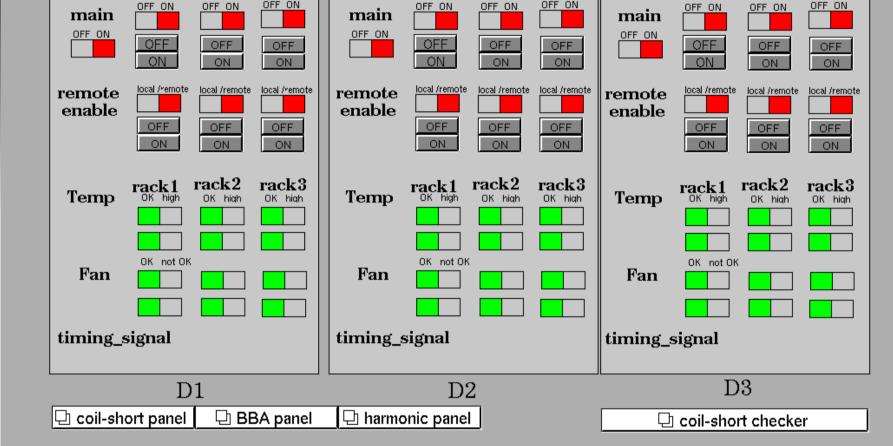


## 2. Trim-coil relay selector

- There are 4 purpose to use the trim-coil.
- **1.** To correct small deviation of each magnetic field
- 2. Beam-Based-Alignment study
- 3. Magnetic flux monitors
- 4. To make a short-circuit to reduce ripples of magnetic field

- Operate a control panel with a digital I/O module. The panel manages power and interlock.
- **Control many relays with 6 digital output modules.**
- 2. Many relays
  - A relay unit have 8 relay (for 2 magnets).
  - A summarize unit gather signal of 8 relay units.
  - A system have 6 summarize units.
  - So, a PLC have to control **384 relays**. (at a building)
- **3. EPICS PVs (Process variable)** 
  - An EPICS IOC makes many PVs.

PV	types	explain	number
status	bi	power, timing	5
interlock	bi	temperature, fan	12
operate	bo	power, remote	6
test switch	bo	test sw, timing	7
relay output	mbboDirect	PLC output	24
extract	calc	16> 4 bits	96



- **Operator see only this display.**
- If necessary, open displays below.

#### **Trim-coil set to "short"**

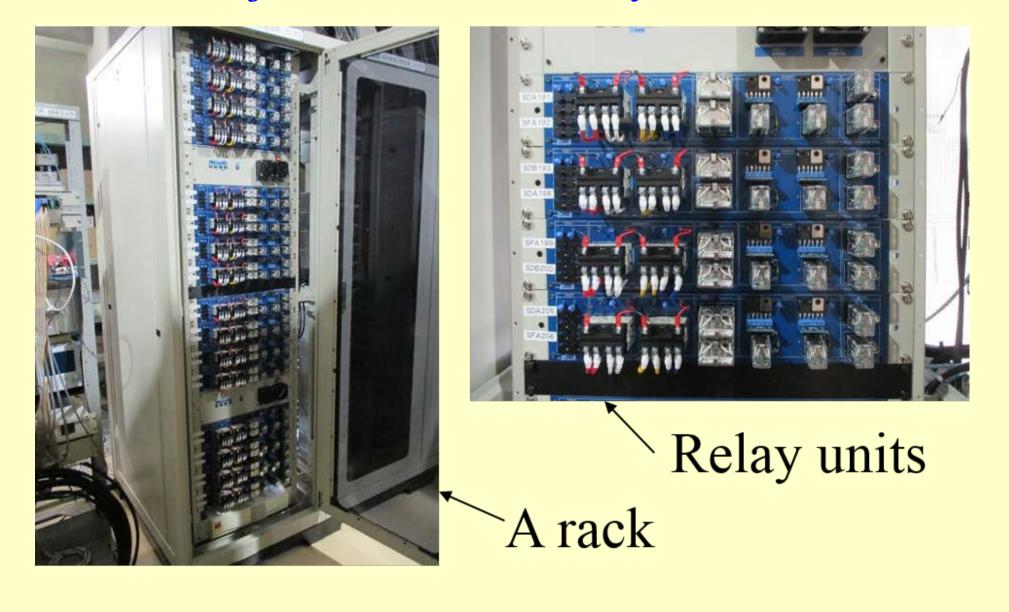
		./trimcoil_short_f	family.edl (jkjblade	41.ccr.jkcont)		_ 0
trim-coil display for coil-short ver.3 (2015.6.3)						
off short	off short	off short	off short	off short	off short	off short
QFN071 off that OFF	QDN090 off hort OFF	QFX141 off thert OFF	QDX160 off thest OFF	QFP004 off there short	SFA020 Joff that OFF	SDB214 Joff that OFF
QFN066 off there OFF	QDN093 off there OFF	QFX140 off there OFF	QDX167 off there OFF	QFP076 off there OFF	SFA027 off there OFF	SDB207 off short OFF
QFN064 off thord OFF	QDN097 off there OFF	QFX134 off thort OFF	QDX174 off those OFF	QFP148 off there OFF	SFA034 off there OFF	SDB200 off that OFF
QFN059 off thord OFF	QDN100 off there OFF	QFX133 off short OFF	QDX181 off thore OFF	QFP156 off there short	SFA041 off there OFF	SDB193 Joff thort OFF
QFN057 off thore OFF	QDN104 off there OFF	QFX127 off thors OFF	QDX188 off there OFF	QFP084 off there OFF	SFA048 off there OFF	SDB186 off short OFF
QFN052 off thort OFF	QDN107 off there OFF	QFX126 off short OFF	QDX195 off there OFF	QFP012 off there OFF	SFA055 off there OFF	SDB179 off thort OFF
QFN050 off these OFF	QDN111 off there OFF	QFX120 off short OFF	QDX202 off there OFF		SFA062 off there OFF	SDB172 off thors OFF
QFN045 off short OFF	QDN114 off there OFF	QFX119 off short OFF	QDX209 off there OFF	QDR079 off short OFF	SFA069 off there OFF	SDB165 off there OFF
QFN043 off short short	QDN118 off there OFF	QFX113 off short OFF	QDX216 off thore OFF	QDR081 off there OFF	SFA092 off there OFF	SDB142 off short OFF
QFN038 off short short	QDN121 off there OFF	QFX112 off short OFF	QDX016 off short short	QDR151 Loff short short	SFA099 off there OFF	SDB135 off short OFF
QFN036 off short short	QDN125 off short OFF	QFX106 off short OFF	QDX023 off there short	QDR153 off there short	SFA106 off there OFF	SDB128 off short OFF
QFN031 off short short	QDN128 off short OFF	QFX105 off there OFF	QDX030 off there short	QDR007 off there OFF	SFA113 OFF	SDB121 off short OFF
QFN029 off short short	QDN132 off thord OFF	QFX099 off thort OFF	QDX037 off short short	QDR009 Joff short OFF	SFA120 off there OFF	SDB114 off short OFF
QFN024 off short short	QDN135 off there OFF	QFX098 off thort OFF	QDX044 off short short	QFR010 off there OFF	SFA127 off there OFF	SDB107 off short OFF
QFN022 off short short	QDN139 off there short	QFX092 off short OFF	QDX051 off short short	QFR008 off there OFF	SFA134 off thors OFF	SDB100 off short OFF
QFN017 off short short	QDN142 off there short	QFX091 off thort OFF	QDX058 off short short	QFR006 off there short	SFA141 off there OFF	SDB093 off thort OFF
QFN215 off short short	QDN162 off there short	QFX069 off thors OFF	QDX065 off short short	QFR154 off there short	SFA164 off there OFF	SDB070 off short OFF
QFN210 off short short	QDN165 off there short	QFX068 off thort OFF	QDX072 off short short	QFR152 off there OFF	SFA171 off there OFF	SDB063 off thort OFF
QFN208 off short short	QDN169 off there short	QFX062 off thord OFF	QDX088 off short short	QFR150 off there short	SFA178 off those OFF	SDB056 off short OFF
QFN203 off there short	QDN172 off there short	QFX061 off short OFF	QDX095 off there short	QFR082 off there short	SFA185 off there OFF	SDB049 off thort OFF
QFN201 off short short	QDN176 off there short	QFX055 off thors OFF	QDX102 off thert short	QFR080 off there short	SFA192 off there OFF	SDB042 off short OFF
QFN196 off short short	QDN179 off there short	QFX054 off thort OFF	QDX109 off there short	QFR078 off there short	SFA199 off there OFF	SDB035 off short OFF
QFN194 off thort short	QDN183 short	QFX048 off thore OFF	QDX116 off short short		SFA206 off there OFF	SDB028 off thort OFF
QFN189 off there short	QDN186 off there short	QFX047 off thors OFF	QDX123 off there short	QDS014 off thet short QDS074 off thet OFF	SFA213 off there OFF	SDB021 off there OFF
QFN187 off short short	QDN190 off there short	QFX041 off thort OFF	QDX130 off thort short	QDS086 off short OFF	SDA019 Joff there OFF	
QFN182 off there short	QDN193 off there short	QFX040 off these OFF	QDX137 off thors short		SDA026 off these OFF	
QFN180 off short short	QDN197 off there short	QFX034 off thort OFF	QDX144 off short short	QDS146 off short short	SDA033 Joff there OFF	
QFN175 off short short	QDN200 off there short	QFX033 off thors OFF		QDS158 off short short	SDA040 off that OFF	
QFN173 off thort short	QDN204 off there short	QFX027 off thort OFF		QDS002 Joff short OFF	SDA047 Joff these OFF	soft-key
QFN168 Joff thert short	QDN207 off short short	QFX026 off that OFF		QFS001 Josef short OFF	SDA054 off these OFF	solency

- Switch these 4 purpose by relay control.
- 1 relay and 1 purpose are one-to-one relationship.

## **3. Control system**

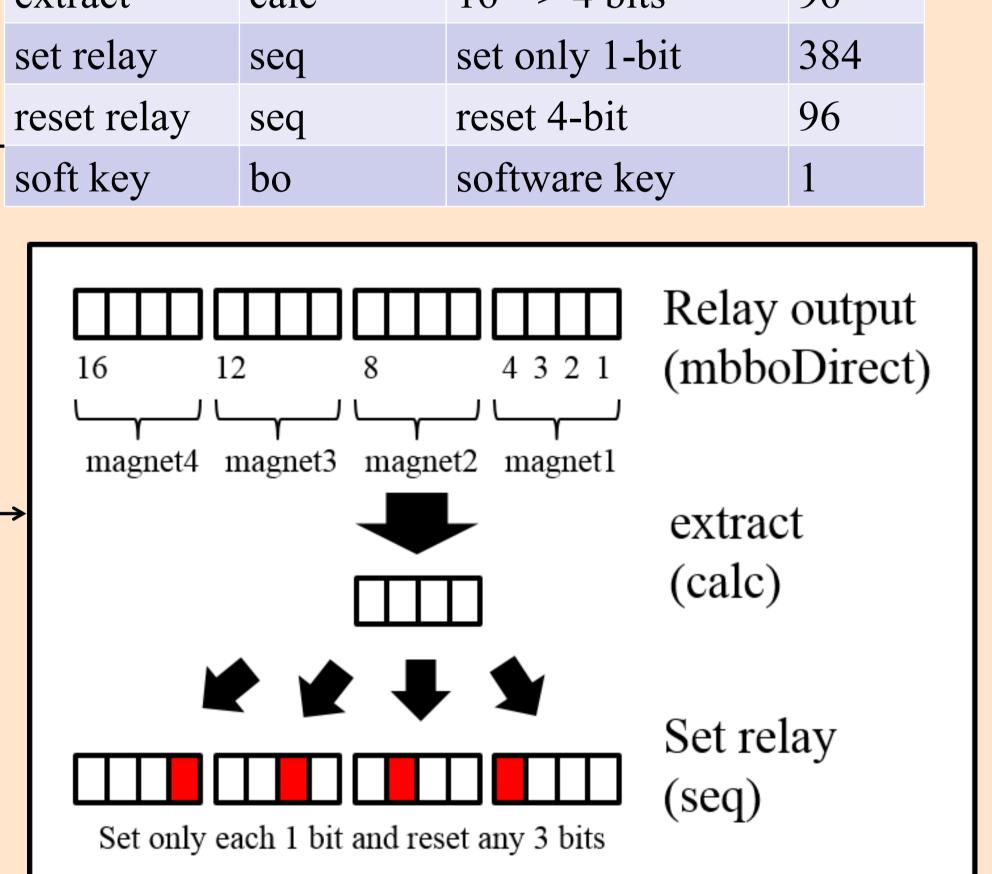
**EPICS control system use PLC-IOC(F3RP61)**  $\bullet$ 

## **Photo of the trim-coil relay selector**



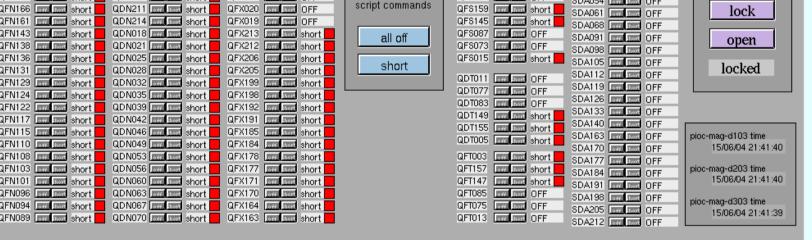
### layout of the trim-coil relay selector

1 1	raalz	rool2
roolz	roolz	<b>*</b> 00174



#### precautions

- **1.** Two or more relays must not be turned ON in a magnet.
- 2. If a relay is OFF, no current flows to the instrument.

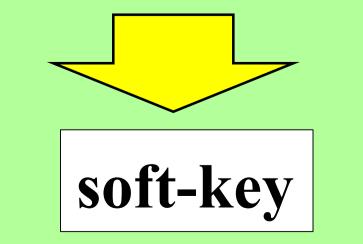


- The top is close to the power supply for each family
- The magnet pattern of "short" is stabled.

#### **Trim-coil set to "BBA"**

rackl	rack2	rack3		
UPS	Control panel & PLC module	Timing   distributer		
		<ul><li>A relay unit</li><li>Summarize unit</li></ul>		

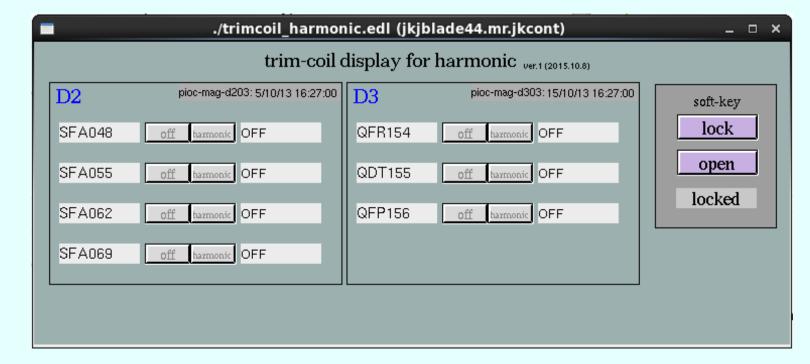
3. Do not change a relay when main magnet is in pattern operation.



- To avoid pushing the wrong button.
- To prevent erroneous operation by combining other conditions

- **Button placement is ascending address order of** quadrupole magnets.
- Don't select 2 or more "BBA" relays in a building.

#### **Trim-coil set to "Trim-coil correction"**



- Select 7 magnets only.
- These magnets don't use "short".