POWER HANDLING AND POWER CONSUMPTION OF THE BRIC

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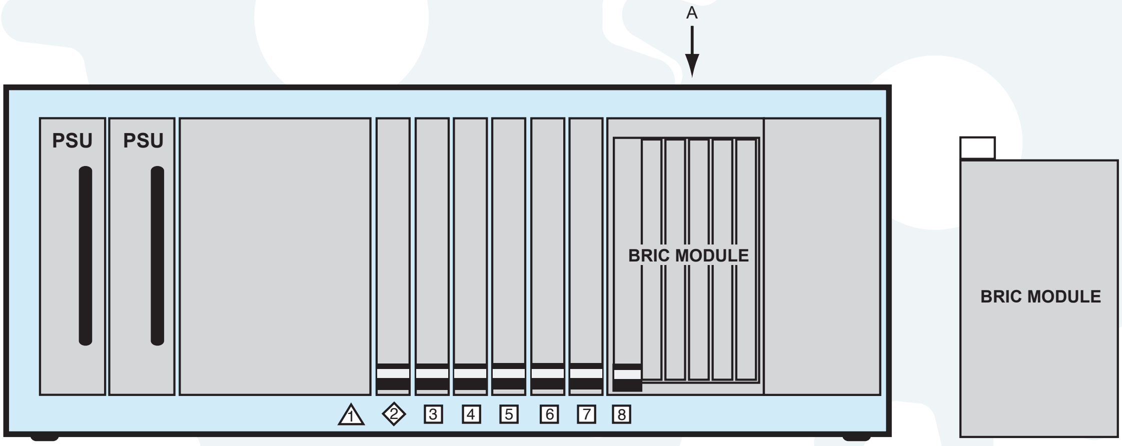
Pickering Interfaces BRIC modules can contain a very large number of relays in a very high density format. The BRIC module uses just the left hand PXI backplane slot to power the module, allowing the module to be used in the vacant slots present on the right hand side of the compact chassis and consuming just one of the active slots (see Figure 1).



Slot 8
An 8-slot PXI chassis fitted with a BRIC Module. The slots to the right of Slot 8 are not provided with PXI connectors.

Top view of BRIC module (direction of Arrow A) showing the PCI connector on the left hand side

Figure 1 - 8 Slot PXI Chassis showing the location of the BRIC Module

Each relay is operated by a coil which needs to be energised in order to make a connection – the default status for each relay is ‘not connected’ when the power is off. As more contacts are closed the power consumption of the BRIC module will rise. This document provides information on how to estimate the worst case current that a BRIC module is likely to consume in a realistic test scenario. It shows that the BRIC module consumes less power than many other PXI modules and cannot place undue stress on a chassis power supply.

The document also explains the power handling limitations of the BRIC module and how to assess the power loss in the BRIC module when switching high current signals.

PXI CHASSIS POWER SUPPLY SPECIFICATION

The capacity of a chassis to supply current to a module is defined in version 2.1 of the standard. The BRIC module only takes power from the +5V supply so the ratings of the +12 V, -12 V and +3.3 V rails are not considered. Many PXI modules will have higher power consumption than a BRIC module because they consume power from several of the power supplies.

The power supply must be capable of delivering at least 2 Amps average on the +5 V to every module fitted in position Slot 2 and higher to the chassis. So if a chassis has 8 slots then Slots 2 to 8 must have 14 Amps at +5 V available from the power supply. Slot 1 has a higher capacity because it is used for controllers that have a higher current capacity than typical modules.

In addition the chassis must be capable of supplying 6 Amps to any one of the slots.

For BRIC modules they occupy either 4 or 8 slots of the chassis, but only one of the slots is actually used to draw power. Consequently the 6 Amp limit must be applied to each BRIC module regardless of its size. No BRIC module can consume more than 30 Watts from the chassis in order to be compatible with minimum specification for a chassis.

IMPLICATIONS FOR THE BRIC

Each BRIC contains many relays and if all of them were energised they would certainly exceed the capacity of the chassis to supply the required power. This condition is not a realistic test scenario since all X and Y axis connections would be connected together – clearly not a useful state in test.

To understand the worst case power consumption likely to be encountered it is first necessary to define the worst case number of relays that require closure. In related documents it has been shown that the BRIC is typically used with both the test equipment and the test access point all connected to the X axis. The Y axis is simply used to provide connections between points on the X axis. In many applications this means that each BRIC module only requires twice the number of Y axis connections to be closed – one for the input and one for the output. There are additional isolation relays that will increase the number of relays to be energised.

This is not likely to be the worst case scenario that is encountered. The most demanding application is typically cases where the user is testing for short circuits between different access points. In this example the terminal under test is connected to an X axis point which is connected to one terminal of a multimeter via the Y and X lines. All of the lines which may have a short circuit to it are connected from their X axis connection through a single Y axis connection to the other terminal of the multimeter. The multimeter then tests for continuity.

This gives the user a simple rule of thumb – the maximum number of relay closures you are likely to have is the same as number of X axis points on the matrix. To this number you have to add the number of isolation relays that need closing, but this number is much less than the number of X axis connections and can usually be ignored.

In reality it is unlikely that a continuity check will be performed to all the other X axis points at the same time, some of them will be connected to test equipment and others will have no potential for a continuity problem, so this is very much an overestimate of the requirement. The test can also be performed in more than one stage to limit the current needed for the relays.

RELAY POWER CONSUMPTION

BRIC modules use a variety of relay designs for the different modules available. Each module type is optimised for different performance and density. All the modules use high reliability Ruthenium plated reed relays.

The power consumption for the different styles is detailed in the table.

Table of Power (Current) Consumption for BRIC models and Relay Types

Relay Type	40-560	40-561	40-562
1 Pole	62.5mW (12.5mA)	62.5mW (12.5mA)	50mW (10mA)
1 Pole Screened	-	To be determined	66.7mW (13.4mA)
2 Pole	-	100mW (20mA)	66.7mW (13.4mA)

The size of the relay and the efficiency of the coil that operates it effect the relay power consumption.

Using this information we can now estimate the power (and current) consumption of a BRIC module.

BRIC PXI POWER CONSUMPTION

Each BRIC module has a PXI interface and other components that consume power not directly related to the power needed to drive the relay coil. Since the BRIC uses a common approach for all the modules this consumption tends to be the same for all models, irrespective of the number of relays fitted to the module. The typical standing power consumption is 0.75 Watt (150 mA) from the +5 V supply.

To this power consumption the user needs to add the power required to operate the relay coils.

LIMITING THE NUMBER OF CONTACT CLOSURES

It is possible for an excessive number of contact closures to be initiated unintentionally, causing excessive current to be drawn.

To avoid this situation the software drivers for the BRIC will automatically limit the number of closures. However, some users may operate the BRIC with their own software tools so in addition each BRIC module is fitted with a resettable fuse with a 2 Amp current rating. This ensures the module will never cause damage to the PXI chassis and allows more than 9 Watts of relay power to be available. This is more than adequate for most applications.

SWITCHING HIGHER CURRENT SIGNALS

There is another source of power dissipation in BRIC modules that is not drawn from the PXI chassis power supply. If a BRIC module is switching relatively high current signals the contact resistance of the switches will cause each relay to dissipate additional power, which adds to the temperature rise caused by the coil resistance. In addition there is power dissipated in the interconnecting tracks between the relays and at the backplane connectors.

UNDERSTANDING THE BRIC SWITCH RATINGS.

The BRIC modules have different ratings for different types of switch as shown in the table.

BRIC Type	Switch Carry Current	Switch current	Switch voltage	Power
40-560	0.5 Amps	0.25 Amps	150 V DC	10 W
40-561	0.5 Amps	0.25 Amps	150 V DC	10 W
40-562	1.2 Amps	1 Amp	150 V DC	20 W

The switch carry current is the maximum current that can be carried if the current is cold switched (switched while the load current is not connected). It is higher than the switch current rating, the rating that applies if the contacts are opened or closed while current source is connected.

The switch voltage is the maximum voltage that the contacts can make and break without introducing excessive contact wear, in the case of the BRIC 150 V DC or 100 V AC.

The power rating is the maximum product of voltage and current that the switch can make or break. For low current, high voltage sources the limiting factor is the voltage rating. For high current applications the limiting factor is the current. At intermediate values the limit is the power rating. For example if the application requires the switching of a 24 V DC source the contacts on a 40-562 will limit the current that can be handled to 0.83 Amps. Exceeding this value may cause excessive arcing that will cause erosion of the switch contact material.

If the switch is used in a cold switching environment the only ratings that need to be considered are the switch carry current and the voltage rating. The switch will survive occasional operation at higher current ratings, but the switch life will be reduced.

EFFECT ON THE SWITCH

Once current is flowing in a switch the principle thermal consideration is the heating effect that the carry current has on the relay.

BRIC modules are constructed from high quality reed relays since they give mechanical reliability figures orders of magnitude higher than electro-mechanical parts. For systems such as the BRIC this is a very important consideration since the number of relays is high, using relays with more modest reliability and life would make the system too unreliable to give a long service life. Reed relays have few moving parts, and consequently are the technology of choice for ATE systems because of their reliability.

The contact resistance of a reed relay is often higher than that of its electro-mechanical equivalent because of its construction. For a reed relay used in a BRIC the maximum switch contact resistance is specified at 120 mohm (with the exception of the 2 pole 40-562 models which are specified at 150 mohms).

One mechanism that could limit the carry current capability of a BRIC module is the temperature rise of the reed relay blades. The temperature rise is determined by a number of factors - the coil heating effect, the heating effect of the carry current and the thermal properties of the switch enclosure being the most significant. The fact that the BRIC relays are closely packed together limits the ability of the relay to shed heat, and causes a rise in temperature of the reed blades.

If the temperature rise is excessive the reed blades start to lose their magnetic properties and may then fail to operate correctly. Contacts can weld together, but the most common failure is likely to be the switch opening its contacts.

For the 40-560 and 40-561 BRIC the maximum carry current is 0.5 Amps and the contact resistance is 120 mohm, giving rise to 30 mW dissipation in the switch contacts. This compares to between 62.5 mW and 100 mW of power dissipated in the coil respectively. The additional temperature rise is significant but not critical. The additional thermal effects have little impact.

For the 40-562 BRIC the carry current rating is 1.2 Amps and the power dissipation at the contact is higher – 173 mW for the 1 pole. This additional power is more than the coil power.

The “worse case” example is the 40-562 2 pole version where in principle two contacts can each be carrying 1.2 Amps. In this case the contacts dissipate a maximum of 216 mW each, plus the dissipation of the coil (66.7 mW). The total package dissipation is then approximately 500 mW. This heat has to conducted out of the relay case. The forced air cooling of the PXI chassis and the ventilation system in the BRIC enclosure has been designed for this requirement. The power consumption is still less than that of many high speed digital and analogue semiconductor devices even under these worse case conditions.

The switch has been tested under these static conditions. In most applications the matrix will not be used in this way since the systems will be sequentially set into different states, resulting in the matrix working under much more benign conditions than this worst case.

The total path resistance between two X contacts on a BRIC matrix has additional components that add to the thermal dissipation of the BRIC. The first is that two separate relays are energised to complete a path – but these are in geographically separate relays and not one package. The thermal loss is located at two different points in the design. Another source of loss is the PCB track resistance that gives rise to heating effects spread across the design. The contact resistance of the connections between the daughter cards and the backplane are a further source of loss but they are small compared to the other factors.

In all cases the thermal losses of a BRIC switching a load are only related to the current being carried – they are not related to “power” the module is switching. If the current is lower than the rated maximum the module can carry, the thermal losses will be much lower (halving the current quarters the power dissipation).

The BRIC has been designed to withstand the worse case thermal conditions of self heating due to both the coil drive and the contact power loss. In real use the BRIC will operate in much more benign conditions than the worse case.

SUMMARY

- The BRIC module has been tested under much more thermally challenging conditions than are required in real life conditions
- BRIC modules are used in ways that result in only a limited number of relay closures being required at any one time
- Power consumption of BRIC modules is often much lower than other modules in a PXI chassis
- The supplied software drivers limit the number of relay closures at any one time which in turn limits the current consumption
- Each BRIC module includes a resettable fuse to protect the chassis from accidental operation with too many contact closures

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