

Preaccelerator Arc Current

Local application

Sat, Jun 2, 2007

Linac output beam current is influenced by the preaccelerator arc current. Variations in beam current require specialized Booster tuning to keep beam losses low. Regulating the preaccelerator arc current can be done by a local application called PARC. This note describes the method used.

Cast of characters

The preaccelerator arc current `L:IARCI` is adjusted by changing the arc supply voltage `L:IARCSV`. The latter runs typically at 260 volts and uses 600 volts full scale. The former may be -36.8 amps and uses 500 amps full scale. A 5 volt adjustment in this supply voltage might change the arc current by 3 amps, but the actual dependence is influenced by other factors as well. These two parameters are needed for this regulation. (These two devices are for the I- preaccelerator; those used for the H- preaccelerator are called `L:HARCI` and `L:HARCSV`.)

A reference value for the arc current can be specified via the nominal value used for the alarm scanning. This reference value would be the goal for the slow regulation. A similar reference value is needed for the supply voltage, because we do not want the regulation effort to adjust the supply voltage too much, although the required adjustments should keep it well within alarm tripping range. Its reference can also be taken from its nominal value used for alarm scanning.

It will be useful to tune certain parameters used for the local application. One is the window outside which the supply is not to be automatically adjusted. A typical value might be ± 10 volts.

Another parameter might be a threshold inside which the regulation should not be made. If the arc current is within this threshold of the reference value, then we should not try to adjust the supply current to bring it closer to the arc current reference value.

The amount of adjustment to be made is to be a constant parameter, rather than being proportional to the deviation from the arc current reference.

Another parameter might be the period of possible adjustments. This same period can be the time over which an average value is calculated. Some means of ignoring wild values would be good.

Parameter layout

Here are the parameters used by PARC:

<i>Prompt</i>		<i>Size</i>	<i>Meaning</i>
ENABLE	B	2	Usual LA enable Bit#
PERIOD		2	Periodic interval for adjustments, in seconds
ARC I	C	2	Arc current Chan#
ARC SV	C	2	Arc supply voltage Chan#
THRESH	C	2	Threshold for adjustment Chan#
WINDOW	C	2	Window for adjusting supply voltage Chan#
LISTLOG	B	2	Start listing output self-clearing Bit#
LISTNODE		2	Target node# for serial port listing

Analysis

The D/A that is used for controlling the power supply voltage is 12 bits. This means that the smallest meaningful adjustment is $600/2048 = 0.3$ volts. Suppose we use this as the tweaking amount. This adjustment may cause the arc current to change by about 0.2 amps. If the threshold for adjustment were set at 1 amp, and the noise in the arc current reading is very low, one can

imagine that the arc current would find itself stable at about 1 amp from its nominal reference.

Operational behavior

The variation of arc current extends over a period of hours or days, in the absence of an adjustment made to the arc supply voltage. It is this slow variation that is to be stabilized by tweaking the arc supply voltage.

Monitor the arc current reading and build an average over the periodic interval, which may be 60 seconds, say. Compare the average with the reference value. If it differs in absolute value by more than the threshold value, perhaps 1 amp, then make an adjustment in the supply voltage by the minimum amount in the opposite direction. But do not make the adjustment if the current reading of the supply voltage is outside the allowable window from its own nominal reference. If this situation occurs, an operator will have to manually adjust it, or “re-nominalize” that channel.

When considering whether to tweak the supply voltage, after building an average for the arc current, avoid the tweak if this average is outside its (nominal, tolerance) range.

PARC Listing

To assist in diagnosing the behavior of PARC as it makes its adjustments, a listing can be produced via the serial port of a selected IRM. The code monitors a selected dummy Bit. If the bit is set to “1”, then PARC starts to output a listing of each entry in its internal log, one each 15 Hz cycle, resetting the bit when it is finished.

Include a field in the log that indicates the type of record, whether it is a record of the initial conditions, or a record of the results of a change, either + or –, in the supply voltage. A way to tag the log record is to take over the milliseconds byte of the time-of-day field for an Ascii character that indicates 0, +, or –.

Note that the log is not up-to-date until the latest averages have been built. This may take one minute after a tweak was made. When a log record has been written, the log-pending flag can be cleared. Consider using the time-of-day year byte for this flag. When a new average is built, check the log-pending flag. If it is set, write a log record, clear the flag, and consider the new average.

The only part of the log record that is not produced at the time the log record is written is the tag character. Even the time-of-day can be written as the time when the averages were calculated, not the time-of-day that the tweak was made.

To initiate a listing, merely set the LISTLOG Bit to a 1. The PARC code will notice this, arrange to generate a listing of the present contents of the internal log, and target the serial port settings to the indicated target node. When the listing is finished, it will automatically clear the Bit.

The format of the listing includes a title line showing the current time-of-day and the names of the two parameters. The records show the time-of-day that the log record was built followed by the tag character followed by the arc current average reading and the supply voltage average reading. Here is an example:

```
06/03/07 1335      HARCI  HARCSV
06/01/07 0552  0  -51.44  192.5
06/01/07 0933  +  -51.66  192.8
06/01/07 1112  -  -51.47  192.5
```