

TLS CORRECTOR MAGNET POWER SUPPLIES UPGRADE

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Abstract

Corrector magnets of TLS storage ring are served with linear power supplies (corrector magnet power supplies), with some modifications the long-term output current stability and ripple of these linear mode power supplies were improved from 500 ppm to 50 ppm[1][2][3]. But these linear mode power supplies are very low efficiency, low power factor and about 20Hz low frequency response bandwidth that waste power, noisy and unable to serve fast orbit correction. MCOR30 is a modular switching power converter with smaller volume, high efficiency and above 100Hz frequency response bandwidth, replacing these linear mode power supplies with MCOR30s that could save power and increasing orbit correction response.

INTRODUCTION

The drawback of a linear mode power supply is low efficiency, most of power is dissipated at power device and transformer. A lot of corrector magnet power supplies used at National Synchrotron Radiation Research Center (NSRRC) is $\pm 20\text{A}/\pm 25\text{V}$ linear mode power supplies. The efficiency of these power supplies is below 30% and with 20Hz low frequency response bandwidth.

To setup a fast orbit correction feedback system need higher frequency response corrector magnet power supplies, power supplies with 20Hz frequency response is too low and would not be used in fast orbit correction feedback system. MCOR30, BiRa inc., is a modular switching power converter with smaller volume high efficiency and about 100Hz frequency response bandwidth, after replacing those linear mode corrector magnet power supplies with MCOR30s that could save a lot of power, decrease THD, increase power factor and beam orbit stability is improved.

THE PERFORMANCE OF THE LINEAR MODE CORRECTOR MAGNET POWER SUPPLY

These linear mode power supplies have been used as corrector magnet power supplies more than 10 years, the original output current stability of this power supply is about 300 ppm, after some modification on circuitry inside of these linear mode power supplies, the output current stability and output current ripple have been improved to about 25ppm and frequency response bandwidth is about 20Hz. Figure 1 shows output current stability, ripple, efficiency, power factor and total harmonic distortion.

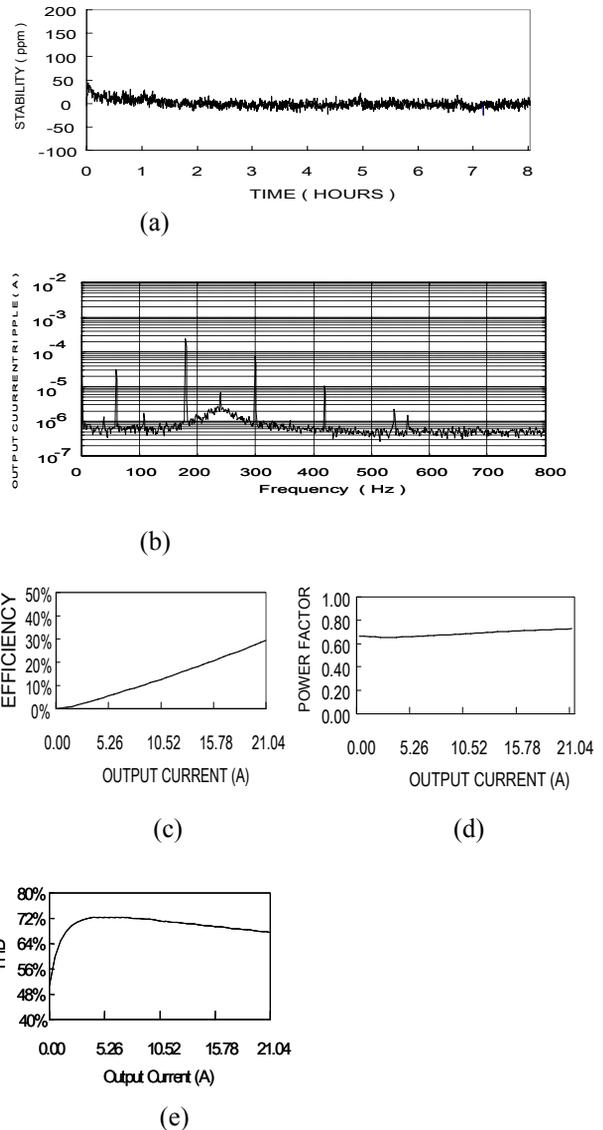


Figure 1: The performance of linear mode corrector magnet power supply (a) Output current stability, (b) Output current ripple, (c) Efficiency, (d) Power factor, (e) THD.

THE PERFORMANCE OF MCOR30 POWER CONVERTER MODULE

The MCOR30 is a multi-channel corrector magnet driver system, capable of providing bi-polar output currents. The MCOR30 design employs a modular architecture, consisting of a rack-mounted crate, with standardized slots for removable power modules, crate

controller and diagnostics. A single, unregulated bulk power supply provides the main DC power for the entire crate. The MCOR30 power module, uses a custom H-bridge configuration, is responsible for converting the unregulated DC bulk power into a bi-polar current source suitable for driving corrector magnets. The power modules are controlled using +10 to -10V FS analog command signals sent over the backplane from the control system.

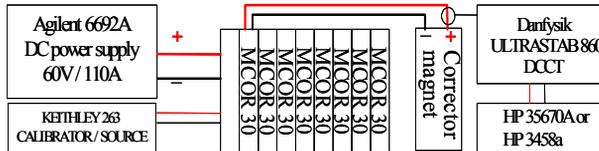


Figure 2: Test structure setup for MCOR30

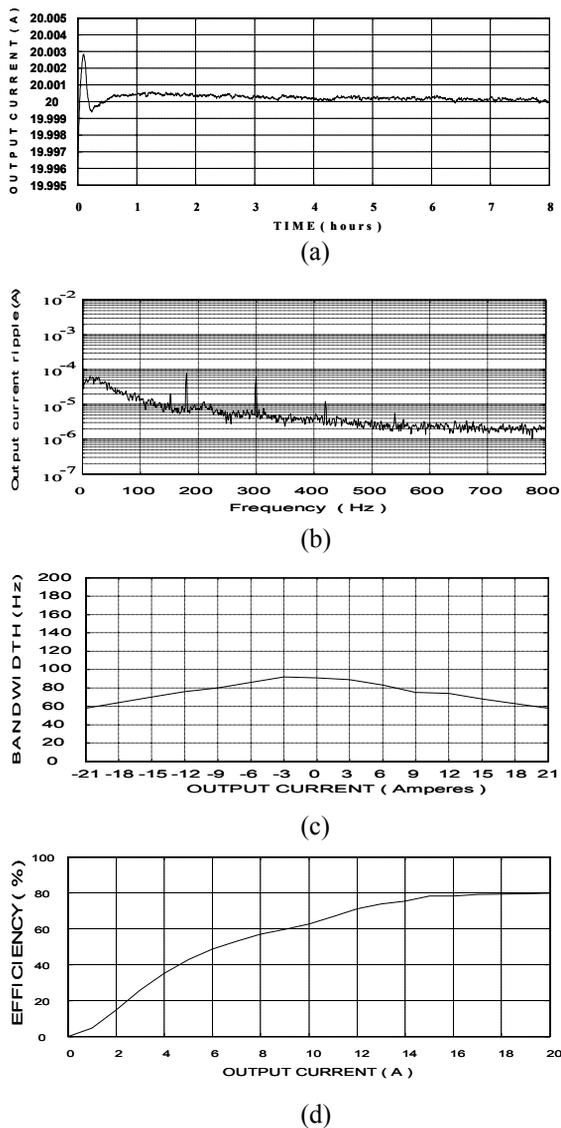


Figure 3: The performance of MCOR30 power module (a) Output current stability, (b) Spectrum of output current ripple, (c) Frequency response bandwidth (d) Efficiency.

Figure 2 shows the setup for measurement of output current performance of MCOR30, Agilent 6692a supply is used as DC bulk power to MCOR30, Keithley 263 sends analog command signal to let MCOR30 output current, HP 3458a measure output current stability and output current frequency spectrum & frequency response is measured by Agilent 35670a, magnet load is 395mΩ/22.29mh.

The performance of MCOR30 is dependent on output current, figure 3 demonstrate the general case of output current stability, spectrum of output current ripple, frequency response and efficiency. Comparing figure 1 and 3, the output current long-term stability is almost the same as 25ppm, the background current ripple spectrum of the linear mode power supply is better than that of the MCOR30, but 60Hz and 60Hz harmonic current ripple, frequency response bandwidth and efficiency of MCOR30 are much better than that of the linear mode power supply.

THE INFLUENCE ON AC MAINS AFTER THE INSTALLATION OF MCOR30S

The well-known low efficiency, high THD and low power factor of the linear mode power supply, after the installation of MCOR30 there must be much more improvement on these parameters.

Table 1: Parameters of AC mains before, first phase and second phase installation of MCOR30s.

	AC MAINS POWER (KW)	AC MAINS CURRENT	POWER FACTOR
Before upgrade	31.5	44 %	76.5 %
1st phase MCOR30 installation	22.5	31 %	82 %
2nd phase MCOR30 installation	5.2	45 %	95 %

(a)

Current Harmonic Distortion (%)	THD _i						
	THD _i	3 rd	5 th	7 th	9 th	11 th	13 th
Before upgrade	71 %	48 %	44 %	24 %	12 %	5 %	3 %
1st phase MCOR30 installation	54 %	37 %	31 %	17 %	12 %	8.5 %	4.5 %
2nd phase MCOR30 installation	55 %	2 %	45 %	30 %	8 %	8 %	8 %
IEEE standard 519	5 %	4 %	4 %	4 %	4 %	2 %	2 %

(b)

Table 1 lists the data of the power, power factor, harmonic current and THD of AC mains before, first phase and second phase installation of MCOR30s.

Based on budget issue, the installation of MCOR30 power module converters is divided into two phase, the first phase was at June, 2006, all vertical plane 48 units linear mode corrector magnet power supplies were replaced with MCOR30s, the second phase was at October, 2008, all horizontal plane 52 units linear mode corrector magnet power supplies and some skew

quadrupole power supplies were replaced with MCOR30s.

There are two Agilent 6692a power supplies used as DC bulk power supplies, one for vertical plane 48 units MCOR30 power modules and the other for horizontal plane 52 units and some skew quadrupole MCOR30 power modules.

THE INFLUENCE ON BEAM STABILITY AFTER THE INSTALLATION OF MCOR30

Although fast orbit correction system is not already set up, but after the installation of MCOR30s there is much improvement on beam position displacement variation and there is different improvement between vertical and horizontal plane. Figure 4 shows spectrum of vertical and horizontal beam position displacement variation after first and second phase installation of MCOR30s.

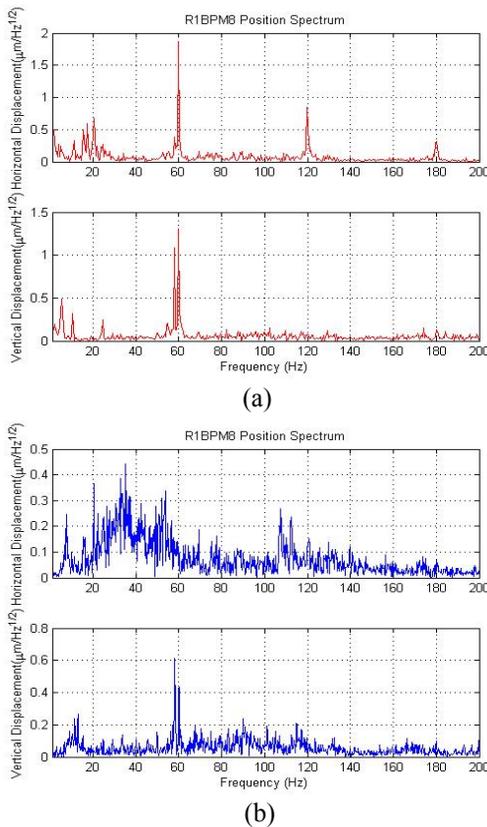


Figure 4: Spectrum of vertical and horizontal beam position displacement variation (a) After 1st phase installation of MCOR30s (b) After 2nd phase installation of MCOR30s.

REFERENCES

- [1] Kuo-Bin Liu, "Improvement of Long-term Stability of Output Current of Correction Power Supply", technical report of power supply group of SRRC, SRRC/PS/IM/98-01, September, 1998.
- [2] Kuo-Bin Liu and Jeng-Tzong Sheu, "HIGH OUTPUT CURRENT STABILITY OF POWER SUPPLY", EPAC 2000.
- [3] Kuo-Bin Liu and Chyi-Shyan Fann, "Reducing Output Current Ripple of Power Supply with Component Replacement", EPAC 2004.