



SPG Starter Panel Introduction

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1.0 SPG Starter Panel Outline

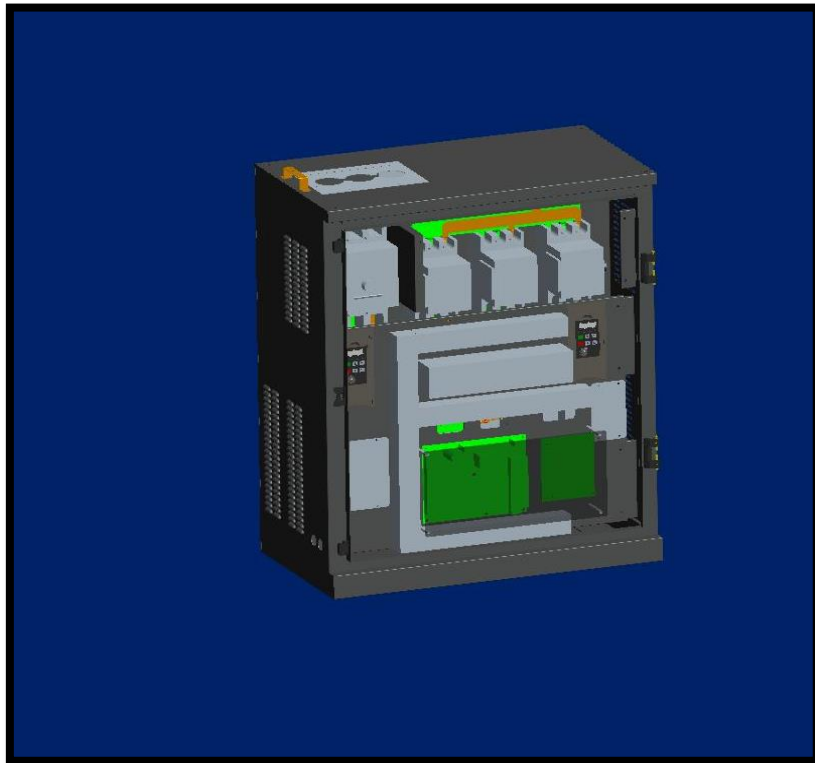


Figure 1: Unit Mount Type (Up to 355kW)

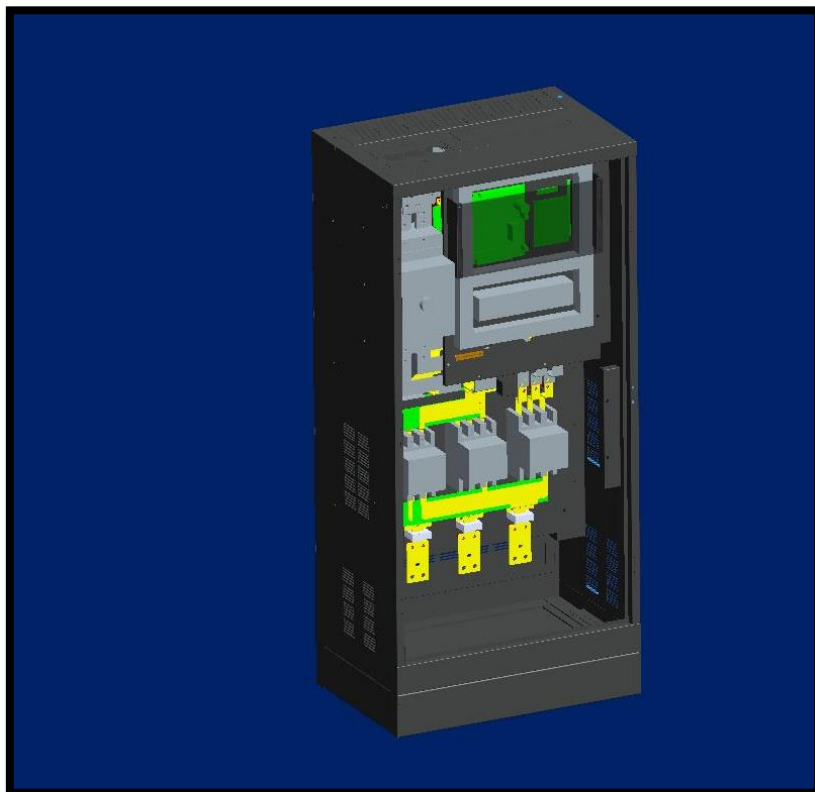


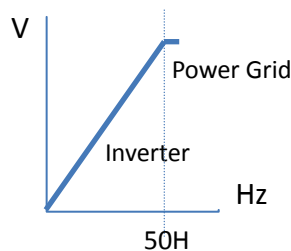
Figure 2: Stand Alone Type (Up to 760kW)

2.0 Market Demand

Comparing to Y-delta starter and soft starter, the smallest starting current of large capacity motor is inverter type starter panel. In general, the starting up current of inverter panel type is under 1.5 times of motor rated current. If the chiller is mostly operating at full load condition, inverter starter panel consumes 3% of total energy. On the other hand, SPG (VFD switch to power grid) starter panel will smoothly switch the chiller to power grid after reaching to rated frequency. Also after switching, the power grid will direct drive the chiller at rated frequency. The advantages of SPG starter panel are small starting current and energy-saving at rated frequency.

3.0 YOLICO SPG Starter Panel Series:

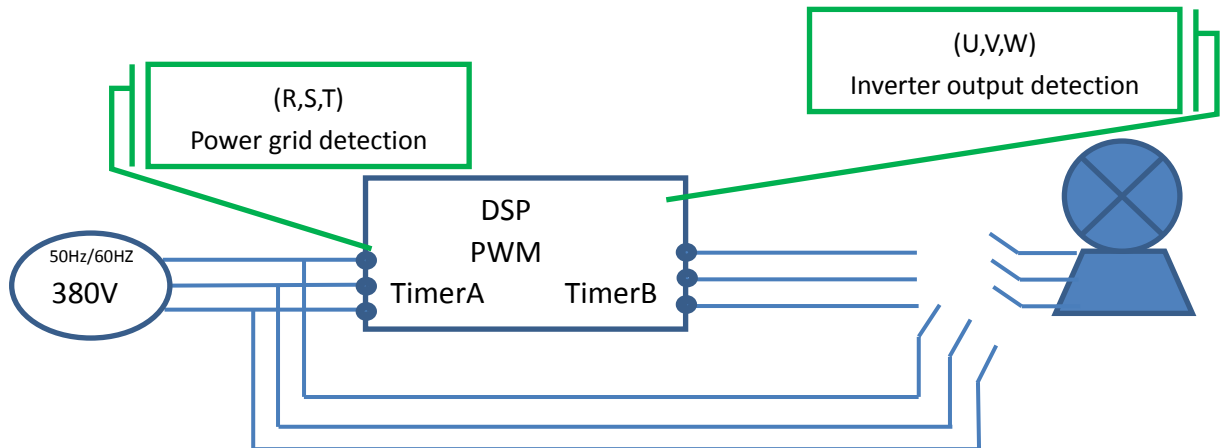
SPG starter panel series is YOLICO patented product aims at specific customers: cost-sensitive, full load operation, and limited starting current. SPG starter panel is the best solution to switch to power grid smoothly. The main function of SPG is reducing starting up current to avoid the MPR or breaker trip. Unlike SPG starter panel, the cost-benefit ratio of inverter starter panel drives the motor and always operates at rated frequency is not high. At full load condition, inverter starters even occur more impacts, such as 3% energy dissipation, high THD issue, and limited inverter life-span. Thus, power grid is more suitable to remain the chiller to operate at rated frequency.



4.0 SPG Starter Panel Theory:

Due to the voltage and frequency of inverter output (U, V, W) are modulated by inverter DSP algorithm. Also the parameter of power grid(R, S, T) can be detected by input phase detection algorithm. Besides, another parameter will effect switch to power grid performance is $\Delta\theta$ (phase angle difference).

Therefore, before switching to power grid, the last step is matching the U,V,W, and R,S,T phase angle. Theoretically, if the parameter of U,V,W and R,S,T is accuracy coupled, the switching current will be under motor rated current.



Below table illustrates the factors to effect magnitude of switching current (I_s).

In theory, the frequency difference and phase angle difference will determine switch current.

Switch current I_s		Phase difference $\Delta \phi$	
		0	- 180
Frequency difference $\Delta \omega$	0	I_s small Optimal	I_s large Poor
	10Hz	I_s large Poor	I_s huge Trip

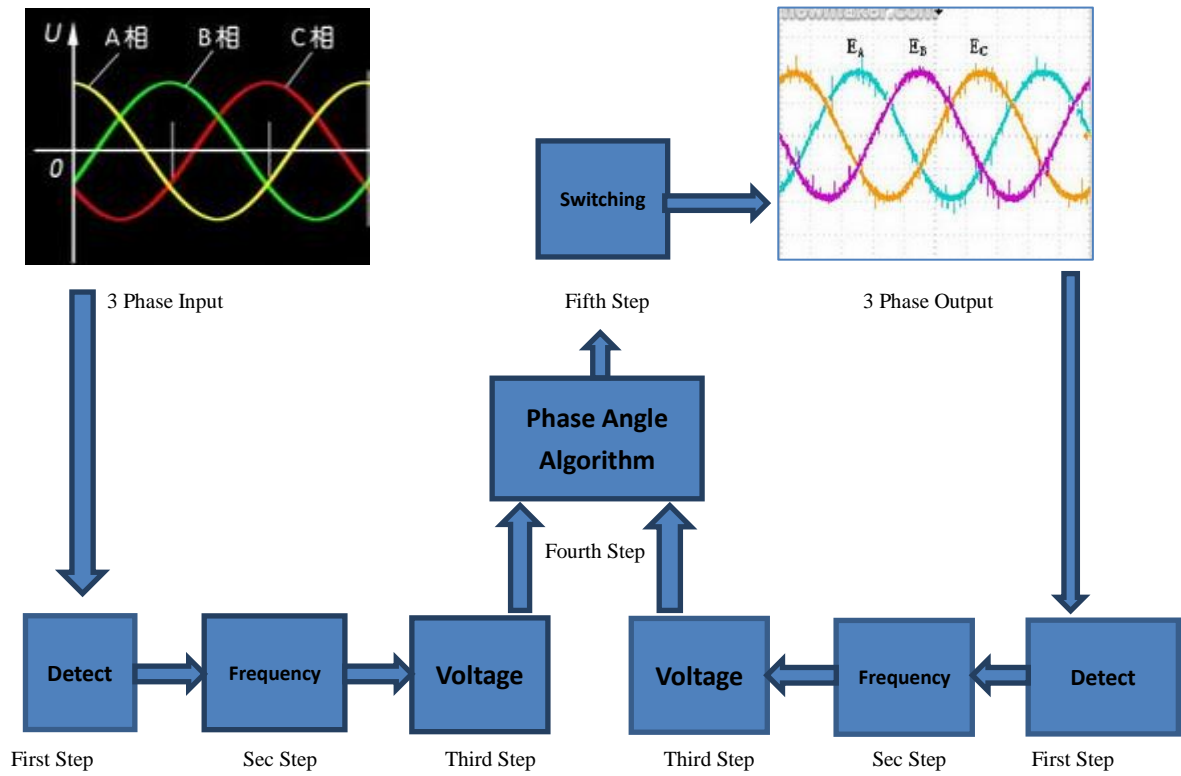
In general, switching current I_s under motor rated current is optimal.

2 times of motor rated current is acceptable.

3 times of motor rated current is NOT acceptable.(Inverter will trip)

Over 3 times of motor rated current will starting fail.

5.0 Implement Diagram



YOLICO SPG series at this stage is able to remain the switching current under 1.5 times of motor rated current. The average switching current is about 1.2 times.

6.0 YOLICO SPG Series Starter Experimental Verification

Motor parameter: (Screw Chiller)

Motor	Specification
Rated Power	Po= 145 kW
Rated Current	Io =260 A RMS
Rated Voltage	Vo = 380 VAC

SPG Testing Result:

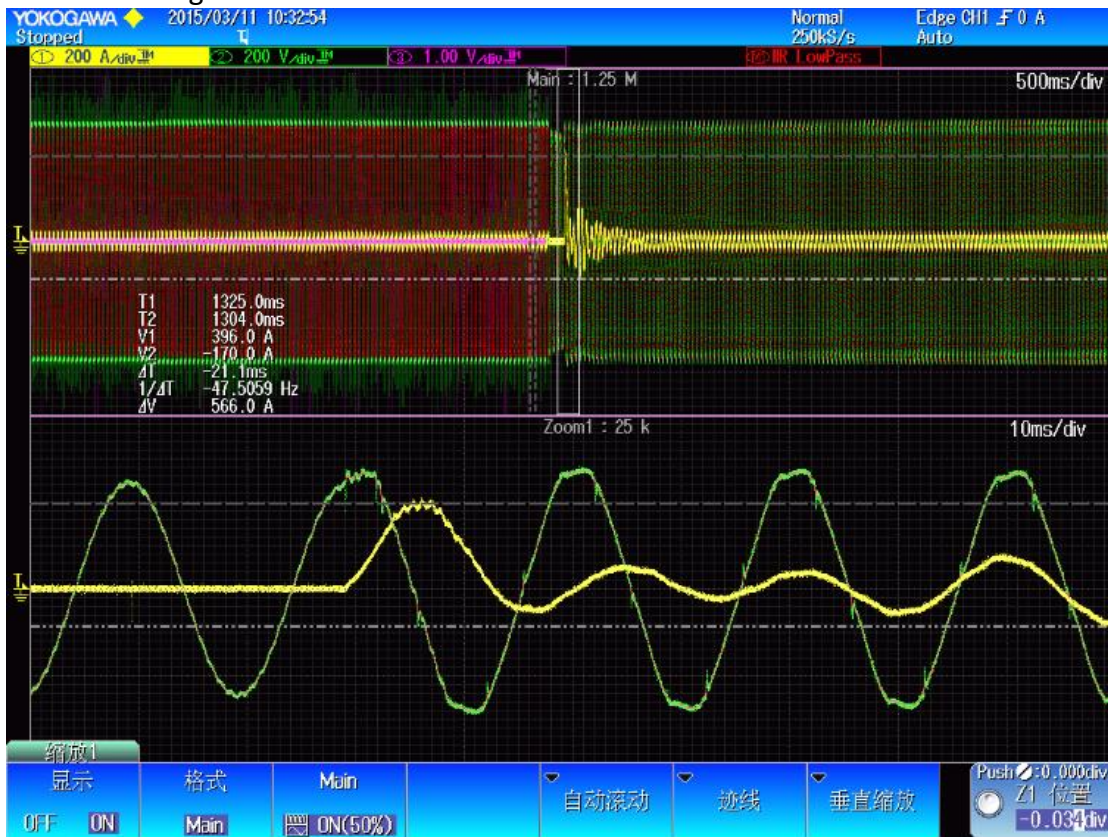


Figure 3: Switching current is 396A, Motor rated current is 360A. Switching current is about 1.1 times.

The switch current within 21ms switching period is 1.1 times of the motor rated current. The vibration of switchover to power grid is small, also the surge to power grid is small.

7.0 Protection Function

a. **OH(overheat):**

OH function trip value is adjustable. The default OH temperature value of SPG is 105 degree centigrade of IGBT.

b. **OL2 (Motor overload):**

OL2 is motor rated current overload protection. This value is depending on actual motor RLA. Depending on the output current of inverter, higher current of OL2 value, inverter will trip OL2 more quickly.

c. **OC (Overcurrent):**

While output current reaches 120% or IGBT value, Inverter panel will trip OC error message.

d. **UV (DC BUS Under Voltage):**

UV protection trip condition is when PN DC bus link voltage is lower than 380V.

e. **OV (DC BUS Over Voltage):**

The OV protection trip condition is when PN DC bus link voltage is higher than 820V.

f. **GF (Ground Fault):**

In general, GF protection function is tripped while output short with ground. In other case is the sum of U,V,W feedback signal is not equal to .

g. **PLE(Phase Detection Error):**

Before switching to power grid, SPG inverter panel will detect the parameters of phase of R, S, T. If any error occurred during detection, SPG inverter panel will trip PLE.

h. **OL1(Inverter Overload):**

OL1 is inverter panel overload. The OL1 tripping value is fixed maximum output current value that can long time operation.

i. **SC (Short Circuit):**

SC is tripped while the output of inverter is shorted.

8.0 Main Parts List

Item	Model	Fan	MCCB	SPG Contactor		IGBT		Bridge Diode		Terminals
				Maker	Model	Maker	Model	Maker	Model	
1	YD1110-T4-SPG	Delta	ABB	ABB	AX115	Mitsubishi	CM225DX-24S1	MACMIC	MMD250FB160x	Phoenix
2	YD1132-T4-SPG	Delta	ABB	ABB	AX185	Mitsubishi	CM300DX-24S1	MACMIC	MMD250FB160x	Phoenix
3	YD1160-T4-SPG	Delta	ABB	ABB	AX185	Mitsubishi	CM300DX-24S1	MACMIC	MMD250FB160x	Phoenix
4	YD1185-T4-SPG	Delta	ABB	ABB	AX185	Mitsubishi	CM300DX-24S1	MACMIC	MMD250FB160x	Phoenix
5	YD1200-T4-SPG	Delta	ABB	ABB	AX185	Mitsubishi	CM450DX-24S1	MACMIC	MMD110A160B	Phoenix
6	YD1220-T4-SPG	Delta	ABB	ABB	AX205	Mitsubishi	CM450DX-24S1	MACMIC	MMD110A160B	Phoenix
7	YD1250-T4-SPG	Delta	ABB	ABB	AX205	Mitsubishi	CM450DX-24S1	MACMIC	MMD110A160B	Phoenix
8	YD1280-T4-SPG	Delta	ABB	ABB	AX260	Mitsubishi	CM600DX-24S1	MACMIC	MMD110A160B	Phoenix
9	YD1315-T4-SPG	Delta	ABB	ABB	AX300	Mitsubishi	CM600DX-24S1	MACMIC	MMD110A160B	Phoenix
10	YD1355-T4-SPG	Delta	ABB	ABB	AX370	Mitsubishi	CM600DX-24S1	MACMIC	MMD200A160B	Phoenix
11	YD1400-T4-SPG	Delta	ABB	ABB	AX370	Mitsubishi	CM450DX-24S1	MACMIC	MMD200A160B	Phoenix
12	YD1450-T4-SPG	Delta	ABB	ABB	AF460	Mitsubishi	CM450DX-24S1	MACMIC	MMD200A160B	Phoenix
13	YD1500-T4-SPG	Delta	ABB	ABB	AF460	Mitsubishi	CM450DX-24S1	MACMIC	MMD200A160B	Phoenix
14	YD1550-T4-SPG	Delta	ABB	ABB	AF580	Mitsubishi	CM450DX-24S1	MACMIC	MMD200A160B	Phoenix
15	YD1630-T4-SPG	Delta	ABB	ABB	AF580	Mitsubishi	CM600DX-24S1	MACMIC	MMD200A160B	Phoenix
16	YD1760-T4-SPG	Delta	ABB	ABB	AF750	Mitsubishi	CM600DX-24S1	MACMIC	MMD200A160B	Phoenix