UNINTERRUPTED VARIABLE FREQUENCY DRIVE

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***Abstract*—** This paper presents the principle of operation of a designed Uninterrupted Variable Frequency Drive. Nowadays VFD is an essential equipment in Industrial world and the application level of VFD is very wide in range. During the power failure VFD will also get tripped like an ordinary starter , but it will take a few more seconds to discharge the DC bus of a VFD.

Whenever the input power to VFD is interrupted for a period of more than 2 seconds, the VFD trips and interrupts the production process. In case of some critical equipment's tripping due to power failure, it will lead to major delays and will take hours to restore the production. The solution is to install a UPS in the concerned equipment power source but this solution is costly. To reduce the investment a simple solution Uninterrupted Variable Frequency Drive is developed.

Some manufacturers are now providing battery backup VFD in the market but the cost is very high while considering the new purchase and the idle use of the existing VFD. By modifying the design of the existing VFD we can provide the uninterrupted service of VFD with very reasonable investment.

***Index Terms*— *VFD* Uninterrupted mode operation and Maintenance**

I. INTRODUCTION

Variable Frequency Drive constitutes an important and critical component in the electric power system of an Industrial organization. Uninterrupted mode operation of a VFD can ensure the smooth operation of the system during power quality problems. Due to the extensive use of power electronic equipment's, power quality problems are very common in an industrial environment. Sometimes a small voltage flicker may lead to the tripping of the VFD. Installation of UPS is the existing solution for avoiding these types of power quality issues. But while considering the cost involved and the space requirement this is not an affordable solution.

A new idea is developed from this context for the very simple solution of existing power quality issues in the VFD incomer supply. The idea is to provide a DC voltage bank with same voltage level of the VFD DC bus with the help of a battery bank and connect this battery bank with the DC bus by using flexible cables of sufficient ratings. During normal operation VFD will take the AC supply from the incomer mains and convert the same to DC. This DC supply will be used for the inverting and charging of the new DC bank at the same time.

If there is any issue in the incomer power quality, it will affect the DC level of the VFD DC bus normally which leads to the poor performance of the VFD. But due to the modification in the design , DC level of the VFD DC bus will remain the specified level with the help of DC battery bank. The time for which the battery can provide the backup depends upon the Ampere Hour (AH) capacity of the battery.

OBJECTIVES

- Increase the reliability of the Power System
- Reduce the down time & Maintenance cost
- Efficient way to support Induction Motor loads during total black out
- Economically Superior Solution as compared to Standard UPS
- Ensures Constant RPM till Battery drains
- Avoid over sizing of the unit
- Avoid loss of material in process

UVFD (Uninterrupted Variable Frequency Drive) which carries out the function of providing power to the motor, it does not require to be oversized in its rating. This is also an energy efficient solution as compared to the conventional UPS.

2. METHODOLOGY

Modification of the existing VFD Hardware circuit by dismantling the VFD and provide a provision to interconnect the Battery bank with the VFD DC Bus and thereby avoiding the unwanted power interruptions to the motor. Based on the developed idea the VFD circuit is redesigned as shown below.

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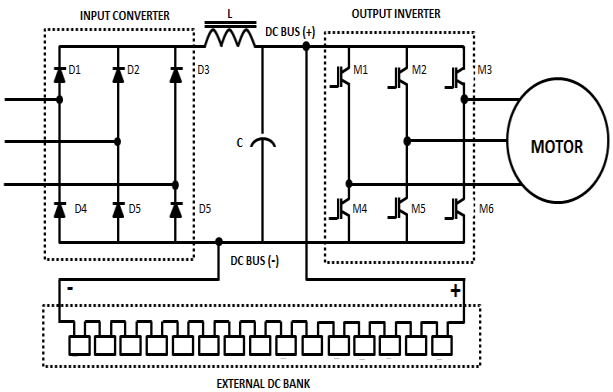

DESIGNING OF BATTERY BANK

There are two important DC bus voltage measurements. The first is the actual DC bus voltage, which should be equal to the line-side peak voltage (RMS voltage x 1.41). Once the capacitors are charged the reading should remain constant. On a 415 V system, the DC bus voltage will be about 585 VDC. The second DC bus voltage measurement is to determine the amount of AC ripple found on the DC bus. This reading helps to pinpoint capacitor breakdown and reduces the filtering of the DC bus, which can cause current trips.

DC bus voltage measurements. While the drive is in operation and carrying a load, take a voltage reading at the DC bus. This measurement at the connections to the drive capacitor or capacitor bank. Set the meter on DC volts and measure the positive and negative sides of the DC bus This should be equal to the line voltage x 1.41.

For Example :

System Voltage : 415 V AC

DC Bus Voltage : 415 x 1.41 = 585 VDC

Battery Voltage : 12 VDC

No of Battery in the Bank : 585 / 12 = 48 Nos (Approx)

AH Capacity of the battery : Depends up on the Capacity of the motor and the required backup time.

3. ANALYSIS

For easy analysis, UVFD is comparing with UPS. The number of battery required and the AH capacity of the batteries are same in both cases. So the net saving is the price of UPS without battery bank.

DESIGNING OF UPS CAPACITY FOR THE MOTOR

Information required for capacity design

Nameplate HP

Running kilowatts (RkW) = [(Nameplate HP) x (0.746kW/HP)] / Efficiency

Running kilovolt-amperes (RkVA) = RkW / Running motor PF

Running motor power factor (PF) = 0.9

Starting motor PF = 0.2 to 0.3

Starting KVA = Running KVA X 1.5 (For VFD)

Starting KW = Running KW X 0.25

Eg : For a 50 HP motor, 92% running efficiency, 0.25 starting PF, 0.91 running PF.

Running kilowatts (RkW) = [50 x 0.746] / 0.92 = 40.54 KW

Running kilovolt-amperes (RkVA) = 40.54 / 0.91 = 44 .55 KVA

Starting KVA = 44.55 X 1.5 = 66.825 KVA

Starting KW = 66.825 X 0.25 = 16.7 KW

Rating of the UPS required for the motor to operate in uninterrupted mode is **75 KVA**

DESIGNING OF BATTERY CAPACITY

Select the battery and quantity (using the typical watts per cell table provided by the battery manufacturer)

For a 75 kVA UPS, 94% efficiency, power factor of 0.8, for a backup time of 15 minutes.

The UPS battery bus voltage is 576 V. The typical table is for 12 V batteries (six cells of 2 V each).

Quantity of batteries per bank = 576/12 = 48 batteries

Number of cells per bank = 48 x 6 = 288 cells

watt/cell = (75 x 1000 x 0.8) / (0.94 x 288) = 221 W / Cell

Looking at the capacity, however, various options are available. For example if we decide to use three banks in parallel:

watt/cell (three banks in parallel) = 221/3 = 73.66

Select a 12 V , 74 W/ Cell Battery

Total number of batteries required = 40 (per bank) x 3 (banks) = 120 , or

Select a 12 V , 221 W/ Cell Battery

Total number of batteries required = 40 (One bank)

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ADVANTAGES OF UVFD

1.Cost Saving

2.Simple in Design

3.There is no need for a battery charger.

UVFD Battery capacity design is similar to that of a UPS. So the cost involved for the Battery Bank is same in both cases.

Saving : Approximate Cost for a 75 KVA Three phase UPS – **Rs 500000/-** (Without Battery)

DISADVANTAGES OF UVFD

1.Warranty will be void in case of new VFD

2.Less battery life due to continuous charging

3.Increased rating of the Dynamic break resistor capacity

4.CONCLUSION

Uninterrupted Variable Frequency Drive is an economically efficient way to support Induction Motor loads during total black out. This a very simple solution for the existing power quality issues in the VFD incomer supply. The feasibility of implementing the system on existing VFD's should be done on the basis of a techno commercial analysis. In case of VFD's without warranty and if there is any space concern to install the UPS along with the VFD then UVFD is the best available option for operating the critical motors in uninterrupted mode.

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