

DMI Manufacturing, Inc.
Energy Bank Unit (EBU) Description

Introduction

The EBU (Energy Bank Unit) was designed and developed by DMI Manufacturing, Inc. The EBU is truly unique in the industry, and its features and functionality represent an industry-leading breakthrough.

The EBU is protected with US and Foreign patents and provides five key features in a single unit:

- Total Harmonic Filtering
- Transient Surge Protection / Lightning
- Phase Balancing
- Power Factor Correction
- Voltage Sag Correction.

Many in the industry are already familiar with Power Factor Correction devices. These devices can range from large capacitor banks connected to a main panel to condition a building to smaller individual “capacitors “in a box” designs that are sized and connected to individual loads within a facility. Although there are many claims that these devices reduce kilo Watt hours (kWh), Power Factor correction alone cannot guarantee any savings.

However, the EBU is far more than just a simple power factor correction device. This paper will help explain how the EBU operates and reduces the electrical utility charges measured in kWh.

EBU Features Defined

As previously mentioned, the EBU provides five key features, all which interact, to provide kWh reduction. The five features are outlined in Table 1 below.

Feature	Description	Consumer Benefit
Patented Iterative Transformer Control Module	Evenly distributes load, captures wasted energy, and regenerates lost energy to useable power	Reduced power consumption and provides a <u>minimum</u> 11% kWh savings
Lightning/Surge Protection	Provides whole building lightning strike and surge suppression	No need to purchase protection devices for individual equipment
Eliminates Harmonic Distortion	Patented active filtration technology	Reduces equipment maintenance, extend life
Power Factor Correction	Power management techniques offset reactive power	Contributes to kWh savings. Reduces infrastructure costs
Phase Balancing	Distributes load across each phase equally	Contributes to kWh savings. Reduces infrastructure costs

Table 1. EBU Features and Benefits

The EBU is an electronic device with no moving parts or microprocessor control. The key to the EBU lies within the patented Iterative Control Transformer. This device interacts with all other devices in the unit to reduce kWh. This now sets the stage for a look inside the EBU.

Inside the EBU

The EBU is connected at the main with a spare breaker in parallel on the load side of the main or sub panels. Other EBU connections include a neutral line and at least one very good ground system.

The following components are connected between the hot line and the neutral line:

- At least one front capacitor;
- At least one arc suppressor device;
- A transient voltage surge suppressor to suppress undesired power spikes;
- An inductor/transformer;
- At least one metal oxide varistor;
- A second capacitor stage;
- A third capacitor stage in a “Wye” configuration;
- A snubber network;
- At least one arc suppressor device;
- A transient voltage surge suppressor.

These components may be arranged for operating as a single phase device. The components may be duplicated to create two connected sets that are arranged for operation as a two phase device. The components may also be tripled to form three connected sets that are arranged as a three phase device that includes at least one resistor having a predetermined resistance.

All capacitors have their own resistors to bleed off capacitance and are self-healing.

The EBU also includes a dual iterative transformer that consists of two circular magnetic coil cores with two wire wrappings arranged in opposition to one another. “Iterative transformer” means a transformer that acts as a dual choke or clamp and is capable of resolving multiple simultaneous power issues by iteratively making corrections, and then “correcting the corrections” in microseconds. In other words, the arrangement of the components in the EBU and these transformers include means and capabilities for correcting intrusive errors to corrections. Additionally, the present invention systems, devices, and iterative transformers function not only at standard 60-hertz cycles but also within a broad range of different cycles including 30 hertz to 100 hertz. The EBU can be installed in many applications with many different load types, and it interacts differently according to its load conditions. These applications include generators, solar inverters, power problems and many other applications as demonstrated in the field over a number of years.

Operation of the EBU

The EBU is connected to the load side of the main panel via a spare breaker. This connection places the EBU in parallel with the main. If there are multiple panels or transformers located within a facility, it will require a properly-sized EBU to be located at each panel and off each transformer load side. The EBU does not condition loads through a transformer. The EBU must be connected to a neutral as well as to a very good ground system, preferably its own ground. State and national electrical codes should be followed.

Fundamental to the operation of the EBU is the fact that the EBU is the least resistive element on the electrical system when installed. Hence, all power is sensed through the EBU on the load side. This eliminates the need to have an EBU located at every single load on the system like

some competitors. From the main(s) and/or transformer(s), the EBU is able to condition the power for the entire facility using one or multiple units.

Figure 1, below, represents a high level diagram of the operations within the EBU.

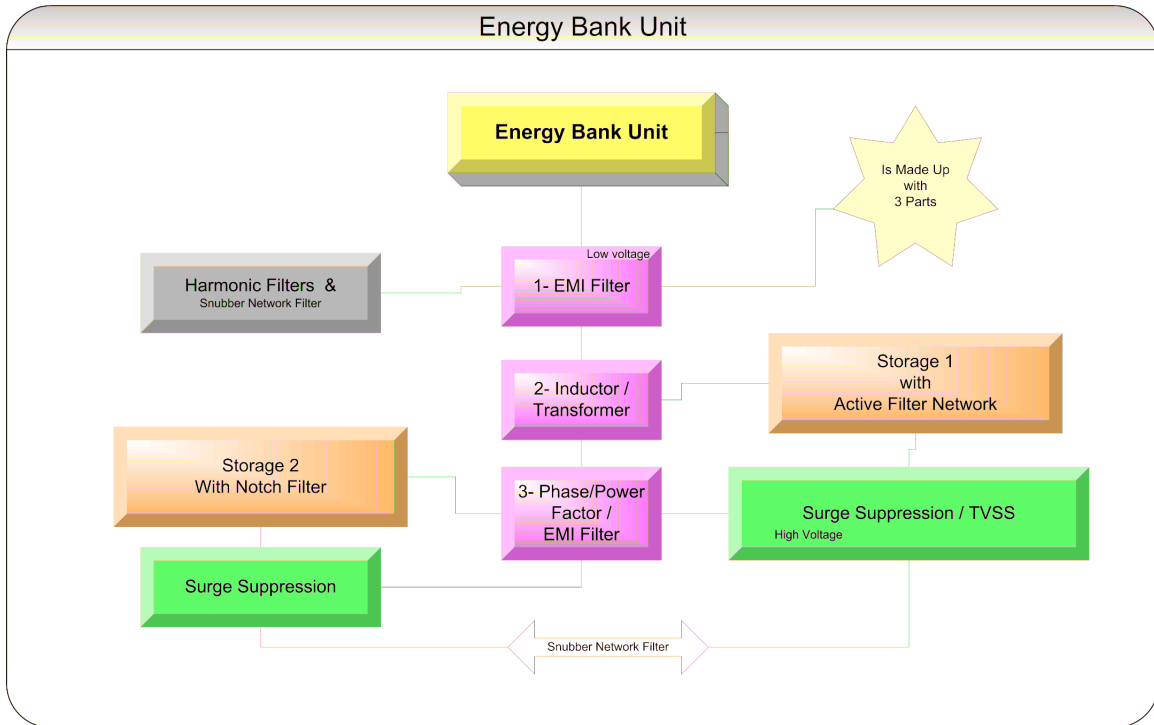


Figure 1. High Level Block Diagram of EBU

The Iterative control transformer modules (Number 2) represent the inductor in Figure 1. This inductor is connected to Storage 1, which is a small capacitor bank (C1). This provides for surge suppression as well as harmonic filtration. The Iterative transformer is also able to capture lost energy and store it for future use. The Iterative control transformer and Storage 1 provides for a voltage drop to Storage 2, which is a larger bank of capacitors (C2). Although Storage 2 acts as an EMI filter, it is primarily a notch filter stage setup for blocking out spikes with the harmonic section. The last stage (Stage 3) is designed for power factor correction, working in conjunction with the other stages. The voltage drop from the Iterative Control Transformer, in parallel with Storage 1, reduces the size and number of capacitors required for power factor correction for the whole facility. It also eliminates harmonics and transients that could adversely affect the larger capacitor bank (Storage 2).

The Iterative Control Transformer also acts as a clamp during inrush conditions. For example, if the main breaker is turned off and suddenly is turned on, all the loads in the facility would be activated. The EBU will clip the peak current inrush demanded by the loads by releasing the power saved by the charged capacitors in the Stage 3 locations.

Operational Scenarios

In order to describe how the EBU can save kWh, operational scenarios are provided below:

Case Study 1: Bottling Facility, Allentown, PA. – Low Power Factor

An Energy Bank Unit (EBU) model C-600 was installed and tested at a bottling facility in Allentown, PA. A series of timed tests with the EBU both “On” and “Off” demonstrated the following results:

- There was a cumulative energy (kWh) savings of 15.8% with the EBU “On”;
- There was a power factor improvement of 28.4% with the EBU “On”;
- Peak current (In-Rush) was reduced by 47.2%;

Bottling Facility (3 phase 480V) – EBU Test Results – March 4, 2009

	EBU OFF	EBU ON	Difference	% Change
Voltage	271.10 V	282.06 V	10.96	4.04%
Current	134.70 A	132.76 A	-1.94	-1.44%
PF	0.679	0.872	0.19	27.98%
Peak Current	328.76A	173.67A	-155.09A	-47.2%
Cumulative Energy (kWh)	13.77	11.60	-155.09	-47.17%

Case Study 2: Fast Food Restaurant – Reduction in Peak Current, Cumulative Energy and Harmonic Energy

An Energy Bank Unit (EBU) Model C-450 was installed and tested in a fast food restaurant just outside of Chicago. A series of timed tests with the EBU both “On” and “Off” demonstrated the following results:

- There was a Cumulative energy (kWh) savings of 19.1% with the EBU “On”;
- Current was reduced by 13.2% with the EBU “On”;
- Voltage was not affected by the EBU;
- Peak (in-rush) current was reduced by 28.0% with the EBU “On”;
- Harmonic energy was reduced by 19.6% with the EBU “On”;

(3 phase 208V) – EBU Test Results – February 27, 2009

	EBU OFF	EBU ON	Difference	% Change
Voltage	120.0 V	119.9 V	-0.10	-0.08%
Current	145.8 A	126.6 A	-19.20	-13.17%
Power Factor	0.94	0.93	-0.01	-1.06%
Peak Current	421.68A	303.48A	-118.2A	-28.04%
Harmonic Energy	79.03W	67.74W	-11.29W	-19.62%
Cumulative Energy (kWh)	11.0	8.9	-118.20	-28.03%

This case study demonstrates the ability of the EBU to reduce kWh even in conditions where the power factor is already high. Savings were achieved in this case due to a combination of reduced peak currents and the recycling of harmonic energy.

Further evidence of the EBU's effectiveness is demonstrated by an analysis of the utility billing for this location. The facility has three electrical services. The EBU was attached to only one of the three services. Comparing year to year data for kWh usage for the three services shows that during the three months after installation of the EBU, electrical consumption dropped by over 40% versus the prior year for the service with the EBU attached (#74856). Consumption rose by 3.7% and 2.0% for the other two services.

Average Daily kWh Usage by Electrical Service						
	Meter **95411		Meter **74855		Meter **74856	
	Current	Prior	Current	Prior	Current	Prior
Mar - Apr	52.2	46.9	899.7	854.5	222.8	383.3
Feb - Mar	51.6	52.9	899.1	887.3	456.1	890.5
Jan - Feb	51.6	50.1	847.6	854.0	647.7	1,008.7
Average	51.8	50.0	882.2	865.3	442.2	760.8
Difference		1.8		16.9		(318.7)
Pct Difference		3.7%		2.0%		-41.9%

Case Study 3: International Airport – Phase Balancing with Reduction in Peak Current and Cumulative Energy

An Energy Bank Unit (EBU) model C-600 was demonstrated at an airport. The selected service used during this test was a 3 phase 480V, which fed the runway lighting. A series of timed tests with the EBU both “On” and “Off” demonstrated the following results:

- There was a cumulative energy (kWh) savings of 13.2% with the EBU “On”;
- Current was reduced by 17.2% with the EBU “On”;
- Voltage was not affected by the EBU;
- The power factor increased by 8.8% with the EBU “On”;
- Peak (in-rush) current was reduced by 20.6% with the EBU “On”;
- Phase balancing, measured as the difference between the current on the highest and lowest legs, was improved by 20.0%.

Runway Lighting (3 phase 480V) – EBU Test Results – April 23, 2009

	EBU OFF	EBU ON	Difference	% Change
Voltage	289.05 V	286.03 V	-3.02	-1.04%
Current	160.78 A	133.2 A	-27.58	-17.15%
PF	0.91	0.99	0.08	8.79%
Peak Current	195.1	154.9	-40.2	-20.6%
Cumulative Energy (kWh)	7.49	6.50	-40.20	-20.60%

As we have shown in the scenarios above, it is possible to have minimal power factor correction while achieving kWh savings. Take for example a building such as a Bank. Let's assume the power factor correction is minimal from 0.95 to 0.98 (3% increase). Assume the harmonics are low and it is reduced from 6% to 2% (4% decrease). Line voltage is also well balanced so the line side of this Bank is very stable. Now, the load side of the Bank must be also taken into account. A bank is generally a minimal load facility based primarily on computer equipment and lighting (daytime and nighttime). Energy savings would be accumulated by minimal power factor correction, harmonic reduction and regeneration, line spikes, and voltage adjustments. This would fall into a category of a minimal 11% kWh savings keeping in mind the differences in the line voltage and current versus the load side voltage and current. This all contributes to kWh savings when all five features interact together. Again, the savings would be greater with less than desirable line side conditions combined with many noise producing loads.

Conclusion

Although many confuse the EBU with a simple power factor correction device, it is far more. The EBU provides 5 key features, all of which interact to provide for kWh reduction. Power factor devices alone are not effective for reducing kWh consumption as they claim.

Furthermore, the EBU has many patents surrounding the iterative control transformer module. This key IP is what allows the EBU to be an industry first.

With the operational scenarios presented above, it is much clearer that the kWh savings is not solely dependent upon power factor correction. It is based upon the five key features of the EBU interacting together all at the same time. Five key features that do not exist in any other product on the market today!