EBA1030C

INSTALLATION MANUAL

!

1. INTRODUCTION

The Grid Control Unit provides an affordable, reliable and convenient method of installing grid connected PV systems to distribution networks that have restricted or zero export limitations.

The EBA 1030C grid controller comes complete with contactors and CTs. Circuit breakers for inverters are provided in the IP66 metal enclosure to comply with network requirements. Utility companies may require extra measures of protection than what inverters can provide.

The EBA 1030C grid controller is a fully integrated unit with the ability to:

- Accurately monitor and measure forward and reverse direction of power flow in the mains of an installation.
- Accurately monitor and measure in real time, Voltage, Current, Frequency, Real Power, Apparent Power and phase fail.
- Manage and limit export power to the grid by way of mechanical isolation.
- Optionally Log and record export, consumption, generation, actual usage on site, current, VA, kWatt, voltage, frequency.
- Optionally ramp SMA and Power One inverters up and down as the zero export limit nears.

HOW IT WORKS

The unit is an all in one IP65 metal enclosure that incorporates sub-main connection terminals, CT connections, inverter communications, digital output connections, din rail three phase contactor and circuit breaker for the inverter AC output connections.

The controller is utility approved and typically throws a relay when solar generation exceeds load to ensure exports don't occur and create voltage rise.

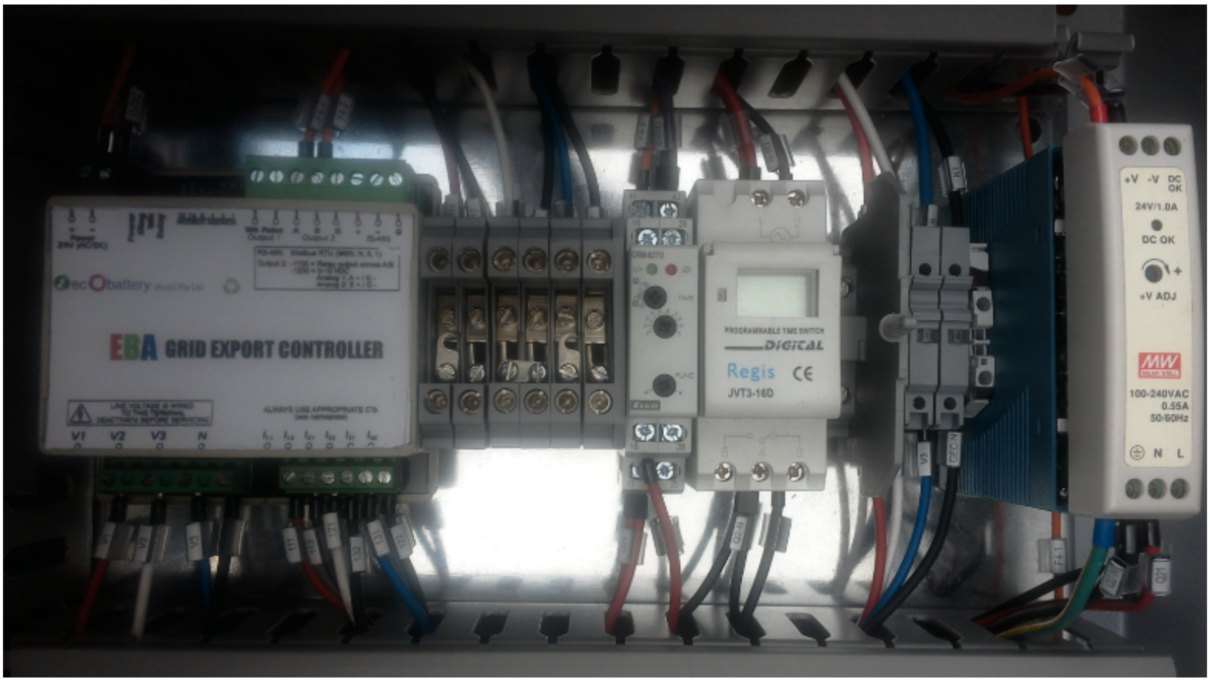
The ramp option controls the inverter output up or down to maximize solar generation without exceeding the load.

The 1030C continuously measures and monitors the value and direction of power flow at the main feed. The device can manage single and three phase systems through to multiple inverter systems up to a maximum of 30kW. When the sites power demands are less than what is generated the 1030C prevents the over generation of power from being exported back to the grid by isolating the selected inverters via the contactor provided. As the power demand increases the 1030C will measure and monitor the value and then reconnect the inverter to compensate the increase in demand.

Easily Configurable

The configuration can be changed during commissioning and then protected by seals to ensure the integrity of the system. Normally, the GCU is set at factory and no need for installation setup.

The 1030C Zero Export Controller provides inverter output control by monitoring the site power at the point of connection to the inverters to maintain the maximum amount of solar power to be generated without exceeding the requirements set by the local network operator.



The inverter controller can be wired to suit many inverter brands with or without power ramping control. The inverter control has a built in relay provided to isolate the inverter. The EBA1030C has Bi-directional CT's that connect to the electrical circuits.

Functionality

When power is in a forward direction (consumption) the EBA will connect auxiliary power generators (PV Solar) to the grid. As power exports this will then de-energize the contactor thus isolating unwanted over generation from the supply. All connections are energized to connect, so on any sort of failure items are to disconnect/isolate on de-energize.

SPECIFICATIONS

Power Limit Up to 50kW
3CTs 100mA 50amps+
Power supply 24VDC @ 1 amp for EBA controller & timer
Inverters 3-Phase Inverters
Contactor 3 x 40A relay per phase
Box Material Power coated IP65 Rated Metal Box
Dimensions 500 x 400 x 200mm
Weight 15kg
Environmental -20 C to 60 C, 5% to 95% R.H.
Accuracy >.1/2,%
Power Consumption Max 5W
STATUS INDICATIONS
Power OK, Fault RE, Export, Ramp signal
EXPANSION INTERFACES
Optional Wh pulse Interface to cascade timers for Ramp
Communications Modbus RTU RS485 connection

GETTING STARTED

Installing the EBA involves the following steps:

Install neutral connection for the mains power supply from the Grid to the neutral bar.

Install the 3 phases mains supply to the bottom of the contactor.

The Solar power is connected to the top of the 3 phase circuit breaker.

Connect corresponding phases to “V1, V2, and V3” as close to grid CT’s

Connect the OUTPUT to the SOLAR INVERTER into the bottom of the contactor.
INPUT CT’S

Connections for the CT’s to corresponding phases

(keeping cabling to the shortest length stops unwanted interference) starting from the left PH1 white, black and so on. CT’s are directional, look for the arrow and place accordingly. All CT links should be open.

The Polarity of current transformers is extremely important. Wrong connection of the current transformers can cause false operation of the device.

Connect as shown with split CTs external -yellow LED should be off unless exporting.

GC Troubleshooting

Basic troubleshooting and commissioning steps for implementation of GC meters in various wiring systems.

Danger Line voltages up to 600 VAC are present on the input terminals of the device and throughout the connected line circuits during normal operation. These voltages may cause severe injury or death. Installation and servicing must be performed only by qualified, properly trained personnel.

GC Meters calibrated for use with 5A CTs have special precautions that must be taken. **NEVER** *disconnect a 5A CT without shorting it first. These CTs are capable of producing very high voltages and arcing when not shorted, and as a result may cause serious injury or death*!

Always ensure that 5A CTs are shorted via a shorting block, or that power to the circuit which the CT is installed on is off before disconnecting from the meter. GC meters with 5A inputs may be identified by the part number or by the yellow sticker on the face of the unit as below: If unsure, contact the vendor to determine GC type.

Power to the GC is provided by to the upper left (black) plug in two-position connector. Valid power supply ranges are: 20-26VDC or 18-24VAC / 100mA Power transformer is capable of sourcing at 100mA. Preferred power is 24v DC, and is attained by using a DIN rail mount switching power supply.

The green Power LED should illuminate when the GC is receiving power, however note that the LED will continue to be illuminated even during low voltage conditions. That is, the LED is not an indication of GC "sanity" or "operation", but rather that power is simply available.

Note that voltages can sag when other equipment is powered on, especially when using a small VA control transformer. Therefore, it is best to verify the input voltage using a DMM, on the terminals of the black plug-in power connector to ensure that the proper voltage is present.

2. DIAG LED: The Red DIAG (diagnostic) LED has a variety of functions. Depending on the state of the LED, it can signify a number of conditions. The table below summarizes the LED states and related conditions: LED State Condition OFF Normal operation, or insufficient power supply voltage (see step 1) Fast Flashing Input Voltages below threshold (typically ≤ 25VAC). Solid (ON) Reverse NET Power (kW) condition Slow Flashing Reverse Sequence (typically this is disabled from the factory) Double-Flash, pause, Double-Flash Firmware update mode check: DIP Address switch must not be"0". Potential firmware problem.

To test for GC functionality or "sanity", it is best to connect power and disconnect voltage inputs. In this configuration, the RED LED should flash rapidly. This is an indication of proper operation. Note: this feature can be disabled in software, however it is ON by default from the factory. If the LED shows a Double-Flash followed by a short pause and another Double-Flash, it may be indicative of Firmware problems. Verify that the DIP switch is set to an address other than "0". By default, from the factory, the address is set to "1". If the address DIP switch is 0, set it to "1", and reset the power to the GC (unplug the black power plug for 5 seconds, and plug it back in).

During normal measurement operation (ie: voltage inputs above 25VAC), the DIAG LED should be OFF. If the LED stays ON constantly, or turns on an off erratically, it is an indication of reverse power detection. This condition arises when the SUM of the real power (watts) in all three phases is negative. Please note however, in a three-phase system (assuming balanced phases), if only one of the phases is reversed, the NET will continue to be positive.

TROUBLESHOOTING via SOFTWARE:

Use of the GC Console software for troubleshooting and commissioning is highly recommended. The software is capable of showing all real time and accumulated parameters, as well as allowing viewing and changing of configuration parameters. First, an

RS485 connection must be available. Typical solutions are RS232-to-RS485 or USB-toRS485 converters.

Many RS485 converters are labeled A/B. Typically A is wired to "-" and B is wired to "+". However, if communications does not work, try to switch the polarity. For short runs, it is not necessary to connect the "GND" connection. Install the GC console software. Make sure that the serial or USB converter is attached to the computer, and start the software. Click on the "Port" menu, and ensure that the Drop-down box is selected to the COM port associated with the Serial port or USB where the RS845 converter is connected. By default, the GC is configured for a Baud Rate of 9600bps. Click "OK" Click on Options > Device Address, and ensure that the address is configured to the same setting as the DIP switch on the GC. If the settings are correct, the text should show COMM OK! Click Close. At this point, real time data should appear on the screen. If communications is still timing out (status can be observed in the status bar across the bottom of the screen), verify the address, COM setting, and RS485 wiring polarity. If problems persist, please refer to Modbus RTU Troubleshooting, or contact the vendor. Device appears as it is plugged in.

The GC Console displays all real-time and accumulated parameters which the GC measures. Using this tool, it is easy to check for proper wiring and operation of the system. When connected to an active system, the measurements are shown on the screen and updated approximately once per second. The software provides the capability to ensure that the wiring is correct and that the measurements are valid. There are typically two common problems associated with CT wiring: 1. Current Magnitude: caused by improper CT selection, CT ratio configuration, and physical CT installation or damaged CT. 2. Power Direction / Low or negative Power Factor: caused by reversed CT orientation on the wire, reversed CT polarity (wiring to GC) or incorrect voltage/current phase matchup.

These steps may only be performed on non-5A input meters. Please see the disclaimer at the beginning of this application note. Current Magnitude: If possible, take a measurement from the line where the GC CT is installed using a clamp on style amp meter. In most typical three-phase installations, the loads should be fairly balanced, and the currents should be approximately equal in all three phases. If the currents are suspected, perform the following diagnostics: Using a mV meter set to AC measurements, measure the mV reading on the input terminals of each CT (between the I11 to I12, etc). Non-5A GCs are configured to interpret a full scale of approximately 333mV AC. That is, a measurement of ~333mV AC is proportional to the full scale rating of the GC (as indicated in the part number and the front yellow sticker). For example:

Full scale is 250A If mV AC measurement on current inputs is 100mV, calculated measured current is approximately 100mV/333mV * 250A = 75A. Keep in mind that this measurement is an approximation. If this calculation yields the same approximate result as the GC measurement, the problem is before the GC. Ensure that the CT wiring is not shorted and that the CT is not damaged. In the case of split core CTs, ensure that the two sides are properly mated together.

POWER FACTOR

Verify that the power factor (PF a, PF b, PF c) readings are within 0.800 to 1.000. Readings that are very low or have a negative sign (a marginally negative power factor ie: -0.950 to -1.000 may be normal) should be given closer examination. Most installations have a nominal power factor within 0.800 to 1.000 (positive). This indicates a lagging power factor, and is normal (caused by motors, fans, etc). An excessively low power factor may be an indicator of incorrect voltage to current phase matching. *It is imperative that the voltages measured by the GC on the V1, V2, V3 terminals, correspond to the same phases as the CTs on I11/I12, I21/I22 and I31/I32.* The easiest way to verify this is to physically inspect the wiring to ensure that the V1 voltage and I11/I12 CT are both connected to the same phase (similarity for phases 2 and 3*). A mismatch may be evidenced by a poor power factor reading*. Verify that the power (Pa, Pb, Pc) shows the correct sign. For a typical installation, with correctly wired and oriented CTs, the power should show POSITIVE values. This indicates that power is being imported (consumed). In a correctly installed system, a negative reading indicates that power is being exported (generated). In most load-only systems, the cause for this is either reverse polarity of the CT into the Ix1, Ix2 terminals or incorrect orientation of the CT on the wire. The solution is to reverse the CT on the wire, or reverse the input polarity. However, before taking these steps it is prudent to understand the origin of the problem as haphazard re-wiring may make the situation worse. Always verify the correct wiring of the installation with the wiring diagram provided by the vendor.

The GC can be used with a variety of Current Transformers. Because of this, care must be taken to properly scale the data values, pulse and analog outputs. This document discusses the methods used to properly configure a system using various CT types. The GC was designed from the perspective of ease of installation and use. As a result, it was required to streamline the method used for CT ratio configuration. To adhere to industry standards, the GC treats all CT types as though they have a 5A output. This allows a consistent approach for system configuration, regardless of the CT type being used. For any given CT type, and full scale, the GC effectively registers a 5.0A reading. Although not all CTs have a 5A output, for the purpose of GC calculations, their ratio should be treated as such. The added advantage of this approach is that system software (DDC, PLC, SCADA, etc) may tread every GC identically, regardless of the actual CT type in use. Regardless of the CT type used, the correct CT ratio must be entered into the GC Modbus registers (CT ratio Primary / Secondary ; register 40131, 40132 respectively) for GC to compute the properly scaled values in the floating point register data bank. 5A CTs with GC When using 5A output CTs, the CT primary value must be written to register 40131, and the value “5” must be written in 40132. Example: when using a 400:5 A CT Set 40131 = 400 Set 40132 = 5 The effective CT ratio is 400/5 = 80. This multiplier may need to be used for the analog outputs (if they are computed without the CT ratio applied). For model 1200 meters (analog outputs), in most cases, the Calibration Sheet shows the analog output configuration WITHOUT CT ratio multipliers since typically the factory is unaware of the CT ratio ahead of time.

Introduction to Current Transformers

Current transformers are devices used to scale large primary currents to a smaller, easy to measure, secondary currents. Like a traditional voltage transformer, the ratio of the windings determines the relation between the input and output currents. Current transformers of various shapes and sizes are used as an interfacing solution between high currents and instrumentation devices.

Current transformers (CTs) are an indispensable tool to aid in the measurement of AC current. They provide a means of scaling a large primary (input) current into a smaller, manageable output (secondary) current for measurement and instrumentation. This indirect method of interfacing allows for easy installation and provides a high level of isolation between the primary circuit and secondary measurement circuits. CTs are available in various sizes, designs and input ranges and output signal types.

Basics A CT is useful for measurements made on AC waveforms., there is no physical connection made to the measured line. The CT uses magnetic fields generated by the AC current flowing through the primary wire to induce a secondary current. The ratio of the number of secondary turns to the number of primary turns determines the amplitude of the current on the output. The output of a CT acts as a current sourceCT cores can be of a solid (closed) or split (open) type.

The solid/split core defines how the CT core is designed, and how it can be installed. Solid core CTs feature a closed loop, which the primary conductor must be passed through. Split core CTs can be temporarily opened to facilitate easier installation.

When using a split core CT, the primary conductor need not be disconnected to install the CT, and in most cases, the conductor can continue to carry current while the CT is being installed. Split core CTs have a large advantage in installations where shutdowns are not practical or economical.

CT Output Types

5A Output CTs

Traditionally, CTs were designed to have a full scale output of 5A for a given full scale primary current. Typical full scale input currents ranged from 50 to 2000 amps. This would be represented as 50:5 or 2000:5. In a 2000:5 CT, 5A flows in the secondary winding when 2000A is flowing through the primary winding. By changing the number of secondary windings, the CT manufacturer defines the input full scale. 5A is a considerable amount of current, and it was designed to be used with electromagnetic meters, to provide the power to move the magnetic needles or power protective relays. This style of CT has advantages in that the metering equipment is all configured for a 5A input. The appropriate CT can therefore be chosen to determine the full scale measurement range of the metering equipment.

As far as the meter is concerned, it will see a range between 0-5A, since the CT is chosen for the proper maximum primary current. Many measurement and monitoring devices support 5A CT inputs, as this has become a defacto standard in the metering industry, especially for large building or sub-metering installations. However, due to the relatively large (5A) current requirement, these CTs require a larger, heavier core, and a larger wire gauge. This translates to a larger, heavier final product and higher costs.

CTs can be extremely dangerous because of the large voltages that are induced when the CT secondaries are not shorted. Since a CT acts as a current source, following Ohm's law, V=IR. If the resistance is increased (a very high value when open circuited), the induced voltage becomes very high. Many of these CTs have enough power to cause large arcing across open secondary wires.

Special shorting blocks are required to ensure that the CTs remain shorted, even if disconnected from the meter. The induced voltages are large enough to ***cause serious injury or even death*** if the appropriate precautions are not taken to prevent open circuiting the output. The added cost and burden of the shorting blocks and their installation must be considered when using these CTs. 5A CTs are available in solid and split core varieties, however, typical 5A split core CTs are quite large, and extremely expensive. It is not unusual for a 5A split core CT to exceed the price of the metering device. In some installations however, such as large bus-bars, the use of these CTs is unavoidable.

With the advent of digital metering, the need for a large output current became unnecessary.

mA Output CTs

The advantage of these CTs is the smaller size and cost, as well as much safer conditions when the CTs are not shorted. Many models have built in voltage suppression devices that will limit the output voltage to a low level (typically around 20V) when opened. As with most types of CTs, the mA output types are available in solid and split core variants. The solid core CTs can have extremely high precision due to the higher quality core and windings that are available. Accuracy, including linearity and phase shift can actually exceed the revenue grade 5A output CTs. Split core varieties tend to have lower accuracy, however their small size and extremely easy wiring makes them ideal for many installations. A mA output split core CT can cost 1/3 that of a 5A output split core CT. The main disadvantage of these CTs is that the metering equipment is tied to the CT type, and the full scale is defined by the calibration within the metering equipment.

mV Output CTs

Using the same hardware as the mA output CTs, mV CTs contain an internal burden resistor that converts the mA signal into mV (V=IR). The resistor can be chosen such that a pre-determined output voltage is generated when a full scale current is flowing. Typical full scale output voltages include 333mV and 1V. For example, a CT can be defined to output 333mV when 100A is flowing through the primary wire. The added advantage of this type of CT is that the output voltage always remains safe, regardless of the connection of the secondary wires. Also, because the full scale current is defined by the burden resistor inside the CT, the metering hardware can be universal (as with 5A CTs), and changing the full scale input current is determined by the CT chosen.

However, mV CTs face disadvantages. Specifically, the accuracy of the CT is greatly determined by the size of the burden resistor. Typically, manufacturers do not trim each CT, and therefore the tolerance of the resistor plays a large role in determining accuracy. Moreover the difference in calculated resistor value and actual resistor value (resistors do not come in an infinite array of values, so the manufacturer must choose the closest value available) influences overall accuracy. To complicate matters further, typical resistor values are small, and as such the resistance of the secondary wires plays a role in influencing the signal.

When using mV output CTs, lead length should be kept to a minimum to avoid errors due to introduced resistance, as well as noise issues due to pickup. 5A and mA output CTs have the added advantage of higher noise immunity because of their characteristics as a current source.

CT types must never be mixed, and only CTs designed for the metering apparatus should be used with the device. Use of the incorrect CT Output type may cause severe damage to the equipment, and create a potential hazardous situation. CT Installation During CT installation care should be taken in the placement of the CT primary wire. Ideally, the wire should be placed in the middle of the CT to obtain the best performance. When using split core CTs, the wire should be placed either in the middle, or as far away from the opening mechanism as possible. The air gap created by the opening mechanism induces error in the magnetic field and therefore the output accuracy. A quick method to change the CT turns ratio is to add multiple primary turns. For example, if the primary wire is passed through a 2000 turn CT 4 times, the effective ratio becomes 4:2000, (1:500). This method in effect decreases the effective full scale of the CT, and has the added advantage of increasing accuracy by increasing the effective performance of the core. CT Labeling .

The polarity of the CT must be taken into account to avoid phase reversal situations. The voltage and current measurements must have the same polarity to keep the power factor and direction of power flow measurements accurate and consistent. Most CTs are labeled with a means that shows which side of the CT should face either the source or the load. Alternatively, a dot (or the label “H1”) defines the direction as flowing into the CT (ie: the dot should face the “source” side).

The output wires are typically designated with the labels “X1” and “X2”. X1 corresponds to H1, or the input. The figure below shows various CT wiring notations. X1 X2 SOURCE LOAD H1 X1 X2 H1 I CURRENT INPUT X1 X2 *Care must always be taken with both the physical orientation of the CT*, as well as the wiring polarity. Instructions must always be followed as per the metering manufacturer’s manual and labelling.