

Conext™ RL and ComBox Export Limiting Control Application

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Application Note

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DANGER

RISK OF FIRE, ELECTRIC SHOCK, EXPLOSION, AND ARC FLASH

This Application Note is in addition to, and incorporates by reference, the relevant product manuals for each Conext product. Before reviewing this Application Note you must read the relevant Conext product manuals. Unless specified, information on safety, specifications, installation, and operation is as shown in the primary documentation received with the product. Ensure you are familiar with that information before proceeding.

Failure to follow these instructions will result in death or serious injury

Objective

The purpose of this application note is to explain about the use of Conext RL inverter, Conext ComBox and Acti9 iEM3x55 self-powered energy meter for Self-consumption / Export Limiting Control / No Export application. This application is achieved by limiting Conext RL output based on read data from energy meter installed at Main Switch Board (MSB).

This application note does not cover:

- 1ph Self-consumption applications for grid connect PV Storage system with only DC Coupling solar using Conext MPPT Solar Charge Controller
- 3ph Self-consumption applications for grid connect PV Storage system
- Off Grid Standalone PV Storage system
- Backup Power application
- Energy and Load Management application
- Microgrid PV system installed and act as providing spinning reserve to Generator

The core products below will be required for this application:

- Conext RL 3000E/4000E/5000E
- Conext ComBox
- Acti9 iEM3255 (CT connect) / Acti9 iEM3155 (direct connect up to 63A)
- PowerLogic Current Transformer (CT) 200A/250/300A:5A (up to Ø21mm Cable)
- Acti9 iC60H 16A/20A/25A MCB (for Conext RL 3000E/4000E/5000E)

The products below are required for Meter and Current Transformer (CT) Installation:

- Linergy TR Current Transformer (CT) Screw Terminal Blocks Measuring Terminal 1P
- Linergy TR Current Transformer (CT) Screw Terminal Blocks Neutral Disconnect 1P
- Linergy TR Current Transformer (CT) Screw Terminal Blocks Plug-in Bridge 2P
- Acti9 STI Isolatable Fuse Carriers 1P+N or 1P, 500V, 10x38mm
- Acti9 iC120H 63A MCB (for Acti9 iEM3155)

The 3rd party products below are required for Meter and Current Transformer (CT) Installation:

- Eaton Cooper Bussman 500mA, 500V Fuse, 10x38mm Class gG/gL
- Remarks: Fuse protecting Acti9 iEM3x55 must be at least or close to 250mA and suitable for 277V voltage operating.

The 3rd party products below are required for the ModBus RTU (RS485) network:

- 120-ohm resistor, Metal Film 0.25W (1-2 units)
- CAT5/CAT5e/CAT6 RJ45 network cable (straight-through)

▲ CAUTION
EQUIPMENT DAMAGE
Do not use a crossover CAT5/CAT5e/CAT6 RJ45 network cable.
Failure to follow these instructions can cause damage to connected equipment.

Schneider Electric Product	Part Number
Conext RL 3000E - 3kW 1ph Inverter (Max Output: 13.9A)	PVSNVC3000/PVSNVC3000S
Conext RL 4000E - 4kW 1ph Inverter (Max Output: 18.2A)	PVSNVC4000/PVSNVC4000S
Conext RL 5000E - 5kW 1ph Inverter (Max Output: 23.2A)	PVSNVC5000/PVSNVC5000S
Conext ComBox	865-1058
Acti9 iEM3155 - Direct Connect self-powered Energy Meter (<63A)	A9MEM3155
Acti9 iEM3255 - CT Connect self-powered Energy Meter	A9MEM3255
PowerLogic Current Transformer (CT) 200A/5A suitable for <22mmsq Cable	METSECT5ME020
PowerLogic Current Transformer (CT) 250A/5A suitable for <22mmsq Cable	METSECT5ME025
PowerLogic Current Transformer (CT) 300A/5A suitable for <22mmsq Cable	METSECT5ME030
Linergy TR Current Transformer (CT) Screw Terminal Blocks Measuring Terminal 1P	NSYTRV62TTD
Linergy TR Current Transformer (CT) Screw Terminal Blocks Neutral Disconnect 1P	NSYTRV62NE
Linergy TR Current Transformer (CT) Screw Terminal Blocks Plug-in Bridge 2P	NSYTRAL62
Acti9 STI Isolatable Fuse Carriers 1P+N 500V, 10.3x38mm	15646
Acti9 iC60H 10kA @ 240V/415V C Curve, 16A, 1P - for Conext RL 3000E	A9F54116
Acti9 iC60H 10kA @ 240V/415V C Curve, 20A, 1P - for Conext RL 4000E	A9554120
Acti9 iC60H 10kA @ 240V/415V C Curve, 25A, 1P - for Conext RL 5000E	A9F54125
Acti9 iC120H 15kA @ 240V/415V C Curve, 63A, 1P - for Acti9 iEM3155	A9N18445

3rd Party's Product	Part Number
Eaton Cooper Bussman Compact Circuit Protector, 2P, 600Vac	CCP-30-CC
Eaton Cooper Bussman 500mA, 500V Fuse, 10x38mm Class gG/gL	C10G0.5
Eaton Cooper Bussman Base Mount Double Row Terminal Blocks	KUXSC6S2644

Use Case Scenario / Technical Challenge

There are several occasions where the Asset Owner would be required by utility to implement this application to their grid connected PV system. Usually this requirement is applicable to PV system connecting to the Low Voltage (LV) Distribution Network.

This application is mostly known as “Self-Consumption” or “No-Export” in most countries where PV energy is not allowed to be exported back to the grid. Certain countries or utility may allow a specific amount of PV energy to be exported, and hence the application could be known as “Export Limiting Control”.

Listed below are the usual reasons where Self-Consumption application is required by utility or energy retailer:

- **The Asset Owner could not secure a Power Purchase Agreement (PPA) or Net Excess Feed-In Tariff (FiT) from Energy Retailer**

The Asset Owner is not allowed to export excess PV energy to the grid because the Energy Retailer is not obliged by law to provide revenue to the Asset Owner for the unused PV energy. In some countries, the Energy Retailer and Distributed Network Service Provider (DNSP) are the same entity, which govern the energy market in the country and they have the choice to source the energy from their preferred long term Energy Generator.

- **Grid Voltage is too high due to saturated grid tied solar systems in the area**

PV Inverter increases AC Output Voltage in order to export solar energy. Due to large solar penetration in the network and the fact most Grid Connected PV Inverters are transformerless, it will cause the grid voltage to increase along the distribution line resulting in large voltage fluctuations.

- **High Penetration of Solar Energy which introduces Reverse Power flow that could disrupt Distribution Network Assets**

This could lead to increased short circuit currents, fault level, affecting protection coordination and sensitivity, and introduction of harmonics and transients.

- **Local site’s existing LV/MV Transformer has reached its capacity**

When PV System is connected to Shared LV Circuit or Dedicated LV Circuit that utilised Shared Transformer with other Load, the capacity of Transformer may be reached and hence Export Limiting Control may be required to avoid upgrading Local Existing Transformer

In general, Residential PV System for Conext RL and ComBox Export Limiting Control Application Note will cover the categories below:

- 1ph Grid Connect PV System without Battery Storage
- 1ph Grid Connect PV Storage and AC Coupling Solar

Introduction to Features

Conext RL is a 1ph grid connect inverter that produces energy whenever there is solar irradiance. In order to control or limit the energy output of the inverter, a control device which could perform algorithm calculation with ModBus RTU (RS485) is required. The algorithm will be performed based on measured data reference from a point.

In this case, Conext ComBox is the control device which performs algorithm calculation, and Acti9 iEM3x55 meter connected at Main SB is the device which is feeding data to Conext ComBox. With the information from Acti9 iEM3x55, Conext ComBox will write to Conext RL register to re-define its output limit in order to avoid generating excess solar energy to be exported from Main SB back to the Grid. In other words, the Conext RL will only output energy based on local measured Load Demand. This application will require the inverter to respond quickly to load change.

Feature of Conext ComBox which will be utilized:

Zero Inverter Output This feature allows Conext ComBox to power curtail AC Coupled Conext RL inverter via ModBus RTU (RS485). It is applicable with or without Conext XW+/SW Inverter but it requires Acti9 iEM3x55 (or meter compatible with Conext ComBox). ModBus RTU (RS485) network must be established, with Conext ComBox set as Master Device for this feature to work.

Features of Conext XW+/SW which will be utilized:

AC Coupling This feature allows the Conext XW+/SW Inverter to be AC Coupled with the Conext RL Inverter at the Load side (AC Out or AC Load). Conext RL is a 1ph Inverter and hence if it is installed for PV Storage application, the Conext XW+/SW shall remain as 1ph and connected at the same phase. AC Coupled Conext RL total output current shall not exceed Conext XW+/SW continuous output current, with a RL: XW+/SW as 1:1 ratio.

Charge Block This feature allows the Conext XW+/SW Inverter to define when to disallow the Battery to be charged using AC Energy. For users who intend to use excess solar energy from the Conext RL to charge Battery Storage when using Conext XW+, Charge Block gate shall be opened during peak sun hours and allow charging from AC Energy generated by the Conext RL, before being power curtailed by the Conext ComBox.

Feature of Conext XW+ which will be utilized:

Grid Sell This feature allows the Conext XW+ to selectively export excess solar energy from DC Coupling solar. For self-consumption application, Grid Sell shall be **Disable**. User can choose to **Enable** but define Maximum Sell Amps as **0A** to minimize current draw from grid for maintaining Conext XW+'s control loop. This feature is not available on the Conext SW product.

Feature of Conext SW which will be utilized:

AC Support This feature allows the Conext SW Inverter to conduct Load Shave without drawing current from Grid as long as the Battery State-Of-Charge (SOC) or Battery Voltage condition allows it. This feature is not available on Conext XW+ product.

Meter Connection at Main SB

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E or CSA Z462.
- This equipment must only be installed and serviced by qualified electrical personnel.
- Never operate devices energized.
- When opening devices with cabinet doors identify the power source, de-energize, lock-out, and tag-out and wait 2 minutes for circuits to discharge. See applicable “Lock-Out Tag-Out (LOTO) Procedure” on site.
- Always use a properly rated voltage sensing device to confirm all circuits are de-energized.

Failure to follow these instructions will result in death or serious injury.

It is important to have the Acti9 iEM3x55 meter installed at the closest point to the Grid Incoming Supply, on the same phase which Conext RL connects. The meter shall be wired in a way where **energy consumed by premise is read as positive**.

- If the user has incoming feeder <63A, Acti9 iEM3x55 meter could be used with direct connection to Live and Neutral cables. The meter will require 63A MCB at upstream to protect itself from fault current coming from grid. Meter must be installed at upstream when used with a Contactor.
- If the user has incoming feeder of >63A, Acti9 iEM3255 meter could be used with external Current Transformer measuring the Live cable. This approach is recommended because Main SB may not have sufficient space to install additional meter or existing cable is not suitable to be sliced for direct connected meter.
 - I/E: Current Transformer 250A/5A (PART#: METSECT5ME025) is suitable for up to 125A Feeder Supply for Class 1.0 and up to 80A Feeder Supply for Class 0.5

Feeder CB	PVC Cable Size	PVC Cable Size	Cable Diameter	Class 0.5 CT	Part Number	Class 1.0 CT	Part Number	CT Diameter
<63A	16mmsq	5 AWG	7.3mm	250A/5A	METSECT 5ME025	200A/5A	METSECT 5ME020	22mm
80A	25mmsq	3 AWG	8.9mm	250A/5A	METSECT 5ME025	200A/5A	METSECT 5ME020	22mm
100A	35mmsq	2 AWG	10.1mm	300A/5A	METSECT 5ME030	200A/5A	METSECT 5ME020	22mm
125A	50mmsq	1/0 AWG	11.9mm	300A/5A	METSECT 5ME030	250A/5A	METSECT 5ME025	22mm

Feeder CB	XLPE Cable Size	XLPE Cable Size	Cable Diameter	Class 0.5 CT	Part Number	Class 1.0 CT	Part Number	CT Diameter
<63A	16mmsq	5 AWG	9.5mm	250A/5A	METSECT 5ME025	200A/5A	METSECT 5ME020	22mm
80A	25mmsq	3 AWG	11.2mm	250A/5A	METSECT 5ME025	200A/5A	METSECT 5ME020	22mm
100A	35mmsq	2 AWG	12.4mm	300A/5A	METSECT 5ME030	200A/5A	METSECT 5ME020	22mm
125A	50mmsq	1/0 AWG	13.9mm	300A/5A	METSECT 5ME030	250A/5A	METSECT 5ME025	22mm

- Current Transformer Class 1.0 would suffice for this application because Power and Energy measurement is not for revenue purpose. Most 1ph Residential Premise in Australia will have <100A feeder supply and hence it is recommended to use 250A/5A Current Transformer for this application.

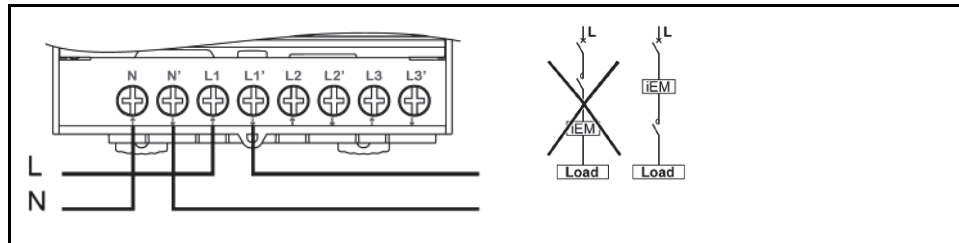


Figure 1 Feeder Cable Directly Wired to Acti9 iEM3x55 Meter

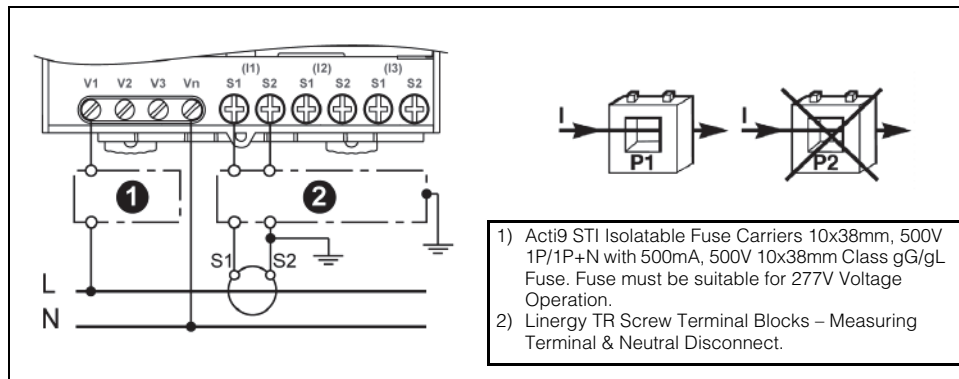


Figure 2 How Current Transformers Shall Be Wired to Acti9 iEM3x55 Meter

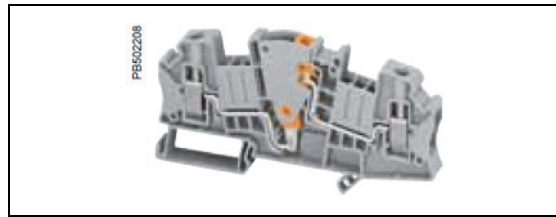


Figure 3 Linergy TR Screw Terminal Blocks - Measuring Terminals

Figure 3 shows Linergy TR Screw Terminal Blocks – Measuring Terminals: Knife disconnect, 500V, 30A. This is required to connect external Current Transformer to the iEM3255 Meter.

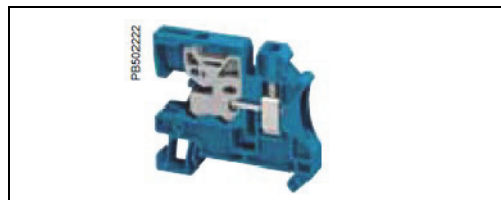


Figure 4 Linergy TR Screw Terminal Blocks - Neutral Disconnect

Figure 4 shows Linergy TR Screw Terminal Blocks – Neutral disconnect: 250V, 32A. This is required to connect external Current Transformer's Neutral to Ground.

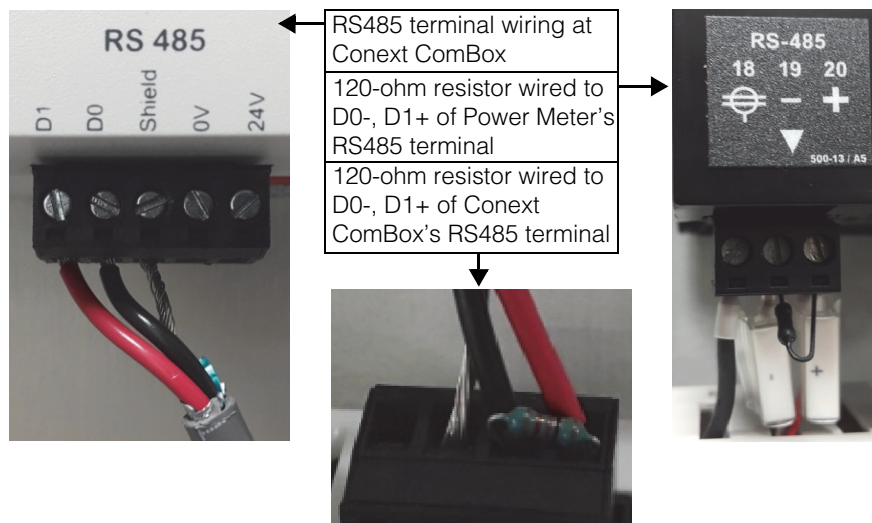
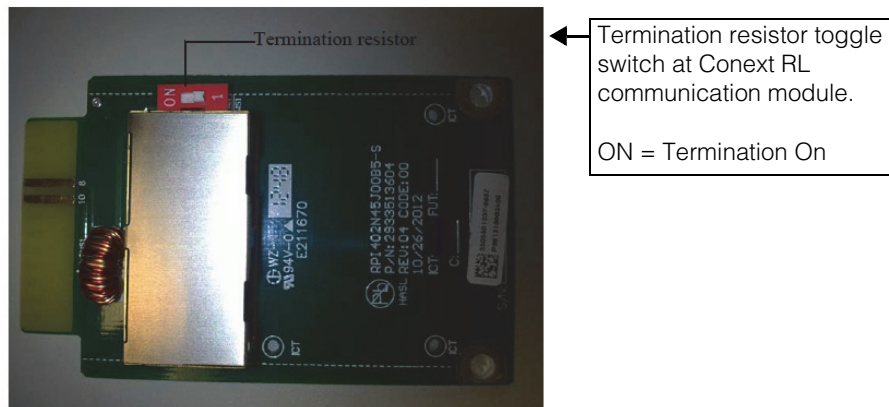
Communication Connection

The Conext ComBox being the Master Controller in Self-Consumption application must be connected to Conext RL and Acti9 iEM3x55 meter on the same ModBus RTU (RS485) network. The serial connection of ModBus RTU (RS485) will need to be terminated at both ends using 120-ohm resistor.

The Conext RL communication module has a built-in termination resistor toggle switch, hence if the Conext RL is the last device, the user will only require a single 120-ohm resistor at Acti9 iEM3x55 meter because in most cases, Acti9 iEM3x55 meter will be installed at the Main SB located furthest from PV system.

If the Conext ComBox is the last device, user will require two 120-ohm resistors at both Conext ComBox and Acti9 iEM3x55 meter because these two devices do not have built-in termination resistor toggle switch.

The 120-ohm resistor shall be connected to D0-, D1+ of the ModBus RTU (RS485) network cable.



Architecture 1: Only Conext RL

Figure 5 and Figure 6 are typical architectures of how the Conext RL Inverter, Acti9 iEM3x55 meter, and the Conext ComBox would be connected in a 1ph Grid Connected PV system. Regardless if Conext RL is connecting to Sub DB or Main SB, the Acti9 iEM3x55 meter must be monitoring the Main SB incoming supply.

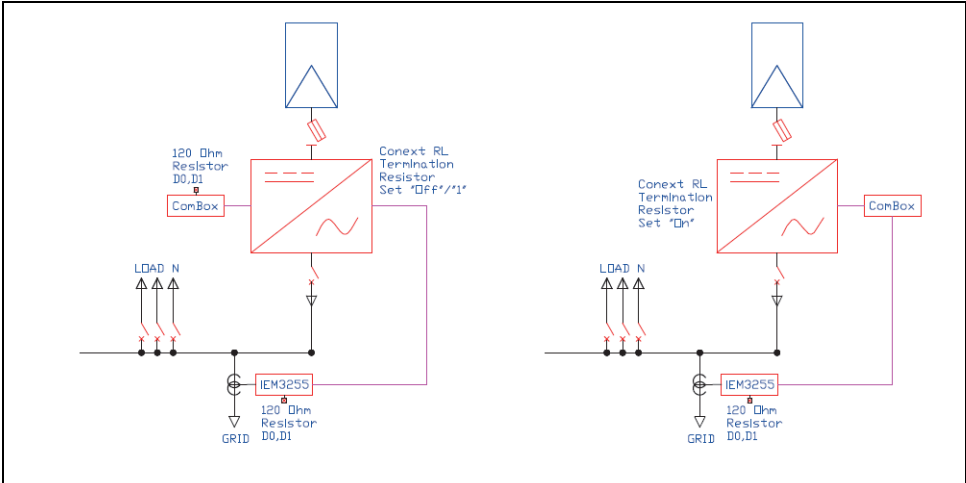


Figure 5 Conext RL connecting to Main SB, Acti9 iEM3x55 meter connecting to Main SB

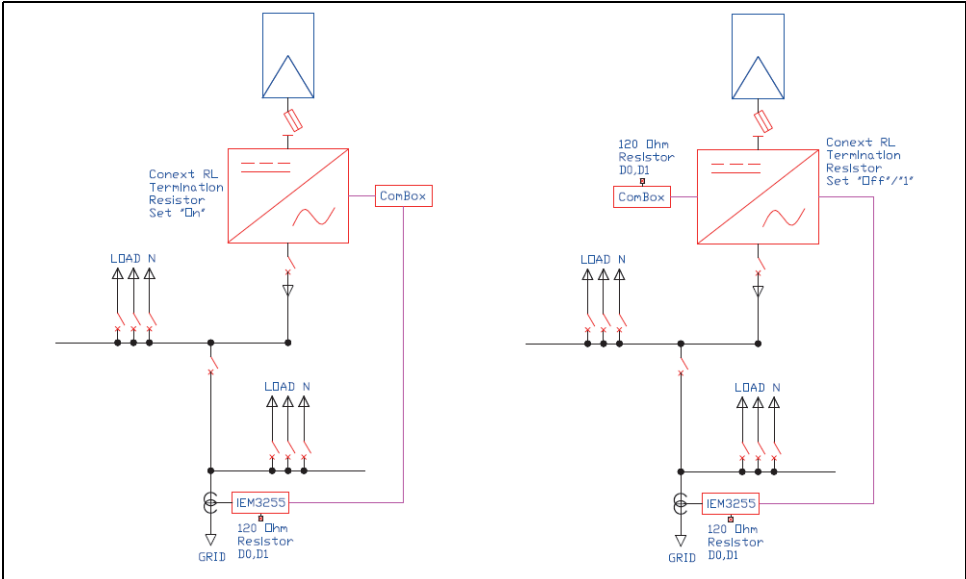


Figure 6 Conext RL connecting to Sub DB, Acti9 iEM3x55 meter connecting to Main SB

Procedure

Major steps in configuring the systems:

1. Configure Acti9 iEM3x55 meter.
2. Update Conext ComBox's firmware (Version V3.01) and configure Conext ComBox.
3. Suppress Grid Tied Faults/Warnings and Change System Diagrams on Conext ComBox.

Configure Acti9 iEM3x55 Meter

Refer to the **Acti9 iEM3x55 Installation and Operating Manual for full installation instructions.**

1. From Acti9 iEM3x55 meter display, hold **OK** and **ESC** button on Acti9 iEM3x55 for 2 seconds to enter Configuration Mode.
Enter **Password: 0010**.
2. Acti9 iEM3155 \ Access Counter \
 - a. Wiring \ Wiring Type \ 1PH2W
 - b. Frequency \ 50Hz
 - c. Define Date and Time setting
 - d. Digital Input \ Input Status (Normal)
 - e. Communication \ **Slave address: 1~9** \
Baud Rate: 9600 \ **Parity: None**
 - f. **Communication Protection: Disable**
3. Acti9 iEM3255 \ Access Counter \
 - a. Wiring \ Wiring Type \ 1PH2W \ Direct-No VT \ 1CT on L1
 - b. CT and VT Ratio \ **CT Secondary: 5A** \ **CT Primary: 200A/250A/300A**
 - c. Frequency \ 50Hz
 - d. Define Date and Time setting
 - e. Digital Input \ Input Status (Normal)
 - f. Communication \ **Slave address: 1~9** \
Baud Rate: 9600 \ **Parity: None**
 - g. **Communication Protection: Disable**

Update Conext ComBox's firmware and configure

Refer to the Conext ComBox Installation and Configuration Manual for full installation instructions.

1. Connect Conext ComBox to a Router or Ethernet Switch via CAT 5/5e/6 network cable. Ensure that Conext ComBox is within the same Local Area Network (LAN) as the PC.
2. Place **Conext ComBox Device Locator** software in PC Desktop. This software assists a user to identify the IP Address of Conext ComBox. The software can be downloaded from <http://solar.schneider-electric.com/product/conext-combox/>.
3. Log in to Conext ComBox with:
 - a. **default Username: *admin***
 - b. **default Password: *password***
4. Refer to the Conext ComBox Installation and Configuration Manual to update to the latest firmware. This application will require firmware **V3.01 BN746** or later release. The latest firmware can be downloaded from <http://solar.schneider-electric.com/product/conext-combox/>.
5. Configure Conext ComBox Configuration \ Setting
 - a. Setting \ Inverter Zero Export:
 - **Inverter Zero Output: Enabled**
 - b. Reboot Conext ComBox after enable/disable export control
6. Configure Conext ComBox Configuration \ ModBus Master Configuration
 - a. ModBus Master Configuration \ Communication Setup
 - **Enable ModBus Master Mode: Enabled**
 - **Enable ModBus Master Serial Port: Enabled**
 - **Enable ModBus Slave Serial Port: Disabled**
 - **Enable ModBus Master Device Polling: Enabled**
 - **Enable ModBus Master Energy Aggregation: Enabled**
 - **RS-485 Baud Rate: 9600**
 - **RS-485 Parity: N**
 - **RS-485 Stop Bits: 1**
 - b. ModBus Master Configuration \ Automated ModBus Device Discovery
 - **Start Address: 1**
 - **End Address: 9**
 - c. ModBus Master Configuration \ Manually Add Device
 - **Address: 1~9 Type: iEM32XX**
 - **Address: 1~9 Type: CONEXT_RL**

- d. ModBus Master Configuration \ ModBus Power Meter
 - **Meter: PM3x55 / iEM3x55 Address: 1~9**
Association: Grid (see NOTE below)
NOTE: If your system has Conext XW+/SW devices, you have to first put these devices in **Standby** mode, in order to allow the iEM3x55 to be associated with Grid.
- e. ModBus Master Configuration \ ModBus Device List
 - **Address: 1~9 Type: CONEXT_RL**
 - **Address: 1~9 Type: iEM32XX**

Suppress Grid Tied Faults/Warnings and Change System Diagrams on Conext ComBox

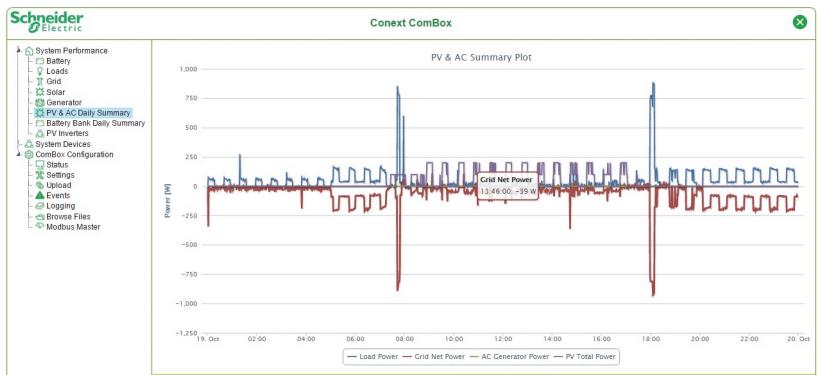
Conext ComBox when communicating with Conext RL shall also suppress certain Grid Tied Faults/ Warnings such as **F11**, **F54**, **F58**, and **F61**. This can be configured under:

- ComBox Configuration \ Setting \ Suppress Device Faults/Warnings.
- ComBox Configuration \ Conext ComBox Settings \ System Diagram
 - Show **System Diagram Grid** (check)
 - Show **System Diagram Battery** (check only if the system is PV Storage)
 - Show **System Diagram Generator** (check only if the system is Hybrid PV Storage)
 - Show **System Diagram PV** (check)
 - Show **System Diagram Load** (check only if the system is PV Storage)

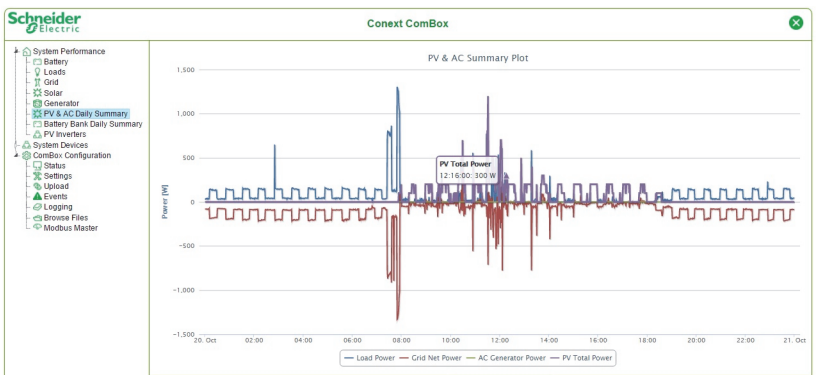
Test System and Observation

From Conext ComBox's System Performance tab, users should observe trending characteristics below:

1. Conext ComBox \ System Performance \ PV and AC Daily Summary:
 - During sun hours, Grid Net Power (Red) shall always stay negative or near zero. If Grid Net Power (Red) is reading positive, it means the system is exporting.
 - During sun hours, the usual trend for Load Power (Blue) will be "converted" to PV Total Power (Purple) because solar energy from Conext RL is "temporary allowed" to meet temporary load demand before being limited by Conext ComBox.



- During sun hours, when Grid Net Power (Red) negative trend increases, PV Total Power (Purple) positive trend will respond and increases. This shows Conext ComBox allows Conext RL to output energy to meet load demand and then subsequently reduce it after Load is reduced or turned off.



2. Conext ComBox \ System Performance \ Grid:

- Grid Output (Orange) is very minimal during sun hours when solar is supposed to be generating. This is because Conext RL's energy output is being limited.



Modbus Connection Diagrams

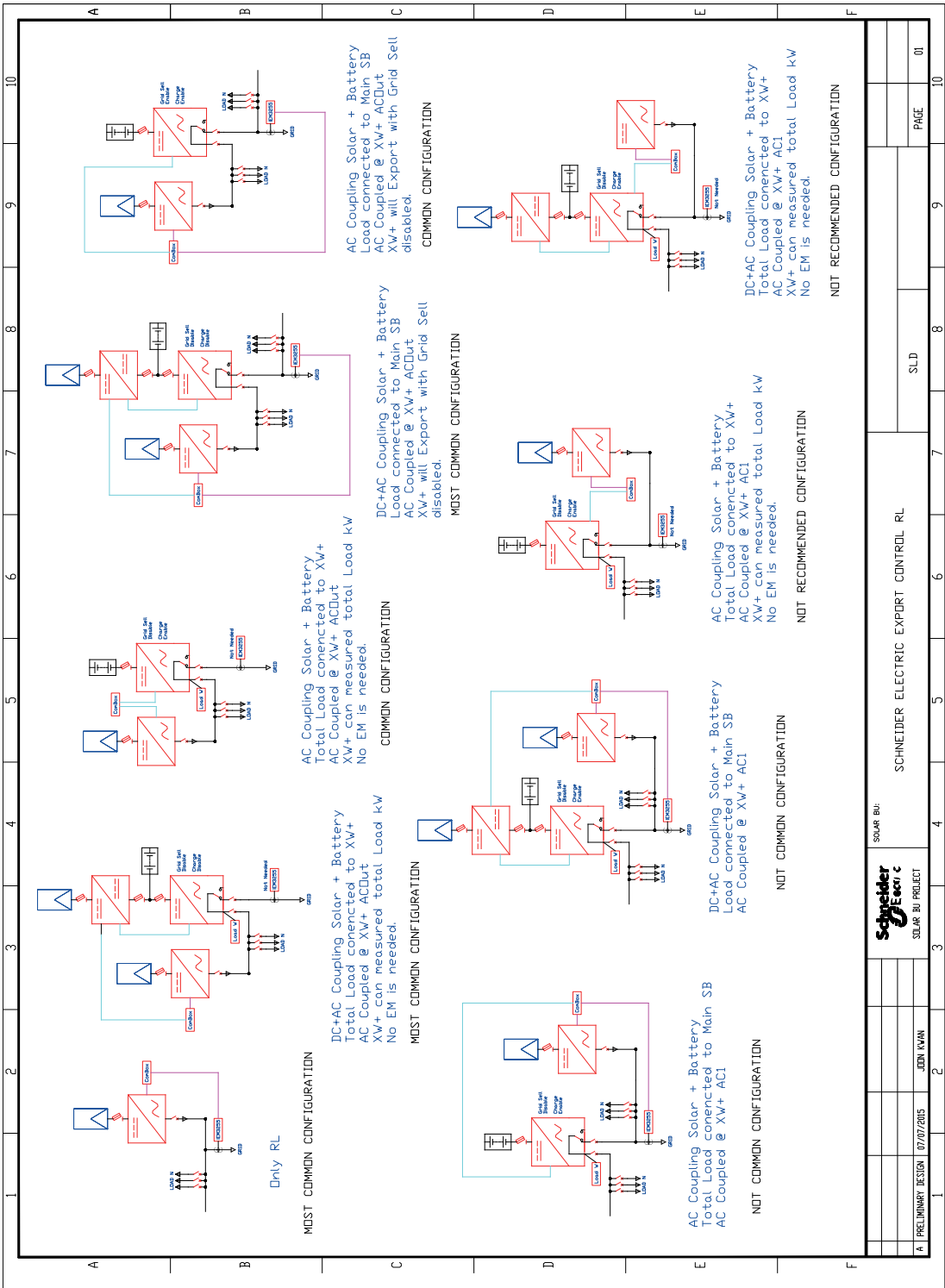


Figure 7 Export Control RL Connections

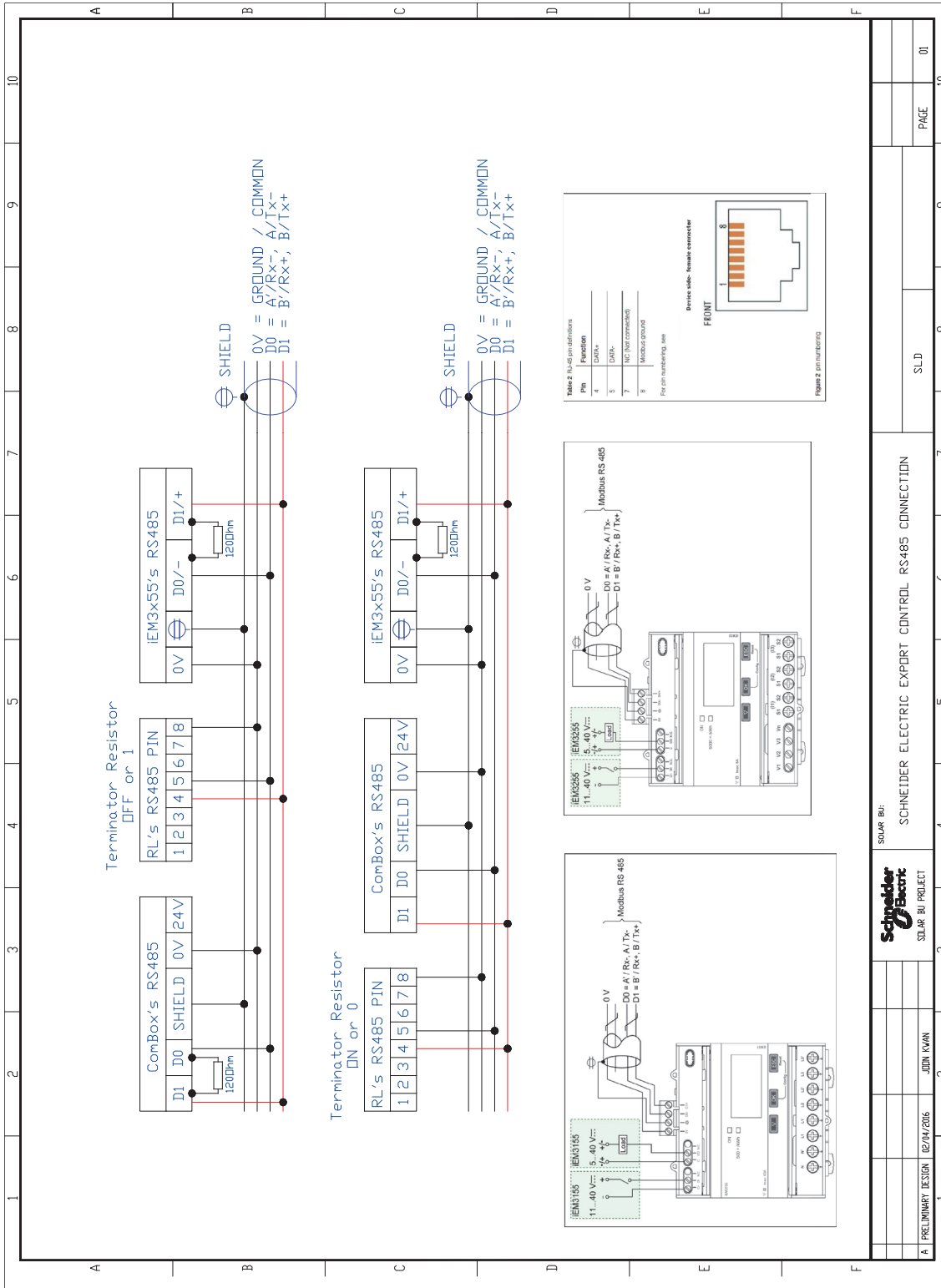


Figure 8 Export Control RS485 Connection

Exceptions / Precautions

The purpose of this application is to avoid the Asset Owner to export energy back to the Grid. Normally, there are several seconds delay expected from the Conext RL to respond to the Conext ComBox's power curtailment command. The frequency of the Conext RL being power curtailed will depend on the Load fluctuation. Similarly, whether the response speed of the Conext RL towards power curtailment could meet expectation would also depend on the speed of Load changes. The Asset Owner shall pay attention to site suitability for this application. For example, a site with many VFD and Compressor will have frequent fast load changes and may not be suitable.

Having Export Limiting / No Export solution in place does not mean the user could excessively oversize AC Coupling solar on the Load side of Conext XW+/SW system beyond recommendation specified in the AC Coupling Application Note. The delay period required by Conext RL to respond to the Conext ComBox's command change could cause excess current to flow through Conext XW+/SW towards Battery Storage because Conext XW+/SW cannot export. This may cause damage on Battery Storage or trip the Battery Management System's over-current protection.

If the application requires the Asset Owner to guarantee minimum power import at all time from the Grid (measured in % Inverter rating), Conext ComBox is also not suitable for this because the user is not allowed to define this parameter and the application is strictly for No Export purpose. Similarly, if the application requires the Asset Owner to achieve minimum/maximum solar penetration within a Minigrid with Genset, this requirement also should not be met with this application.