AEM11900 Evaluation Kit User Guide

Description

The AEM11900 evaluation kit (EVK) is a printed circuit board (PCB) featuring all the required components to operate the AEM11900 integrated circuit (IC) in QFN 24-pin package.

The AEM11900 evaluation kit allows users to test e-peas IC and analyze its performances in a laboratory-like setting or in product mock-ups.

It allows easy connections to an energy harvester, a storage element and an application circuit. Thanks to headers and resistors, it also provides all configuration options to set the device in any of the modes described in the datasheet. A status signal is available on a standard pin header.

The AEM11900 EVK is an easy-to-use, intuitive and efficient tool to optimize AEM11900 configuration, allowing users to design a highly efficient subsystem for the desired target application. Component replacement and operating mode switching is convenient and easy.

Detailed information about AEM11900 features can be found in the datasheet.

Applications

Smart home	Industrial sensor
Smart building	Retail
Edge IoT	PC accessories

Features and Benefits

Very high conversion efficiency
- Average 93 % from source to storage element.

Two-way screw terminals
- DC source of energy (SRC).
- Energy storage element (STO).
- Application circuit.

3-pin headers
- Source regulation voltage configuration.
- Source MPPT ratio and timings configuration.
- Storage element protection thresholds configuration.
- Shipping mode configuration.
- Boost timings configuration.
- Custom mode configuration.

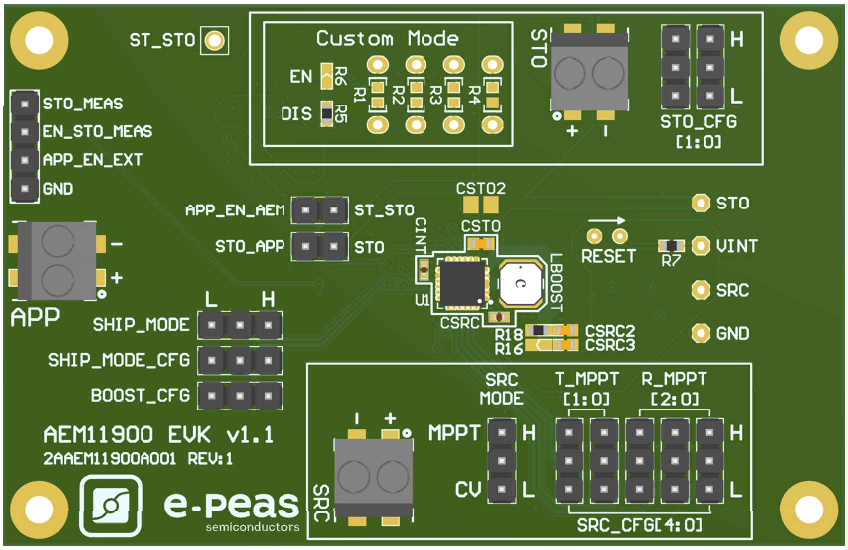
Provision for resistors
- Custom mode configuration.

Evaluation Kit Information

Part number	Dimensions
2AAEM11900A001 REV:1	76 mm x 49 mm

Device Information

Part Number	Package	Body size
10AEM11900A0001	QFN 24-pin	4 x 4 mm



1. EVK Connection Diagram

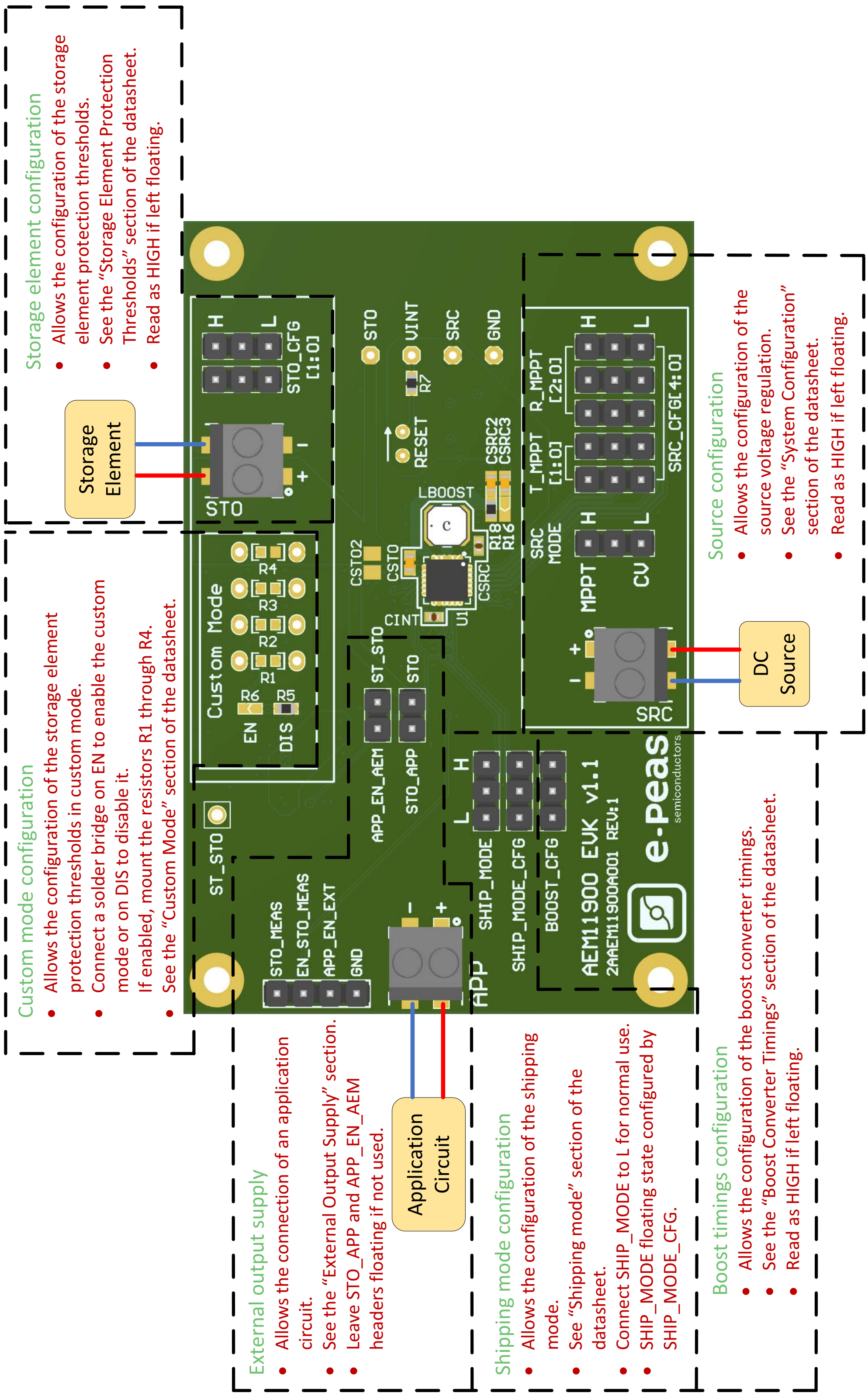


Figure 1: AEM11900 EVK connection diagram

2. Pin Configuration and Functions

NAME	FUNCTION	CONNECTION	
		If used	If not used
Power Pins			
SRC	Connection to the energy source harvested by the boost converter.	Connect the source element.	Can be left floating or connected to GND.
STO	Connection to the energy storage element (rechargeable battery or LiC).	Connect the storage element.	Leave floating. If left floating, storage element is on-board capacitor C_{STO}, which may be too small for most applications.
APP	Connection to the application circuit. (see Section 3.3.7)	Connect the application circuit. Connect a jumper on STO_APP and optionally in APP_EN_AEM.	Leave floating. Remove the jumpers on STO_APP and APP_EN_AEM.
Control Pin			
SHIP_MODE	When HIGH: - Minimum consumption from the storage element. - Storage element charge is disabled (boost converter is disabled). - Only VINT is charged if energy is available on SRC. (see Section 3.3.6)	Connect jumper to H.	Connect to GND or see SHIP_MODE_CFG pin configuration if left floating.
STO_APP	Application circuit supply input. (see Section 3.3.7)	Connect a jumper between STO_APP and STO to supply the application from STO.	Leave floating.
APP_EN_AEM	Internal enabling signal for the application supply. (see Section 3.3.7)	Connect a jumper between APP_EN_AEM and ST_STO to allow enabling the application supply with ST_STO signal.	Leave floating.
APP_EN_EXT	External enabling signal for the application supply. (see Section 3.3.7)	Use an external signal to enable the application supply from STO.	Leave floating.
EN_STO_MEAS	Enabling pin for the storage element measurement. (see Section 3.3.7)	Use an external signal to enable the STO_MEAS output.	Leave floating.

Table 1: Signals description

NAME	FUNCTION	CONNECTION	
		If used	If not used
Configuration Pins			
SRC_MODE	Used to configure the SRC voltage regulation mode: - LOW: constant voltage mode. - HIGH: MPPT ratio mode. (see Section 3.3.1)	Connect jumper.	Read as HIGH if left floating.
SRC_CFG[4:0]	Used to configure the SRC regulation voltage. SRC_MODE = LOW (constant voltage mode): - SRC_CFG[4:0] are used to set the SRC constant regulation voltage. SRC_MODE = HIGH (MPPT ratio mode): - SRC_CFG[2:0] are used to set the SRC MPPT ratio. - SRC_CFG[4:3] are used to set the SRC MPPT timings.	Connect jumpers.	Read as HIGH if left floating.
STO_CFG[1:0]	Used to configure the storage element voltage thresholds.	Connect jumpers.	Read as HIGH if left floating.
BOOST_CFG	Used to configure the boost converter timings.	Connect jumper to L for timings x1 or connect jumper to H for timings x3.	Read as HIGH if left floating.
CM_D	Used to enable the custom mode.	Mount R1, R2, R3 and R4 resistors and a 0 Ω resistor or solder bridge in EN position.	Place a 0 Ω resistor or solder bridge in DIS position.
SHIP_MODE_CFG	Sets the SHIP_MODE behavior when left floating: - SHIP_MODE_CFG is LOW: SHIP_MODE read as HIGH if left floating. - SHIP_MODE_CFG is HIGH: SHIP_MODE read as LOW if left floating.	Connect jumper.	Read as HIGH if left floating.
Status Pin			
ST_STO	Logic output. - HIGH when in SUPPLY STATE or in SLEEP STATE. - LOW otherwise.	Connect to the application circuit. HIGH level is STO.	Leave floating.
STO_MEAS	Voltage level of the storage element. See Section 3.3.7.	Apply a signal to EN_STO_MEAS to enable the measurement on STO_MEAS output.	Leave floating.

Table 1: Signals description

3. General Considerations

3.1. Safety Information

Always perform the following steps in the correct order:

1. Reset the board by temporally connecting the “RESET” pads to GND, from left to right (as shown on PCB silkscreen).

2. Completely configure the PCB (jumpers/resistors):
   - Source voltage regulation mode and value (SRC_MODE and SRC_CFG[4:0]).
   - Storage element protection thresholds (STO_CFG[1:0]) or custom mode (CM_D and R1 through R4) if used.
   - Boost converter timings (BOOST_CFG).
   - Application circuit supply (STO_APP and APP_EN_AEM).

4. Connect the storage element to the STO screw connector.

5. Connect the application circuit to the APP screw connector.

6. Connect the harvester to the SRC screw connector.

3.2. AEM11900 Reset

The following procedure must be followed to properly reset the AEM11900:

- Connect a wire to GND.
- Use this wire to short the “Reset” pads to GND from left to right, as indicated on the EVK silkscreen.

3.3. Configurations

3.3.1. Source Regulation Voltage Configuration

3.3.1.1. Constant Voltage Mode (SRC_MODE = L)

Configuration pins					Voltage [V]
SRC_CFG[4:0]					$V_{SRC,REG}$
L	L	L	L	L	0.25
L	L	L	L	H	0.30
L	L	L	H	L	0.35
L	L	L	H	H	0.41
L	L	H	L	L	0.45
L	L	H	L	H	0.50
L	L	H	H	L	0.56
L	L	H	H	H	0.60
L	H	L	L	L	0.65
L	H	L	L	H	0.71
L	H	L	H	L	0.75
L	H	L	H	H	0.80
L	H	H	L	L	0.86
L	H	H	L	H	0.90
L	H	H	H	L	0.95
L	H	H	H	H	1.01

Configuration pins					Voltage [V]
SRC_CFG[4:0]					$V_{SRC,REG}$
H	L	L	L	L	1.10
H	L	L	L	H	1.20
H	L	L	H	L	1.31
H	L	L	H	H	1.40
H	L	H	L	L	1.50
H	L	H	L	H	1.61
H	L	H	H	L	1.70
H	L	H	H	H	1.79
H	H	L	L	L	1.90
H	H	L	L	H	1.99
H	H	L	H	L	2.19
H	H	L	H	H	2.41
H	H	H	L	L	2.59
H	H	H	L	H	2.82
H	H	H	H	L	3.00
H	H	H	H	H	3.18

Table 2: Configuration of the source constant regulation voltage with SRC_CFG[4:0] pins

3.3.1.2. MPPT Ratio Mode (SRC_MODE = H)

Configuration			Function
SRC_CFG[2:0]			V_{MPP} / V_{OC}
L	L	L	35 %
L	L	H	50 %
L	H	L	65 %
L	H	H	70 %
H	L	L	75 %
H	L	H	80 %
H	H	L	85 %
H	H	H	90 %

Configuration		Function	
SRC_CFG[4:3]		$T_{MPPT,PERIOD}$ [s]	$T_{MPPT,SAMPLING}$ [s]
L	L	15	0.25
L	H	15	0.50
H	L	25	0.25
H	H	25	0.50

Table 3: MPPT ratio and timings configuration with SRC_CFG[4:0] pins

3.3.2. Source Capacitance Configuration

When using the MPPT ratio source regulation mode, the total capacitance connected at the source of the AEM11900 should be selected based on the characteristics of the energy harvester (PV cell) connected to the evaluation board and the available power. The source capacitors charging time, during the Maximum Power Point (MPP) evaluations, must remain shorter than the configured $T_{MPPT,SAMPLING}$. This will ensure an accurate measurement of the open-circuit voltage and thus, an accurate source voltage regulation.

A higher capacitance improves voltage stability but increases the time required to charge the source capacitors, which may prevent certain PV cells at low power from reaching their open-circuit voltage during the MPP evaluation. In such cases, lowering the capacitance will reduce the time needed to reach the PV cell's open-circuit voltage, at the expense of decoupling performance.

To allow this flexibility, the AEM11900 evaluation board includes three configurable capacitors:

- CSRC is always mounted and connected.
- CSRC2 is mounted and connected by default through a 0 Ω resistor, which can be removed to disconnect it.
- CSRC3 is mounted and not connected by default. It can be enabled by adding a 0 Ω resistor or a solder bridge.

The default configuration (CSRC and CSRC2 connected, CSRC3 disconnected) is suitable for most PV cells and use cases.

See Figure 8 for values and placement.

The following figure shows the impact of source capacitance sizing on the AEM11900's behavior during MPP evaluation.

- Left graph: When the source capacitance is too large, the PV cell cannot reach its open-circuit voltage within $T_{MPPT,SAMPLING}$. As a result, the measured V_{OC} is inaccurate and V_{MPP} is regulated below the expected voltage.
- Right graph: With a properly sized source capacitance, the source voltage reaches the open-circuit voltage before the end of $T_{MPPT,SAMPLING}$. This allows for accurate V_{OC} measurement and V_{MPP} regulation.

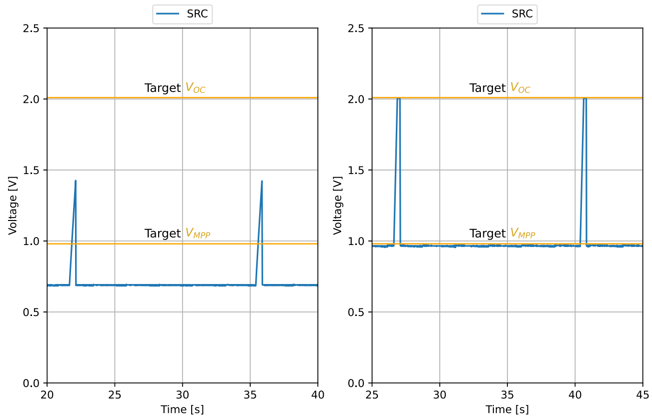


Figure 2: Impact of source capacitance on open-circuit voltage evaluation

3.3.3. Storage Element Protection Thresholds Configuration

Configuration pins		Overdischarge voltage [V]	Charge ready voltage [V]	Overcharge voltage [V]	Storage element type
STO_CFG[1:0]		V_{OVDIS}	V_{CHRDY}	V_{OVCH}	
L	L	2.51	2.61	3.79	Lithium-ion Super Capacitor (LiC)
L	H	3.00	3.21	4.13	Lithium-ion battery
H	L	3.00	3.21	4.35	LiPo battery
H	H	3.51	3.60	3.90	Li-ion battery (ultra long life)

Table 4: Storage element configuration with STO_CFG[1:0] pins

3.3.4. Custom Mode Configuration

When placing a resistor or solder bridge in EN position, the custom mode is selected regardless of STO_CFG[1:0] pins.

V_{OVDIS}, V_{CHRDY} and V_{OVCH} defined through R1, R2, R3, and R4 are calculated as follows:

- $R_T = R_1 + R_2 + R_3 + R_4$
- $100k\Omega \leq R_T \leq 400k\Omega$
- $R_1 = R_T \cdot \frac{0.5V}{V_{OVCH}}$
- $R_2 = R_T \cdot \left(\frac{0.5V}{V_{CHRDY}} - \frac{0.5V}{V_{OVCH}}\right)$
- $R_3 = R_T \cdot \left(\frac{0.5V}{V_{OVDIS}} - \frac{0.5V}{V_{CHRDY}}\right)$
- $R_4 = R_T - (R_1 + R_2 + R_3)$

The following constraints must be met to ensure the functionality of the AEM11900:

- $2.40\text{ V} \leq V_{OVDIS} \leq 4.39\text{ V}$
- $2.51\text{ V} \leq V_{CHRDY} \leq 4.50\text{ V}$
- $2.61\text{ V} \leq V_{OVCH} \leq 4.59\text{ V}$
- $V_{OVCH} > V_{CHRDY} + 100\text{ mV}$
- $V_{CHRDY} > V_{OVDIS} + 100\text{ mV}$

If the custom mode is not used, please make sure that CM_D is connected to GND by placing a resistor or solder bridge in DIS position, this pin cannot be left floating.

3.3.5. Boost Converter Timings Configuration

The BOOST_CFG pin allows for modifying the peak current of the boost inductor by multiplying the on/off timings of the boost converter.

The peak current in the inductor also depends on the value of the inductor. Place a jumper in H position for timing x3, for the default 33 µH mounted inductor. Table 5 shows the minimum and best efficiency inductor values to be used for each timing. Lower than the minimum value may cause damage to the AEM11900.

Configuration pin	Function		
BOOST_CFG	Timing multiplier factor	Minimum L_{BOOST} [µH]	Recommended[1] L_{BOOST} [µH]
L	x1	3.3	10
H	x3	9.9	33

Table 5: Boost converter timings configuration

1. Recommended L_{BOOST} for the best efficiency/current capability trade-off according to the tests carried out in e-peas laboratory.

3.3.6. Shipping Mode Configuration

The shipping mode feature allows to force the AEM11900 in RESET STATE (see datasheet), to disable the boost converter and therefore to prevent the charge of the storage element. Only VINT is charged from SRC if V_{SRC} is above $V_{SRC,CS}$.

The shipping mode can be configured as follows:

The SHIP_MODE pin controls the shipping mode state:

- If SHIP_MODE is LOW, the shipping mode is disabled.
- If SHIP_MODE is HIGH, the shipping mode is enabled.

If SHIP_MODE is left floating, its state depends on the SHIP_MODE_CFG pin:

- If SHIP_MODE_CFG is LOW, SHIP_MODE is interpreted as HIGH if left floating.
- If SHIP_MODE_CFG is HIGH, SHIP_MODE is interpreted as LOW if left floating.

SHIP_MODE_CFG pin state	SHIP_MODE pin state	Shipping Mode Functionality
LOW	LOW	Disabled
	Floating	Enabled
	HIGH	Enabled
HIGH	LOW	Disabled
	Floating	Disabled
	HIGH	Enabled

Table 6: Shipping mode configuration

3.3.7. External Output Supply

The AEM11900 is a storage element charger only. However, an external application can be supplied from the storage element using the APP connector on the EVK.

To supply an external application circuit through the APP connector, place a jumper connecting STO_APP to STO.

The application circuit will be supplied by the storage element through a switch, controlled either internally or externally:

- Internally:
  To control the application supply by the AEM11900 ST_STO signal, place a jumper connecting APP_EN_AEM to ST_STO. This will enable the APP output when the storage element voltage rises above V_{CHRDY}, and remains above V_{OVDIS}. If V_{STO} falls below V_{OVDIS} for T_{CRIT}, the AEM11900 goes into RESET STATE and sets ST_STO LOW, disabling the APP output.
- Externally:
  To control the application supply externally, connect a signal on APP_EN_EXT. The APP output will be enabled when a HIGH logic level (higher than 1 V) is applied on APP_EN_EXT.

It is possible to use the ST_STO and APP_EN_EXT signals in parallel to control the APP output. This is useful when the AEM11900 is initially in RESET STATE, and thus, the application is not powered and not able to apply an external signal to APP_EN_EXT. In this case, the ST_STO signal is used to initially enable the APP output. Once the application is powered, the APP_EN_EXT can be used to maintain the APP output enabled, even if V_{STO} falls below V_{OVDIS} longer than T_{CRIT}. This allows having additional time to properly shutdown the application. In this case the jumper shorting APP_EN_AEM and ST_STO must be placed.

In addition to the external output supply, the AEM11900 evaluation board allows the measurement of the storage element voltage by the application, through the STO_MEAS pin. This pin is connected to a power gated resistor bridge, providing an output voltage of V_{STO} / 4. To enable the measurement, a HIGH level (higher than 1 V) must be applied to EN_STO_MEAS.

4. Functional Tests

This section presents a few simple tests that allow users to understand the functional behavior of the AEM11900. To avoid damaging the board, follow the procedure found in Section 3.1. If a test has to be restarted, make sure to properly reset the system to obtain reproducible results.

Users can adapt the setup to match the use case system as long as the source limitations are respected, as well as the minimum storage voltage and cold-start constraints (see "Electrical Characteristics at 25 °C" Section of AEM11900 datasheet).

In the following sections, when a "power supply" is required, it can be either a standard one quadrant positive voltage / positive current laboratory power supply with regulated voltage, or an SMU set as voltage source with current compliance.

4.1. Start up

4.1.1. Description

The following example allows users to observe the start-up behavior of the AEM11900.

4.1.2. Setup

- Oscilloscope:
  - Channel 1: STO.
  - Channel 2: VINT (may be probed on H pin on STO_CFG[1] header for example).
- SRC (2 alternatives, initially disconnected):
  - 1 V / 10 mA power supply with a 100 Ω resistor in series (I_{SRC} = 2.5 mA with $V_{SRC,REG}$ = 0.75 V).
  - SMU set as 2.5 mA current source with 1 V compliance.
- SRC_MODE = L.
  - Constant voltage regulation mode.
- SRC_CFG[4:0] = LHLHL.
  - $V_{SRC,REG}$ = 0.75 V.
  - $I_{SRC} = \frac{1\text{ V} - 0.75\text{ V}}{100\ \Omega} = 2.5\text{ mA}$ (PSU).
  - I_{SRC} = 2.5 mA (SMU).
- 1000 µF capacitor connected to STO as storage element.
- 3 V power supply or SMU connected to STO beforehand.
- STO_CFG[1:0] = LH.
  - V_{OVDIS} = 3.00 V.
  - V_{CHRDY} = 3.21 V.
  - V_{OVCH} = 4.13 V.
- No application circuit is connected to the APP connector, STO_APP and APP_EN_AEM headers are left floating.

4.1.3. Measurements

- Reset the AEM11900 as described in Section 3.2.
- Start with:
  - 3 V power supply connected to STO so that C_{STO} is charged to 3.0 V beforehand.
  - No source connected to SRC.
- Disconnect the power supply from STO.
- Connect the 1 V / 100 Ω PSU or the 2.5 mA current source SMU to SRC.
- Observe V_{INT} rise up to 2.3 V and be regulated around 2.25 V.
- Energy is transferred from SRC to STO: V_{STO} rises from its initial 3.0 V voltage to V_{OVCH} (4.13 V).
- V_{STO} is regulated to V_{OVCH} (4.13 V) as the AEM11900 prevents the storage element to be charged any further.

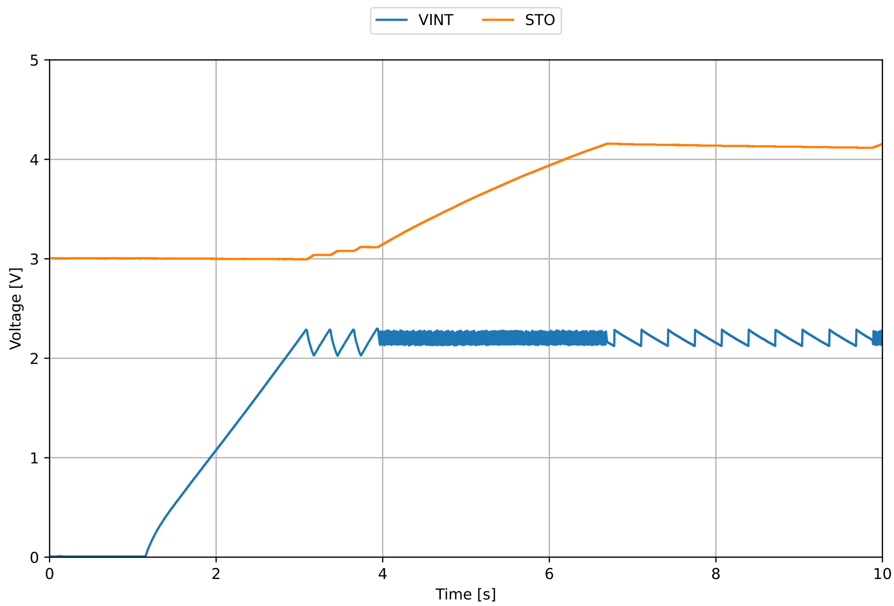


Figure 3: AEM11900 start-up behavior

4.2. Cold Start

4.2.1. Description

The following example allows users to observe the cold-start behavior of the AEM11900.

4.2.2. Setup

- Oscilloscope:
  - Channel 1: SRC.
  - Channel 2: VINT (may be probed on H pin on STO_CFG[1] header for example).
  - For the cold-start test to be successful and to ensure accurate minimum cold-start power measurements, use an oscilloscope with a 10 MΩ input impedance to avoid significant loading effects from the probes.
- SRC (2 alternatives, initially disconnected):
  - 1 V / 10 mA power supply with a 68 kΩ resistor in series (I_{SRC} = 10 µA with source voltage clamped to 0.3 V during cold start). Please note that using a standard power supply allows for validating the minimum cold-start voltage but does not allow for validating the minimum cold-start power.
  - SMU set as 10 µA current source with 1 V compliance. Using an SMU allows for validating the minimum cold-start power as well as the minimum cold-start voltage.
- For constant voltage mode (Figure 4):
  - SRC_MODE = L.
  - SRC_CFG[4:0] = LHLHL.
    - $V_{SRC,REG}$ = 0.75 V.
- For MPPT ratio mode (Figure 5):
  - SRC_MODE = H.
  - SRC_CFG[2:0] = HLL.
    - R_{MPPT} = 75%.
  - SRC_CFG[4:3] = LH.
    - $T_{MPPT,PERIOD}$ = 15 s
    - $T_{MPPT,SAMPLING}$ = 500 ms.
- Source current during cold start:
  - $I_{SRC} = \frac{1\ V - 0.3\ V}{68\ k\Omega} = 10 \mu A$ (PSU).
  - $I_{SRC} = 10 \mu A$ (SMU).
- 1000 µF capacitor connected to STO as storage element.
- 3 V power supply connected to STO beforehand.
- STO_CFG[1:0] = LH.
  - V_{OVDIS} = 3.00 V.
  - V_{CHRDY} = 3.21 V.
  - V_{OVCH} = 4.13 V.
- No application circuit is connected to the APP connector, STO_APP and APP_EN_AEM headers are left floating.

4.2.3. Measurements

- Reset the AEM11900 as described in Section 3.2.
- Start with:
  - 3 V power supply connected to STO so that C_{STO} is charged to 3.0 V beforehand.
  - No source connected to SRC.
- Disconnect the power supply from STO.
- Connect the power supply or SMU to SRC.
- The cold-start test can be performed in constant voltage mode or in MPPT ratio mode. The behavior during the cold-start phase will be the same in both modes (V_{SRC} clamped to 0.3 V while charging V_{INT}).
- Cold-start phase:
  - Observe V_{SRC} clamped to 0.3 V.
  - Observe V_{INT} rise up to 2.3 V and be regulated around 2.25 V.
- Once V_{INT} has reached its regulation voltage, the AEM11900 will regulate V_{SRC} either to $V_{SRC,REG}$ if in constant voltage mode (see Figure 4), or to V_{MPP} with V_{OC} evaluations every 15 s if in MPPT ratio mode (see Figure 5).
- Note that, in MPPT ratio mode (see Figure 5), during the first V_{OC} evaluation, the source current is insufficient to charge C_{SRC} up to the V_{OC} within $T_{MPPT,SAMPLING}$, resulting in a lower V_{MPP} compared to the target. However, the following evaluations allow a correct measurement of V_{OC} and thus, an accurate source voltage regulation. This behavior is explained in Section 3.3.2.

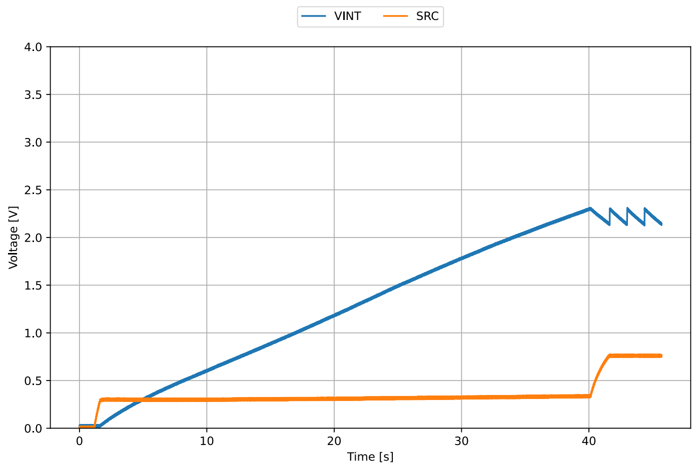


Figure 4: AEM11900 cold-start behavior in constant voltage mode

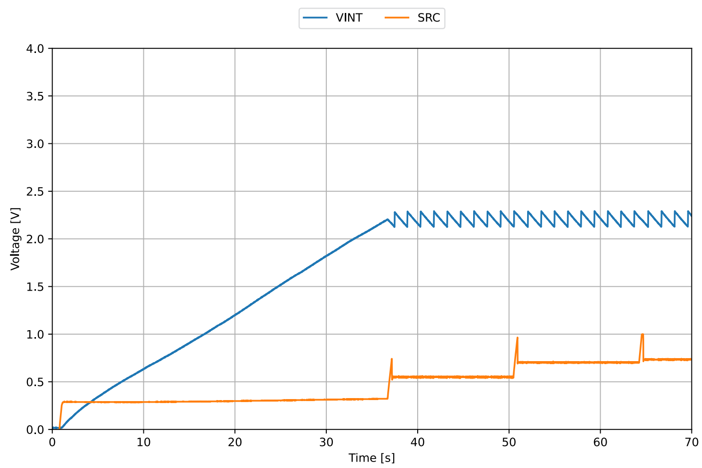


Figure 5: AEM11900 cold-start behavior in MPPT ratio mode

4.3. Storage Element Protection Thresholds

4.3.1. Description

The following example allows users to observe the behavior of the AEM11900 for the different thresholds of the storage element.

4.3.2. Setup

- Oscilloscope:
  - Channel 1: STO.
  - Channel 2: ST_STO.
- SRC (2 alternatives, initially disconnected):
  - 1 V / 10 mA power supply with a 22 kΩ resistor in series (I_{SRC} = 2.5 mA with $V_{SRC,REG}$ = 0.75 V).
  - SMU set as 2.5 mA current source with 1 V compliance.
- SRC_MODE = L.
  - Constant voltage regulation mode.
- SRC_CFG[4:0] = LHLHL.
  - $V_{SRC,REG}$ = 0.75 V.
  - $I_{SRC} = \frac{1\ V - 0.75\ V}{100\ \Omega} = 2.5$ mA (PSU).
  - $I_{SRC} = 2.5$ mA (SMU).
- No storage element or capacitor connected to STO, only the default 47 µF C_{STO} capacitor.
- 2.8 V power supply or SMU connected to STO beforehand.
- STO_CFG[1:0] = LH.
  - V_{OVDIS} = 3.00 V.
  - V_{CHRDY} = 3.21 V.
  - V_{OVCH} = 4.13 V.
- No application circuit is connected to the APP connector, STO_APP and APP_EN_AEM headers are left floating.

4.3.3. Measurements

- Reset the AEM11900 as described in Section 3.2.
- Start with:
  - 2.8 V power supply connected to STO so that C_{STO} is charged to 2.8 V beforehand.
  - No source connected to SRC.
- Disconnect the power supply from STO.
- Connect the power supply or SMU to SRC.
- Observe the storage element charging.
- When $V_{STO} > V_{CHRDY}$:
  - ST_STO is asserted.
  - There is more energy harvested than consumed (positive power budget), so the storage element keeps being charged.
- When $V_{STO} = V_{OVCH}$:
  - The voltage in the storage element reaches the V_{OVCH} threshold and stops charging, thus protecting the storage element from being overcharged.
- Disconnect the power supply from SRC (done at about 30 s on Figure 6).
- C_{STO} is now being discharged by the probes connected to STO and ST_STO, and the internal consumption of the AEM11900, as no more energy is harvested from the SRC.
- When V_{STO} falls below V_{OVDIS}, the AEM11900 waits for T_{CRIT} (1.86 s) and then goes to OVDIS STATE. ST_STO is cleared.

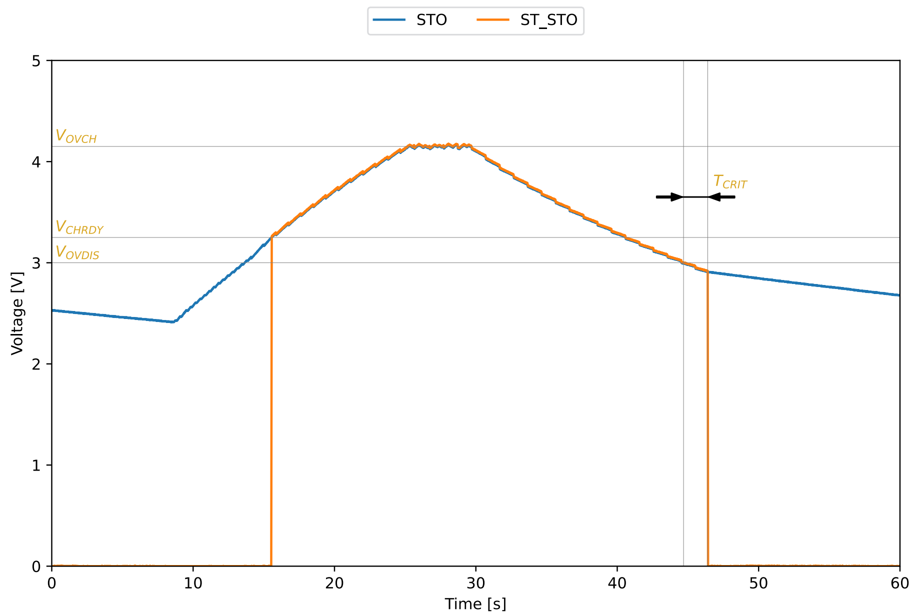


Figure 6: AEM11900 storage element protection thresholds behavior

5. Performance Tests

This section presents the tests to reproduce the performance graphs found in the AEM11900 datasheet. To be able to reproduce those tests, you will need the following:

- 2 source measure units (SMU, typically Keithley 2450). Those must be set with longest integration time.

To avoid damaging the board, follow the procedure found in Section 3.1 “Safety information”. If a test has to be restarted, make sure to properly reset the system to obtain reproducible results, as shown in Section 3.2.

5.1. Boost Converter Efficiency

5.1.1. Description

The boost converter efficiency is determined for a fixed set point of the AEM11900:

- Fixed SRC voltage V_{SRC}.
- Fixed SRC current I_{SRC}.
- Fixed STO voltage V_{STO}.
- Fixed inductor value L_{BOOST}. Please note that the inductor model has a subsequent influence on the efficiency.

Boost efficiency measurement is about measuring the current provided to STO with all other parameters fixed.

Please note that to avoid any leakage that would affect the measurement, no probe or voltmeter must be connected to the AEM11900 pins while measuring the boost efficiency.

5.1.2. Setup

- SRC_MODE = L.
  - Constant voltage regulation mode.
- SRC_CFG[4:0]: configured accordingly to the desired $V_{SRC,REG}$ set point (see Table 2).
- SRC: SMU configured as a current source.
  - Current set to the desired I_{SRC}.
  - Voltage compliance set 0.5 V above the desired $V_{SRC,REG}$.
- STO: SMU configured as a voltage source:
  - Voltage set to the desired V_{STO} set point.
  - Current compliance must be set so that the power on STO (V_{STO} x I_{STO}) is at least higher that the power of the SMU connected to SRC (V_{SRC} x I_{SRC}). Do not set the current compliance lower than 100 µA.

5.1.3. Measurements

Cold start and initialization

This part must only be done for the first efficiency data point measurement. To avoid having to do it between two subsequent set points, users must make sure that V_{STO} does not drop below V_{OVDIS} between measurements.

- Start with both SMU switched OFF.
- Reset the AEM11900.
- STO SMU: set the voltage to 5.0 V to make sure that V_{STO} is above V_{OVCH} and switch it on.
- SRC SMU: set the voltage source to 1.0 V with 1 mA current compliance to trigger the AEM11900 cold start.
- Wait for V_{INT} to rise to its regulation voltage of 2.25 V.
- The AEM11900 is now ready to perform an efficiency measurement. Do not lower V_{STO} below V_{OVDIS} from that point to avoid the AEM11900 going to OVDIS STATE. Keep STO SMU current compliance at least 100 µA.

Efficiency measurement

The following needs to be done for all desired set points:

- Set SRC SMU to the desired voltage and current set point.
- Set STO SMU to the desired voltage and current set point.
- Clear both SMU buffers.
- Wait for the number of measures of both SMU to be sufficient (the lower the current the higher the necessary number of measures to obtain an accurate value).
- Determine the average currents and voltages from both SMU buffers.
- Determine the boost efficiency with the following formula:

$$\eta[\%] = \frac{V_{STO} \cdot I_{STO}}{V_{SRC} \cdot I_{SRC}} \cdot 100$$

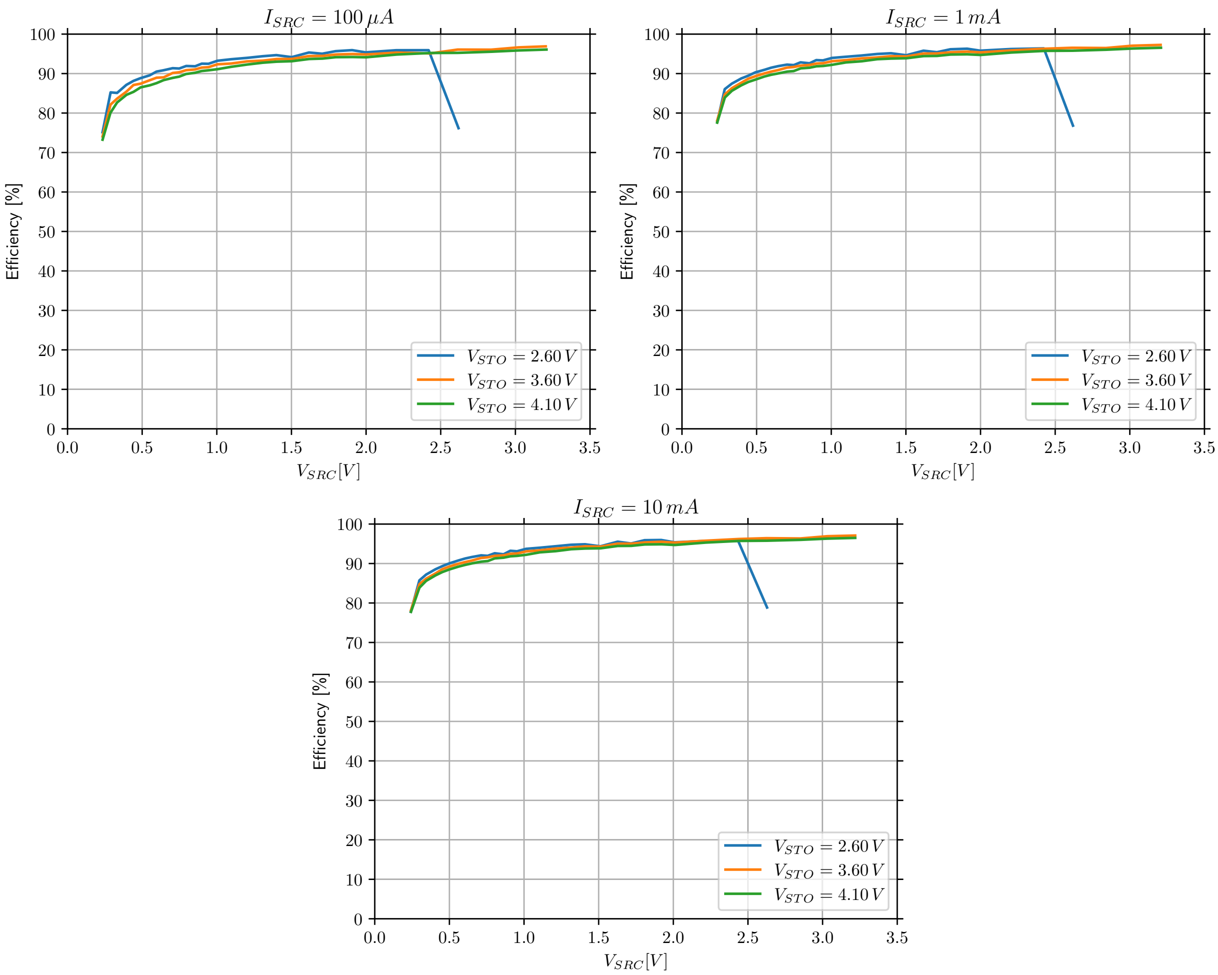


Figure 7: Boost converter efficiency with L_{BOOST} = 33 µH (Coilcraft LPS4018-333MRB) and timings x3

6. EVK Schematic

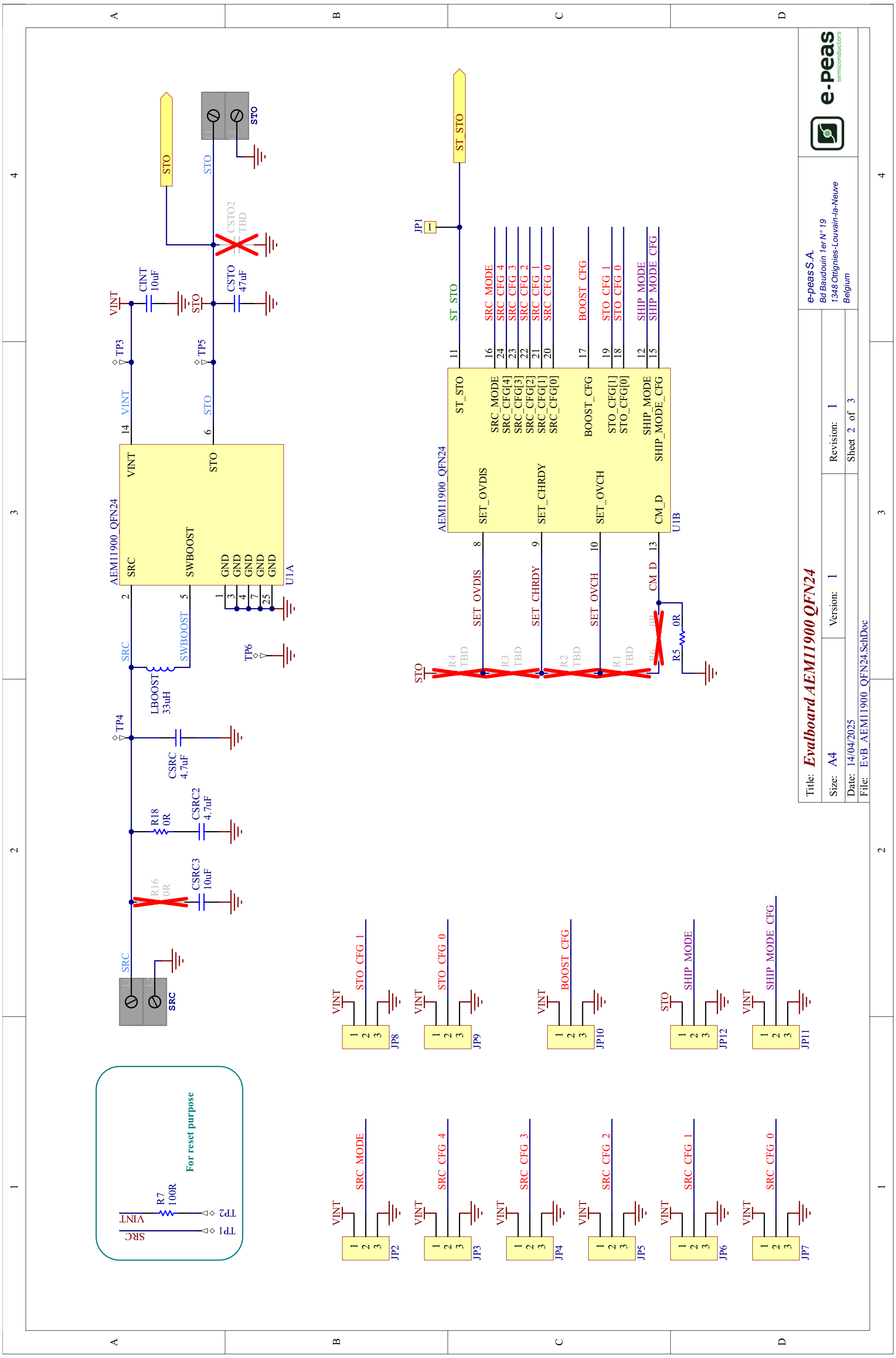


Figure 8: EVK schematic (part 1)

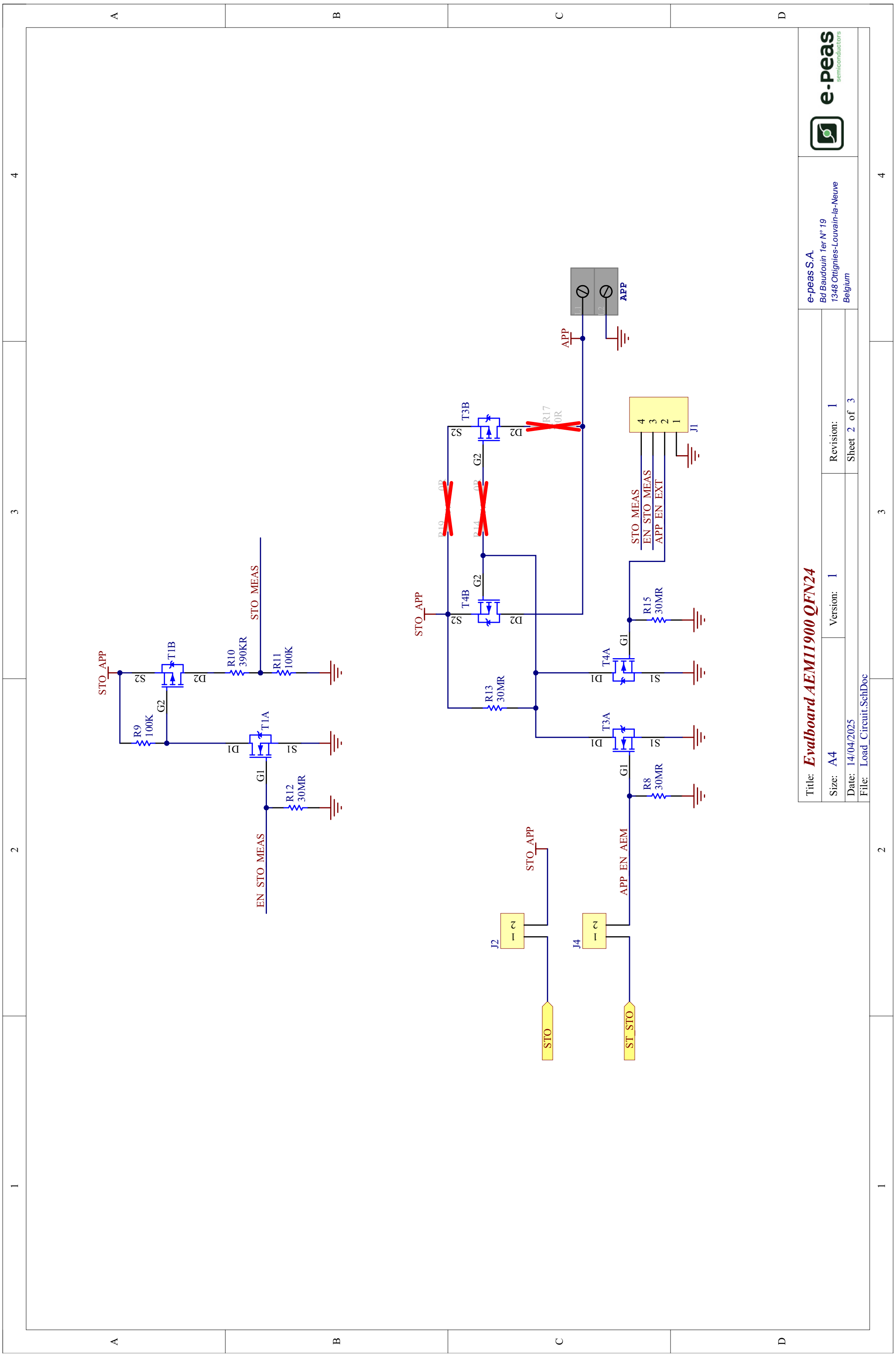


Figure 9: EVK schematic (part 2)

7. Revision History

EVK Version	User Guide Revision	Date	Description
1.1	1.0	June, 2025	Creation of the document.
1.1	1.1	November, 2025	- Updated the AEM11900 part number on first page to 10AEM11900A0001, no functional changes. - Updated the recommended L_{BOOST} value for each timing multipliers in the "Boost Converter Timings Configuration" section.

Table 7: Revision history