

## 1. General Description

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The EMS3900 is a bidirectional low-power dual port, high-speed, USB 2.0 analog switch. The device is configured as a dual 2:1 or 1:2 switch. It is optimized for use with the USB 2.0 DP/DM data lines.

The device has low bit-to-bit skew and high channel-to-channel noise isolation, and is compatible with various standards, such as high-speed USB 2.0 (480Mbps). Each switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. Its bandwidth is wide enough to pass high-speed USB 2.0 differential signals (480 Mb/s) with good signal integrity.

The GPIO control of SEL is 1.8V logic compatible. EMS3900 is available in QFN 1.4x1.8-10L with Pb-free and Halogen-free making it a perfect candidate for mobile and space constrained applications.

## 2. Features and Benefits

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- Low On-resistance,  $R_{ON} = 1.9 \Omega$  when  $V_{CC} = 5.5 V$
- 12 pF typical ON capacitance
- High Bandwidth ( -3 dB @ 800 MHz) Suitable For USB2.0 High-Speed Routing
- Low Quiescent Current ( $< 1 \mu A$ ) when  $V_{CC} = 3.3 V$
- 1.8 V Logic Compatible Control Pin
- High Off-Isolation: -80 dB @ 10 KHz
- Low Channel-to-Channel Crosstalk: -82 dB @ 10 KHz
- ESD protection: HBM ESDA/JEDEC JS-001 Class 2 exceeds 2000 V

## 3. Applications

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- Mobile Phones, Tablets and Notebooks
- USB port devices

## EMS3900

Dual high-speed USB 2.0 double-pole double-throw analog switch

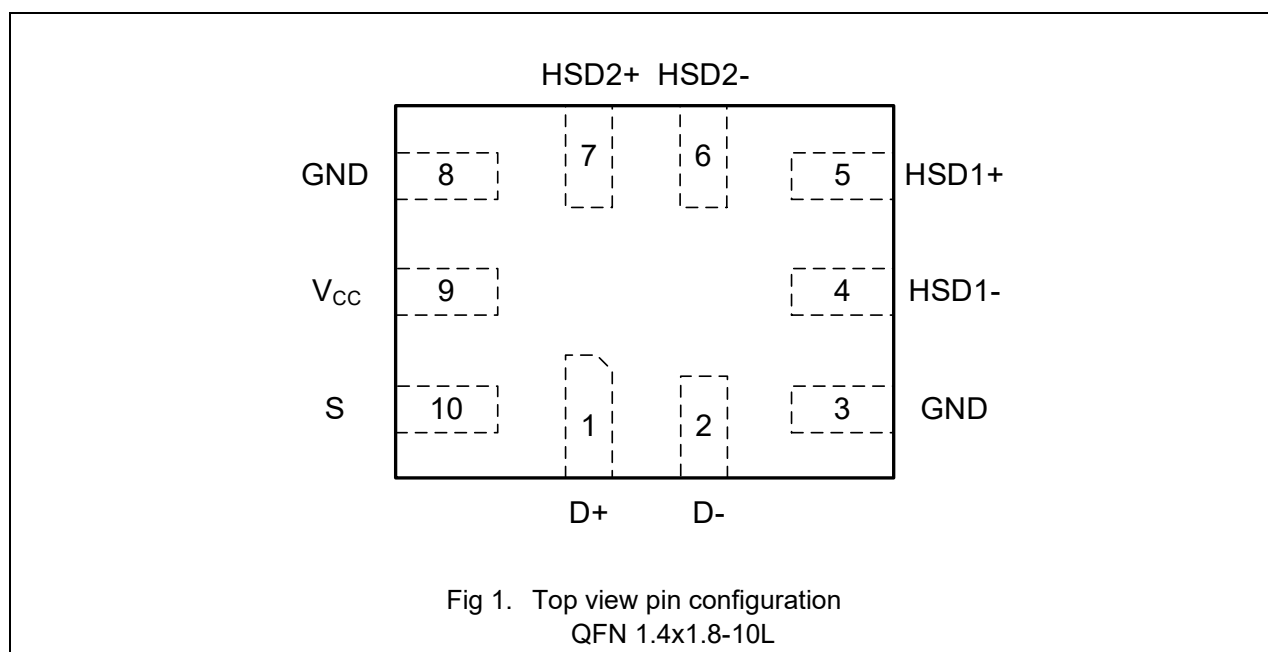
## 4. Ordering Information

Table 1. Ordering information

| Type number | Topside marking | Package        |                                                               | Quantity |
|-------------|-----------------|----------------|---------------------------------------------------------------|----------|
|             |                 | Name           | Description                                                   |          |
| EMS3900RSW  | 3900<br>YYWW    | QFN1.4×1.8-10L | QFN package, 10 pins<br>1.4 mm × 1.8 mm; 0.55 mm (Max) height | 3000     |

## 5. Pinning Information

### 5.1. Pin map



## EMS3900

### Dual high-speed USB 2.0 double-pole double-throw analog switch

## 5.2. Pin description

Table 2. Pin description

| Symbol          | Pin  | Description                 |
|-----------------|------|-----------------------------|
| V <sub>CC</sub> | 9    | Single Power Supply         |
| HSD2-, HSD2+    | 6, 7 | Analog/Digital Signal Ports |
| D+, D-          | 1, 2 | Common Signal Ports         |
| HSD1-, HSD1+    | 4, 5 | Analog/Digital Signal Ports |
| GND             | 3, 8 | Ground                      |
| S               | 10   | Selection Logic Control     |

## 6. Functional Description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level.

| Input S | Switch                   |
|---------|--------------------------|
| L       | HSD1+ to D+, HSD1- to D- |
| H       | HSD2+ to D+, HSD2- to D- |

## 7. Typical Application

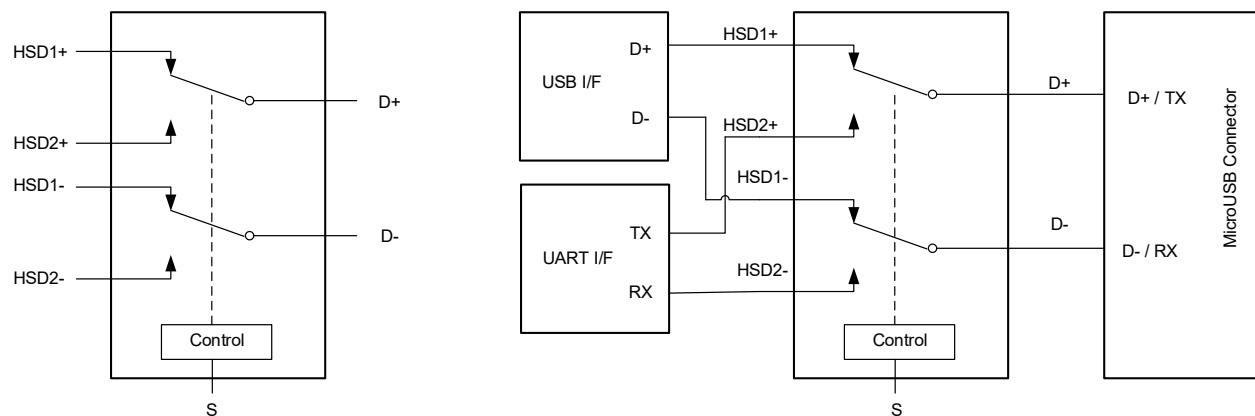


Fig 2. USB2.0 Switch

## 8. Absolute Maximum Ratings

Absolute Maximum Ratings may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied.

**Table 4. Absolute Maximum Ratings**

| Symbol           | Parameter                                             | Conditions | Min  | Max  | Unit |
|------------------|-------------------------------------------------------|------------|------|------|------|
| V <sub>CC</sub>  | supply voltage                                        |            | -0.3 | 6.5  | V    |
| V <sub>SW</sub>  | switch voltage                                        |            | -0.3 | 6.5  | V    |
| V <sub>IN</sub>  | control input voltage                                 |            | -0.3 | 6.5  | V    |
| I <sub>C</sub>   | continuous current HSDn or Dn                         |            |      | ±100 | mA   |
| I <sub>P</sub>   | peak current HSDn or Dn(pulsed at 1ms 50% duty cycle) |            |      | ±200 | mA   |
| P <sub>D</sub>   | power dissipation                                     |            |      | 250  | mW   |
| T <sub>stg</sub> | storage temperature                                   |            | -55  | 150  | °C   |
| T <sub>J</sub>   | junction temperature under bias                       |            |      | 125  | °C   |
| T <sub>L</sub>   | lead temperature (soldering, 10 seconds)              |            |      | 260  | °C   |

## 9. Recommended Operating Conditions

**Table 5. Recommend operating ratings**

| Symbol          | Parameter                | Conditions | Min | Max             | Unit |
|-----------------|--------------------------|------------|-----|-----------------|------|
| V <sub>CC</sub> | supply voltage operating |            | 1.5 | 5.5             | V    |
| V <sub>SW</sub> | switch voltage           |            | 0   | V <sub>CC</sub> | V    |
| V <sub>IN</sub> | control input voltage    |            | 0   | 5.5             | V    |
| T <sub>A</sub>  | operating temperature    |            | -40 | 125             | °C   |

## 10. Electrical Characteristics

**Table 6. Static characteristics**
 $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V}$ , unless otherwise specified

| Symbol                    | Parameter                               | Conditions                                                                                   | Min | Typ  | Max       | Unit          |
|---------------------------|-----------------------------------------|----------------------------------------------------------------------------------------------|-----|------|-----------|---------------|
| <b>DC Characteristics</b> |                                         |                                                                                              |     |      |           |               |
| $V_{IH}$                  | input logic high level                  | $V_{CC} = 3.4\text{ V to } 5.5\text{ V}$                                                     | 1.6 |      |           | V             |
|                           |                                         | $V_{CC} = 1.5\text{ V to } 3.3\text{ V}$                                                     | 1.4 |      |           | V             |
| $V_{IL}$                  | input logic low level                   | $V_{CC} = 3.4\text{ V to } 5.5\text{ V}$                                                     |     |      | 0.6       | V             |
|                           |                                         | $V_{CC} = 1.5\text{ V to } 3.3\text{ V}$                                                     |     |      | 0.4       | V             |
| $I_{CC}$                  | supply quiescent current                | $I_D = 0$ , $V_{IN} = 0$ or $V_{IN} = V_{CC}$                                                |     |      | 1.0       | $\mu\text{A}$ |
| $\Delta I_{CC}$           | increase in $I_{CC}$ per input          | $I_D = 0$ , $V_{CC} = 2.5\text{ V or } 4.2\text{ V}$<br>$V_{IN} = 1.6\text{ V}$              |     |      | 3.0       | $\mu\text{A}$ |
| $I_{OFF}$                 | off state leakage from Dn to HSDn       | $V_{CC} = 5.5\text{ V}$ , $V_{Dn} = 5\text{ V}$ , $V_{HSDn} = 0\text{ V}$                    |     |      | $\pm 2.0$ | $\mu\text{A}$ |
| $R_{ON}$                  | on-resistance                           | $V_{CC} = 3.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.0\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 3.4  | 4.0       | $\Omega$      |
|                           |                                         | $V_{CC} = 4.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.3\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 2.4  | 3.0       | $\Omega$      |
|                           |                                         | $V_{CC} = 5.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.6\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 1.9  | 2.5       | $\Omega$      |
| $R_{FLAT}$                | on-resistance flatness                  | $V_{CC} = 3.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.0\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 0.2  | 0.4       | $\Omega$      |
|                           |                                         | $V_{CC} = 4.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.3\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 0.25 | 0.45      | $\Omega$      |
|                           |                                         | $V_{CC} = 5.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.6\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 0.3  | 0.5       | $\Omega$      |
| $\Delta R_{ON}$           | on-resistance matching between channels | $V_{CC} = 3.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.0\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 0.1  | 0.2       | $\Omega$      |
|                           |                                         | $V_{CC} = 4.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.3\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 0.1  | 0.2       | $\Omega$      |
|                           |                                         | $V_{CC} = 5.5\text{ V}$ , $V_{SW} = 0.8\text{ V to } 2.6\text{ V}$ ,<br>$I_D = 10\text{ mA}$ |     | 0.1  | 0.2       | $\Omega$      |

## EMS3900

### Dual high-speed USB 2.0 double-pole double-throw analog switch

| Symbol                    | Parameter                 | Conditions                                                                               | Min | Typ | Max | Unit |
|---------------------------|---------------------------|------------------------------------------------------------------------------------------|-----|-----|-----|------|
| <b>AC Characteristics</b> |                           |                                                                                          |     |     |     |      |
| $C_{ON}$                  | on capacitance            | $f = 100 \text{ kHz}$                                                                    |     | 12  |     | pF   |
| $C_{OFF}$                 | off capacitance           | $f = 100 \text{ kHz}$                                                                    |     | 4   |     | pF   |
| OIRR                      | off isolation             | $f = 10 \text{ kHz}$                                                                     |     | -80 |     | dB   |
|                           |                           | $f = 240 \text{ MHz}$                                                                    |     | -31 |     | dB   |
| $X_{TALK}$                | crosstalk                 | $f = 10 \text{ kHz}$                                                                     |     | -82 |     | dB   |
|                           |                           | $f = 240 \text{ MHz}$                                                                    |     | -26 |     | dB   |
| BW                        | -3dB bandwidth            | $C_L = 0 \text{ pF}$                                                                     |     | 800 |     | MHz  |
| $t_{BBM}$                 | break-before-make time    | $V_{SW} = 1.5 \text{ V}$ , $C_L = 50 \text{ pF}$ , $R_L = 50 \Omega$                     |     | 600 |     | ns   |
| $t_{ON}$                  | turn-on time              | $V_{SW} = 1.5 \text{ V}$ , $C_L = 50 \text{ pF}$ , $R_L = 50 \Omega$                     |     | 470 |     | ns   |
| $t_{OFF}$                 | turn-off time             | $V_{SW} = 1.5 \text{ V}$ , $C_L = 50 \text{ pF}$ , $R_L = 50 \Omega$                     |     | 120 |     | ns   |
| THD                       | total harmonic distortion | $f = 20 \text{ Hz to } 20 \text{ KHz}$ , $V_{SW} = 600 \text{ mVpp}$ , $R_L = 32 \Omega$ |     | -80 |     | dB   |

## 11. Typical Performance Curves

$T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 3.0\text{ V}$ , unless otherwise noted

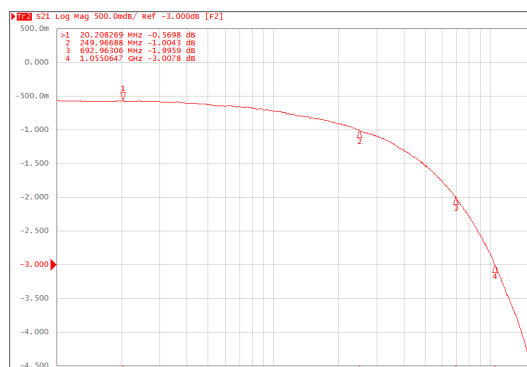


Fig 3. Bandwidth

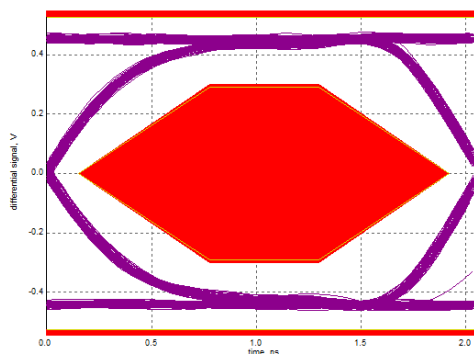


Fig 4. Eye Diagram (480Mbps)

## 12. Test Circuits

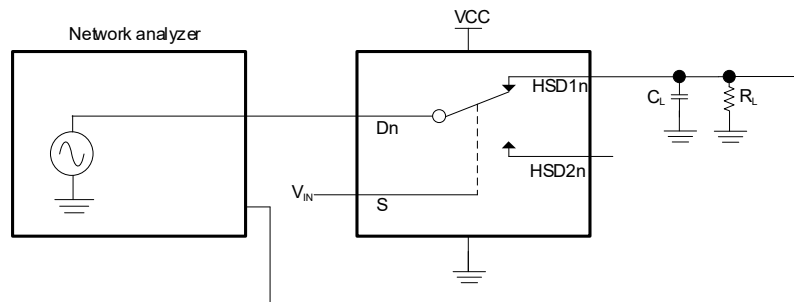


Fig 5. Bandwidth

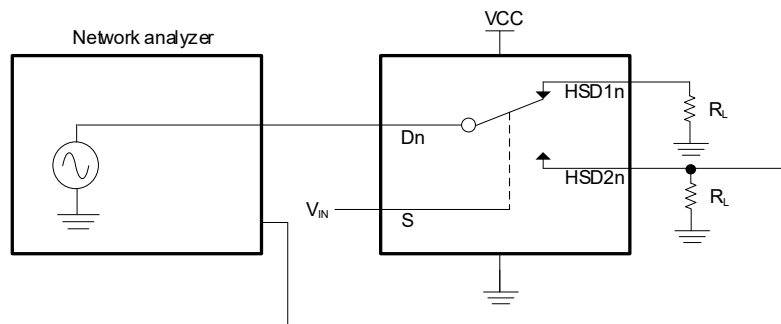


Fig 6. Off isolation

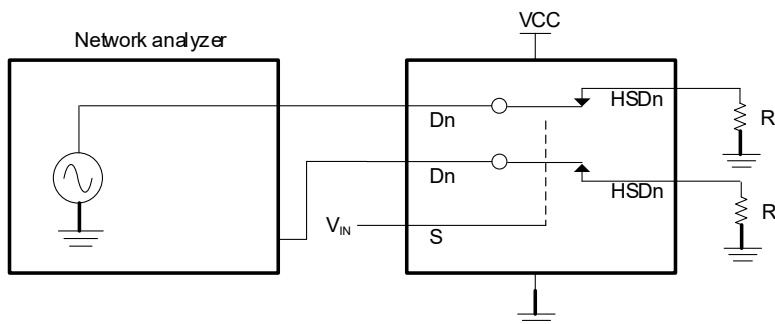


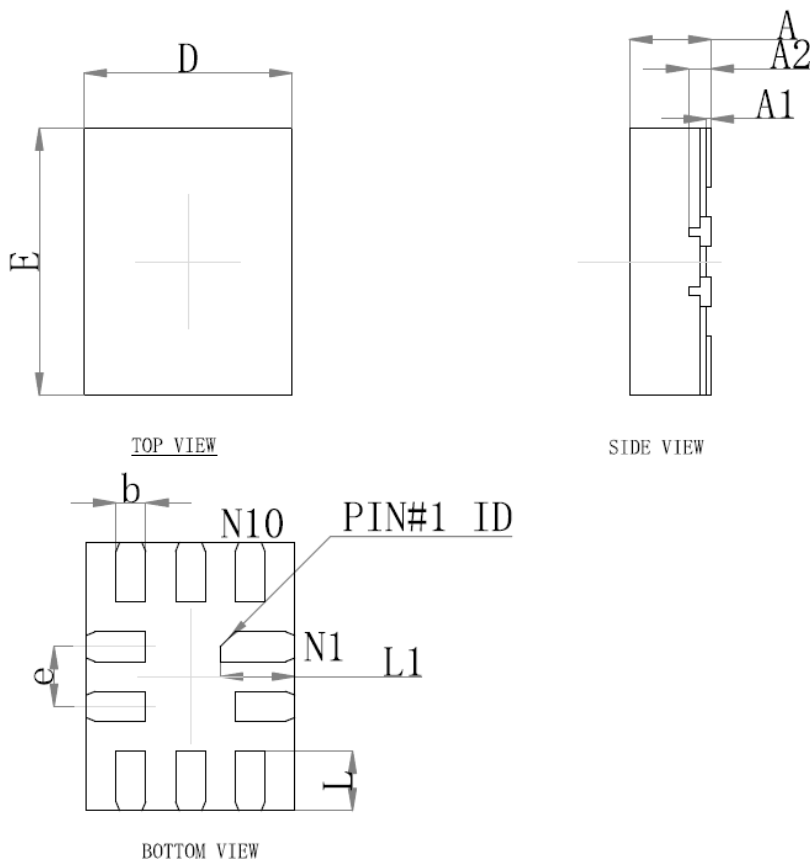
Fig 7. Crosstalk

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# 13. Package Outline

QFN 1.4x1.8 -10L



| Symbol | Dimension in Millimeters |       |       |
|--------|--------------------------|-------|-------|
|        | Min.                     | NOM.  | Max.  |
| A      | 0.500                    | 0.550 | 0.600 |
| A1     | 0.000                    | --    | 0.050 |
| A2     | 0.152 Ref.               |       |       |
| D      | 1.324                    | 1.400 | 1.476 |
| E      | 1.724                    | 1.800 | 1.876 |
| b      | 0.150                    | 0.200 | 0.250 |
| e      | 0.400 Typ.               |       |       |
| L      | 0.350                    | 0.400 | 0.450 |
| L1     | 0.450                    | 0.500 | 0.550 |

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# 14. Revision History

**Table 7. Revision history**

| Document ID      | Release Date                                                                                                                                                                                                             | Data sheet status | Change notice | Supersedes       |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------------|------------------|
| EMS3900 Rev. 1.5 | Jun 09, 2025                                                                                                                                                                                                             | Product datasheet |               | EMS3900 Rev. 1.4 |
| Modifications:   | <ul style="list-style-type: none"> <li>Pin description updated</li> </ul>                                                                                                                                                |                   |               |                  |
| EMS3900 Rev. 1.4 | Mar 31, 2025                                                                                                                                                                                                             | Product datasheet |               | EMS3900 Rev. 1.3 |
| Modifications:   | <ul style="list-style-type: none"> <li>Features and Benefits: HBM updated.</li> <li>Table6: OIRR and <math>X_{TALK}</math> updated.</li> </ul>                                                                           |                   |               |                  |
| EMS3900 Rev. 1.3 | Feb 13, 2025                                                                                                                                                                                                             | Product datasheet |               | EMS3900 Rev. 1.2 |
| Modifications:   | <ul style="list-style-type: none"> <li>Table 6: The specification of <math>R_{FLAT}</math> updated.</li> </ul>                                                                                                           |                   |               |                  |
| EMS3900 Rev. 1.2 | Jan 6, 2025                                                                                                                                                                                                              | Product datasheet |               | EMS3900 Rev. 1.1 |
| Modifications:   | <ul style="list-style-type: none"> <li>Table 6: The condition of <math>\Delta I_{CC}</math> and <math>R_{ON}</math> updated.</li> <li>QFN package outline drawings updated.</li> <li>Topside marking updated.</li> </ul> |                   |               |                  |
| EMS3900 Rev. 1.1 | Nov 8, 2024                                                                                                                                                                                                              | Product datasheet |               | EMS3900 Rev. 1.0 |
| Modifications:   | <ul style="list-style-type: none"> <li>Table 6: <math>I_{CCT}</math> and AC Characteristics updated.</li> </ul>                                                                                                          |                   |               |                  |
| EMS3900 Rev. 1.0 | June 30, 2024                                                                                                                                                                                                            | Product datasheet |               |                  |