# High Current Power Distribution Switches

## General Description

The EM5213 is an N-channel MOSFET high-side power switch without parasitic body diode between drain and source. The EM5213 provides very low on-resistance as 40mΩ and continuously delivers up to 3.4A output current. The fault flag output function indicates fault conditions to the local USB controller. The other features include soft start, current limit protection, Power-On-Reset function, and over temperature protection. The EM5213 is available in SOT23-5L and DFN2X2-06 package.

## Ordering Information

| Part Number | Package | Remark |
|---|---|---|
| EM5213AJ-34 | SOT23-5 | 3.4A/Active High |
| EM5213J-34 | SOT23-5 | 3.4A/Active Low |
| EM5213AJ-30 | SOT23-5 | 3A/Active High |
| EM5213J-30 | SOT23-5 | 3A/Active Low |
| EM5213AJ-25 | SOT23-5 | 2.5A/Active High |
| EM5213J-25 | SOT23-5 | 2.5A/Active Low |
| EM5213AVA-30 | DFN2X2-06 | 3A/Active High |
| EM5213VA-30 | DFN2X2-06 | 3A/Active Low |

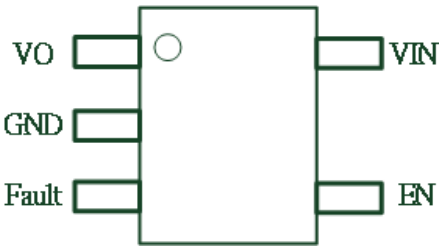
## Features

- Wide Input Range 2.7V to 5.5V
- Low MOSFET On Resistance(40mΩ)
- 2us Short Protection Response
- Low Quiescent(65uA) & Shutdown Current
- Deglitched Open-Drain Fault Flag Output
- Reverse Current Flow blocking
- Power On Reset Function
- Current Limit Protection
- Over Temperature Protection
- Soft Start and Fast turn off
- Reverse Voltage Protection
- Enable Active High or Active Low
- UL Recognized

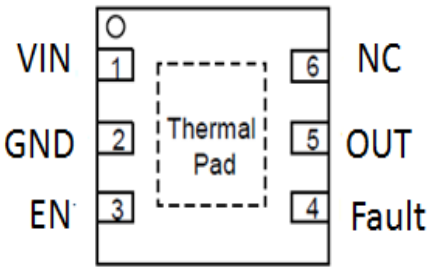
## Applications

- USB
- Notebook & Netbook &MB

## Pin Configuration

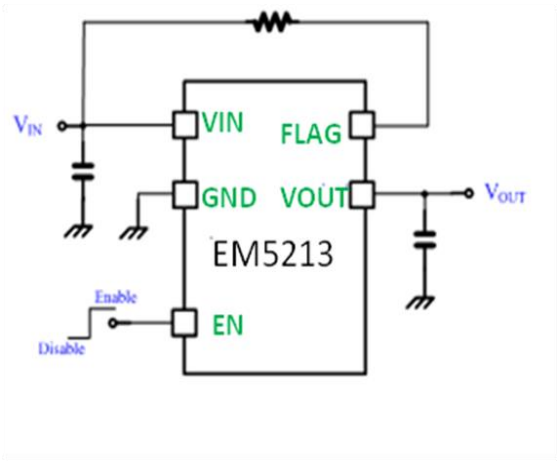



**SOT23-5**




**TDFN2X2-6**

## Typical Application Circuit

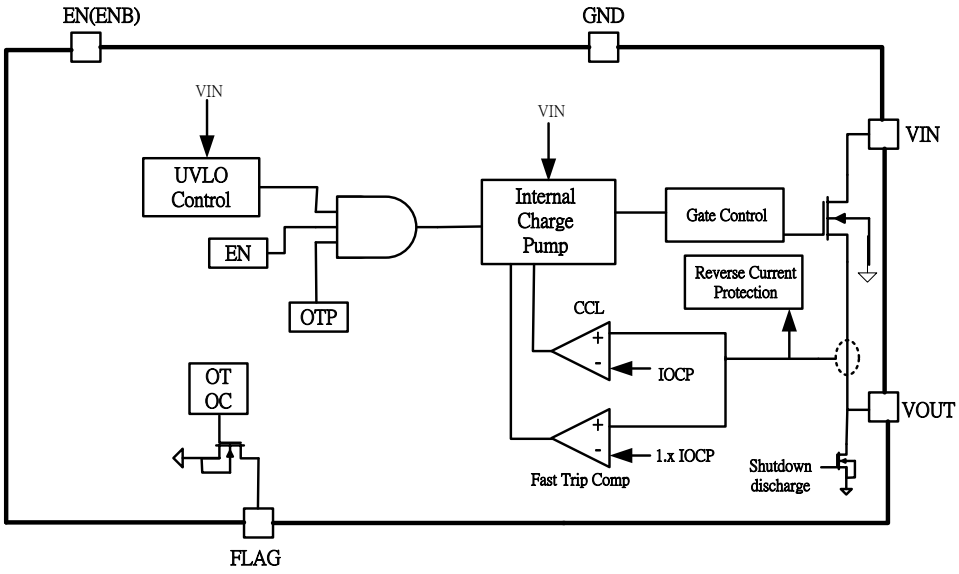



Note: A low ESR >1uF capacitor between VOUT & VIN to GND is recommended.

## Pin Assignment

| Pin Name | Pin No. SOT/DFN | Pin Function |
|---|---|---|
| GND | 2/2 | **Ground.** |
| VIN | 5/1 | **Input Voltage.** This is the drain input to the power device that supplies current to the output pin. Minimum 1uF low ESR ceramic capacitor is recommended at this pin. |
| EN / EN# | 4/3 | **Chip Enable Input** (Active high for EN, Active low for EN#) |
| FLAG (Fault) | 3/4 | **Fault Flag Output.** This is an open-drain output and is set low impedance once current limit or over temperature protection enabled. |
| VOUT | 1/5 | **Output Voltage.** VOUT is power output pin. |

## Function Block Diagram




## Absolute Maximum Ratings (Note1)

- $V_{IN}$ ---------- -0.3V to +6.0V
- Other Pins---------- -0.3V to ($V_{IN}$+0.3V)
- Power Dissipation, $P_D$ @ $T_A$ = 25°C, EM5213-25 ---------- 0.45W
- Package Thermal Resistance, $\theta_{JA}$, EM5213-25 (Note 2) ---------- 230°C/W
- Power Dissipation, $P_D$ @ $T_A$ = 25°C, EM5213-30/34 ---------- 0.8 W
- Package Thermal Resistance, $\theta_{JA}$, EM5213-30/34 (Note 2) ---------- 100°C/W
- Power Dissipation, $P_D$ @ $T_A$ = 25°C, EM5213VA-30 ---------- 1.1 W
- Package Thermal Resistance, $\theta_{JA}$, EM5213VA-30 (Note 2) ---------- 90°C/W
- Junction Temperature---------- 150°C
- Lead Temperature (Soldering, 10 sec.)---------- 260°C
- Storage Temperature ---------- –65°C to 150°C
- ESD susceptibility (Note3)
  HBM (Human Body Mode)---------- 2KV
  MM (Machine Mode)---------- 200V
  CDM (Charged Device Mode) ---------- 1KV

## Recommended Operating Conditions (Note4)

- Supply Input Voltage, $V_{IN}$ ---------- +2.5V to +5.5V
- Junction Temperature ---------- –40°C to 125°C
- Ambient Temperature ---------- -40°C to 85°C

## Electrical Characteristics

$V_{IN}$=5V, $T_A$=25℃, unless otherwise specified

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Supply Input Section** | | | | | | |
| POR Threshold | $V_{PORTH}$ | | - | 2.2 | 2.5 | V |
| Quiescent Current | $I_Q$ | $I_{OUT}$=0A | - | 65 | | uA |
| Shutdown Current | $I_{SD}$ | EN#=5V | - | 0.1 | 1 | uA |
| **Output Voltage** | | | | | | |
| On Resistance | $R_{ON}$ | $I_{OUT}$=0.5A, EM5213-25, EM5213VA | - | 60 | 70 | mΩ |
| | | $I_{OUT}$=0.5A, EM5213-30/34 | | 40 | 50 | mΩ |
| Reverse Leakage Current | IRev | VOUT=5V , VIN=0V | - | 0.1 | 2 | uA |
| Soft-Start Time | | Rising from 10% to 90%<br>$C_L$ =1uF ； $R_{LOAD}$ =10Ω | - | 1.5 | | ms |
| **Enable** | | | | | | |
| Enable High Level | $V_{EN}$ | | 1.2 | - | - | V |
| Disable Low Level | $V_{SD}$ | | - | - | 0.5 | V |
| EN Input Current | $I_{EN}$ | | - | 0.1 | 1 | uA |
| **OC# Flag Output** | | | | | | |
| OC# Output Resistance | $R_{FLGB}$ | $I_{SINK}$=1mA | - | 20 | | Ω |
| OC# Off Current | $I_{FLGB\_OFF}$ | $V_{FLGB}$=5V | - | 0.1 | 1 | uA |
| OC# Delay Time | $T_D$ | | 8 | 15 | 22 | ms |
| OUT Shutdown Discharge Resistance | RDIS | | | 100 | | Ω |
| **Protection** | | | | | | |
| OCP Threshold Level | $I_{OCP}$ | EM5213-25 only | 2.6 | 3.2 | 3.9 | A |
| Output Short Circuit Current | $I_{SC}$ | | 1.7 | 2.1 | 3 | A |
| OCP Threshold Level | $I_{OCP}$ | EM5213-30, EM5213VA | 3.1 | 3.6 | 4.5 | A |
| Output Short Circuit Current | $I_{SC}$ | | 1.7 | 2.1 | 2.9 | A |
| OCP Threshold Level | $I_{OCP}$ | EM5213-34 only | 3.5 | 4 | 4.8 | A |
| Output Short Circuit Current | $I_{SC}$ | | 1.7 | 2.3 | 2.9 | A |
| Thermal Shutdown Hysteresis | $T_{SDHYS}$ | | - | 30 | - | °C |
| Thermal Shutdown | | | | 150 | | °C |

**Note 1.** Stresses listed as the above “Absolute Maximum Ratings” may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

**Note 2.** $\theta_{JA}$ is measured in the natural convection at $T_A$=25°C on a low effective thermal conductivity test board (Single layout, 1S) of JEDEC 51-3 thermal measurement standard.

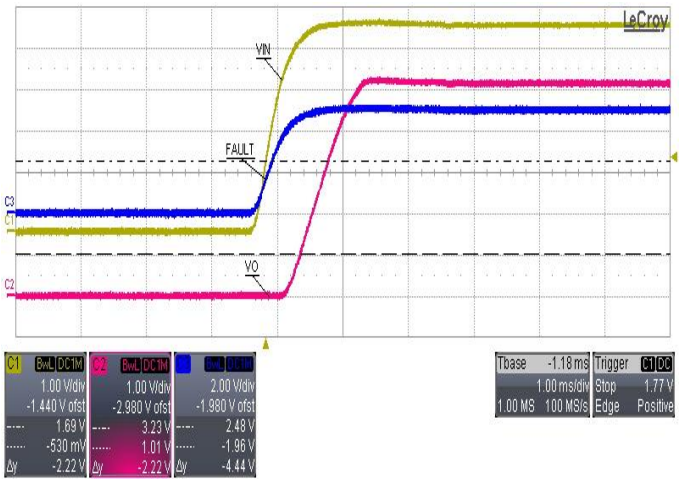
**Note 3.** Devices are ESD sensitive. Handling precaution is recommended.

**Note 4.** The device is not guaranteed to function outside its operating conditions.

**Note 5.** EMC will review datasheet by quarter, and update new version.

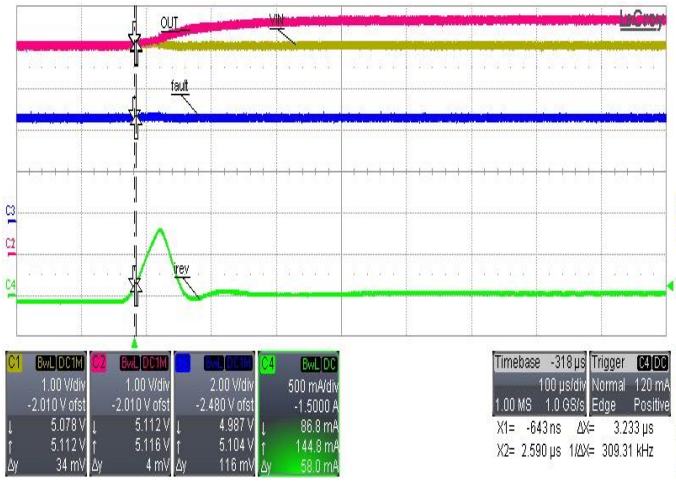
## Typical Operating Characteristics

**Turn on from VIN#**
**CH1: VIN, CH2:Vo, CH3:OCFLAG**

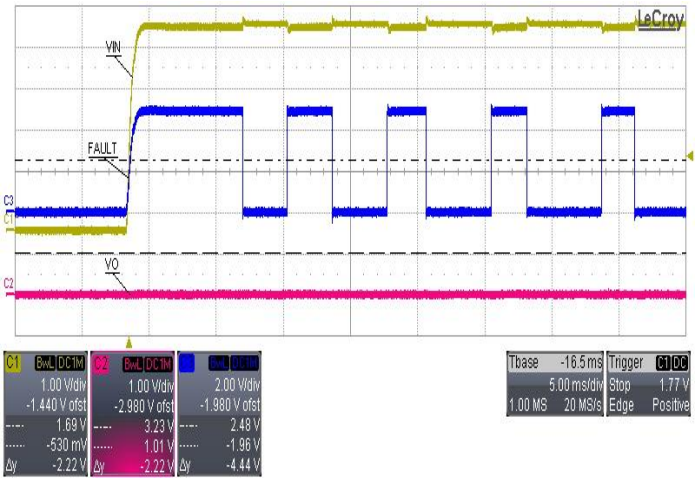



**Turn off from VIN#**
**CH1: VIN, CH2:Vo, CH3:OCFLAG**


**Reverse Voltage Protection**
**CH1:VIN, CH2:Vo, CH3: OCFLAG ,CH4:IREV**

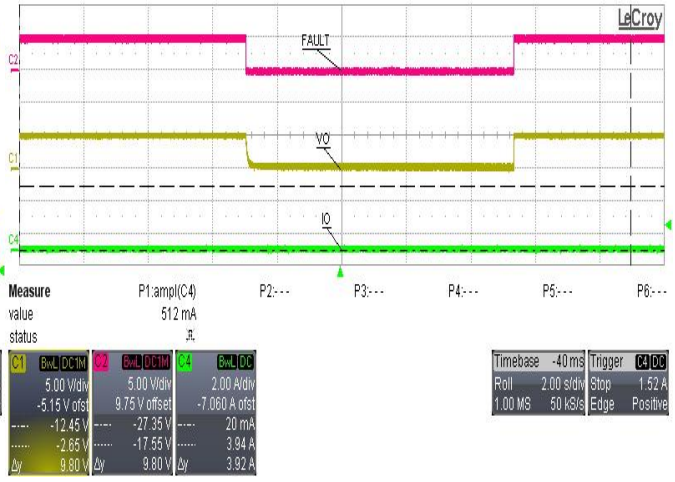



**Short then power on into OT cycle**
**CH1:VIN, CH2:Vo, CH3:OTFLAG**

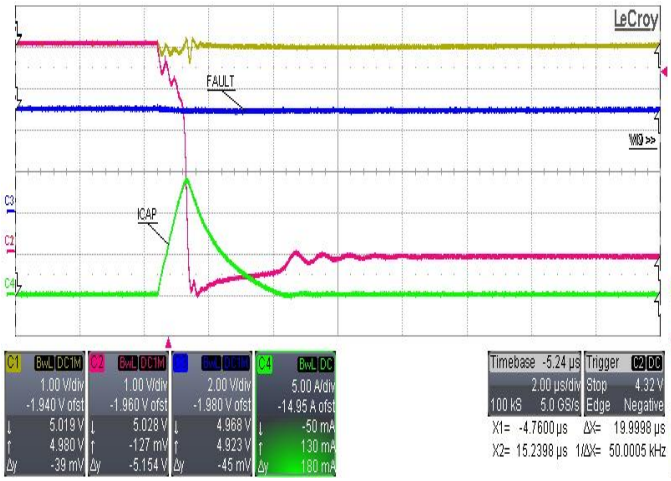



**Fault Signal delay time**
**CH1:VIN, CH2:VO, CH3:OCFLAG,CH4:Io**

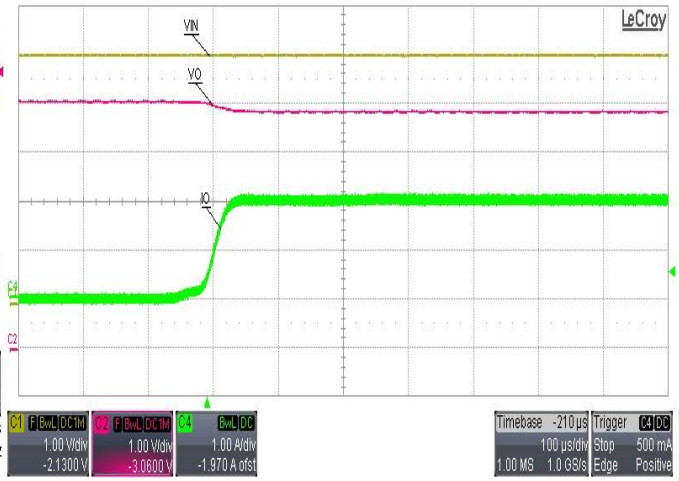

**Fault Signal during OTP occurs**
**CH1:Vo, CH2:OTGLAG#, CH4:Io**



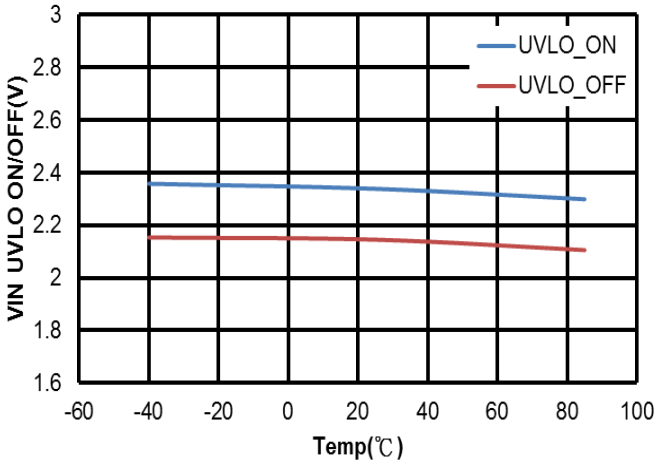
**2uS Response for Output short Protection**
**CH1:VIN, CH2:Vo, CH3:OCFLAG, CH4: IO**



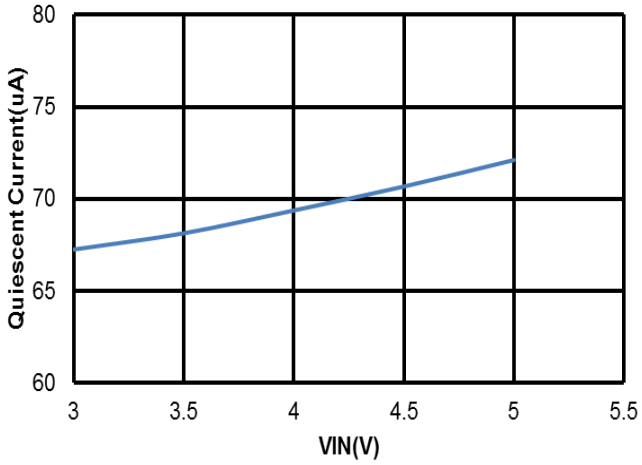

**Normal operating 2A output current**
**CH1:Vo, CH2:Fault, CH4:Io**



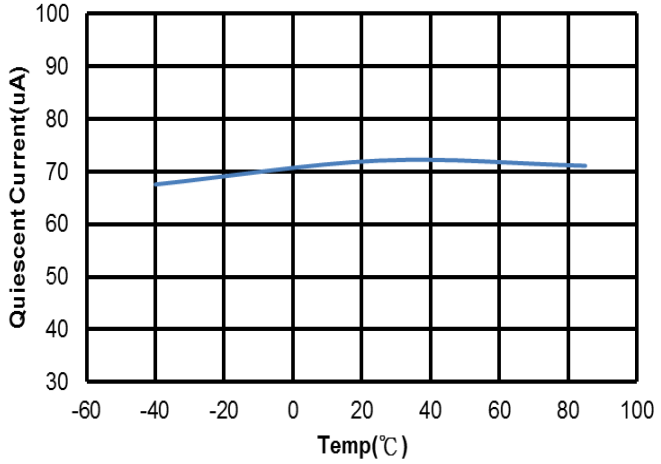

**UVLO ON/OFF Voltage VS Temperature**



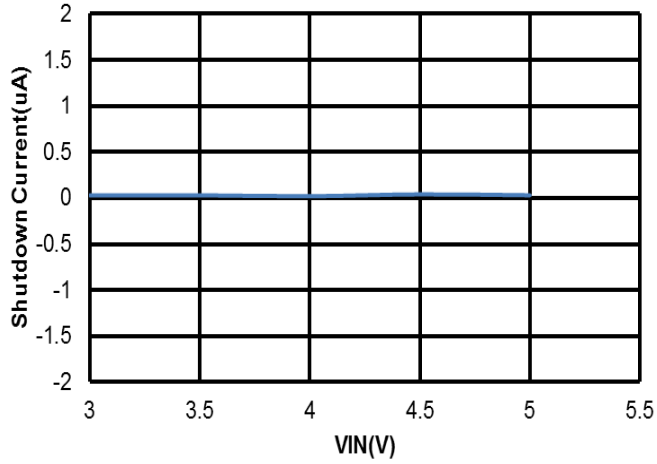

**Quiescent Current VS Input Voltage**



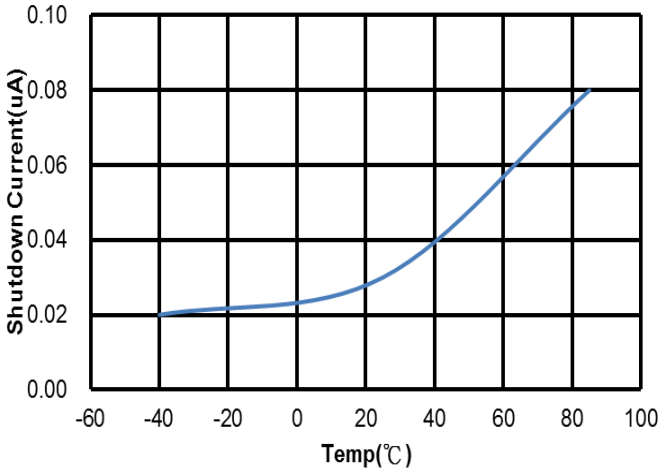

**Quiescent Current VS Temperature**



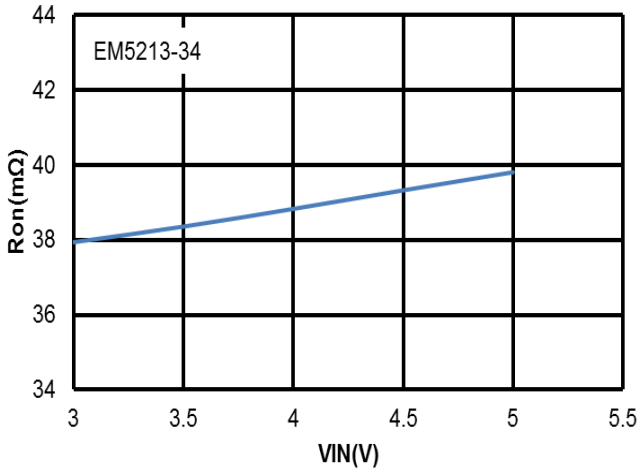

**Shutdown Current VS Input Voltage**



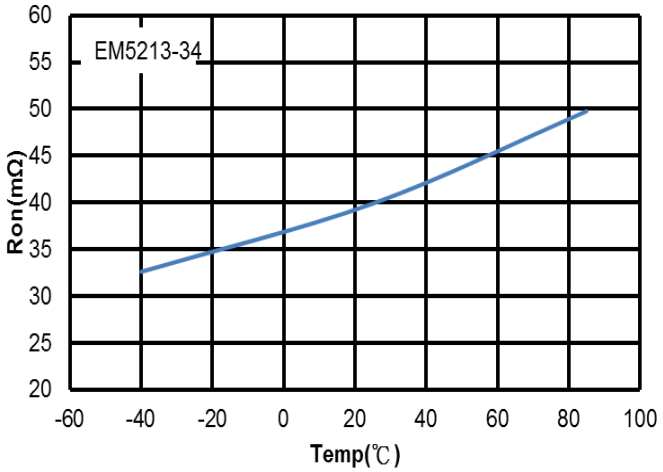
### Shutdown Current VS Temperature



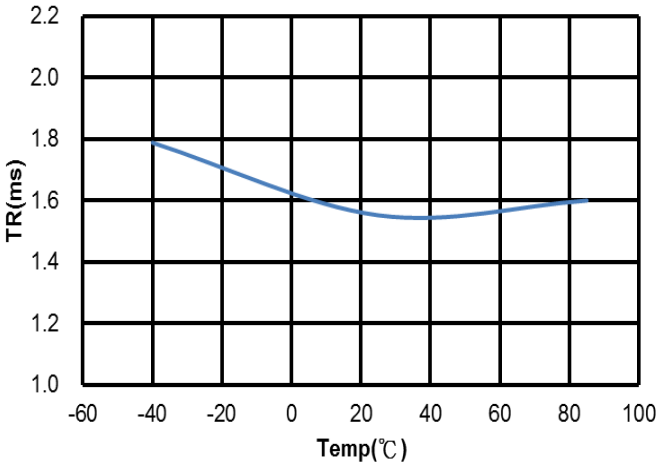

### RON Performance VS Input Voltage



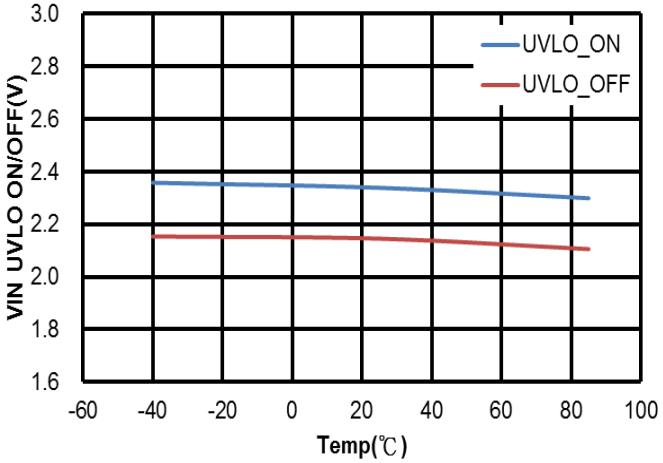

### RON Performance VS Temperature



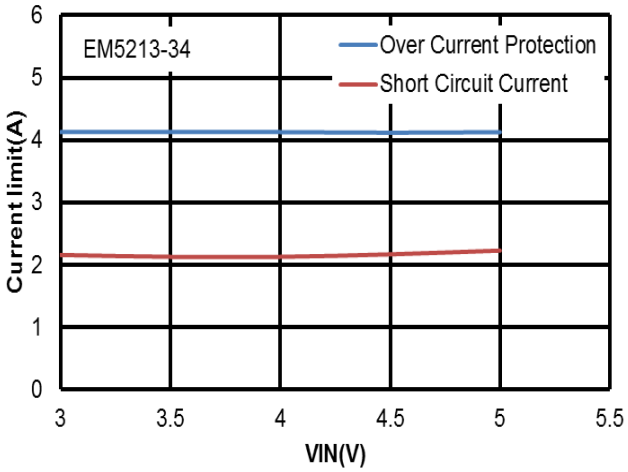

### Output Rising Time VS Temperature



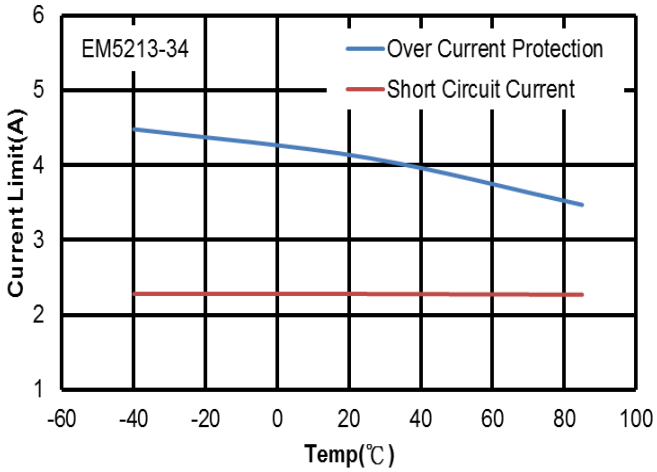

### Enable voltage VS Temperature




### Current limit VS Input Voltage



**Current limit VS Temperature**



# Application Information

## Input Under-Voltage Lockout (UVLO)

The under voltage lockout circuit shut-down the power switch until the input voltage reaches the UVLO turn on threshold.

## Internal Charge Pump

The device built in an internal charge pump for internal N-MOSFT driving. The internal charge pump provides the necessary voltage to pull up the gate voltage above the input source. The charge pump also controls the rising time of the output voltage to limit large current and voltage surges on the input supply, and provides built-in soft-start functionality. The MOSFET will block the current from output to input during shut-down operation.

## FLAG

The FLAG open-drain output is asserted during over current, short circuit or over temperature condition. A typical 9ms deglitch time on output rising edges avoids false reporting at startup.

## Output Discharge

A 100 ohm (typical) internal pull down resistor will discharge the bulk capacitor when the device enters in UVLO or disable mode. The discharged time is dependent on the RC time constant of resistance and output capacitor.

## Reverse Voltage Protection

When the output voltage exceeds the input voltage by 150mV, the reverse voltage circuitry will disconnects the internal Power MOS after 20us deglitch time in order to protect the input power supply. This protection circuit remains active until the voltage at output drops below the input voltage that about 800mV, the Power MOS will be turned back on.

## Reverse Blocking Control

The reverse blocking control feature prevents the current to flow from output to input when device is disabled.

## Over current and short circuit Protection

EM5213 switches into a constant current limitation mode when the output current is above the $I_{OCP}$ threshold. The difference overcurrent conditions and the corresponding response as below,

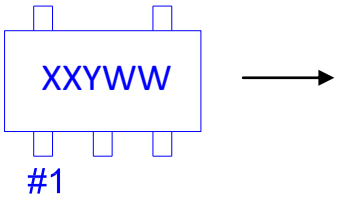
- In case of short circuit or huge load, the higher current may flow for a very short period response time about 2us.After this duration time, the switch turn into constant current limit mode and the short current is clamped at $I_{SC}$ Level. If the output remains shorted or tied to a ground level, the junction temperature of the device exceeds $T_{SD}$ value and device enters in thermal shutdown cycle.
- In case of hot plug with heavy capacitive load, the output voltage is brought down to the capacitor voltage. The device will limit the current to the $I_{SC}$ Level until the charge of the capacitor is completed.
- In case of load increase gradually, once the current over the $I_{OC}$ Level, the device turn into constant current limit mode, until the load current decreasing down to below the $I_{SC}$ Level, then the output will be ramp up to the target voltage level automatically.

## Over Temperature Protection

Over temperature protection prevent the IC from damage when the junction temperature over the 150 degree, the internal thermal sense turns the power switch off and the FLT output is asserted, thus preventing the power switch from damage. Hysteresis in the thermal sense circuit allows the device to cool down by approximately 20degree before the output is re-started.

## Ordering & Marking Information

Device Name: EM5213J/AJ for SOT-23-5

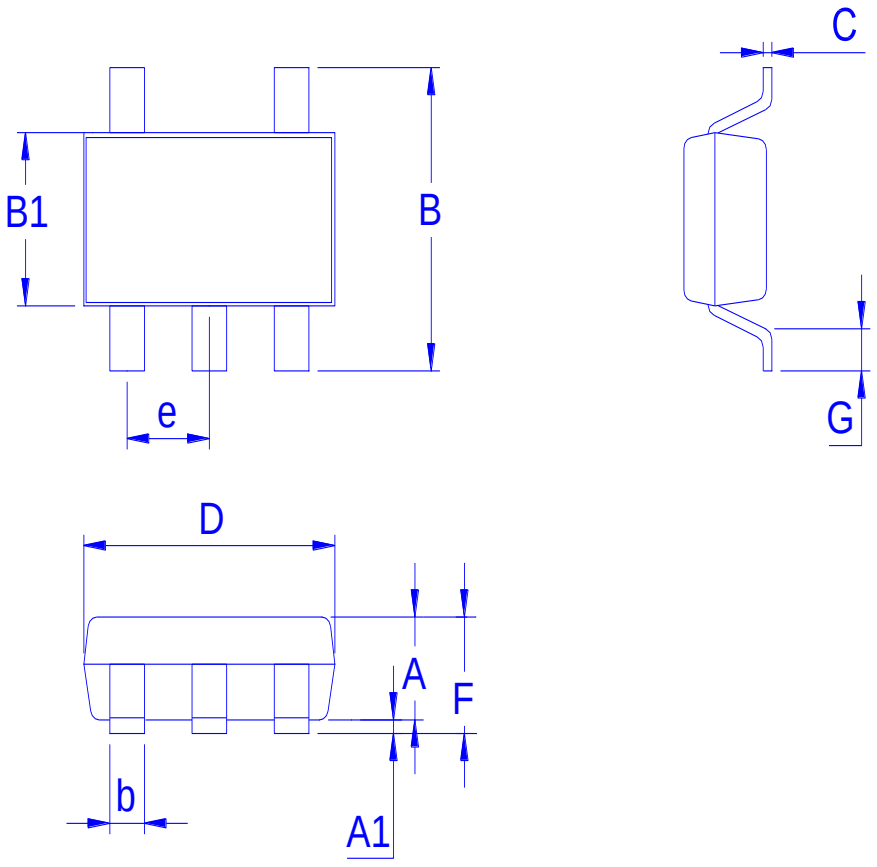



XX: Device Code

| Device | Code |
|---|---|
| EM5213AJ-30 | K3 |
| EM5213J-30 | K4 |
| EM5213AJ-34 | K5 |
| EM5213J-34 | K6 |
| EM5213AJ-25 | K7 |
| EM5213J-25 | K8 |

YWW: Date Code

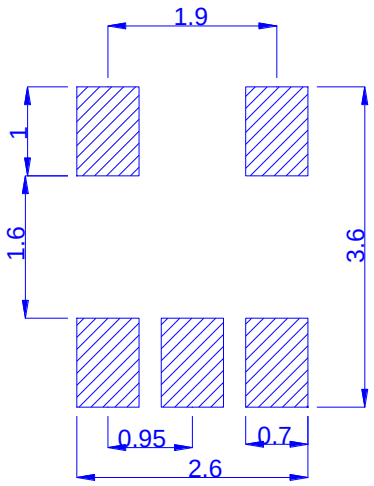
## Outline Drawing




Dimension in mm

| Dimension | A | A1 | B | B1 | b | C | D | e | F | G |
|---|---|---|---|---|---|---|---|---|---|---|
| Min. | 0.90 | 0.00 | | | 0.30 | 0.08 | | | | 0.30 |
| Typ. | 1.15 | | 2.80 | 1.60 | | | 2.90 | 0.95 | | 0.45 |
| Max. | 1.30 | 0.15 | | | 0.50 | 0.22 | | | 1.45 | 0.60 |

## Recommended minimum pads



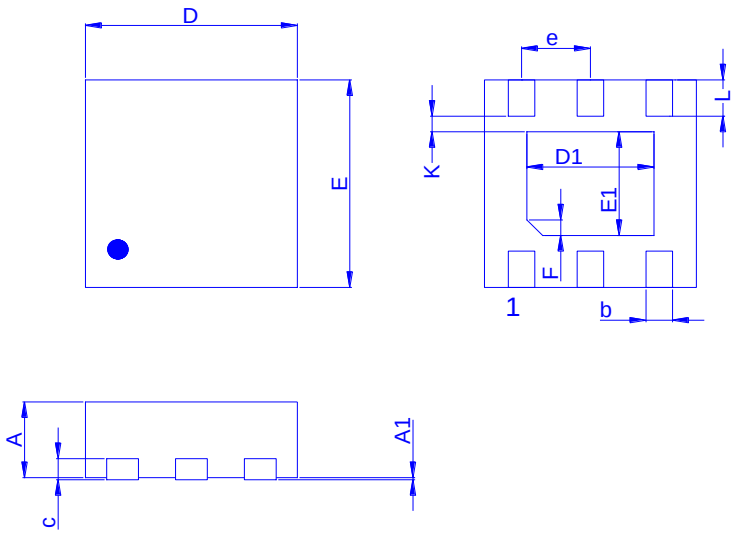
Device Name: EM5213AVA/VA for DFN2206


XX: Device Code

| Device | Code |
|---|---|
| EM5213AVA-30 | K9 |
| EM5213VA-30 | K0 |

YWW: Date Code

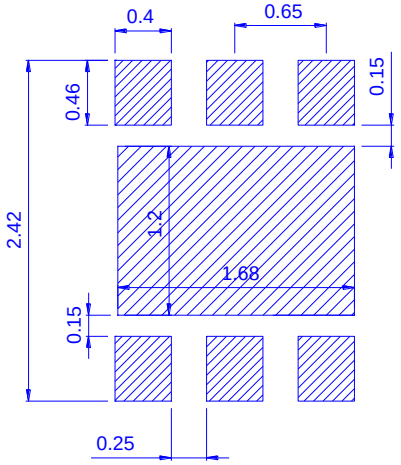
## Outline Drawing



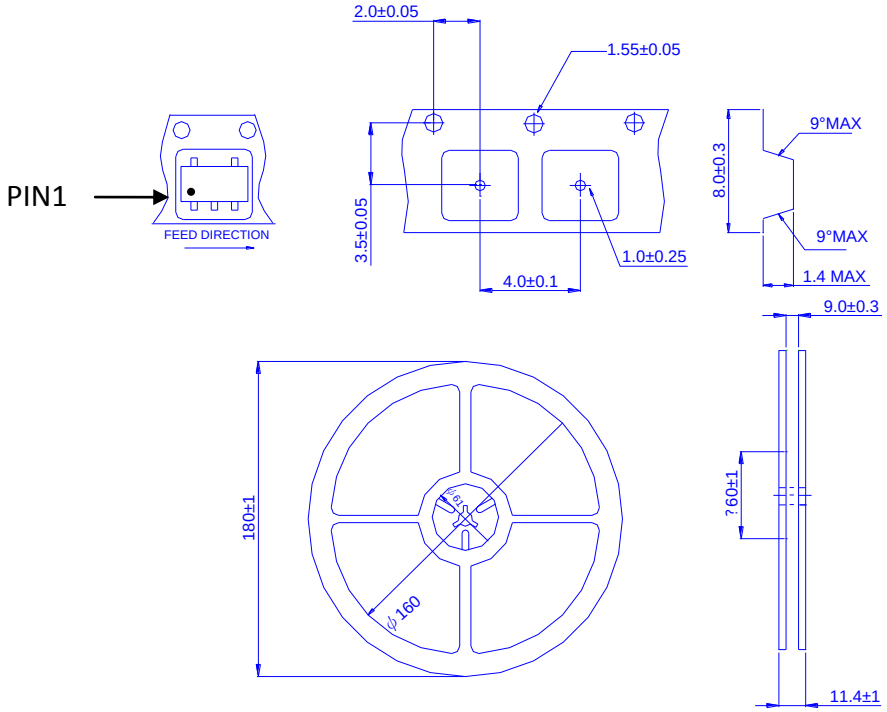

Dimension in mm

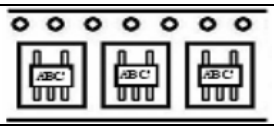
| Dimension | A | A1 | A2 | b | D | D1 | E | E1 | e | F | K1 | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min. | 0.80 | 0.00 | 0.15 | 0.18 | 1.9 | 1.2 | 1.9 | 0.9 | | | 0.2 | 0.3 |
| Typ. | | 0.02 | 0.2 | 0.25 | 2.0 | 1.3 | 2.0 | 0.8 | 0.65 | 0.25 | | 0.35 |
| Max. | 0.90 | 0.05 | 0.25 | 0.30 | 2.1 | 1.4 | 2.1 | 0.7 | | | | 0.4 |

Recommended minimum pads



◆ **Tape&Reel Information:3000pcs/Reel(Dimension in millimeter)**




| | |
|---|---|
| 產品別 | SOT-2X series |
| Reel 尺寸 | 7” |
| 編帶方式 |  |
| 前空格 | 50 |
| 後空格 | 50 |
| 裝箱數 | |
| 滿捲數量 | 3K |
| 捲/內盒比 | 5：1 |
| 內盒滿箱數 | 15K |
| 內/外箱比 | 8：1 |
| 外箱滿箱數 | 120K |