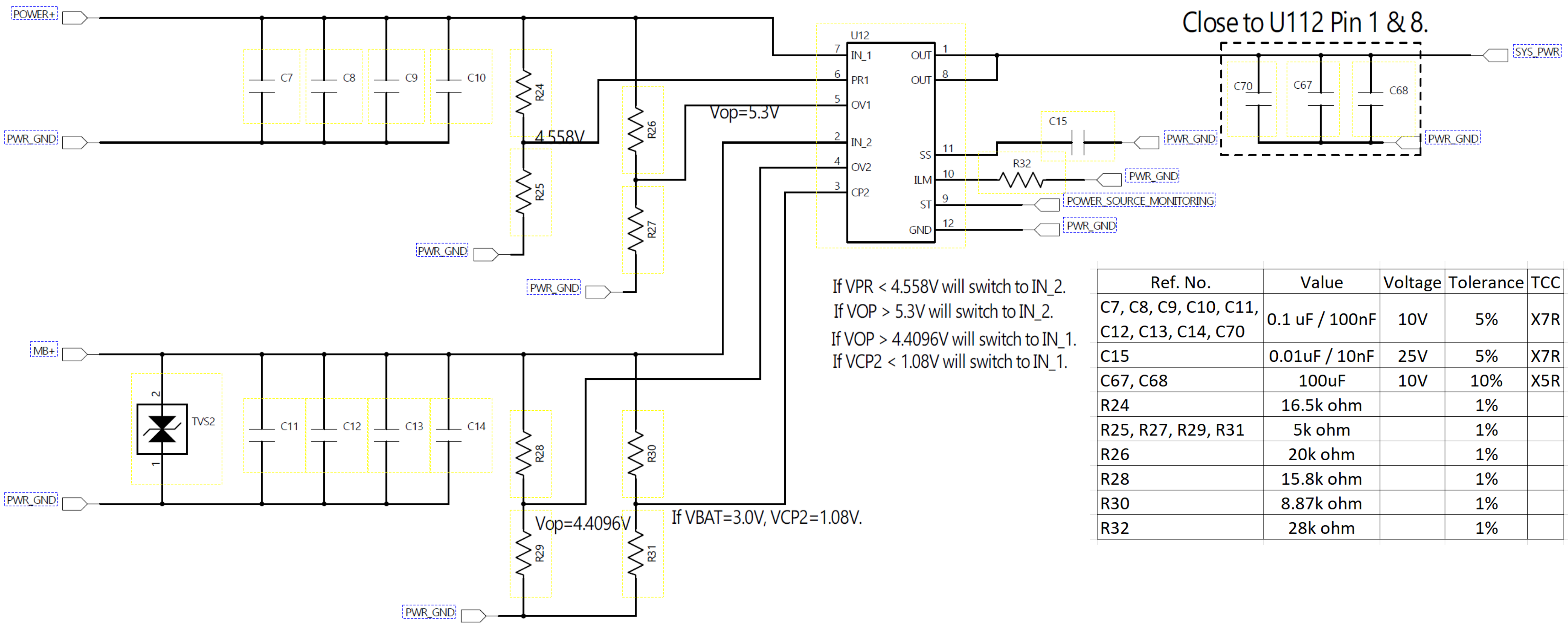
# SCHEMATIC




| Ref. No. | Value | Voltage | Tolerance | TCC |
|---|---|---|---|---|
| C7, C8, C9, C10, C11, C12, C13, C14, C70 | 0.1 uF / 100nF | 10V | 5% | X7R |
| C15 | 0.01uF / 10nF | 25V | 5% | X7R |
| C67, C68 | 100uF | 10V | 10% | X5R |
| R24 | 16.5k ohm | | 1% | |
| R25, R27, R29, R31 | 5k ohm | | 1% | |
| R26 | 20k ohm | | 1% | |
| R28 | 15.8k ohm | | 1% | |
| R30 | 8.87k ohm | | 1% | |
| R32 | 28k ohm | | 1% | |



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# OPERATING CONDITIONS

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## 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| | | Pins | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{IN1}$ , $V_{IN2}$ | Input Voltage Range[1] | IN1, IN2 | 2.8 | 22 | V |
| $V_{OUT}$ | Output Voltage Range | OUT | 0 | 22 | V |
| $V_{OV1}$ , $V_{OV2}$ | Overvoltage Pin Voltage | OV1, OV2 | 0 | 5.5 | V |
| $V_{PRI}$ , $V_{SEL}$ | Control Pin Voltage | PRI, SEL | 0 | 5.5 | V |
| $V_{ST}$ | Control Pin Voltage | ST | 0 | 5.5 | V |
| $R_{ST}$ | Status Pin Pull Up Resistance | ST | 6 | 20 | kΩ |
| $R_{ILM}$ | Current Limit Resistance | ILM | 18 | 100 | kΩ |
| $V_{SS}$ | SS Pin Output Voltage | SS | | 4 | V |
| $I_{IN1}$ , $I_{IN2}$ | TPS2120 Continuous Input Current | IN1, IN2 | | 3 | A |
| $I_{IN1}$ , $I_{IN2}$ | TPS2121 Continuous Input Current | IN1, IN2 | | 4.5 | A |
| $T_J$ | Junction temperature | - | -40 | 125 | °C |

(1) See Power Supply Recommendations Section for more Details



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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CONTROL PINS (PRI, SEL, OV1, OV2)** | | | | | | | |
| $V_{REF,\ x}$ | Internal Voltage Reference | $V_{PR1}$, $V_{CP2}$, $V_{OV1}$, $V_{OV2}$ Rising | -40°C to 125°C | 1.01 | 1.06 | 1.1 | V |
| | | $V_{PR1}$, $V_{CP2}$, $V_{OV1}$, $V_{OV2}$ Falling | -40°C to 125°C | 0.99 | 1.04 | 1.09 | V |
| $V_{OFST}$ | Comparator Offset Voltage (TPS2121 only) | $V_{PR1} > V_{REF}$<br>$V_{CP2} > V_{REF}$ | -40°C to 125°C | 5 | 20 | 40 | mV |
| $I_{LK,\ x}$ | Pin Leakage Current | $V_{PR1}$, $V_{CP2}$, $V_{OV1}$, $V_{OV2}$ = 0 V to 5.5 V | -40°C to 125°C | -0.1 | | 0.1 | µA |



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# CURRENT LIMIT

## Page 13 of TPS2120 / TPS2121 datasheet

### 9.3.2 Active Current Limiting (ILM)

The load current is monitored at all times. When the load current exceed the current limit trip point ILM programmed by RILM resistor, the device regulates the current within $t_{ILM}$. The following equations can be used to find the RILM value for a desired current limit, where RILM is in kΩ and between 18 kΩ to 100 kΩ.

**TPS2121:**

$$I_{LM} = \frac{65.2}{R_{ILM}^{0.861}} \quad (2)$$

During current regulation, the output voltage will drop resulting in increased device power dissipation. If the device junction temperature ($T_J$) reaches the thermal shutdown threshold (TSD) the internal FETs are turned off. After cooling down, the device will automatically restart.

For our current design, we use 28k ohm. According to formula (2), the current will be limited to 3.7A.



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# PR_1 AND CP_2

## Page 23 of TPS2120 / TPS2121 datasheet

***10.2.4.1 Selecting PR1 and CP2 Resistors***

The TPS2120 does not contain a CP2 pin. Instead, a select pin (SEL), enables override of the PR1 / VREF comparison. Once the voltage on SEL is greater than VREF, the device will select IN2 as the output. For manual switchover, an external signal can be connected to the SEL pin. For this example, the external MCU signal is a 3.3-V enable.

The TPS2121 can be configured for manual switchover in a similar manner as the TPS2120. Instead of a SEL pin, the 3.3-V external MCU signal can be connected to CP2. As long as the voltage on CP2 is higher than PR1, the device will select IN2 as the output. When the voltage on CP2 drops below PR1, the device will switch back to IN1. Therefore, the resistor divider on PR1 is configured the same as above, with the 5 kΩ and 10.2 kΩ.

For additional precautions, the voltage on PR1 can also be configured. If the voltage on IN1 were to drop, the device can automatically switchover to IN2. In this example, if voltage on IN1 drops below IN2 (3.3 V) then the device will switch to IN2. Therefore, the resistor divider on PR1 should be configured such that the voltage on PR1 will drop below VREF, when IN1 dips below 3.3 V. The bottom resistor is chosen to be 5 kΩ due to it's commonality and minimal current leakage. If a smaller leakage is desired, a larger resistor can be used. With this configuration, the top resistor was selected to be 10.2 kΩ. With this resistor configuration, the device will switch to IN2 when the voltage on IN1 dips to 3.22 V. Refer to Table 9-2 for additional information regarding the switchover configuration.

See Equation 5 for the VPR1 Calculation

$$V_{PR1} = V_{IN1} \times \frac{5\ k\Omega}{5\ k\Omega + 10.2\ k\Omega}$$

$$1.06\ V = V_{IN1} \times \frac{5\ k\Omega}{5\ k\Omega + 10.2\ k\Omega} = 3.22\ V \quad (5)$$



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# OVERVOLTAGE PROTECTION

Page 14 and 15 of TPS2120 / TPS2121 datasheet

### 9.3.5 Overvoltage Protection (OVx)

Output Overvoltage Protection is available for both IN1 and IN2 in case either applied voltage is greater than the maximum supported load voltage. The VREF comparator on the OVx pins allow for the Overvoltage Protection threshold to be adjusted independently for each input. When overvoltage is engaged, the corresponding channel will turn off immediately. Fast switchover to the other input is supported if it is a valid voltage.

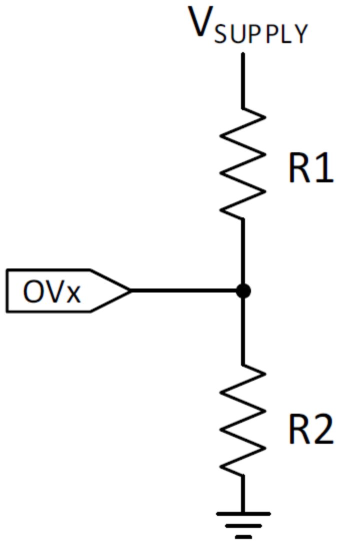


**Figure 9-5. OVP Resistor Configuration**



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# OVERVOLTAGE PROTECTION

## Page 23 of TPS2120 / TPS2121 datasheet

### *10.2.4.2 Selecting OVx Resistors*

Independent output overvoltage protection is available for both IN1 and IN2. The VREF comparator on the OV1 and OV2 pins allows for the overvoltage protection thresholds to be adjusted independently, allowing for different overvoltage thresholds on each channel. When overvoltage is engaged, the corresponding channel will turn off immediately if the pin reaches VREF, 1.06 V (typical). On this design, the overvoltage thresholds are triggered at roughly 1-V higher than the nominal input voltages. On IN1, the overvoltage resistor divider was programmed to be 6.08 V, where as the divider on IN2 was programmed to be 3.96 V. The OV resistor calculations are shown in Equation 6 and Equation 7.

$$1.06\ \text{V} = V_{IN1} \times \left( \frac{5\ \text{k}\Omega}{5\ \text{k}\Omega + 23.7\ \text{k}\Omega} \right) = 6.08\ \text{V} \tag{6}$$

$$1.06\ \text{V} = V_{IN2} \times \left( \frac{5\ \text{k}\Omega}{5\ \text{k}\Omega + 13.7\ \text{k}\Omega} \right) = 3.96\ \text{V} \tag{7}$$



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# CIRCUIT DESIGN

| | | | | | |
|---|---|---|---|---|---|
| VREF (min) | 1.01 | V | | | |
| R24 | 16.5 | k ohm | VPR_1 | 4.34300 | V |
| R25 | 5 | k ohm | | | |
| R26 | 20 | k ohm | VOV_1 | 5.05000 | V |
| R27 | 5 | k ohm | | | |

| | | | | | |
|---|---|---|---|---|---|
| VREF (min) | 1.01 | V | | | |
| R28 | 15.8 | k ohm | VOV_2 | 4.20160 | V |
| R29 | 5 | k ohm | | | |
| R30 | 8.87 | k ohm | VCP_2 | 2.80174 | V |
| R31 | 5 | k ohm | | | |

| | | | | | |
|---|---|---|---|---|---|
| VREF (typ) | 1.06 | V | | | |
| R24 | 16.5 | k ohm | VPR_1 | 4.55800 | V |
| R25 | 5 | k ohm | | | |
| R26 | 20 | k ohm | VOV_1 | 5.30000 | V |
| R27 | 5 | k ohm | | | |

| | | | | | |
|---|---|---|---|---|---|
| VREF (typ) | 1.06 | V | | | |
| R28 | 15.8 | k ohm | VOV_2 | 4.40960 | V |
| R29 | 5 | k ohm | | | |
| R30 | 8.87 | k ohm | VCP_2 | 2.94044 | V |
| R31 | 5 | k ohm | | | |

| | | | | | |
|---|---|---|---|---|---|
| VREF (max) | 1.1 | V | | | |
| R24 | 16.5 | k ohm | VPR_1 | 4.73000 | V |
| R25 | 5 | k ohm | | | |
| R26 | 20 | k ohm | VOV_1 | 5.50000 | V |
| R27 | 5 | k ohm | | | |

| | | | | | |
|---|---|---|---|---|---|
| VREF (max) | 1.1 | V | | | |
| R28 | 15.8 | k ohm | VOV_2 | 4.57600 | V |
| R29 | 5 | k ohm | | | |
| R30 | 8.87 | k ohm | VCP_2 | 3.05140 | V |
| R31 | 5 | k ohm | | | |



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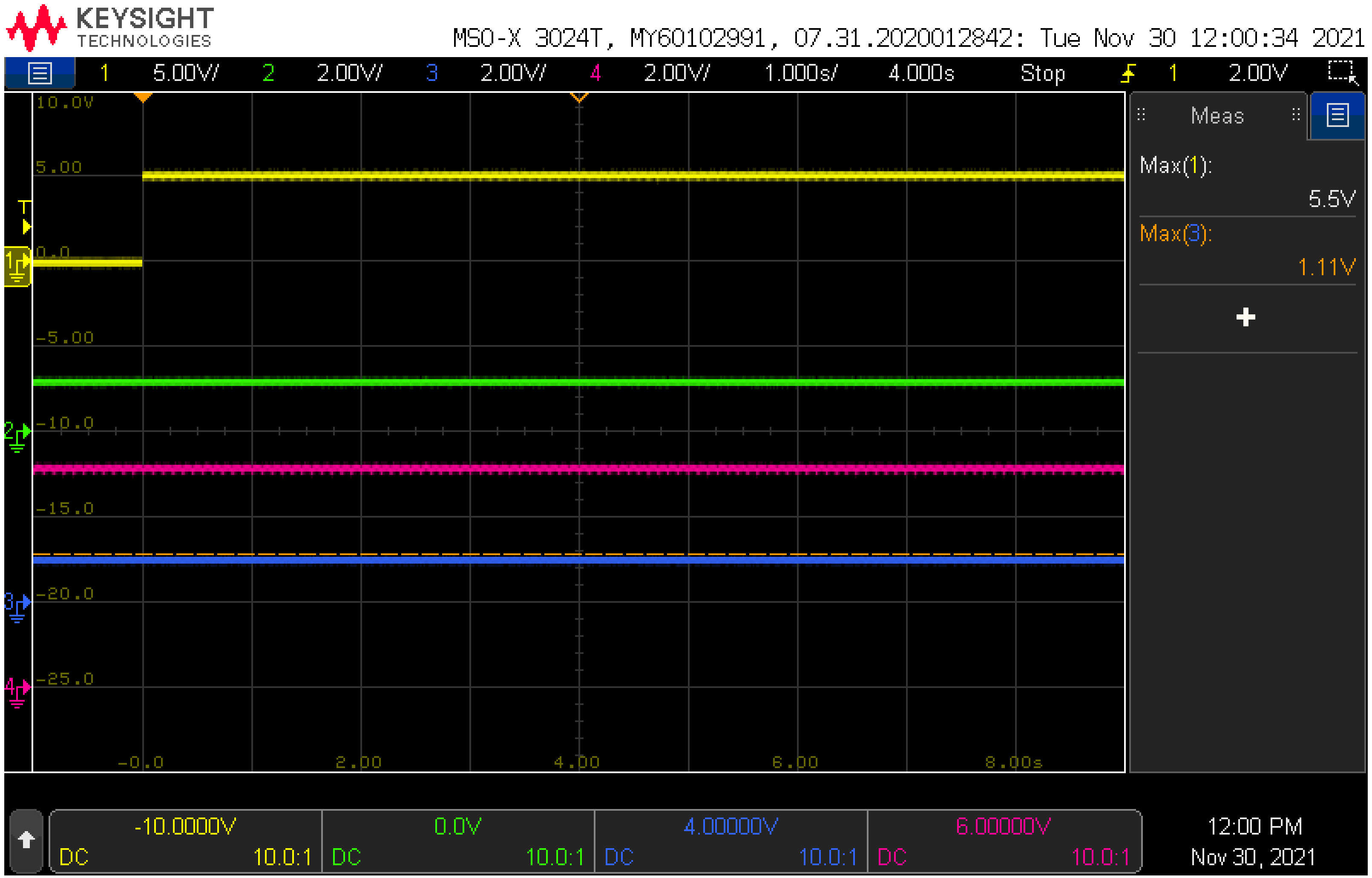
# USB POWER WAVEFORM




| Channel (Color) | Signal | Unit |
|---|---|---|
| CH 1 (Yellow) | IN_1 | Volt |
| CH 2 (Green) | PR_1 | Volt |
| CH 3 (Blue) | OV_1 | Volt |
| CH 4 (Pink) | VOUT | Volt |



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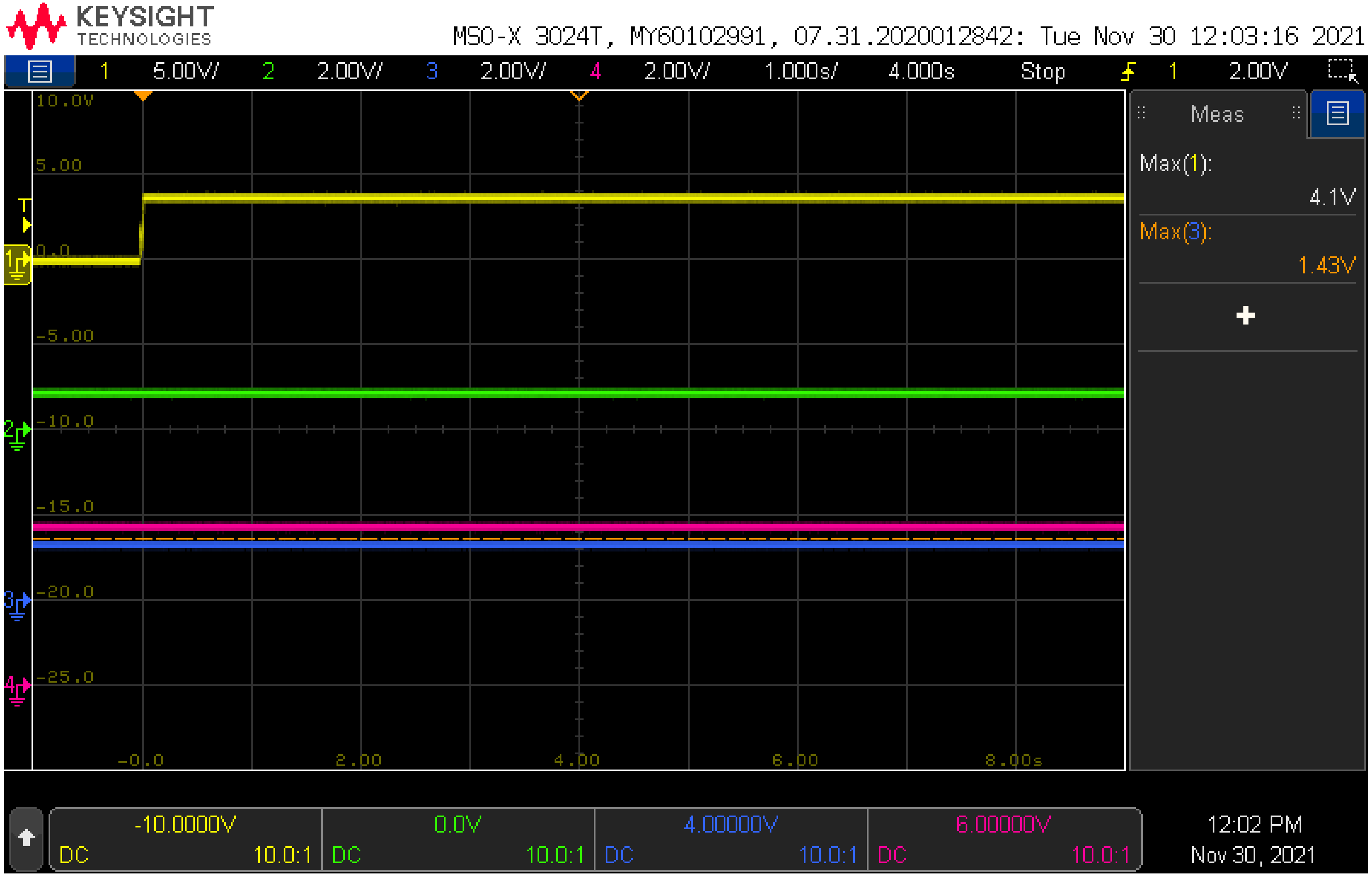
# BATTERY POWER WAVEFORM




| Channel (Color) | Signal | Unit |
|---|---|---|
| CH 1 (Yellow) | IN_2 | Volt |
| CH 2 (Green) | OV_2 | Volt |
| CH 3 (Blue) | CP_2 | Volt |
| CH 4 (Pink) | VOUT | Volt |



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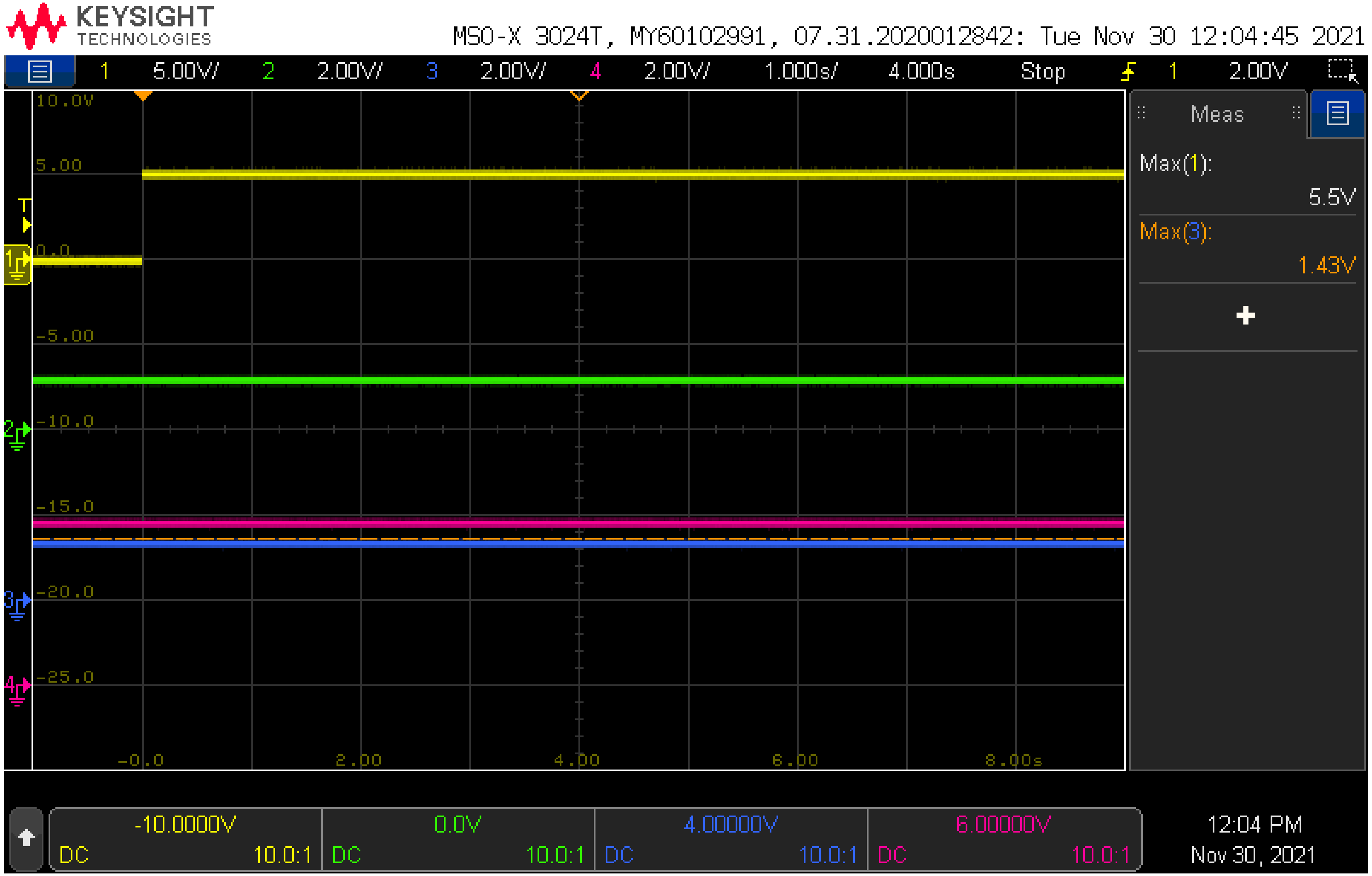
# USB + BATTERY WAVEFORM

ST pin output “LOW”.




| Channel (Color) | Signal | Unit |
|---|---|---|
| CH 1 (Yellow) | IN_1 | Volt |
| CH 2 (Green) | PR_1 | Volt |
| CH 3 (Blue) | CP_2 | Volt |
| CH 4 (Pink) | VOUT | Volt |



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