Ultra-low Resistance with Quick Rising Time Load Switch

General Description

The EM5201 is a small, ultra-low RON, single channel load switch with controlled turn on. The device contains an N-channel MOSFET that can operate over an input voltage range of 0.8V to 5V and can support a maximum continuous current of 10A.

The combination of ultra-low RON and high current capability of the device makes it ideal for driving processor rails with very tight voltage dropout tolerances. The EM5201 is available in a small, space-saving DFN3.0X3.0-08 with integrated thermal pad allowing for high power dissipation.

Ordering Information

Part Number	Package	Remark
EM5201V	DFN3.0X3.0-08	

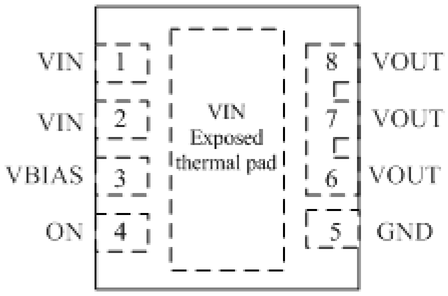
Features

- VBIAS Voltage Range : 3V to 5.5V
- VIN Voltage Range : 0.8V to 5.5V
- Low Ron Internal NMOS: Ron=3.5mohm at Vin=1.05V(VBIAS=3.3V to 5.5V)
- 10A Maximum Continuous Switch Current
- Low Quiescent Current (20uA at VBIAS=5V)
- Low Shutdown Current (1uA at VBIAS=5V)
- Quick Output Discharge
- DFN3.0X3.0-08 with Thermal PAD

Applications

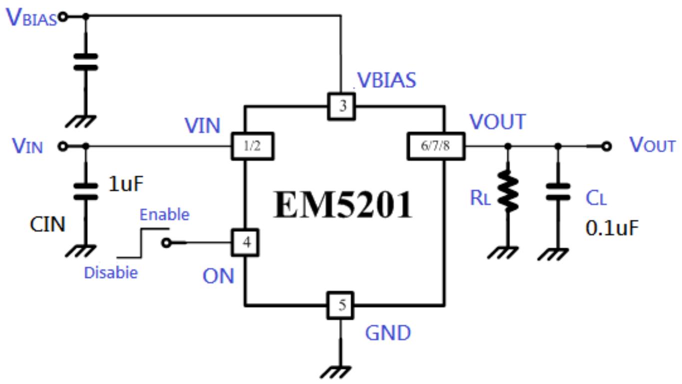
- Notebook & Netbook &MB
- Desktops
- Tablet PC

Pin Configuration



TOP VIEW

Typical Application Circuit

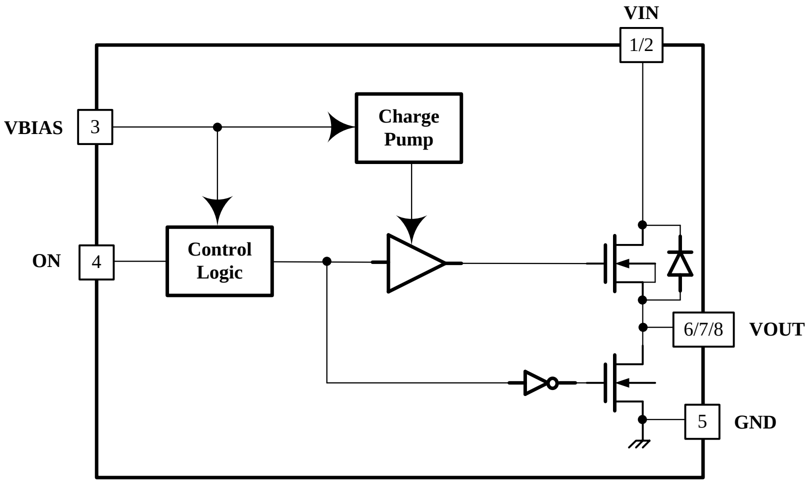


***CIN>10 CL is recommended.**

Pin Assignment

Pin Name	Pin No.	Pin Function
VIN	1,2	Switch input. Place ceramic bypass capacitor(s) between this terminal and GND.
VBIAS	3	Bias voltage. Power supply to the device.
ON	4	Chip Enable Input
GND	5	GND
VOUT	6,7,8	Output Voltage.

Function Block Diagram



Absolute Maximum Ratings (Note1)

- V_{IN} -- 0.8V to 5.5 V
- Other Pins---5.5V
- Power Dissipation, P_D @ T_A = 25°C, DFN3.0X3.0-08 --- 1.67 W
- Package Thermal Resistance, θ_{JA}, DFN3.0X3.0-08 (Note 2)---60°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} -- 0.8V to VBIAS-2V
- Bias Input Voltage, VBIAS -- 3.0V to 5.5V
- Junction Temperature -- –40°C to 125°C
- Ambient Temperature --- 0°C to 85°C

Electrical Characteristics

V_{BIAS}= V_{ON} =3V to 5.5V, VIN=VBIAS-2V, T_A=25℃, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Power Supplies and Currents Section						
V_{BIAS} Supply Voltage	V_{BIAS}		3		5.5	V
V_{BIAS} quiescent current	$I_{Q\text{-}BAIAS}$	I_{OUT} = 0, V_{IN} = 3V		20		uA
V_{BIAS} shutdown current	$I_{SD\text{-}BAIAS}$	V_{ON} = 0V ; V_{OUT} = 0V		1		uA
V_{IN} shutdown current	$I_{SD\text{-}IN}$	V_{ON} = 0V ; V_{OUT} = 0V		1		uA
High-level input voltage	$v_{ON\text{-}H}$		1.2			V
Low-level input voltage	$v_{ON\text{-}L}$				0.6	V
ON pin leakage current	I_{ON}	V_{ON} = 5.5V		1		uA
Resistance Section						
ON-state Resistance	R_{ON}	Io=1A, VBIAS = 3V to 5.5V VIN=VBIAS-2V		3.5	5.5	mΩ
Output Pull-down Resistance	R_{PD}	V_{IN} = 5.0V, V_{ON} = 0V, I_{OUT} = 5mA		250	300	Ω

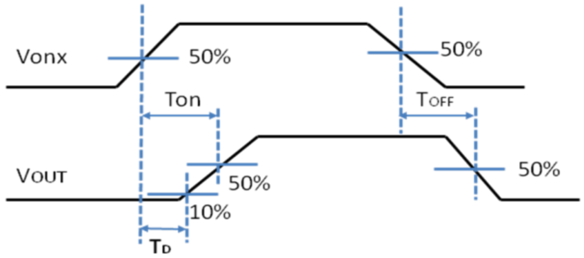
Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

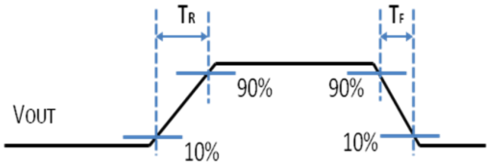
Note 2. θ_{JA} is measured in the natural convection at T_A=25°C on a low effective thermal conductivity test board (Single layout, 1S) of JEDEC 51-3 thermal measurement standard.

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

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

Switching Timing Diagrams





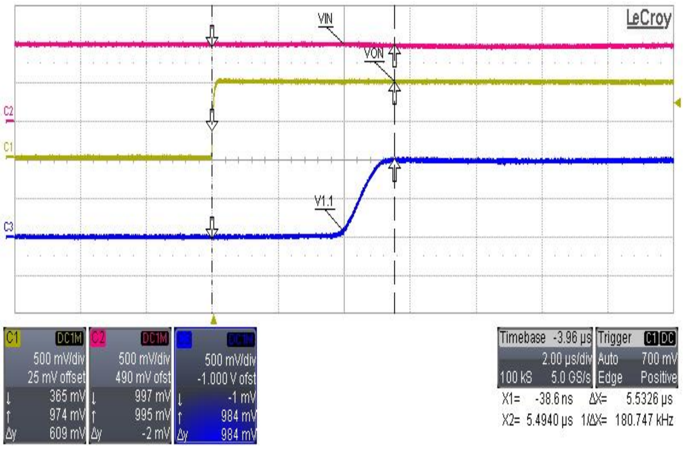
Switching characteristics

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
V_{IN}=2.5V；V_{ON}=V_{BIAS}=5V； T_A=25℃						
Turn-on time	T_{ON}	R_L=10Ω；C_L=0.1uF		10.0		uS
Turn-off time	T_{OFF}			3.5		uS
Vout Rising time	T_R			6.3		uS
Vout falling time	T_F			2.0		uS
ON Delay time	T_D			8.1		uS
V_{IN}=1.05V；V_{ON}=V_{BIAS}=5V； T_A=25℃						
Turn-on time	T_{ON}	R_L=10Ω；C_L=0.1uF		7.5		uS
Turn-off time	T_{OFF}			5.0		uS
Vout Rising time	T_R			4.2		uS
Vout falling time	T_F			2.0		uS
ON Delay time	T_D			8.1		uS
V_{IN}=1.8V；V_{ON}=V_{BIAS}=3.3V； T_A=25℃						
Turn-on time	T_{ON}	R_L=10Ω；C_L=0.1uF		12.5		uS
Turn-off time	T_{OFF}			3.5		uS
Vout Rising time	T_R			20		uS
Vout falling time	T_F			3.5		uS
ON Delay time	T_D			8.1		uS
V_{IN}=1.05V；V_{ON}=V_{BIAS}=3.3V； T_A=25℃						
Turn-on time	T_{ON}	R_L=10Ω；C_L=0.1uF		10		uS
Turn-off time	T_{OFF}			3.5		uS
Vout Rising time	T_R			8.5		uS
Vout falling time	T_F			3.5		uS
ON Delay time	T_D			8.1		uS

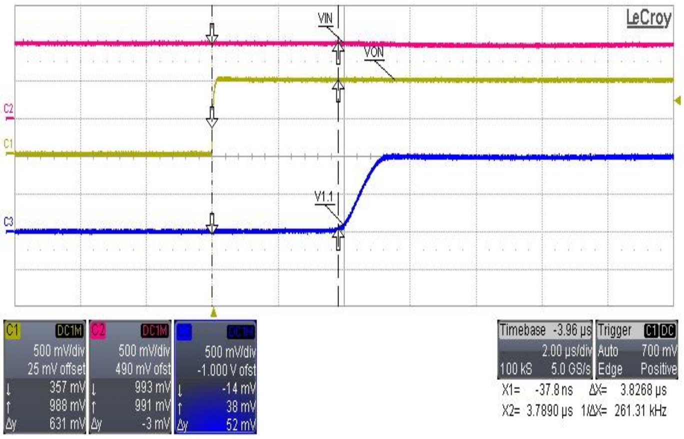
Typical Operating Characteristics

CIN=1u, Co=0.1u, CL=10Ω, VIN=VBIAS-2V.

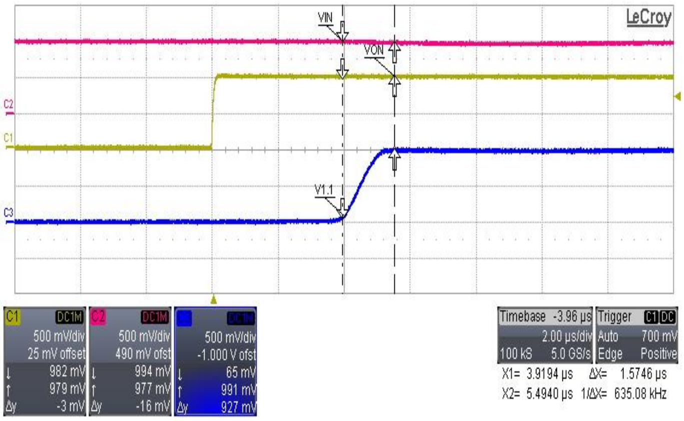
Von to Vo Ready, VIN=1.05V, VBIAS=5V.
CH1:VON, CH2:VIN, CH3:Vo



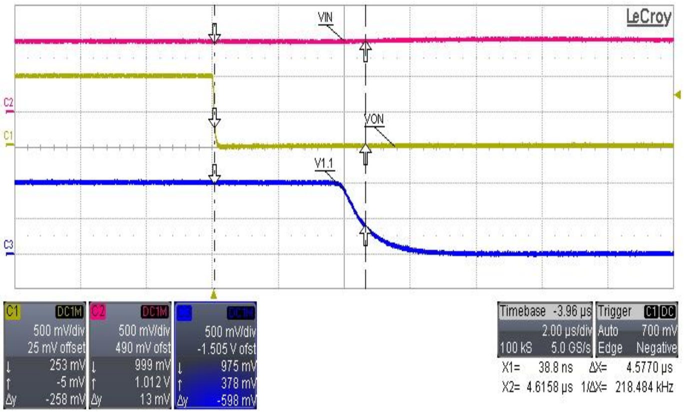
Von to Vo TD, VIN=1.05V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:Vo



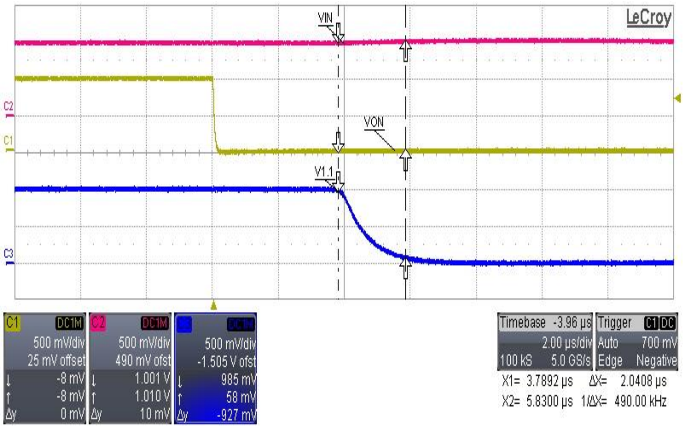
Rising time TR, VIN=1.05V, VBIAS=5V.
CH1:VON, CH2:VIN, CH3:VO



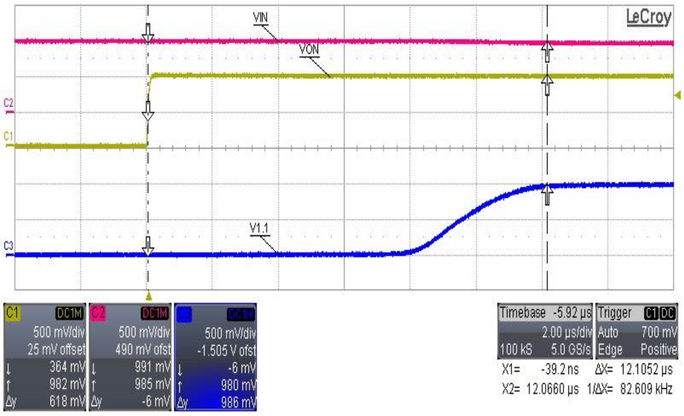
Turn off TOFF from VON, VIN=1.05V, VBIAS=5V
CH1:VIN, CH2:VON, CH3:VO



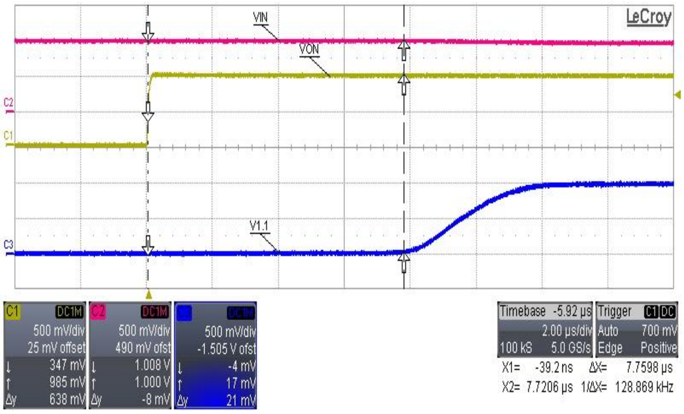
Turn off TF from VON, VIN=1.05V, VBIAS=5V
CH1:VIN, CH2:VON, CH3:VO



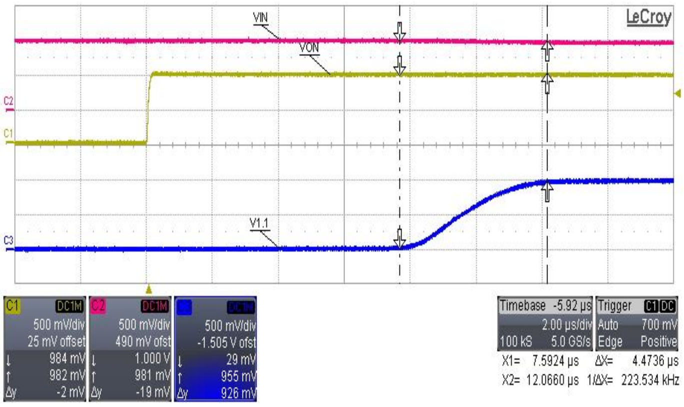
Von to Vo Ready, VIN=1.05V, VBIAS=3.3V.
CH1:VON, CH2:VIN, CH3:Vo



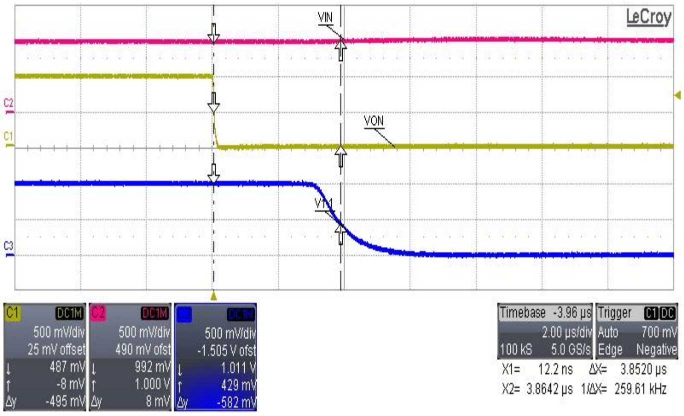
Von to Vo TD, VIN=1.05V, VBIAS=3.3V
CH1:VON, CH2:VIN, CH3:Vo



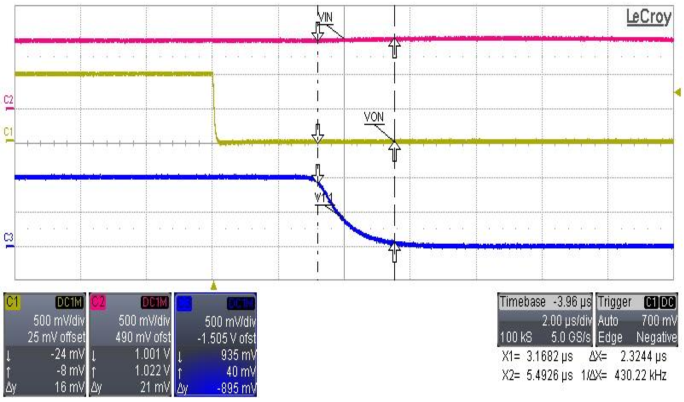
Rising time TR, VIN=1.05V, VBIAS=3.3V
CH1:VON, CH2:VIN, CH3:VO



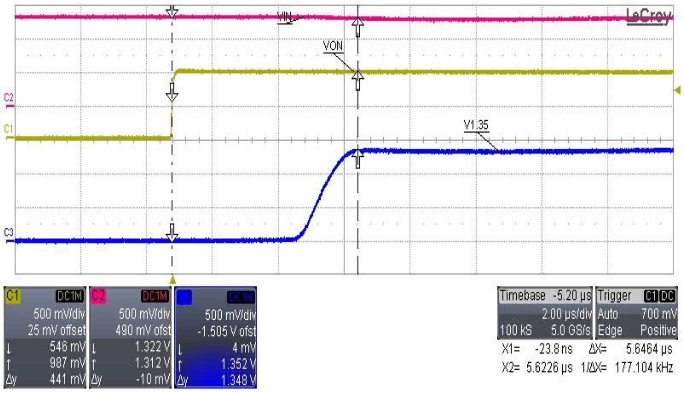
Turn off TOFF from VON, VIN=1.05V, VBIAS=3.3V
CH1:VIN, CH2:VON, CH3:VO



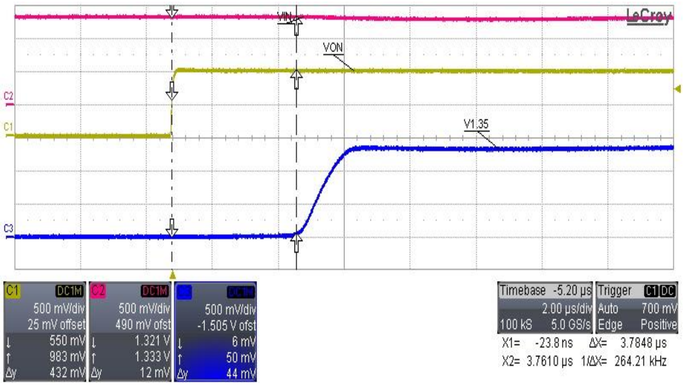
Turn off TF from VON, VIN=1.05V, VBIAS=3.3V
CH1:VIN, CH2:VON, CH3:VO



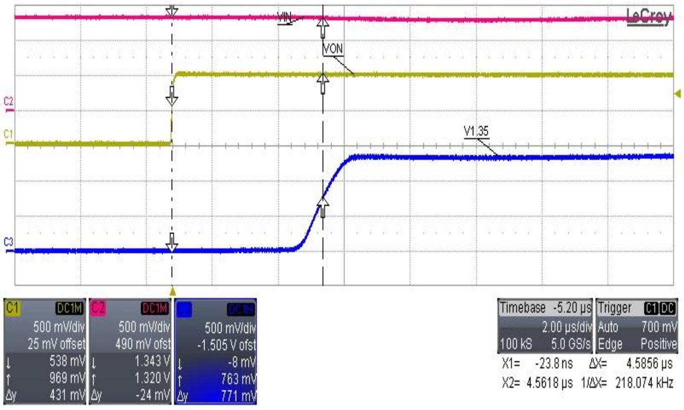
Von to Vo Ready, VIN=1.35V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:Vo



Von to Vo TD, VIN=1.35V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:Vo

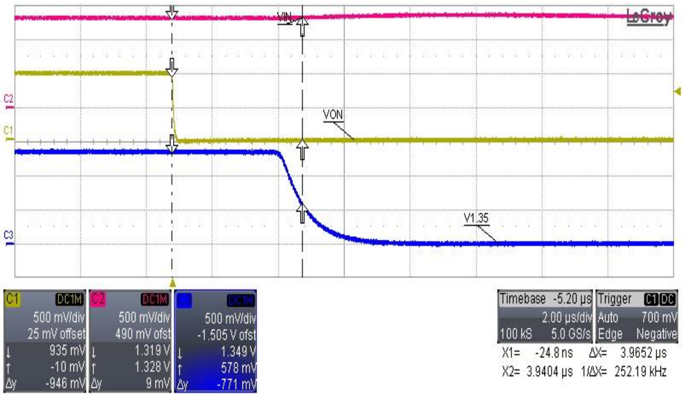


Rising time TR, VIN=1.35V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:VO



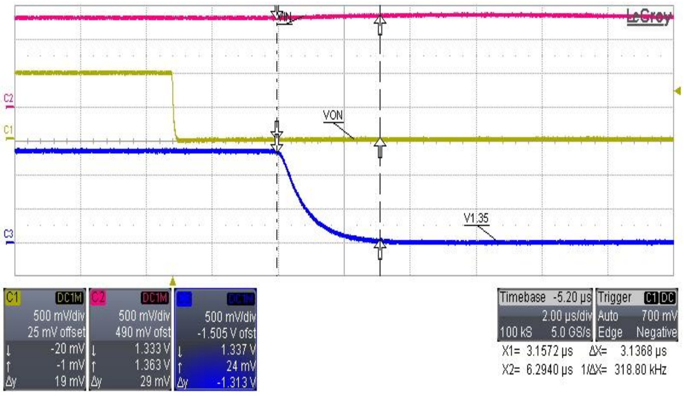
C1 DC1M 500 mV/div 25 mV offset ↓ 538 mV ↑ 969 mV Δy 431 mV
C2 DC1M 500 mV/div 490 mV ofst ↓ 1.343 V ↑ 1.320 V Δy -24 mV
DC1M 500 mV/div -1.505 V ofst ↓ -8 mV ↑ 763 mV Δy 771 mV
Timebase -5.20 µs 2.00 µs/div 100 kS 5.0 GS/s
Trigger C1 DC Auto 700 mV Edge Positive
X1= -23.8 ns ΔX= 4.5856 µs
X2= 4.5618 µs 1/ΔX= 218.074 kHz

Turn off TOFF from VON, VIN=1.35V, VBIAS=5V
CH1:VIN, CH2:VON, CH3:VO



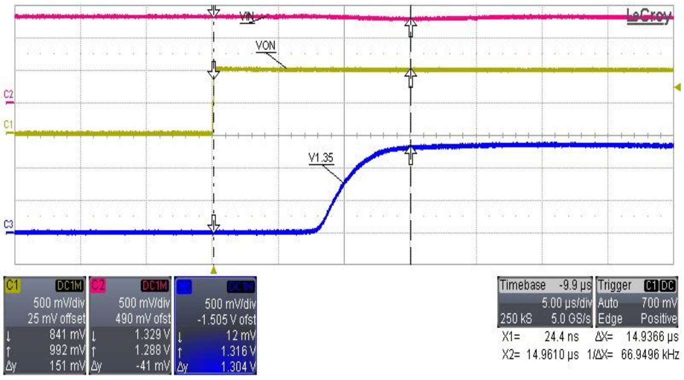
C1 DC1M 500 mV/div 25 mV offset ↓ 935 mV ↑ -10 mV Δy -946 mV
C2 DC1M 500 mV/div 490 mV ofst ↓ 1.319 V ↑ 1.328 V Δy 9 mV
DC1M 500 mV/div -1.505 V ofst ↓ 1.349 V ↑ 578 mV Δy -771 mV
Timebase -5.20 µs 2.00 µs/div 100 kS 5.0 GS/s
Trigger C1 DC Auto 700 mV Edge Negative
X1= -24.8 ns ΔX= 3.9652 µs
X2= 3.9404 µs 1/ΔX= 252.19 kHz

Turn off TF from VON, VIN=1.35V, VBIAS=5V
CH1:VIN, CH2:VON, CH3:VO



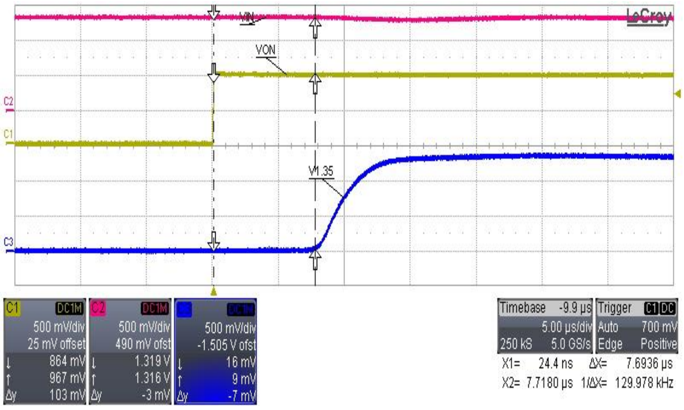
C1 DC1M 500 mV/div 25 mV offset ↓ -20 mV ↑ -1 mV Δy 19 mV
C2 DC1M 500 mV/div 490 mV ofst ↓ 1.333 V ↑ 1.363 V Δy 29 mV
DC1M 500 mV/div -1.505 V ofst ↓ 1.337 V ↑ 24 mV Δy -1.313 V
Timebase -5.20 µs 2.00 µs/div 100 kS 5.0 GS/s
Trigger C1 DC Auto 700 mV Edge Negative
X1= 3.1572 µs ΔX= 3.1368 µs
X2= 6.2940 µs 1/ΔX= 318.80 kHz

Von to Vo Ready, VIN=1.35V, VBIAS=3.3V
CH1:VON, CH2:VIN, CH3:Vo



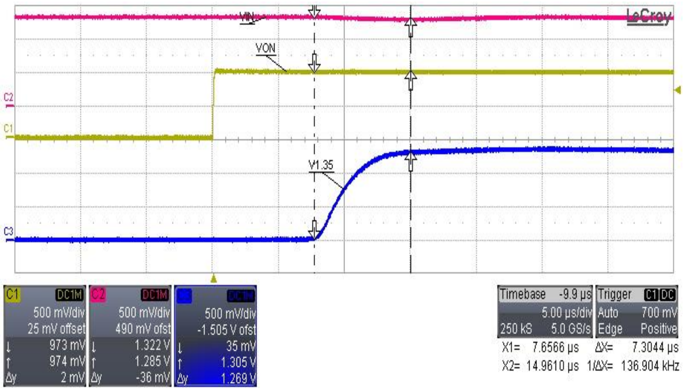
C1 DC1M 500 mV/div 25 mV offset ↓ 841 mV ↑ 992 mV Δy 151 mV
C2 DC1M 500 mV/div 490 mV ofst ↓ 1.329 V ↑ 1.288 V Δy -41 mV
DC1M 500 mV/div -1.505 V ofst ↓ 12 mV ↑ 1.316 V Δy 1.304 V
Timebase -9.9 µs 5.00 µs/div 250 kS 5.0 GS/s
Trigger C1 DC Auto 700 mV Edge Positive
X1= 24.4 ns ΔX= 14.9366 µs
X2= 14.9610 µs 1/ΔX= 66.9496 kHz

Von to Vo TD, VIN=1.35V, VBIAS=3.3V
CH1:VON, CH2:VIN, CH3:Vo



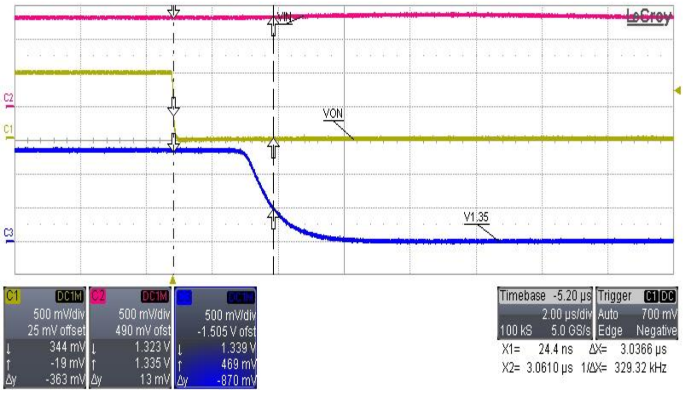
C1 DC1M 500 mV/div 25 mV offset ↓ 864 mV ↑ 967 mV Δy 103 mV
C2 DC1M 500 mV/div 490 mV ofst ↓ 1.319 V ↑ 1.316 V Δy -3 mV
DC1M 500 mV/div -1.505 V ofst ↓ 16 mV ↑ 9 mV Δy -7 mV
Timebase -9.9 µs 5.00 µs/div 250 kS 5.0 GS/s
Trigger C1 DC Auto 700 mV Edge Positive
X1= 24.4 ns ΔX= 7.6936 µs
X2= 7.7180 µs 1/ΔX= 129.978 kHz

Rising time TR, VIN=1.35V, VBIAS=3.3V
CH1:VON, CH2:VIN, CH3:VO

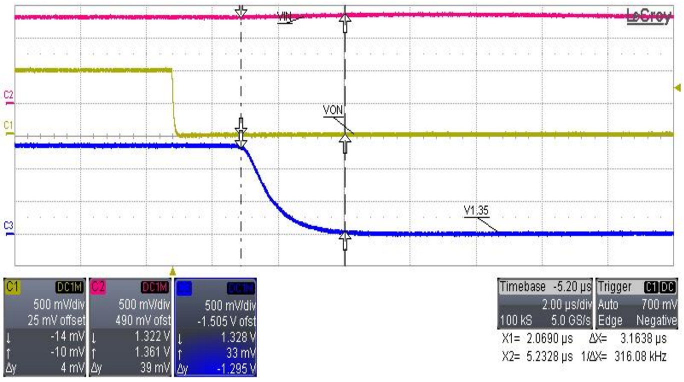


C1 DC1M 500 mV/div 25 mV offset ↓ 973 mV ↑ 974 mV Δy 2 mV
C2 DC1M 500 mV/div 490 mV ofst ↓ 1.322 V ↑ 1.285 V Δy -36 mV
DC1M 500 mV/div -1.505 V ofst ↓ 35 mV ↑ 1.305 V Δy 1.269 V
Timebase -9.9 µs 5.00 µs/div 250 kS 5.0 GS/s
Trigger C1 DC Auto 700 mV Edge Positive
X1= 7.6566 µs ΔX= 7.3044 µs
X2= 14.9610 µs 1/ΔX= 136.904 kHz

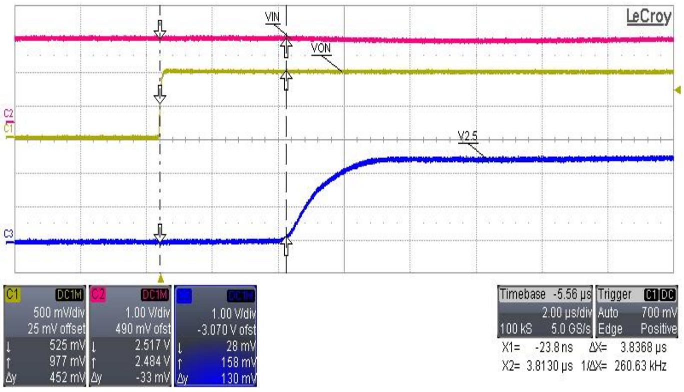
Turn off TOFF from VON, VIN=1.35V, VBIAS=3.3V
CH1:VIN, CH2:VON, CH3:VO



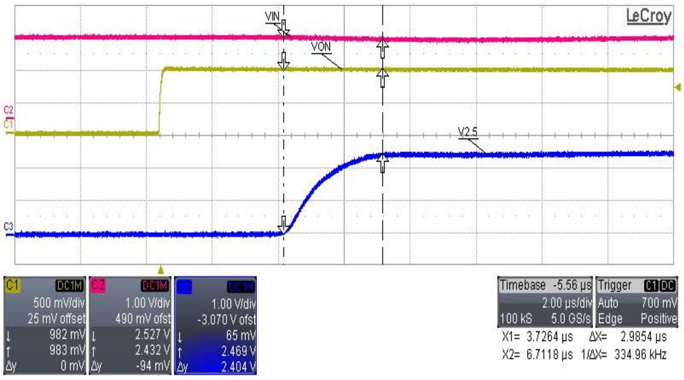
Turn off TF from VON, VIN=1.35V, VBIAS=3.3V
CH1:VIN, CH2:VON, CH3:VO



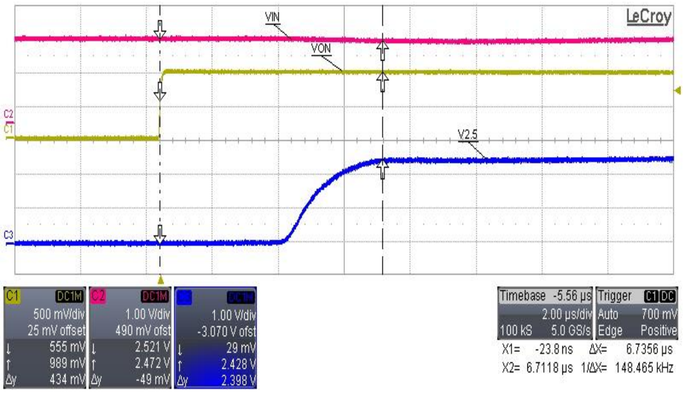
Von to Vo TD, VIN=2.5V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:Vo



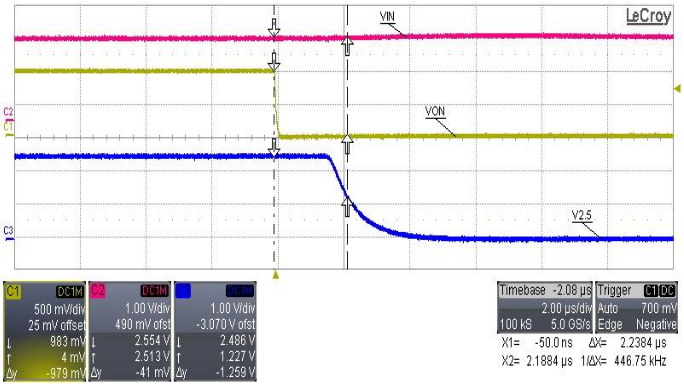
Rising time TR, VIN=2.5V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:VO



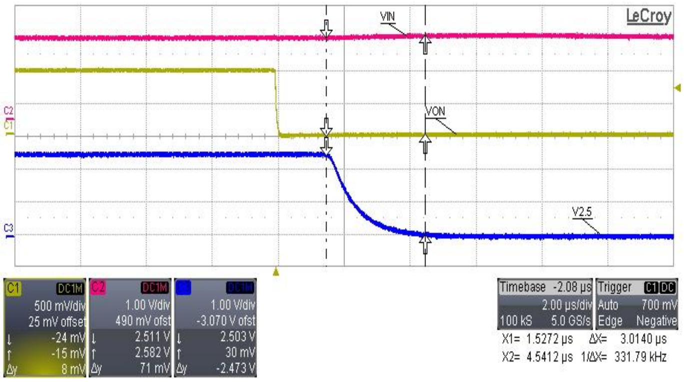
Von to Vo Ready, VIN=2.5V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:Vo



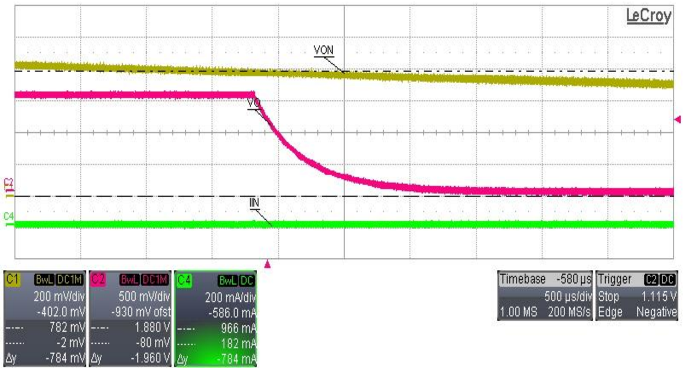
Von to Vo TOFF, VIN=2.5V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:Vo



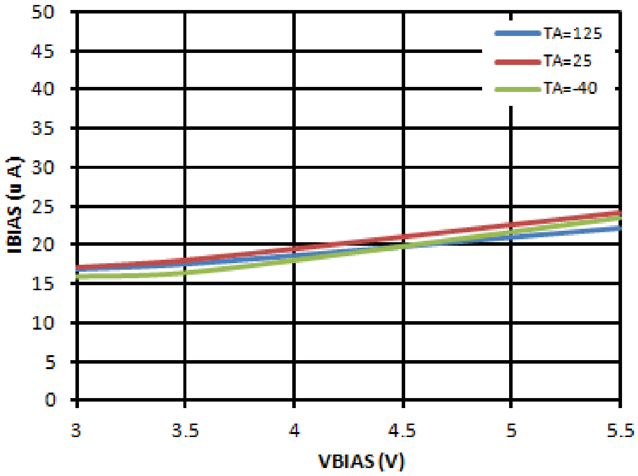
Von to Vo TF, VIN=2.5V, VBIAS=5V
CH1:VON, CH2:VIN, CH3:Vo



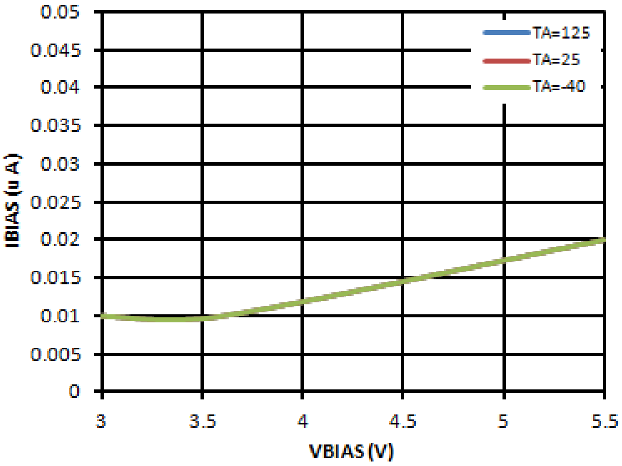
Turn off when no load
CH1:VON, CH2:VIN, CH3:IN



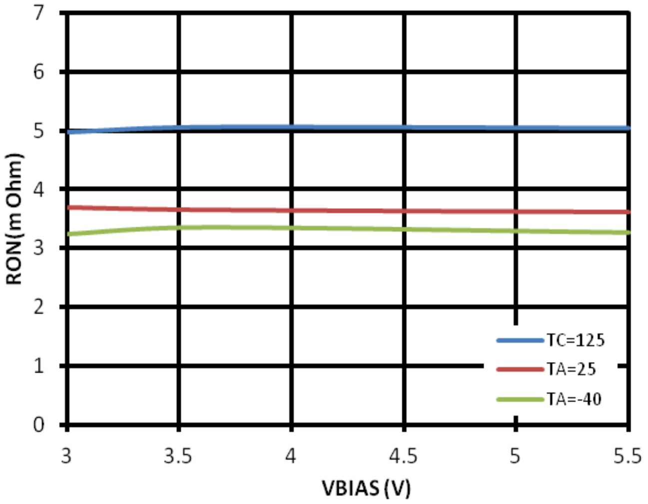
BIAS Supply Current VS. Temperature
VIN=1V, VBIAS=3V to 5.5V



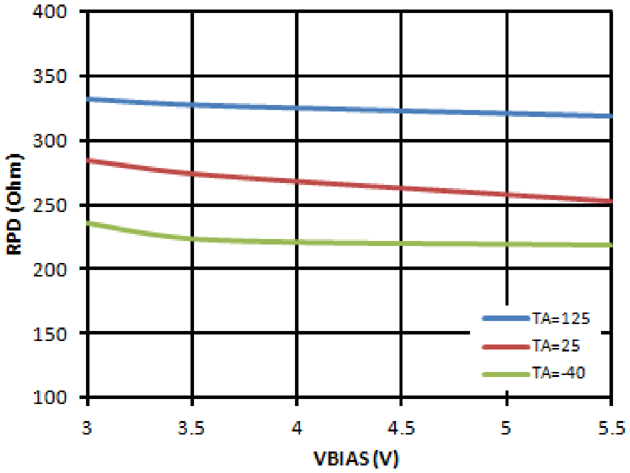
BIAS Shunt down Current VS. Temperature
VIN=1V, VBIAS=3V to 5.5V



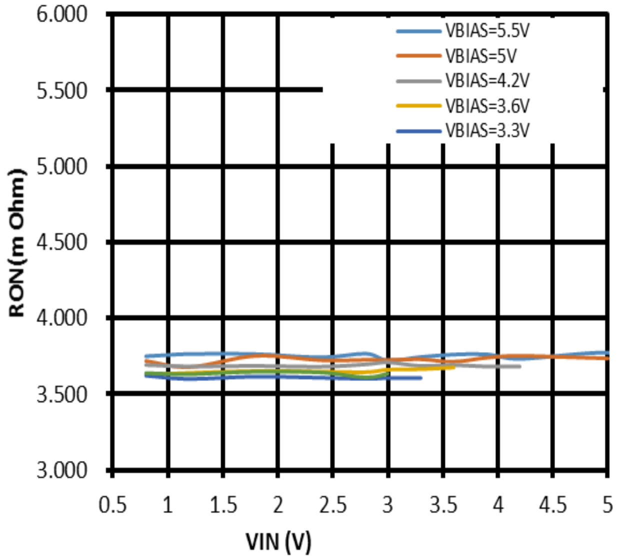
Ron Performance VS. Temperature
VIN=1V, VBIAS=3V to 5.5V



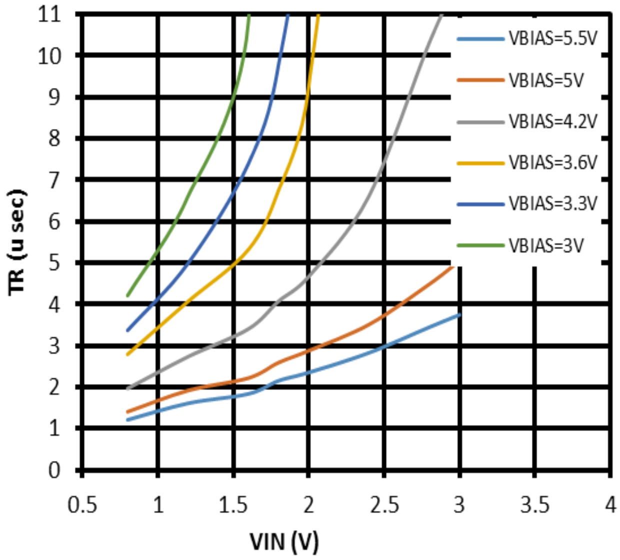
RPD Performance VS. Temperature
VIN=1V, VBIAS=3V to 5.5V



**Ron Performance VS. Input Voltage
VIN=0.8V to VBIAS, VBIAS=3V to 5.5V**



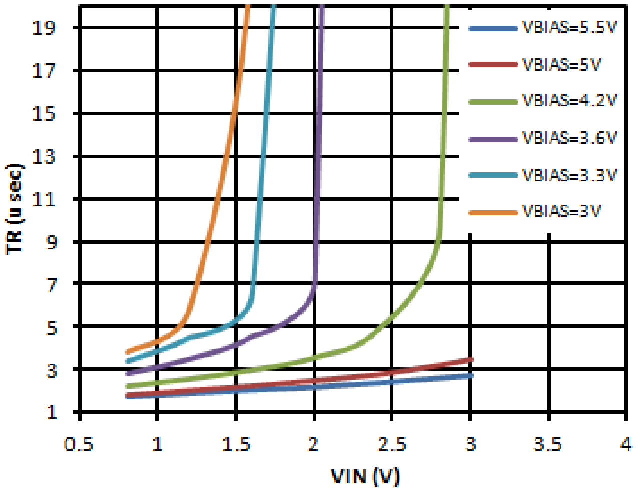
**Output Rising Time VS. VIN VS. VBIAS
VIN=0.8V to 3V, VBIAS=3V to 5.5V**

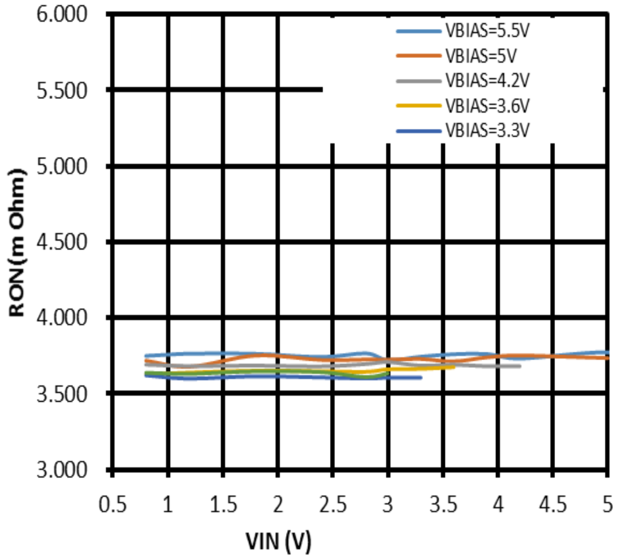


Functional Description

VIN and VBIAS Voltage Range

The MOSFET gate voltage in the EM5201 is driven by an internal charge pump. The output voltage of the charge pump is dependent on the voltage on VBIAS pin. Care must be taken to ensure a sufficient VBIAS is used to keep the desired output rising time when given the anticipated input voltage. For quickly output rising requirement that may be under 60usec, make sure VIN ≤ (VBIAS – 2V) is highly recommended. For example, in order to have VIN=3V, VBIAS must be 5V. The Ron of EM5201 will still be keep constant if VIN > (VBIAS – 2V) but it will exhibit slowly output rising time. See figure as below.





ON/OFF Control

EM5201 is enabled if the voltage of the Von pin is greater than logic high level and the VBIAS voltage has an adequate applied. If the voltage of the EN pin is less than logic low level, the device will be disabled.

Input Capacitor CIN

The EM5201 do not require an input capacitor. In order to limit the voltage drop on the input supply caused by transient inrush current, an input bypass capacitor is recommended. A 1uF ceramic capacitor should be placed as closed as possible to the VIN pin. Higher values capacitor can help to further reduce the voltage drop.

Output Capacitor Co

Due to the integrated body diode in the NMOS switch, the CIN greater than Co is highly recommended. A CIN to Co ratio of 10 to 1 is recommended for minimizing VIN drop caused by inrush during startup. It also helps to prevent parasitic inductance forces Vo below GND when switching off. A 0.1uF ceramic capacitor should be placed as closed as possible to the Vo pin.

Thermal and Layout Consideration

EM5201 is designed to maintain a constant output load current. Due to physical limitations of the chip layout and assembly of the device the maximum switch current is 10A. All copper traces for the VIN and Vo pin should be widely and short to carry the maximum continuous current and obtain the best effect. The input and output capacitor should be close to the device as possible to minimize the parasitic trace inductances and prevents the voltage drop when load transient.

The maximum IC junction temperature should be restricted to 125 ℃ under normal operating conditions. To calculate the maximum allowable dissipation, PD(MAX) for a given output current and ambient temperature, used the following equation:

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}}$$

Where:

PD(MAX)=Maximum allowable power dissipation

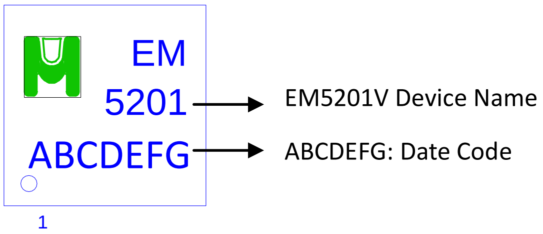
TJ(MAX)=Maximum allowable junction temperature (125 ℃ for the EM5201)

TA=Ambient Temperature of the device

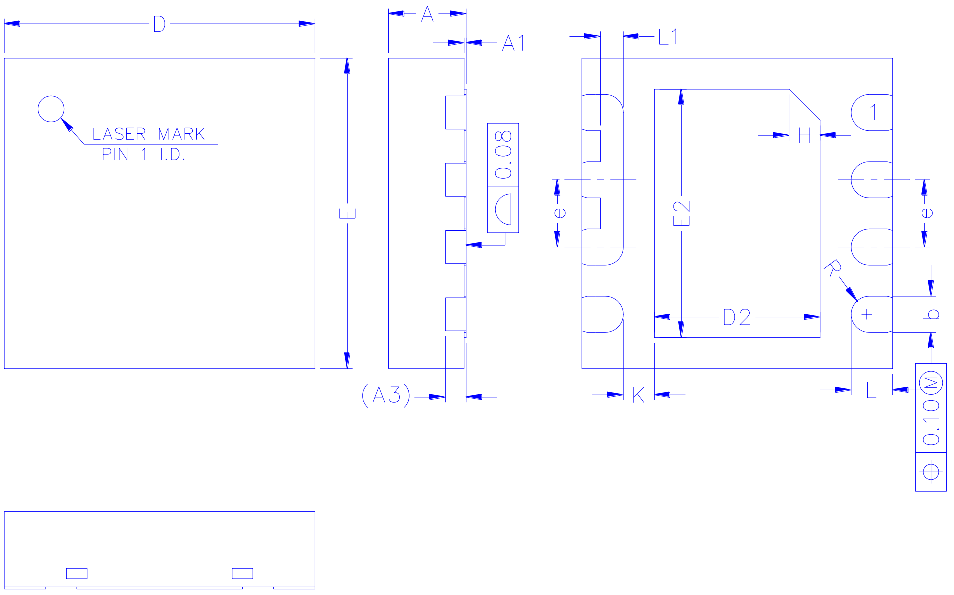
ΘJA= Junction to air thermal impedance. This parameter is also dependent upon PCB layput.

Ordering & Marking Information

Device Name: EM5201V for DFN3.0X3.0-08



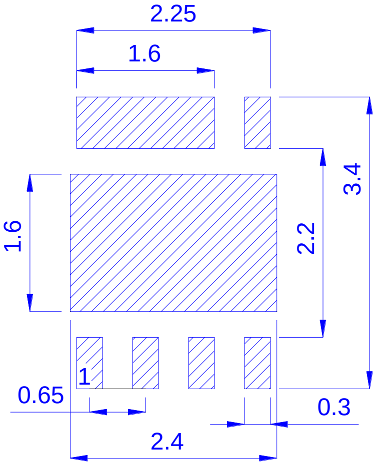
Outline Drawing



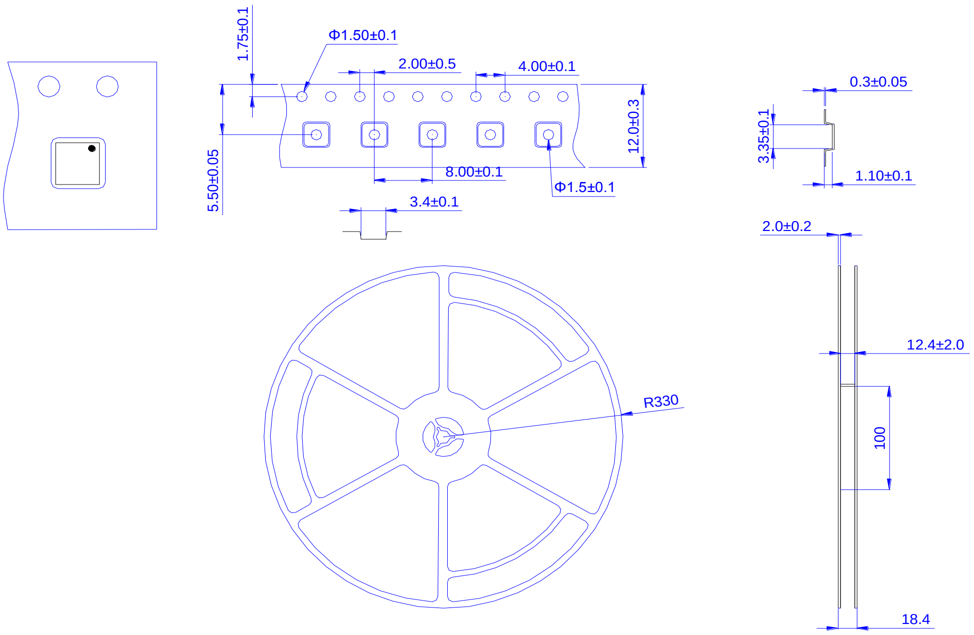
Dimension in mm

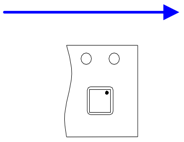
Dimension	A	A1	A3	b	D	E	D2	E2	e	H	K	L	L1	R
Min.	0.7	0.00	0.2 REF	0.3	2.9	2.9	1.5	2.3	0.55	0.3REF	0.2	0.3	0.12	0.16
Typ.	0.75	0.02		0.35	3.0	3.0	1.6	2.4	0.65		0.3	0.4	0.22	
Max.	0.8	0.05		0.4	3.1	3.1	1.7	2.5	0.75		0.4	0.5	0.32	

Recommended minimum pads



◆ Tape&Reel Information: 5000pcs/Reel



產品別	DFN3.0X3.0-08
Reel 尺寸	13”
編帶方式	FEED DIRECTION 
前空格	50
後空格	50
裝箱數	
滿捲數量	5K
捲/內盒比	1 : 1
內盒滿箱數	5K
內/外箱比	10 : 1
外箱滿箱數	50K