

### General Description

The SY6321DAC is a high-performance positive voltage regulator designed for applications which require very low input voltage and very low dropout voltage at up to 2A output. It operates with a  $V_{IN}$  as low as 1.4V, with output voltage programmable as low as 0.5V. The SY6321DAC features ultra-low dropout, ideal for applications where  $V_{OUT}$  is very close to  $V_{IN}$ . Additionally, it has an enable pin to further reduce power dissipation while shutdown. The device provides excellent regulation over variations in line, load and temperature.

The SY6321DAC has an adjustable output which can be set by two external resistors. The SY6321DAC is available in the DFN3x3-8 package.

### Features

- Input Voltage as Low as 1.4V
- 450mV Dropout @ 2A
- Adjustable Output from 0.5V
- 0.9ms Internal Soft-start Minimizes Inrush Current
- 10µA Quiescent Current in Shutdown
- Over Current and Over Temperature Protection
- Enable Control: Default High
- Reverse Blocking from Output to Input
- RoHS Compliant and Halogen Free
- Package: DFN3x3-8

### Applications

- Telecom/Networking Cards
- Motherboards/Peripheral Cards
- Industrial Applications
- Wireless Infrastructure
- Set Top Box
- Medical Equipment
- Notebook Computers
- Battery Powered Systems

### Typical Application

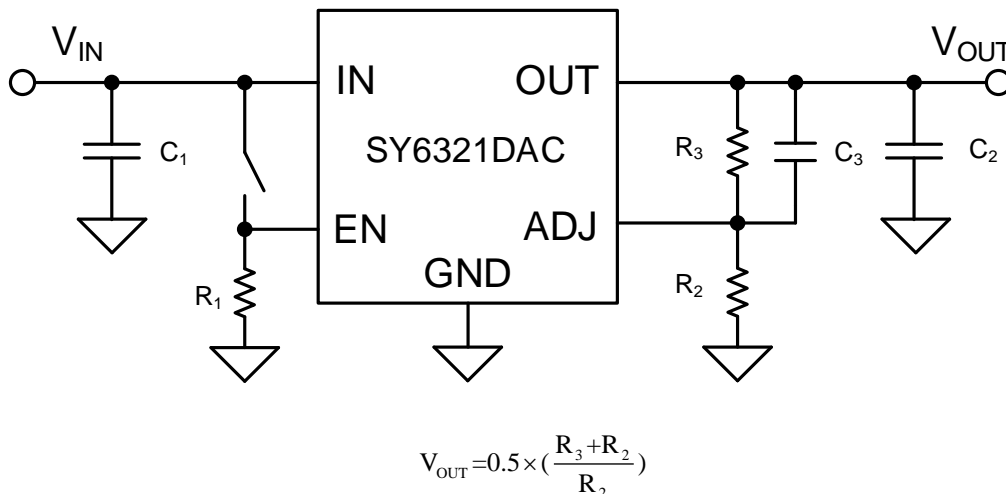


Figure1. Schematic Diagram

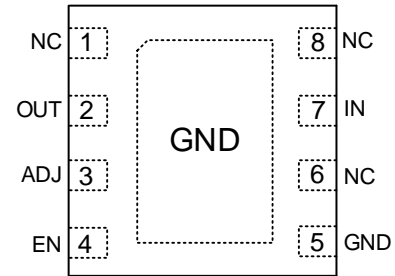
## Ordering Information

Ordering Part Number	Package Type	Top Mark
<b>SY6321DAC</b>	DFN3x3-8 RoHS Compliant and Halogen Free	<b>EHWxyz</b>

Device code: EHW

*x = year code, y = week code, z = lot number code*

## Pinout (top view)



Pin Name	Pin Number	Pin Description
NC	1, 6, 8	NO internal connection.
OUT	2	Output pin. A minimum of 22 $\mu$ F capacitor should be placed directly at this pin.
ADJ	3	Feedback voltage input. If external feedback resistors are used, the output voltage will be determined by the resistor ratio.
EN	4	Enable control input (Active-High). Pulling this pin below 0.4V turns the regulator off, reducing the quiescent current to a fraction of its operating value. The device will be enabled if this pin is left open.
GND	5, Exposed Pad	Ground pin. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation.
IN	7	Input supply pin. For regulation at full load, the input to this pin must be between ( $V_{out} + 0.4V$ ) and 6V. Minimum input voltage is 1.4V. A large bulk capacitance should be placed closely to this pin to ensure that the input supply does not sag below 1.4V. Also, a minimum of 10 $\mu$ F ceramic capacitor should be placed directly at this pin.

## Block Diagram

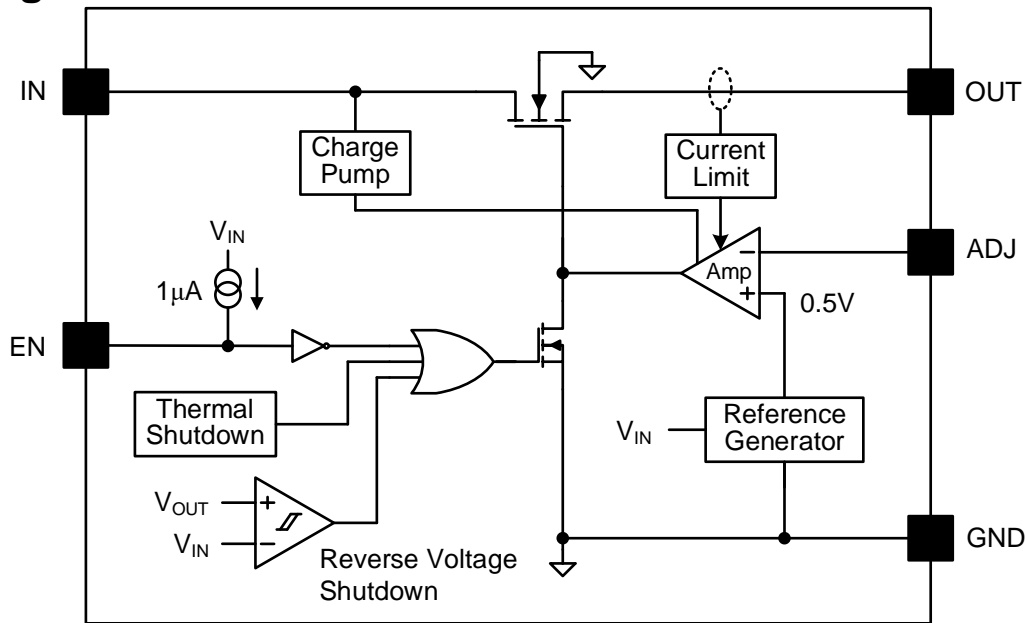


Figure2. Block Diagram

## Absolute Maximum Ratings

Parameter (Note 1)	Min	Max	Unit
IN, EN, OUT, ADJ	-0.3	7	V
Lead Temperature (Soldering, 10s)		260	°C
Junction Temperature, Operating	-40	150	
Storage Temperature	-65	150	

## Thermal Information

Parameter (Note 2)	Typ	Unit
$\theta_{JA}$ Junction-to-Ambient Thermal Resistance	41	°C/W
$\theta_{JC}$ Junction-to-Case Thermal Resistance	5	
$P_D$ Power Dissipation $T_A = 25^\circ\text{C}$	2.439	W

## Recommended Operating Conditions

Parameter (Note 3)	Min	Max	Unit
IN	1.4	6	V
Maximum Output Current		2	A
Junction Temperature, Operating	-40	125	°C

## Electrical Characteristics

( $V_{IN} = V_{EN} = 1.4$  to  $6\text{V}$ ;  $V_{OUT} = V_{ADJ} = 0.5\text{V}$ ;  $I_{OUT} = 10\mu\text{A}$  to  $2\text{A}$ ,  $C_{IN} = 10\mu\text{F}$ ;  $C_{OUT} = 22\mu\text{F}$ ;  $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ . Typical values are at  $T_J = 25^\circ\text{C}$ , unless otherwise specified. The values are guaranteed by test, design or statistical correlation.)

Parameter	Symbol	Test Conditions	$T_J$	Min	Typ	Max	Unit
Input Voltage Range	$V_{IN}$		$-40^\circ\text{C} \sim 125^\circ\text{C}$	1.4		6	V
Reference Accuracy	$V_{REF}$	$V_{IN} = 3.3\text{V}$ , $I_{OUT} = 10\text{mA}$	$25^\circ\text{C}$	0.495	0.5	0.505	V
			$-40^\circ\text{C} \sim 125^\circ\text{C}$	0.49	0.5	0.51	
		$1.4\text{V} < V_{IN} < 6\text{V}$ , $10\text{mA} < I_{OUT} < 2\text{A}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	0.485	0.5	0.515	
Line Regulation		$I_{OUT} = 10\text{mA}$	$25^\circ\text{C}$		0.2		%/V
Load Regulation		$10\text{mA} \leq I_{OUT} \leq 2\text{A}$	$25^\circ\text{C}$		0.3		%/A
Shutdown Current	$I_{SD}$	$V_{IN} = 6.0\text{V}$ , $V_{EN} = 0\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$		10	50	$\mu\text{A}$
Ground pin current	$I_{GND}$	$V_{IN} = 3.3\text{V}$ , $I_{OUT} = 0\text{A}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$			3	mA
Dropout Voltage	$V_{DO}$	$I_O = 1\text{A}$	$1.4\text{V} \leq V_{IN} < 3\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$		400	mV
			$3\text{V} \leq V_{IN} \leq 6\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	110	250	
		$I_O = 1.5\text{A}$	$1.4\text{V} \leq V_{IN} < 3\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$		500	
			$3\text{V} \leq V_{IN} \leq 6\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	170	350	
		$I_O = 2\text{A}$	$1.6\text{V} \leq V_{IN} < 3\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$		600	
			$3\text{V} \leq V_{IN} \leq 6\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	235	450	
Minimum Load Current	$I_{O,MIN}$		$-40^\circ\text{C} \sim 125^\circ\text{C}$			10	$\mu\text{A}$
Output Current Limit	$I_{LIMIT}$	$V_{IN} = 1.4\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	1.9			A
		$V_{IN} = 1.5\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	2			A
		$V_{IN} = 3.3\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	2.1	3	4.4	A
Feedback Pin Current	$I_{FB}$	$V_{IN} = V_{REF}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$		80	200	nA
EN High Level	$V_{EN(HI)}$	$V_{IN} = 3.3\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	1.2			V
EN Low Level	$V_{EN(LO)}$	$V_{IN} = 3.3\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$			0.4	V
Enable pin current	$I_{EN}$	$EN = 0\text{V}$ , $V_{IN} = 3.3\text{V}$	$-40^\circ\text{C} \sim 125^\circ\text{C}$	1.5		10	$\mu\text{A}$



# SY6321DAC

Parameter	Symbol	Test Conditions	T <sub>J</sub>	Min	Typ	Max	Unit
Soft-start Time	t <sub>SS</sub>	V <sub>IN</sub> =3.3V, 10%V <sub>OUT</sub> to 90% V <sub>OUT</sub>	-40°C ~125°C	0.35	0.9	2.1	ms
Power Supply Rejection (Note 4)	PSRR	V <sub>IN</sub> = 5.0V V <sub>OUT</sub> = 3.3V I <sub>OUT</sub> = 100mA	f=100Hz	25°C		50	dB
			f=100kHz	25°C		30	
Thermal Shutdown Threshold (Note 4)	T <sub>SD</sub>				150		°C
Thermal Shutdown Hysteresis (Note 4)	T <sub>HYS</sub>				20		°C

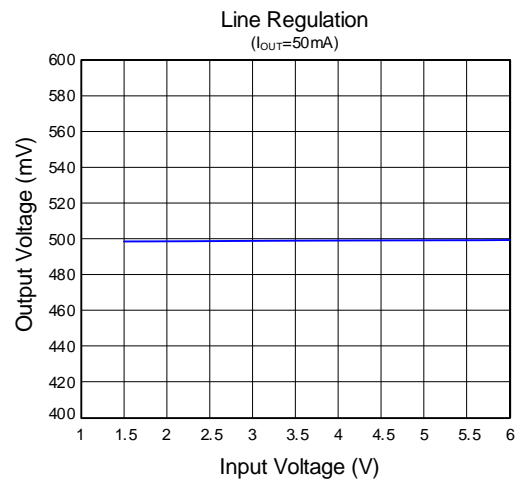
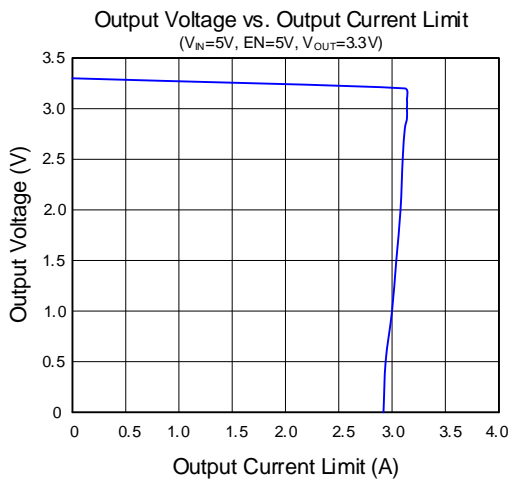
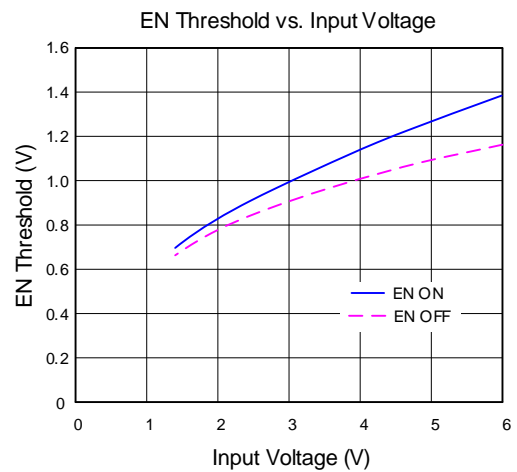
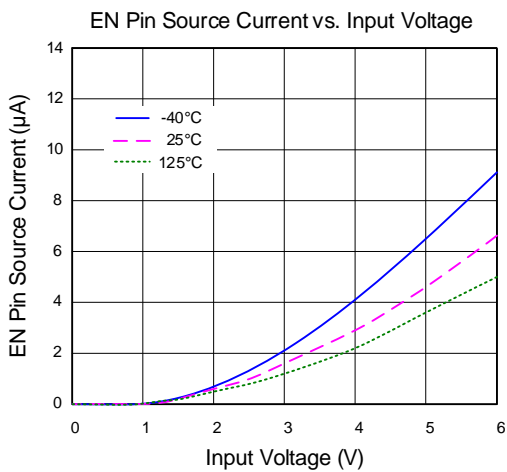
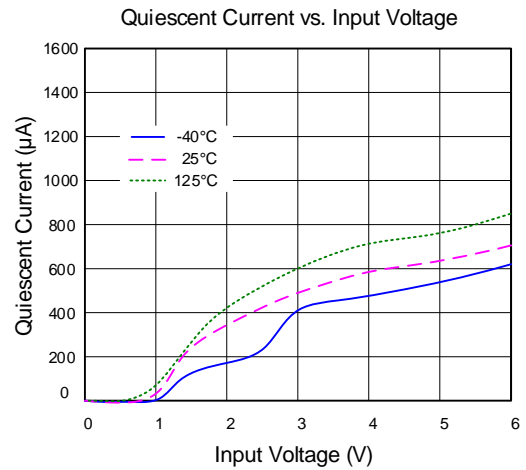
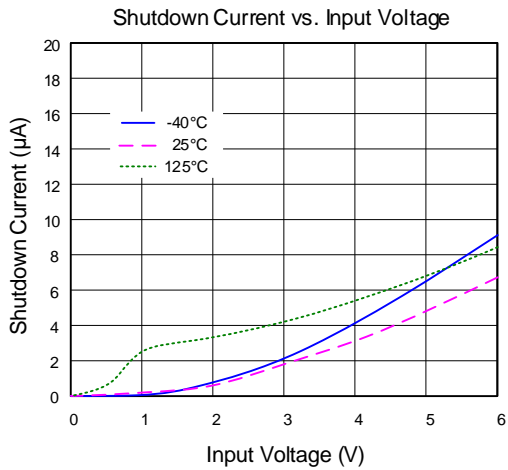
**Note 1:** Stresses beyond “Absolute Maximum Ratings” may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute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

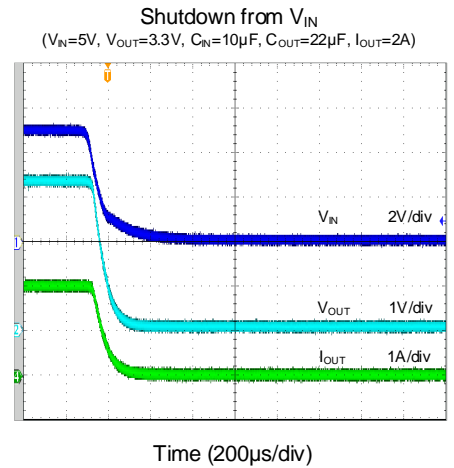
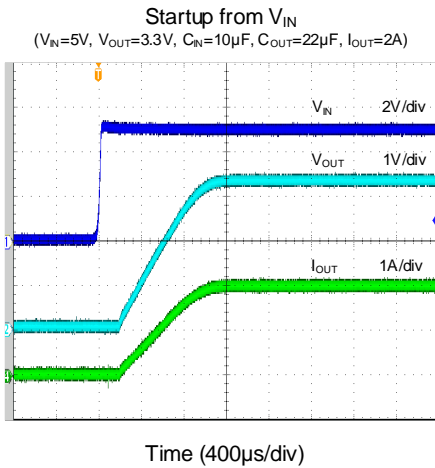
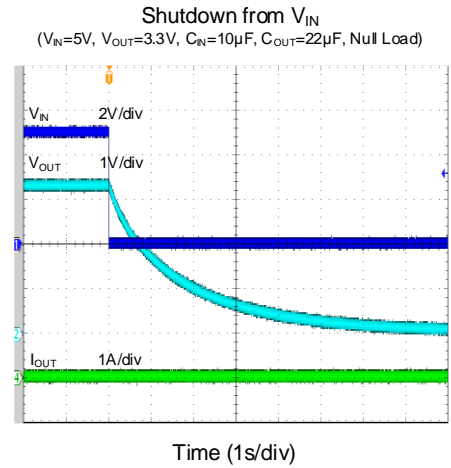
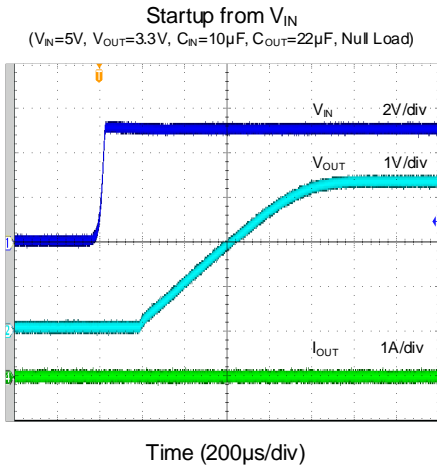
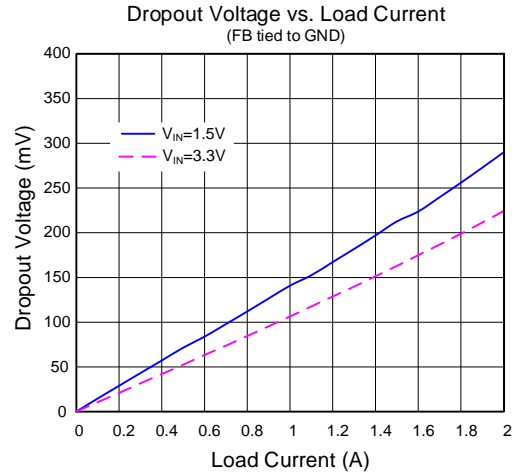
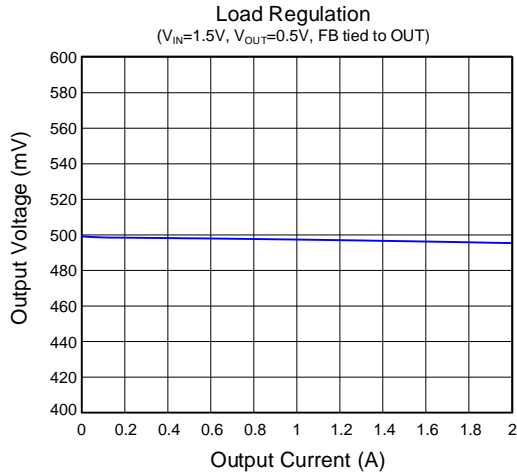
**Note 2:**  $\theta_{JA}$  is measured in the natural convection at T<sub>A</sub> = 25°C on a Silergy evaluation board. Exposed Pad of DFN3x3-8 package is the case position for  $\theta_{JC}$  measurement.

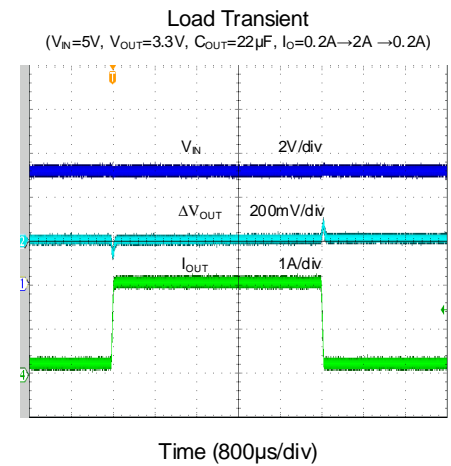
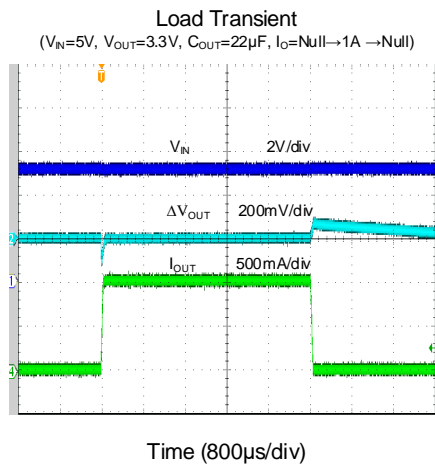
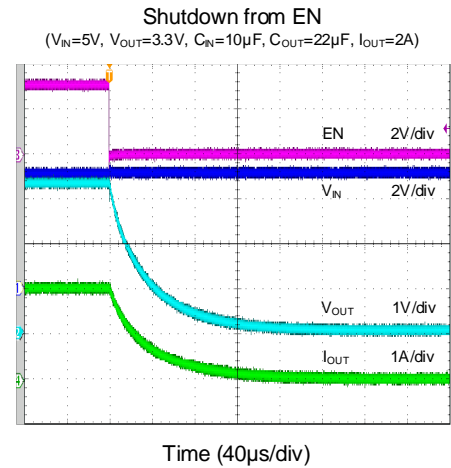
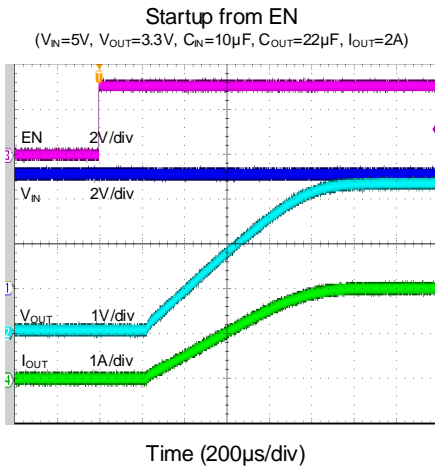
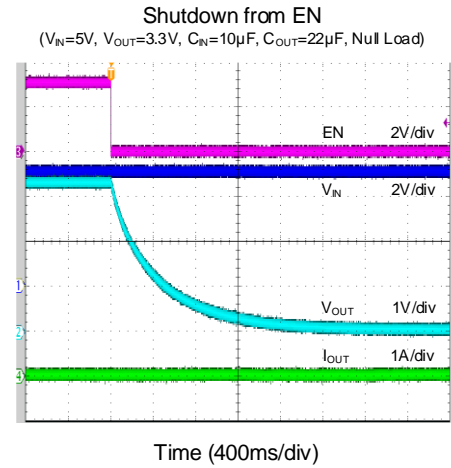
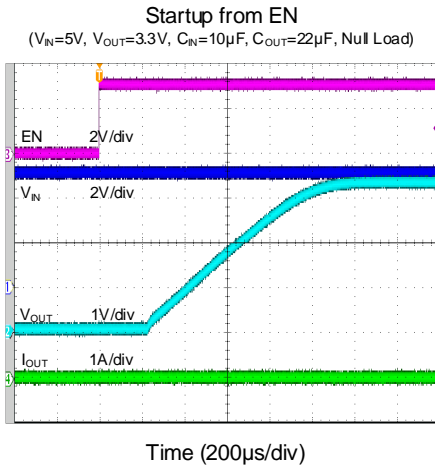
**Note 3:** The device is not guaranteed to function outside its operating conditions.

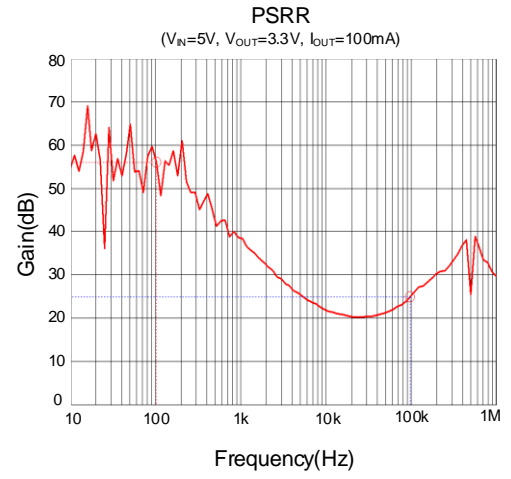
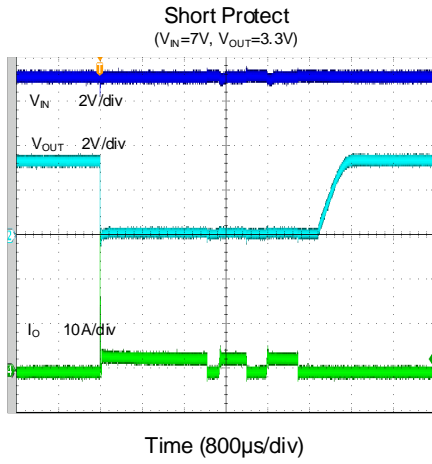
**Note 4:** Guaranteed by design.

## Typical Performance Characteristics









## Operation

The SY6321DAC is a high-performance positive voltage regulator designed for applications which require very low input voltage and very low dropout voltage at up to 2A output. It operates with a  $V_{IN}$  as low as 1.4V, with output voltage programmable as low as 0.5V.

The SY6321DAC features ultra-low dropout, ideal for applications where  $V_{OUT}$  is very close to  $V_{IN}$ . Additionally, it has an enable pin to further reduce power dissipation while shutdown. The device provides excellent regulation over variations in line, load, and temperature.

## Applications Information

### Input Capacitor $C_{IN}$ :

To minimize the potential noise problem and improve power-supply rejection ratio (PSRR) and transient response, place a typical X5R or better grade ceramic capacitor close to the IN and GND pins. Care should be taken to minimize the loop area formed by  $C_{IN}$ , and IN/GND pins. In this case, a 10 $\mu$ F low ESR ceramic capacitor is recommended.

### Output Capacitor $C_{OUT}$ :

For stable operation over the full temperature range, a 22 $\mu$ F low-ESR ceramic capacitor is recommended. Use 22 $\mu$ F to reduce noise, improve load-transient response and PSRR.

### Feedback Resistor Dividers $R_3$ and $R_2$ :

Choose  $R_3$  and  $R_2$  to program the proper output voltage. To minimize the power consumption under light loads, it is desirable to choose large resistance values for both  $R_3$  and  $R_2$ . A value of between 10k $\Omega$  and 1M $\Omega$  is highly recommended for both resistors. If  $V_{OUT}$  is 3.3V,  $R_3=56k\Omega$  is chosen, then using following equation,  $R_2$  can be calculated to be 10k $\Omega$ :

$$R_2 = \frac{0.5V}{V_{OUT} - 0.5V} \times R_3$$

### Over Current Protection:

The device includes over current protection. The current limitation circuit regulates the output current to its limitation threshold to protect IC from damage.

Under over current condition, the power loss of the IC is relatively high. And that may trigger the thermal protection.

### Enable Protection:

The enable pin for the SY6321DAC is active high. The output voltage is enabled when the enable pin voltage is greater than  $V_{EN(HI)}$  and disabled with the enable pin voltage is less than  $V_{EN(LO)}$ . If independent control of the output voltage is not needed, then connect the enable pin to the input.

### Thermal Considerations:

The SY6321DAC can deliver a current of up to 2A over the full operating temperature range. However, the maximum output current must be derated at higher ambient temperature. With all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

The final operating junction temperature for any set of condition can be estimated by the following thermal equation:

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

Where  $T_{J(MAX)}$  is the maximum junction temperature of die (125 °C ) and  $T_A$  is the maximum ambient temperature. The junction to ambient thermal resistance ( $\theta_{JA}$ ) footprint is 41°C/W for DFN package.

### PCB Layout Guide:

For best performance the SY6321DAC, the following guidelines must be strictly followed:

- 1) Keep all Power traces ( $V_{IN}$  /  $V_{OUT}$  / GND) as short and wide as possible and use at least 2-ounce copper for all Power traces.
- 2) Place a ground plane under all circuitry to lower both resistance and inductance and improve DC and transient performance.
- 3) Input and output capacitors should be placed closed to the SY6321 and connected to ground plane to reduce noise coupling.

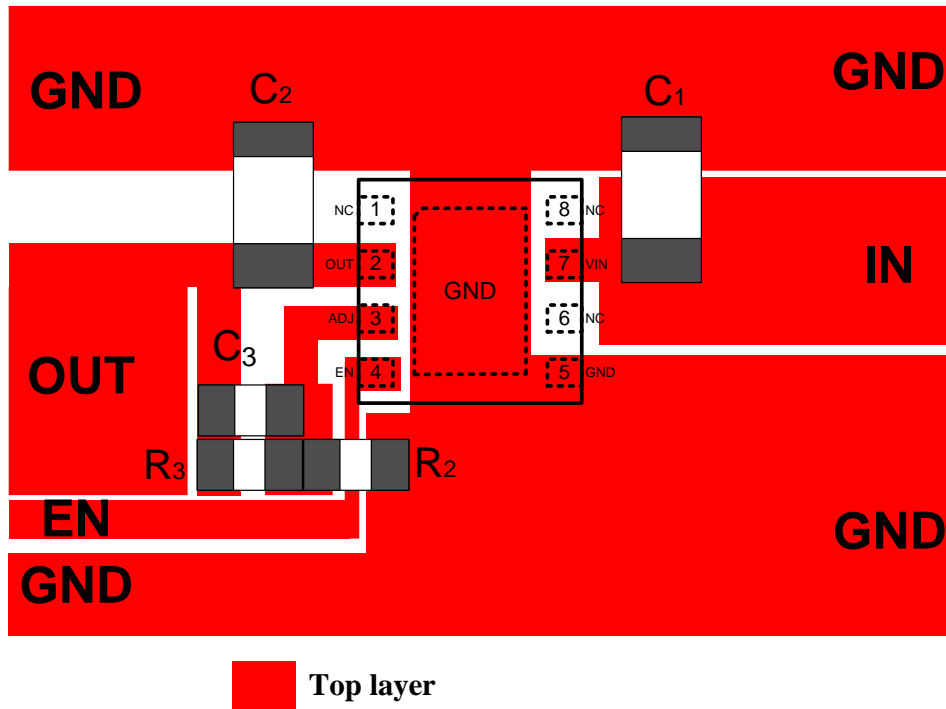
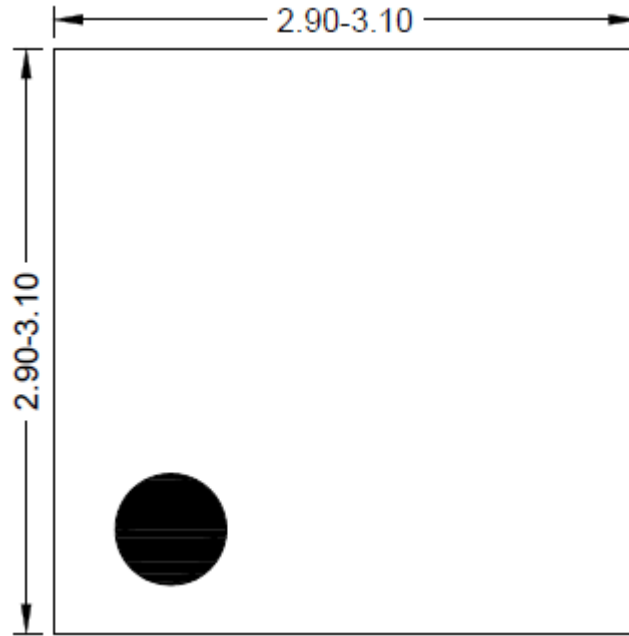
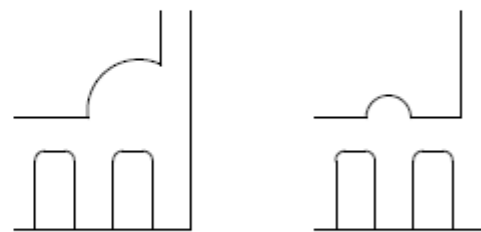
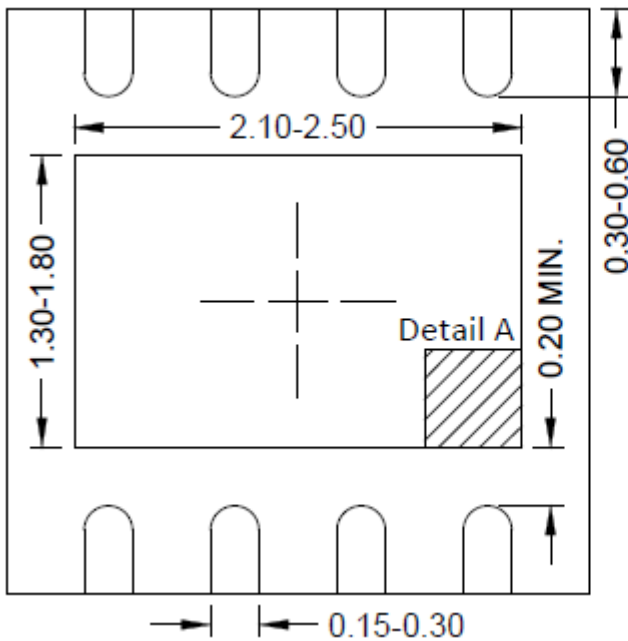


Figure3. PCB Layout Suggestion

**DFN3x3-8 Package Outline Drawing**



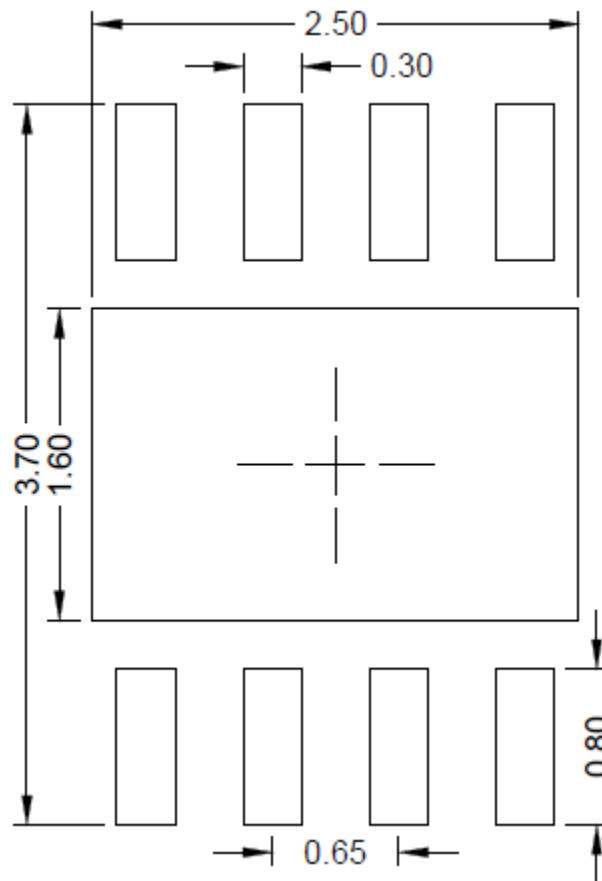
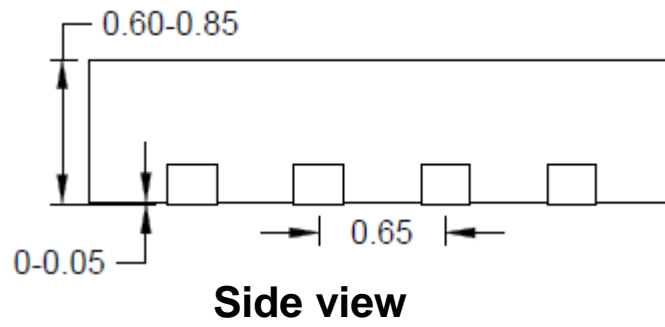
**Top view**



**Detail A**

Pin1 Identifier: two options

**Bottom view**



*Notes: All dimension in millimeter and exclude mold flash & metal burr.*





## Revision History

The revision history provided is for informational purpose only and is believed to be accurate, however, not warranted. Please make sure that you have the latest revision.

Date	Revision	Change
Sep.12, 2024	Revision 1.0	Initial Release



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