SA21345CDFD

36V, 300mA LDO

General Description

The SA21345CDFD is an automotive grade, efficient, precise low-dropout voltage regulator designed for high input voltage and ultra-low quiescent current applications.

The SA21345CDFD provides adjustable output voltage and very low drop out (300mV at 300mA). It offers protection features including over-current protection, thermal shutdown, and stable operation with low ESR ceramic or tantalum capacitors due to the optimized internal compensation.

The SA21345CDFD is available in a compact DFN2×2-8 package.

Features

- Wide Input Voltage Range: 4V to 36V
- 300mA Maximum Load Current
- Low Dropout Voltage of (300mV @ 300mA)
- Low Quiescent Current (10μA typ.)
- Low Shutdown Current (6μA max.)
- Stability with Tantalum or Ceramic Capacitors
- Excellent Load and Line Regulation
- Enable Control Input
- Over Current Protection
- Thermal Shutdown
- Package: DFN2×2-8
- Automotive AEC- Q100 Grade 1 Qualified

Applications

- Automotive Applications
- Battery-Powered Equipment
- Gateway Applications
- Remote Keyless Entry Systems
- SMPS Post-regulator/ DC-DC Modules

Typical Application

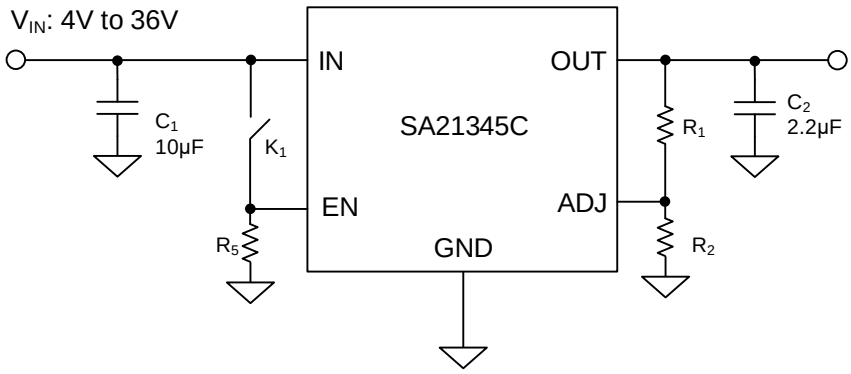


Figure1. Schematic Diagram

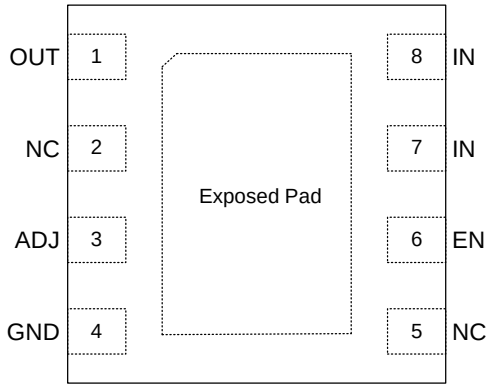
Ordering Information

Ordering Part Number	Package Type	Top Mark
SA21345CDFD	DFN2×2-8 RoHS Compliant and Halogen Free	GTH***xyz***

Device code: GTH

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

Pinout (top view)



Pin Description

Pin Name	Pin Number	Pin Description
OUT	1	Output pin. Bypass this pin to the ground pin with a 2.2μF output capacitor.
NC	2,5	Not connected.
ADJ	3	Output voltage adjust pin. Feedback the output voltage through resistor voltage divider network. $V_{OUT}=0.6\times(1+R_1/R_2)$
GND	4	Ground pin.
EN	6	Enable pin. Pull it low to shut down or pull it high to enable, do not leave floating.
IN	7,8	Power supply input. Bypass this pin to the Ground pin with a 10μF capacitor.
	Exposed Pad	The exposed pad should be connected to the ground plane for better thermal performance.

Block Diagram

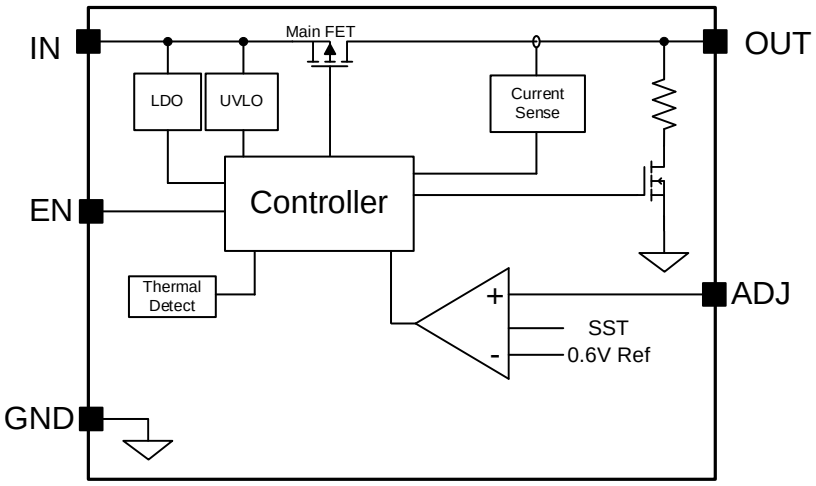


Figure2. Block Diagram

Absolute Maximum Ratings

Parameter (Note1)	Min	Max	Unit
IN to GND	-0.3	40	V
OUT, EN, ADJ to GND	-0.3	min (0.3V+V_{IN}, 40V)	
Lead Temperature (Soldering, 10 sec.)		260	°C
Junction Temperature, Operating	-40	150	
Storage Temperature	-65	150	

Thermal Information

Parameter (Note2)	Typ	Unit
θ_{JA} Junction-to-ambient Thermal Resistance	57	°C/W
θ_{JC} Junction-to-case Thermal Resistance	26	
P_D Power Dissipation T_A=25°C	1.754	W

Recommended Operating Conditions

Parameter (Note3)	Min	Max	Unit
IN	4	36	V
Ambient Temperature	-40	125	°C

Electrical Characteristics

(V_{IN} =12V V_{OUT}=3.3V, V_{EN}=V_{IN} T_J = -40°C~125°C, unless otherwise specified (Note 4))

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage	V_{IN}	I_{OUT}=10mA	4		36	V
Reference Voltage	V_{REF}		588	600	612	mV
Input Voltage UVLO Threshold	V_{ULVO}	V_{IN} rising	2.9	3.4	4	V
UVLO Hysteresis	V_{UVLO_HYS}			0.1		V
Line Regulation	ΔV_{LNR}	V_{IN}=(V_{OUT}+0.3V) to 36V, I_O=10mA		1	1.5	mV/V
Load Regulation	ΔV_{LDR}	V_{IN}=5V, I_O=10mA to 300mA		0.25	0.5	%
Dropout Voltage	ΔV_{DROP}	I_O=10mA		10	20	mV
		I_O=150mA		150	300	mV
		I_O=300mA		300	550	mV
Quiescent Current	I_Q	No Load		10	17	μA
Shutdown Current	I_{SHDN}	V_{EN}=0V, V_{IN}=24V			6	μA
Output Current	Io	V_{IN}=V_{OUT}+0.6V	0		300	mA
Output Current Limit	I_{LIM}	V_{IN}=6V,V_{OUT}=0.9×V_{OUT}(normal)	300		900	mA
Output Short Protection Threshold	$V_{ADJ,SHORT}$	V_{FB} Falling	8	16	30	%V_{REF}
Power Supply Rejection Ratio (Note 5)	PSRR	f=1kHz, C_{OUT}=10μF		60		dB
		f=150kHz, C_{OUT}=10μF		30		dB
Enable Input Logic-High Voltage	V_{EN_H}	V_{IN} =5V	1.5			V
Enable Input Logic-Low Voltage	V_{EN_L}	V_{IN} =5V			0.4	V
Shutdown Discharge Resistance	R_{DIS}			600		Ω
Thermal Shutdown Temperature(Note 5)	T_{SD}			150		°C

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Thermal Shutdown Hysteresis(Note 5)	T_{HYS}			20		°C

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

Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

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

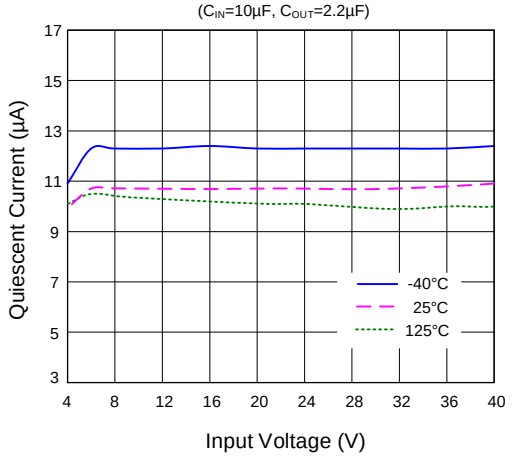
Note 4: Unless otherwise stated, limits are 100% production tested under pulsed load conditions such that $T_A \cong T_J$ = 25°C. Limits over the operating temperature range (See recommended operating conditions) and relevant voltage range(s) are guaranteed by design, test, or statistical correlation.

Note 5: Guaranteed by design.

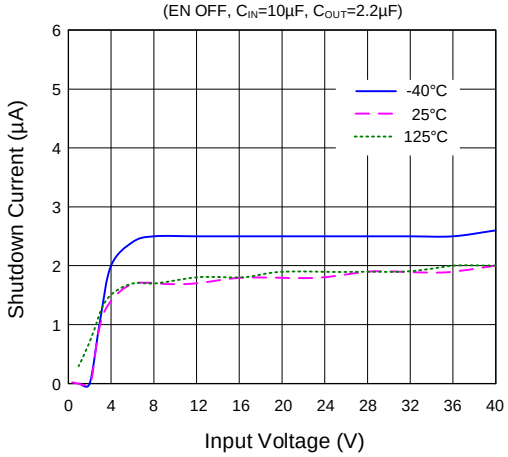
Note 6: Operating lifetime is derated for junction temperatures greater than 125°C.

Typical Performance Characteristics

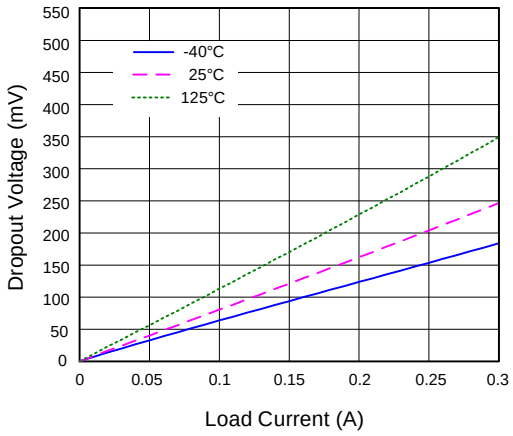
Quiescent Current vs. Input Voltage
(C_{IN}=10μF, C_{OUT}=2.2μF)



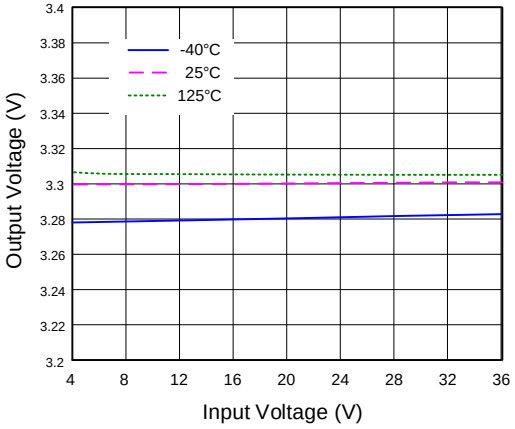
Shutdown Current vs. Input Voltage
(EN OFF, C_{IN}=10μF, C_{OUT}=2.2μF)



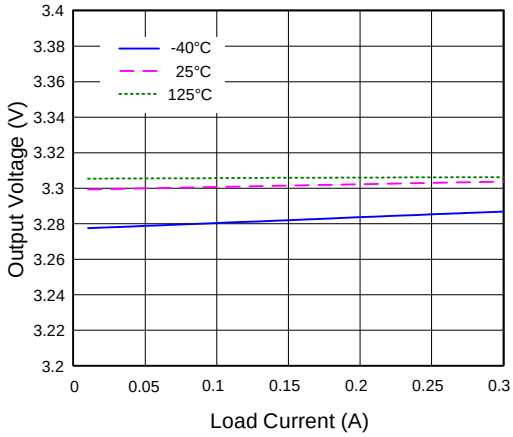
Dropout Voltage vs. Load Current
(V_{IN}=12V, ADJ=0.5V, C_{IN}=10μF, C_{OUT}=2.2μF)



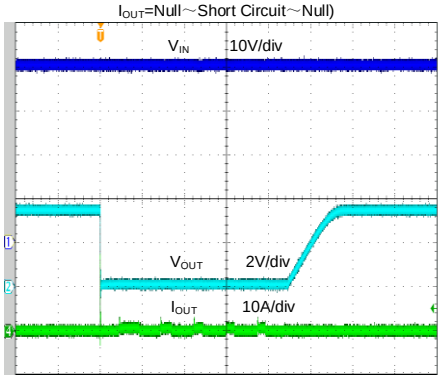
Output Voltage vs. Input Voltage
(V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF, I_{OUT}=10mA)



Output Voltage vs. Load Current
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF)



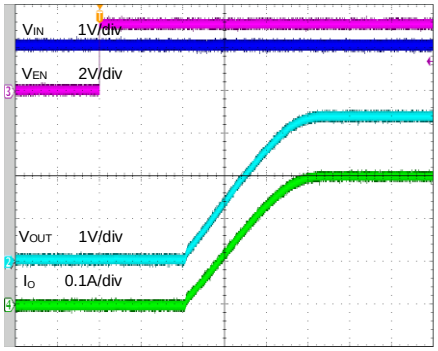
Short Protect
(V_{IN}=40V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF,
I_{OUT}=Null～Short Circuit～Null)



Time (1ms/div)

Startup from Enable

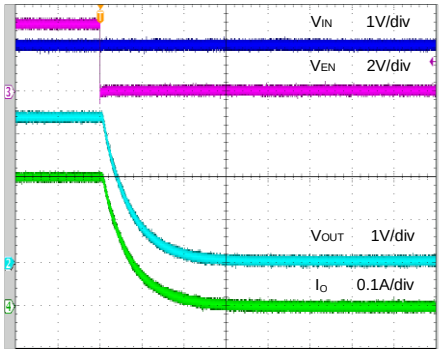
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF, I_{OUT}=300mA)



Time (400μs/div)

Shutdown from Enable

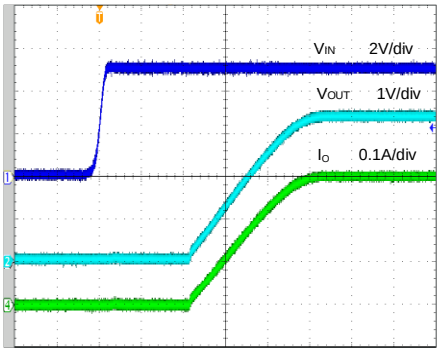
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF, I_{OUT}=300mA)



Time (40μs/div)

Startup from V_{IN}

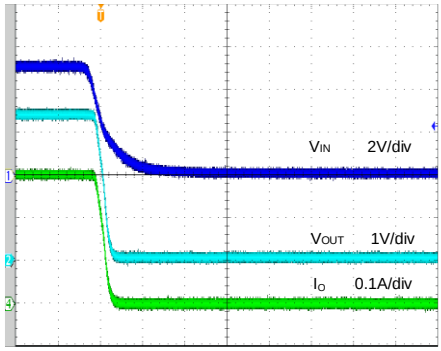
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF, I_{OUT}=300mA)



Time (400μs/div)

Shutdown from V_{IN}

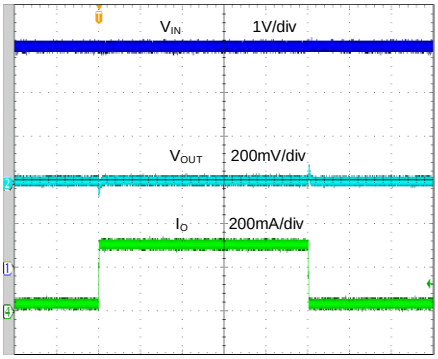
(V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF, I_{OUT}=300mA)



Time (400μs/div)

Load Transient

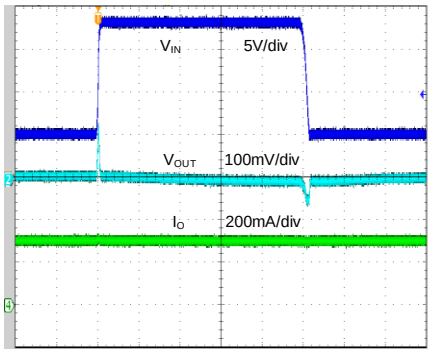
V_{IN}=5V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF,
I_{OUT}=30mA～300mA～30mA)



Time (400μs/div)

Line Transient

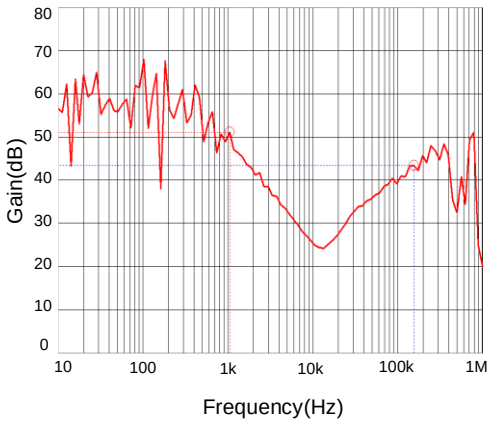
(V_{IN}=5V~18V~5V, V_{OUT}=3.3V, C_{IN}=10μF, C_{OUT}=2.2μF,
I_{OUT}=300mA)



Time (1ms/div)

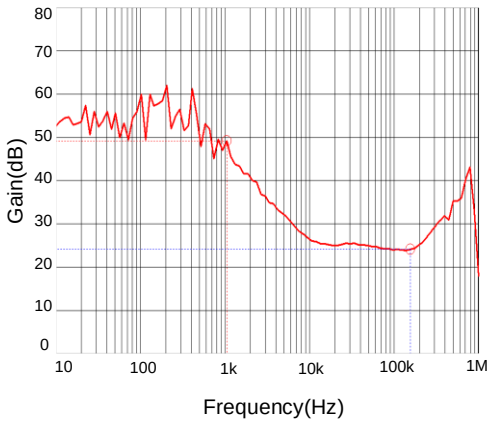
PSRR

(V_{IN}=5V, V_{OUT}=3.3V, C_{OUT}=10μF, I_{OUT}=10mA)



PSRR

(V_{IN}=5V, V_{OUT}=3.3V, C_{OUT}=10μF, I_{OUT}=300mA)



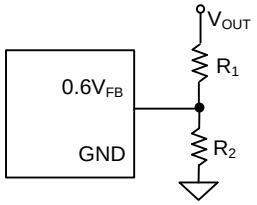
Applications Information

The SA21345CDFD is a 300mA linear regulator with a low dropout voltage. Like any low-dropout regulator, the SA21345CDFD requires input and output decoupling capacitors. The SA21345CDFD has an adjustable output which can be set by two external resistors. The device offers protection features, including over-current limit, output short and over-temperature protections.

Feedback Resistor Dividers R_1 and R_2:

Choose R_1 and R_2 to program the proper output voltage. To minimize the power consumption under light loads, choosing large resistance values for both R_1 and R_2.is recommended. A value of between 10kΩ and 10MΩ is highly recommended for both resistors. If V_{OUT} is 3.3V and R_1=1.6MΩ is selected, then using the following equation, R_2 can be calculated to be 357kΩ:

$$R_2 = \frac{0.6V}{V_{OUT} - 0.6V} R_1$$



Input Capacitor C_{IN}:

An input capacitor with a value of 10μF between the device input and ground pin is recommended. A typical X5R or better ceramic capacitor is recommended for most applications. This input capacitor must be located close to the device to minimize the input noise.

Output Capacitor C_{OUT}:

The SA21345CDFD is designed specifically to work with very small ceramic output capacitors for transient stability. A 2.2μF output capacitance can be used in this application. Higher capacitance values help to improve stability. For low output voltage application, like output is 1V, a higher output capacitor, like 10μF is recommended to get enough phase margin.

Dropout Voltage:

The SA21345CDFD has a very low dropout voltage due to its low $R_{DS(ON)}$ of the main PMOS, which determines the lowest usable supply.

$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

Over Current and Short Circuit Protection:

The device includes over current and short circuit protection. The current limitation circuit regulates the output current to its limitation threshold to protect IC from damage. Under over current or short circuit condition, the power loss of the IC is relatively high. And that may trigger the thermal protection.

Thermal Considerations:

The SA21345CDFD can deliver a current of up to 300mA over the full operating temperature range. However, the maximum output current must be derated at a higher ambient temperature. During all possible conditions, the junction temperature must be within the range specified under the operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

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

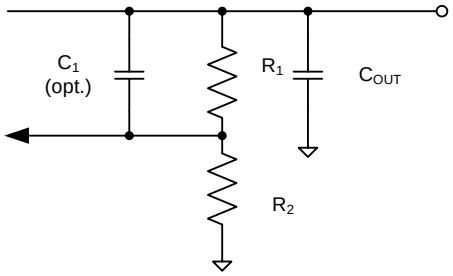
The final operating junction temperature for any set of condition can be estimated by the following thermal equation:

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

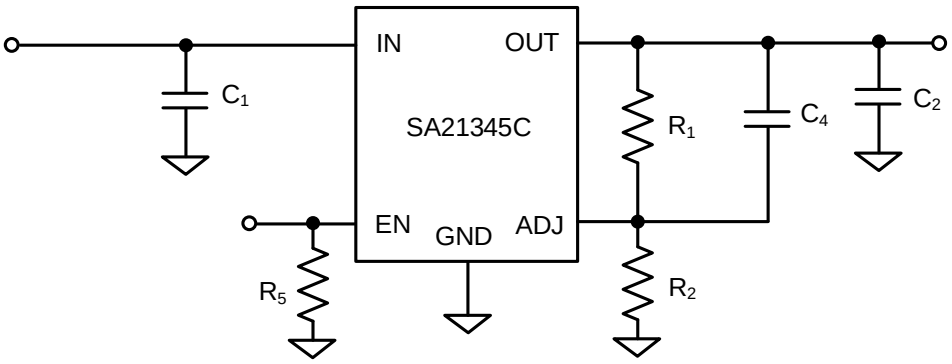
Where $T_{J(MAX)}$ is the maximum junction temperature of die and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA}) footprint is 57°C/W for DFN2×2-8 package.

Load Transient Considerations:

The SA21345CDFD integrates the compensation components to achieve good stability and fast transient responses. In some applications, adding a small ceramic cap in parallel with R_1 may further speed up the load transient responses and is thus recommended for applications with large load transient step requirements.



Application Schematic



BOM List

Reference Designator	Description	Part Number	Manufacturer
C_1	10μF/50V, 1206, X5R	GRM31CR61H106K	Murata
C_2	2.2μF/25V, 1206, X5R	GRM31CR61E225K	Murata
C_4	Null		
R_1	100kΩ		
R_2	22.1kΩ		
R_5	1MΩ		

PCB Layout Guide

For best performance of the SA21345CDFD, the following guidelines must be strictly followed:

1. Keep all power trace as short and wide as possible. And it is desirable to use 2-layer or 4-layer board for thermal performance and better capability of current flow.
2. Place input/output capacitor close to the IC for better transient performance.

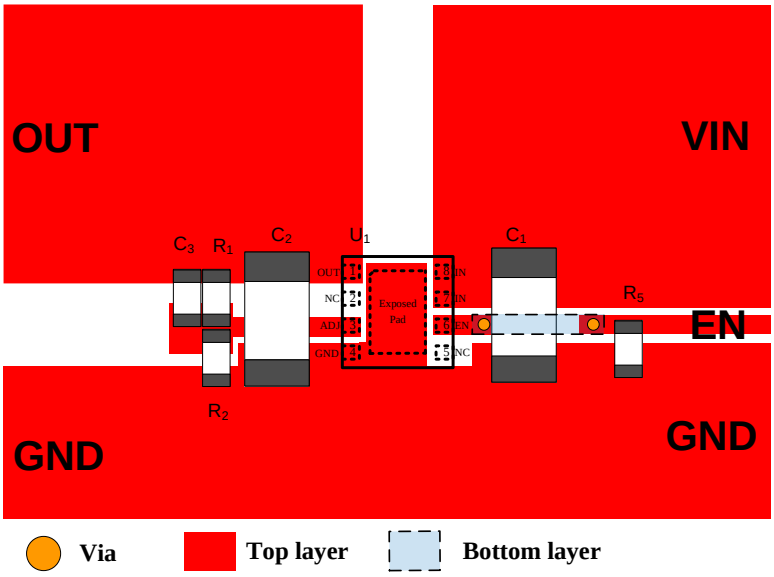
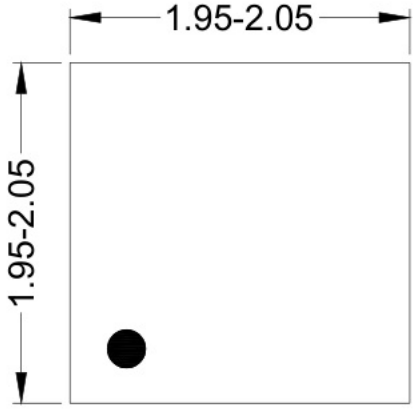
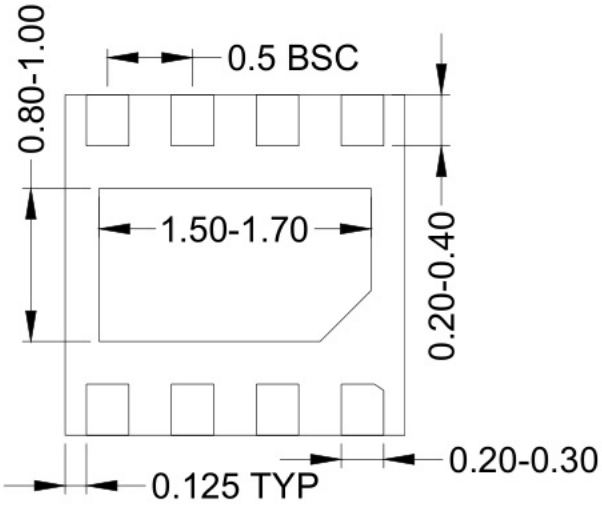


Figure3. PCB Layout Suggestion

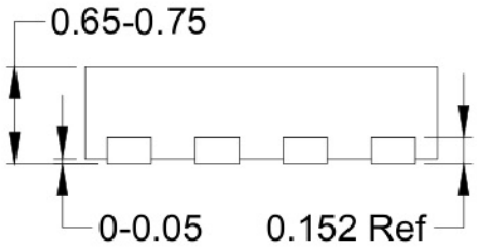
DFN2×2-8 Package Outline Drawing



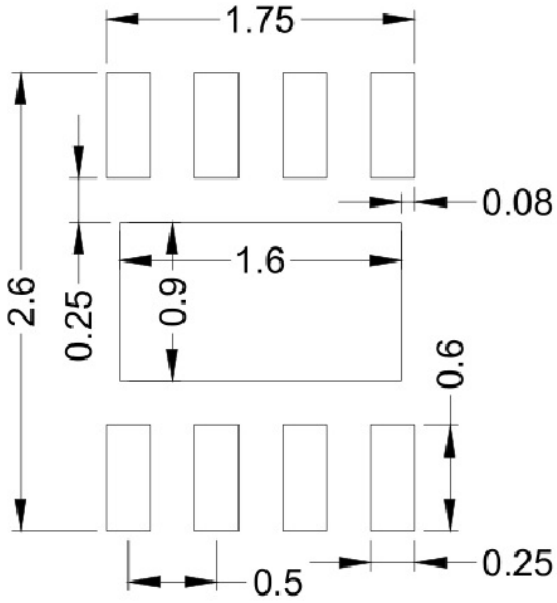
Top View



Bottom View



Side View

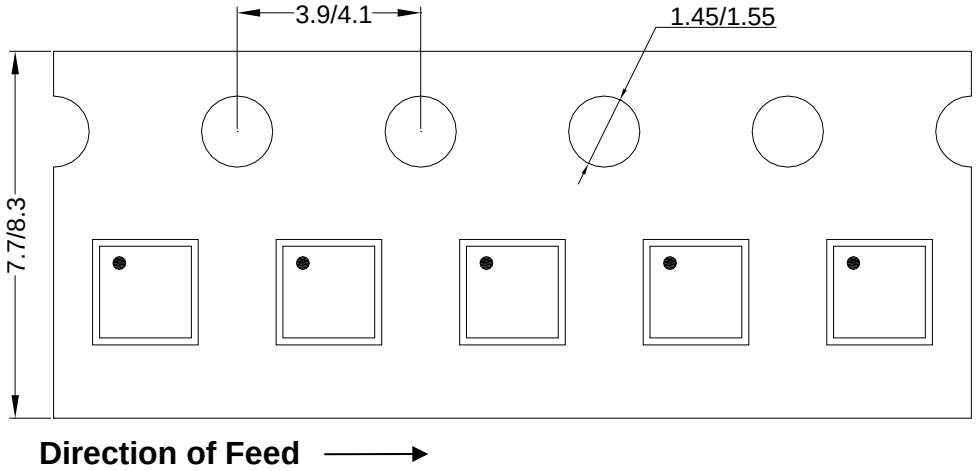


Recommended PCB layout
(Reference only)

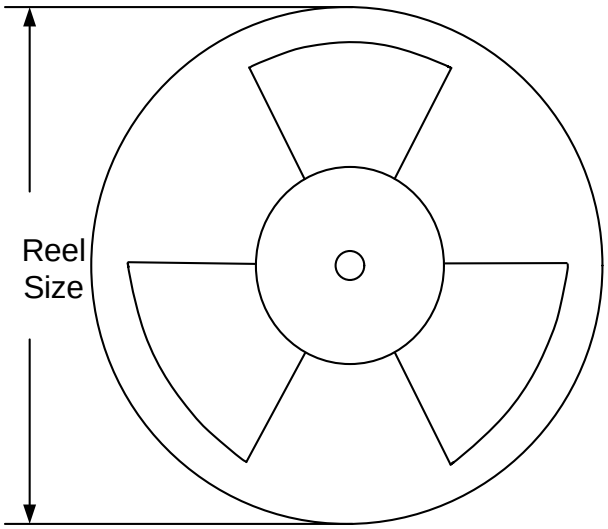
Notes: All dimensions are in millimeters and don't include mold flash & metal burr.

Tape and Reel Information

1. Tape Dimensions and Pin1 Orientation



2. Reel Dimensions



Package type	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel （pcs）
DFN2×2	8	4	7"	400	160	3000

Revision History

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

Date	Revision	Change
Aug. 29, 2024	Revision 1.0	Initial Release

IMPORTANT NOTICE

1. **Right to make changes.** Silergy and its subsidiaries (hereafter Silergy) reserve the right to change any information published in this document, including but not limited to circuitry, specification and/or product design, manufacturing or descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products are sold subject to Silergy's standard terms and conditions of sale.

2. Applications. Application examples that are described herein for any of these products are for illustrative purposes only. Silergy makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Buyers are responsible for the design and operation of their applications and products using Silergy products. Silergy or its subsidiaries assume no liability for any application assistance or designs of customer products. It is customer's sole responsibility to determine whether the Silergy product is suitable and fit for the customer's applications and products planned. To minimize the risks associated with customer's products and applications, customer should provide adequate design and operating safeguards. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Silergy assumes no liability related to any default, damage, costs or problem in the customer's applications or products, or the application or use by customer's third-party buyers. Customer will fully indemnify Silergy, its subsidiaries, and their representatives against any damages arising out of the use of any Silergy components in safety-critical applications. It is also buyers' sole responsibility to warrant and guarantee that any intellectual property rights of a third party are not infringed upon when integrating Silergy products into any application. Silergy assumes no responsibility for any said applications or for any use of any circuitry other than circuitry entirely embodied in a Silergy product.

3. **Limited warranty and liability.** Information furnished by Silergy in this document is believed to be accurate and reliable. However, Silergy makes no representation or warranty, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. In no event shall Silergy be liable for any indirect, incidental, punitive, special or consequential damages, including but not limited to lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges, whether or not such damages are based on tort or negligence, warranty, breach of contract or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, Silergy' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Standard Terms and Conditions of Sale of Silergy.

4. **Suitability for use.** Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Silergy components in its applications, notwithstanding any applications-related information or support that may be provided by Silergy. Silergy products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of a Silergy product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Silergy assumes no liability for inclusion and/or use of Silergy products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

5. **Terms and conditions of commercial sale**. Silergy products are sold subject to the standard terms and conditions of commercial sale, as published at http://www.silergy.com/stdterms, unless otherwise agreed in a valid written individual agreement specifically agreed to in writing by an authorized officer of Silergy. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. Silergy hereby expressly objects to and denies the application of any customer's general terms and conditions with regard to the purchase of Silergy products by the customer.

6. **No offer to sell or license**. Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights. Silergy makes no representation or warranty that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right. Information published by Silergy regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Silergy under the patents or other intellectual property of Silergy.

For more information, please visit: www.silergy.com