User Manual

DA9231 DA9230 Evaluation Board - 342-03-A

UM-PM-040

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1 Introduction

DA9231 is an ultra-low quiescent current PMIC, highly optimized for wearables and home-automation applications. The device has a buck converter that is efficient down to 10 µA and a nano-ampere LDO with an independent power input which can be connected to either the battery or buck output.

DA9230 is the device with only a single ultra-low quiescent buck converter.

Both DA9231 and DA9230 have the same compact WLCSP package and compatible footprint.

The 342-03-A evaluation board accommodates either DA9231 or DA9230 device. It operates from 5.5 V to 2.5 V input voltage and supports full performance of DA9231 or DA9230. The key feature of evaluation board 342-03-A includes:

- Ultra-low no load operating current:
  - 750 nA typical input current when buck switching at no load (DA9230)
  - 1.35 µA typical total input current when buck switching at no load and LDO enabled at no load (DA9231)
- 1.25 mm x 1.65 mm WLCSP package and 5 external components for a compact solution size of 18 mm^2
- Configurable wide buck output range: 0.6 V to 1.9 V with 50 mV step, and support up to 300 mA load current.
- Configurable wide LDO output range: 0.7 V to 3.3 V with 100 mV step, and support up to 100 mA load current.
- Interface for I^2C control. Paired with Dialog's USB module and SmartCanvas GUI.

2 Board Descriptions

2.1 Board Overview

Figure 1 is the top view of the board 342-03-A and Figure 2 shows the top overlay with 18 mm^2 layout solution size highlighted.

Figure 1: 342-03-A Evaluation Board Top View

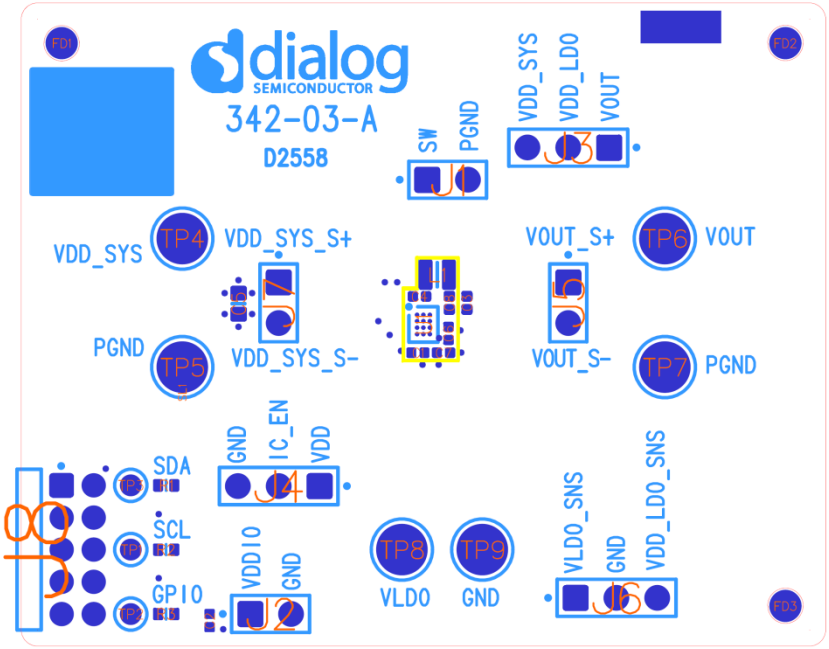

Figure 2: 342-03-A Evaluation Board Top Overlay (Solution Size: 18 mm^2)

2.2 Connectors and Test Points Descriptions

Table 1 describes the pin names and functions of the connectors and test points used on the board.

Table 1: Descriptions of Connectors and test points on Board 342-03-A

Connectors/ Test Points	Pin1 / Pin2 / Pin3 Name	Descriptions
J1	SW / PGND	Connector for sensing buck switching node.
J2	VDDIO / GND	Connector for external pull-up voltage on SDA, SCL and GPO pins.
J3	VOUT / VDD_LDO / VDD_SYS	LDO input source selector. LDO input VDD_LDO can be selected from either VDD_SYS or buck VOUT.
J4	VDD / IC_EN / GND	IC_EN input signal selector. Connect IC_EN to VDD enables the IC; connect IC_EN to GND completely disable the IC.
J5	VOUT _S+ / VOUT _S-	Buck output voltage Kelvin sense. Measure the buck output voltage at this connector for best accuracy.
J6	VLDO _SNS / GND / VDD_LDO_SNS	VDD_LDO_SNS: LDO input voltage Kelvin sense point. VLDO_SNS: LDO output voltage Kelvin sense point. Measure the LDO input and output voltage at this connector for best accuracy.
J7	VDD_SYS_S+ / VDD_SYS_S-	Buck input VDD_SYS voltage Kelvin sense. Measure the buck input voltage at this connector for best accuracy.
J8		10-pin connector. Connect to Dialog USB module for I^2C communication to GUI.
TP1	SCL	Test point. Connect to SCL pin of DUT (U1).
TP2	GPIO	Test point. Connect to GPO pin of DUT (U1).
TP3	SDA	Test point. Connect to SDA pin of DUT (U1).
TP4	VDD_SYS	Terminal for buck power input. Apply buck supply voltage between TP4 and TP5.
TP5, TP7	PGND	Terminals for power ground.
TP6	VOUT	Terminal for buck output. Connect electronic load between TP6 and TP7.
TP8	VLDO	Terminal for LDO output. Connect electronic load between TP8 and TP9.
TP9	GND	Terminal for analog ground.

2.3 Default Board Setup

The 342-03-A evaluation board is pre-programmed to the default OTP settings according the device OTP number shown in Table 2 and using the default jumper positions as shown in Table 3.

I^2C communication is not required for powering up the board though it can be used to re-configure the device features or monitor the device status.

Table 2: Descriptions of Default OTP Settings

Device OTP number	Buck V_{OUT} (V)	LDO V_{OUT} (V)	I^2C Address
DA9230_07VZ2	0.6 V	N/A	2F
DA9230_08VZ2	0.8 V	N/A	2F
DA9230_09VZ2	1.2 V	N/A	2F
DA9230_0AVZ2	1.8 V	N/A	2F
DA9231_0BVZ2	1.8 V	3.3	2F
DA9231_0CVZ2	0.6 V	3.3	2F
DA9231_0DVZ2	1.2	3.0	2D
DA9231_0EVZ2	1.8	Load Switch	2F

Table 3: Default Jumper Position

Jumper	Default Position
J3	VDD_LDO = VDD_SYS
J4	IC_EN = VDD
J1, J2, J5, J6, J7, J8	Open

3 Test Setup

3.1 Recommended Operating Conditions

The recommended operating conditions for board 342-03-A are shown in Table 4.

Table 4: Recommended Operating Conditions

Parameter	Description	Conditions	Min	Typ	Max	Unit
VDD_SYS, VDD	Input voltage Range	VDD_SYS = VDD	2.5 Note 1		5.5	V
VDD_LDO	Input Voltage Range for LDO mode		1.8		VDD	V
	Input Voltage Range for Load Switch mode		0.8		VDD	V
I_{SW}	Output DC Current from SW				300	mA
I_{LDO}	Output DC Current from LDO				100	mA
T_A	Operation ambient Temperature Range		-40		85	°C

Note 1 Requires minimal 2.75 V for start-up. Once started, input voltage range can down to 2.5 V.

3.2 Recommended Test Equipment

3.2.1 Power Supply Requirement

To support full-load operation, it requires one DC power supply (PS#1) capable of supplying VDD_SYS with 5.5 V at 0.5 A.

3.2.2 Load Requirement

Load #1: To support full-load operation of buck, it requires an electronic load or source meter that is capable of sinking 300 mA load current with 1 µA resolution. Fine resolution is required for efficiency sweep over load current at light load condition, for example Keithley 2460.

Load #2: To support full-load operation of LDO, it requires an electronic load or source meter that is capable of sinking 100 mA load current.

3.2.3 Multimeters

Voltage meter VM#1, VM#2, VM#3, VM#4: The voltage meters must have an input resistance > 10 GΩ to prevent drawing too much current that can affect quiescent current and efficiency measurement, for example Keithley 2700, 2000/1/2.

Current meter CM#1: The buck input current meter must be able to measure 500 mA current. It also requires current resolution at least 1 nA to measure no-load operating current, for example Keithley 2001/2.

Current meter CM#2: The buck output current meter must be able to measure 300 mA current. It also requires current resolution at least 1 µA for efficiency sweep over load current.

3.3 Recommended Test Setup

Set the jumper position according to Table 3 or refer to Figure 1 (Install J3 and J4). Then follow the guideline for recommended test equipment setup.

3.3.1 No-Load Input Current Measurement Setup

Due to the ultra-low no-load operating current of DA9231 or DA9230, any in-proper setup can result in a significant measurement error. The following guidelines provide the recommended setup for no-load input current measurement, also shown in Figure 3.

1. Select a proper DC power supply PS#1 according to Section 3.2.1 and turn it off. Connect the positive output of PS#1 through a current meter (CM#1) to VDD_SYS terminal (TP4) and negative output to Terminal PGND (TP5).
2. Remove all oscilloscope probes from the board as they could draw significant current from the board if their input impedance is not high enough.
3. Disconnect VOUT terminal (TP6) from any load equipment since the load equipment could still draw leakage current from VOUT even if it is in OFF state.
4. Turn on PS#1. Read CM#1 after it is settled.

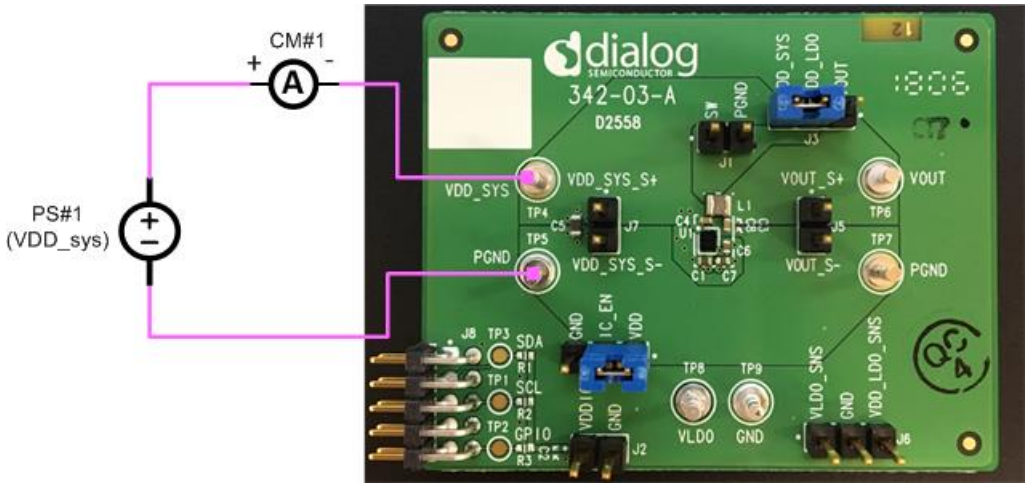

Figure 3: Recommended Setup for No-Load Input Current Measurement

3.3.2 Buck Efficiency Measurement Setup

The following guidelines provide the recommended test equipment setup for buck efficiency measurement. The test setup is also shown in Figure 4.

1. Select a proper DC power supply PS#1 according to Section 3.2.1 and turn it off. Connect the positive output of PS#1 through a current meter (CM#1) to VDD_SYS terminal (TP4) and negative output to Terminal PGND (TP5).
2. Connect a voltage meter (VM#1) to J7. Connect a voltage meter (VM#2) to J5.
3. Select a proper load equipment Load#1 according to Section 3.2.2 and turn it off. Connect Load#1 terminal through a current meter (CM#2) to VOUT terminal (TP6) and the other terminal to Terminal PGND (TP7). Make sure the current always drawn from VOUT (TP6) and flow into PGND (TP7).
4. Turn on PS#1. Check VM#2 is showing OTP programmed buck V_{OUT} voltage.
5. Turn on Load#1. Adjust Load#1 current to measure VM#1, VM#2, CM#1 and CM#2 and calculate efficiency over load current.

Figure 4: Recommended Setup for Buck Efficiency Measurement

3.3.3 LDO Measurement

The following guidelines provide the recommended test equipment setup for LDO measurement. The test setup is also shown in Figure 5.

1. Select a proper DC power supply PS#1 according to Section 3.2.1 and turn it off. Connect the positive output of PS#1 to VDD_SYS terminal (TP4) and negative output to Terminal PGND (TP5).
2. Connect a voltage meter (VM#3) to J6 between VLDO_SNS and GND pins. Connect a voltage meter (VM#4) to J6 between VDD_LDO_SNS and GND pins.
3. Select a proper load equipment Load#2 according to Section 3.2.2 and turn it off. Connect Load#2 terminal to VLDO terminal (TP8) and the other terminal to Terminal GND (TP9). Make sure the current always drawn from VLDO (TP8) and flow into GND (TP9).
4. Turn on PS#1. Check VM#3 is showing OTP programmed LDO output voltage.
5. Turn on Load#2. Adjust Load#2 current to measure VM#3, VM#4.

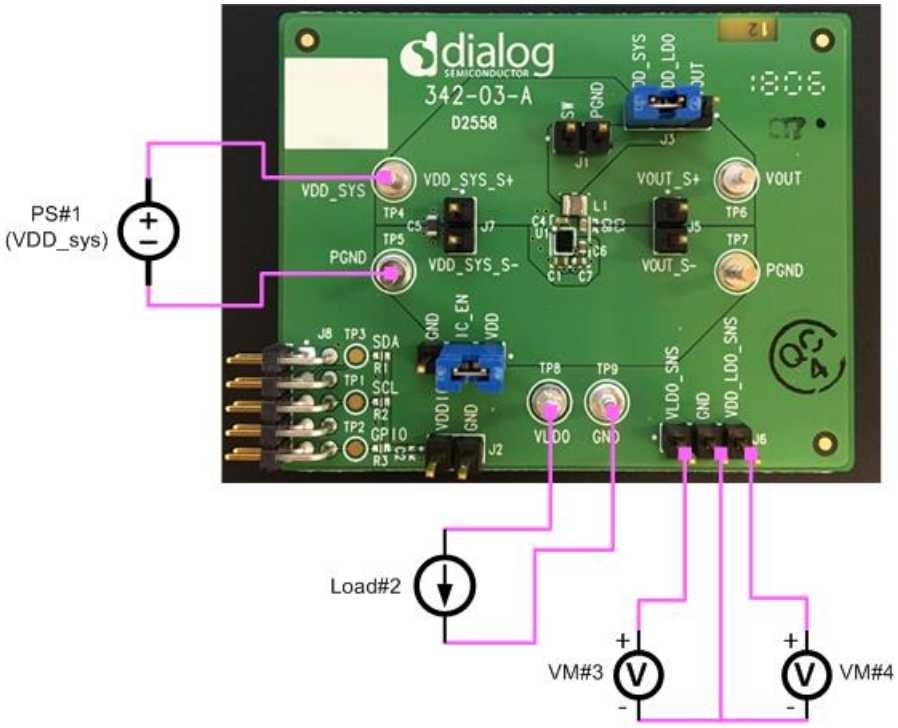

Figure 5: Recommended Setup for LDO Measurement

3.3.4 I²C and GPO Pull-Up Supply

342-03-A has the option to use on-board pull-up resistor and external VDDIO supply to drive SDA, SCL and GPO lines. If there are no pull-up resistors on the host side, simply populate R1 for SDA, R2 for SCL and R3 for GPO lines on 342-03-A board. Then apply an external voltage supply (≤VDD_SYS) to J2 between VDDIO and GND.

Dialog USB module 162-09 provides pull-up resistors on SDA and SCL lines, but no pull-up on GPO line.

3.4 Software GUI

To use software GUI for IC re-configuration and status monitoring, connect Dialog's USB module 162-09 to the 10-pin connector J8 with the header on the module facing up, as shown in Figure 6.

Figure 6: Dialog USB Module 162-09

3.4.1 I²C Address Re-configuration

By default, the GUI will automatically communicate to the device when its I²C address is 0x2F. However, if the device has an I²C address other than 0x2F, the GUI needs to be re-configured in order to build a communication with the device.

1. Open DA9230/DA9231 GUI and go to menu -> Options-> Settings. See Figure 7.

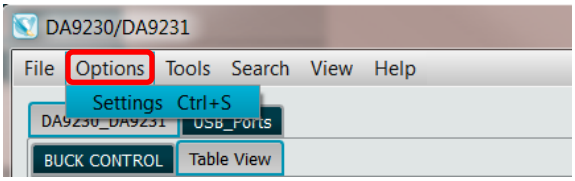

Figure 7: Open GUI Settings

2. In the Settings window, go to Bus Interface. See Figure 8. The default I²C address is “0x5E on bus 47 : Bus_0x2F”. Select the correct I²C address from the drop-down list based on device OTP versions. For example: Select “0x5A on bus 45 : Bus_0x2D” for DA9231_0DVZ2. Then make sure “Interface Enabled” is highlighted. The GUI I²C address is selectable from 00-7F.

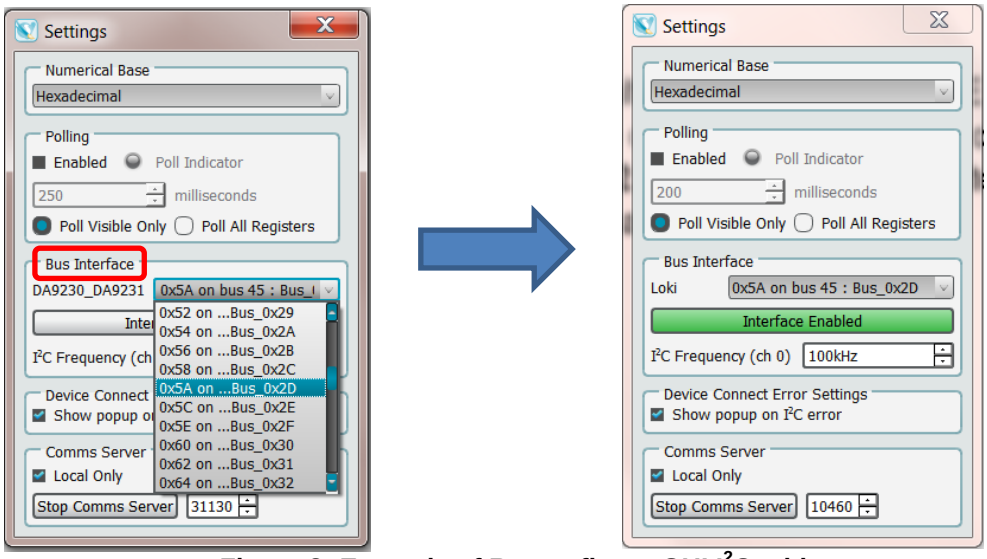

Figure 8: Example of Re-configure GUI I²C address

3.4.2 Device OTP Information

Device OTP information can be read from GUI as well.

1. Open DA9230/DA9231 GUI and go to SYSTEM MODULE page. See Figure 9.

2. Read Register 0x82. It will show the OTP version of the device. For example: it shows 0x0B when the device on board is DA9231_0BVZ2.

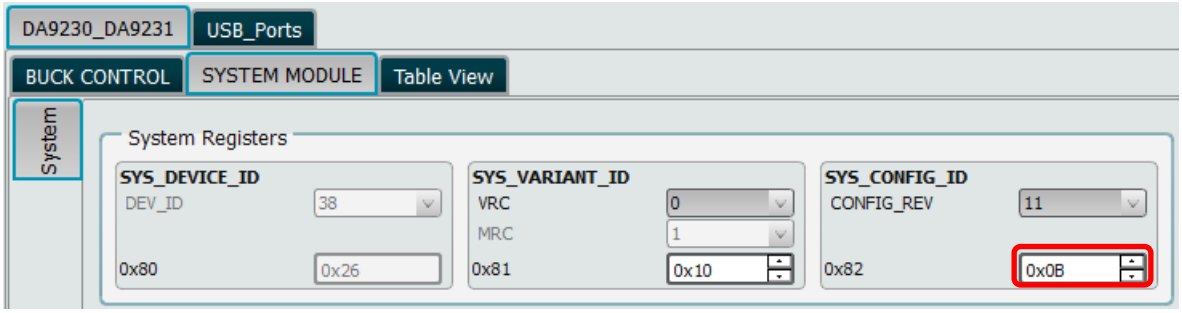

Figure 9: Read Device OTP information

3.4.3 Device Configuration and Status Monitor

1. Open DA9230/DA9231 GUI and go to BUCK CONTROL page, see Figure 10.
2. Uncheck all boxes in MASK section to enable all fault event indicators.
3. Configure the GPO pin function in GPO section.
4. Set the desired voltages using the droplist of BUCK_VOUT and LS_LDO.
5. Select buck peak current limit through SEL_BUCK_ILIM (default is 600 mA).
6. Choose to Enable/Disable buck output pull-down resistor through BUCK_PD_CFG1 and BUCK_PD_CFG2.
7. Configure the FAULT_CTL registers. Choose to disable or not disable buck/LDO during VIN_UV/OT/OV_BUCK/OC_BUCK/UV_BUCK event. Set the recovery number through RCVRY_NUM.
8. Click BUCK_EN and EN_LS_LDO buttons to turn ON/OFF buck and LDO/LS respectively.

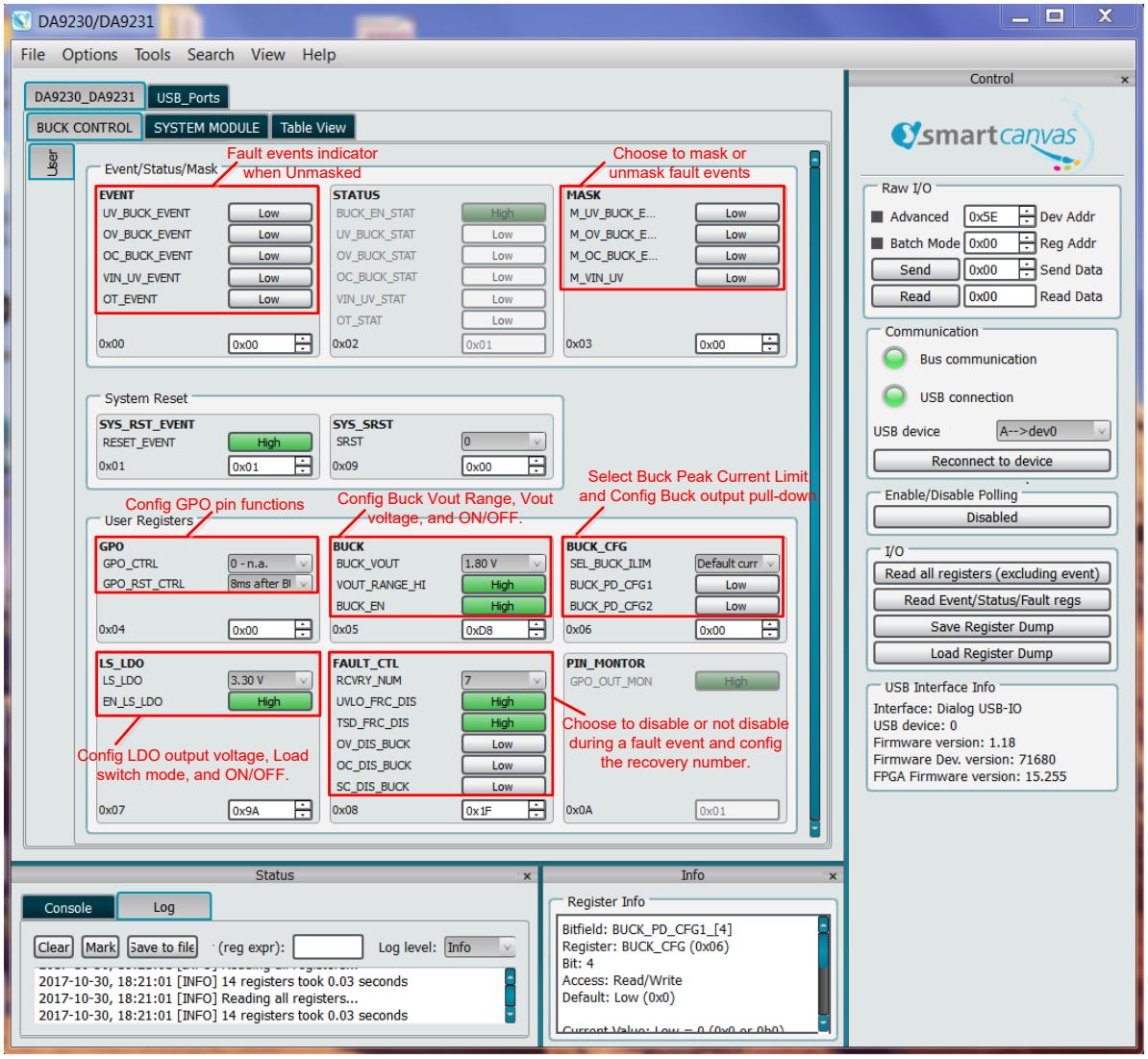

Figure 10: DA9231 GUI Control Page

4 Schematic

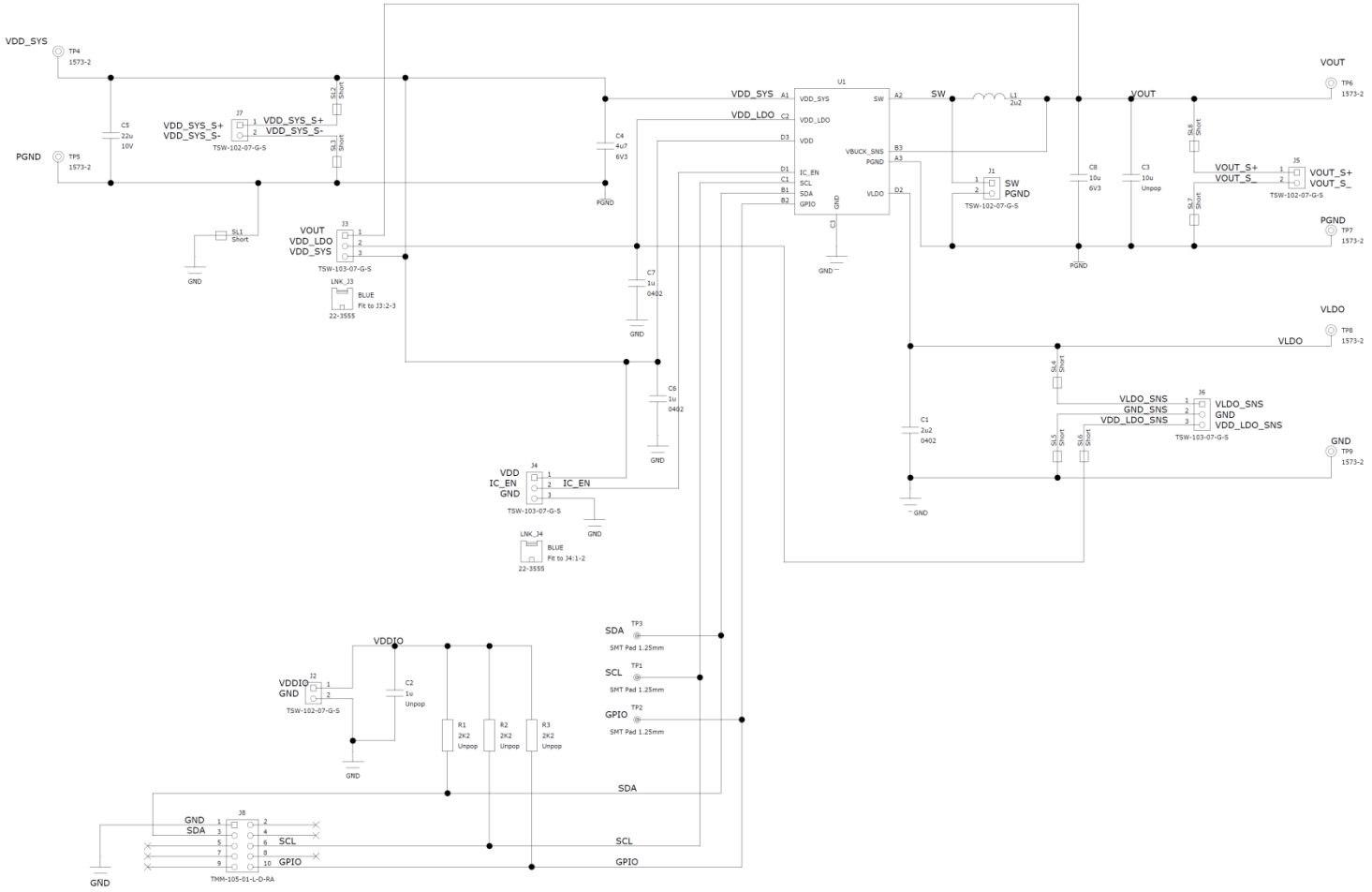

Figure 11: 342-03-A Evaluation Board Schematic

5 Board Layout and Bill of Materials

5.1 Board Layout

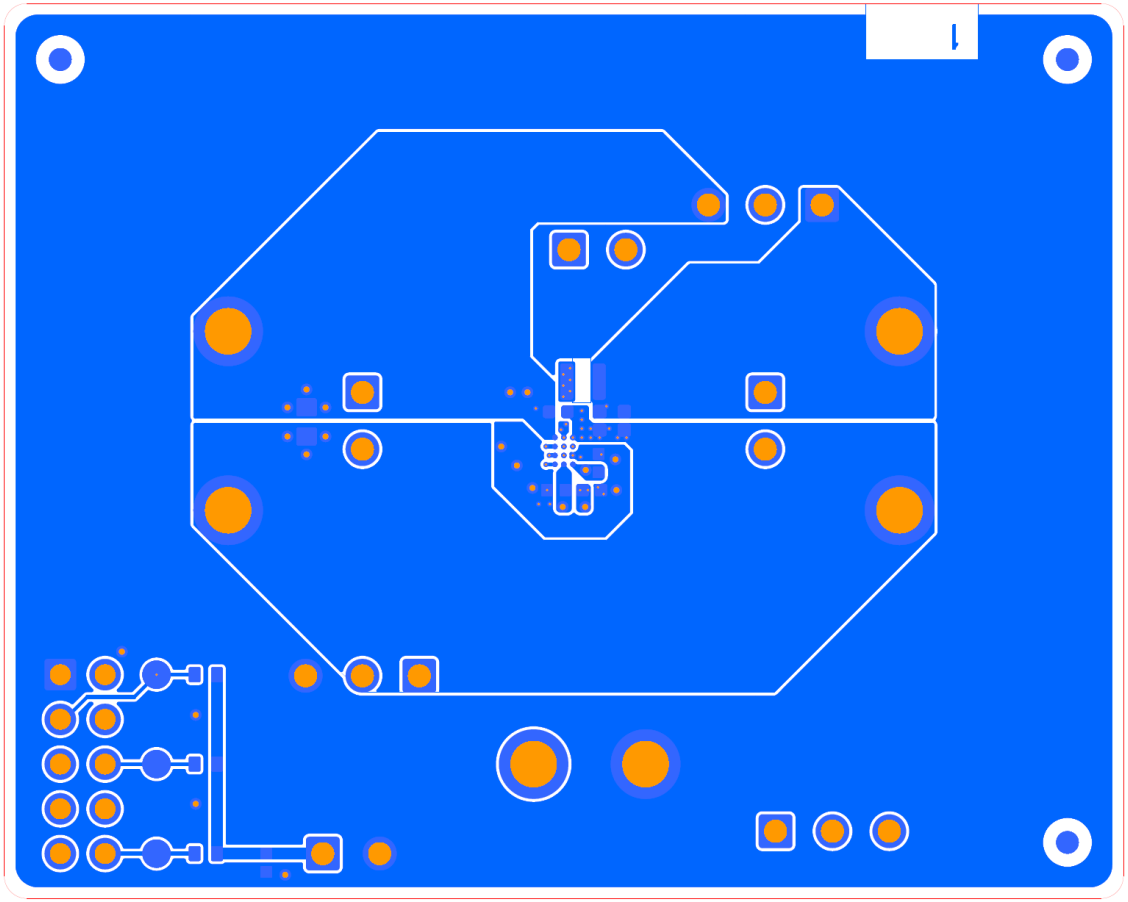

Figure 12: Top Layer

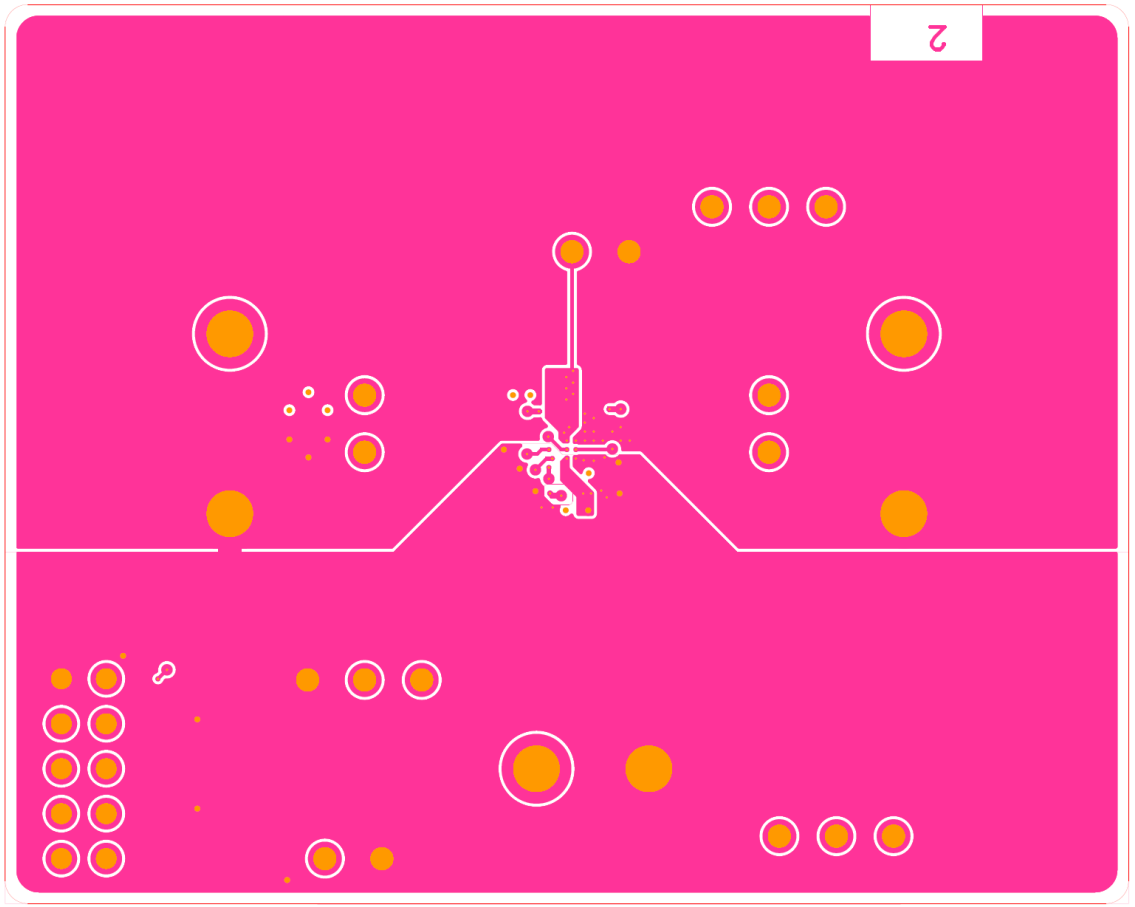

Figure 13: Inner Layer-2

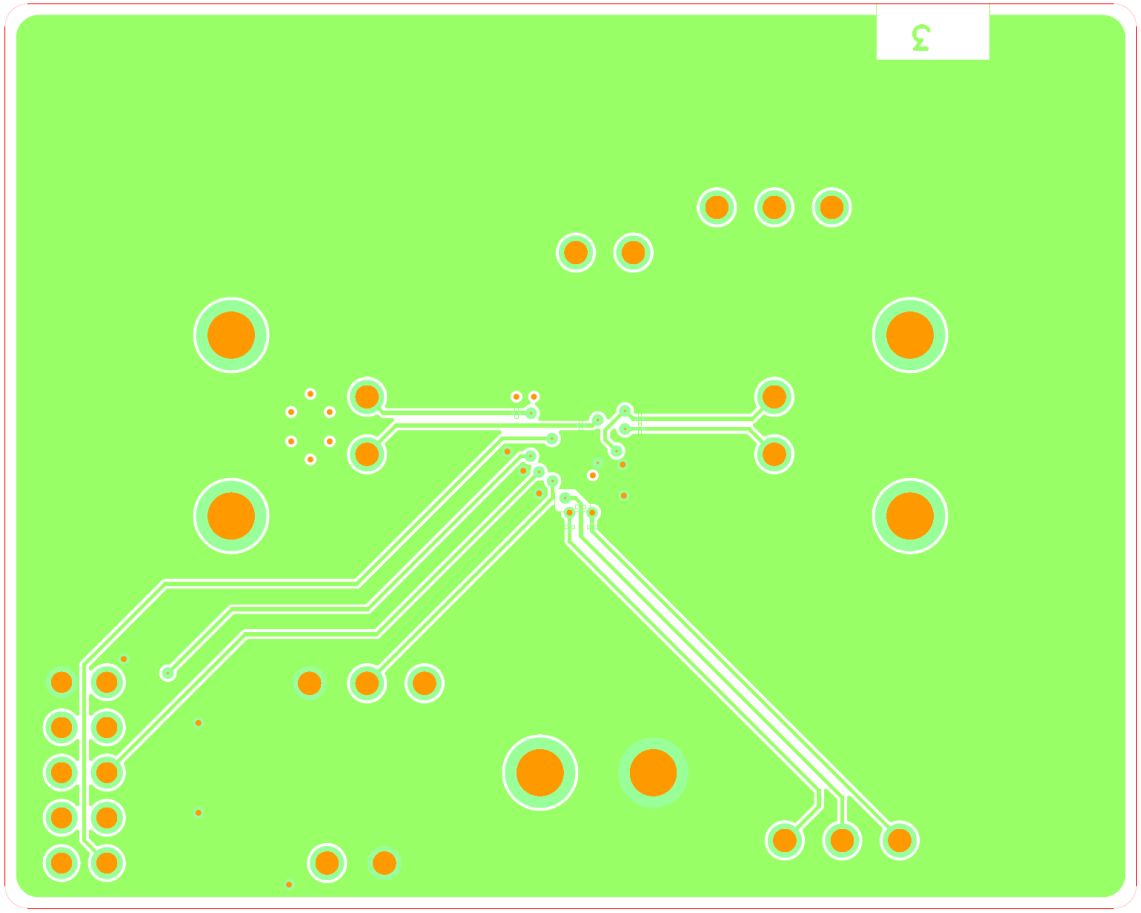

Figure 14: Inner Layer-3

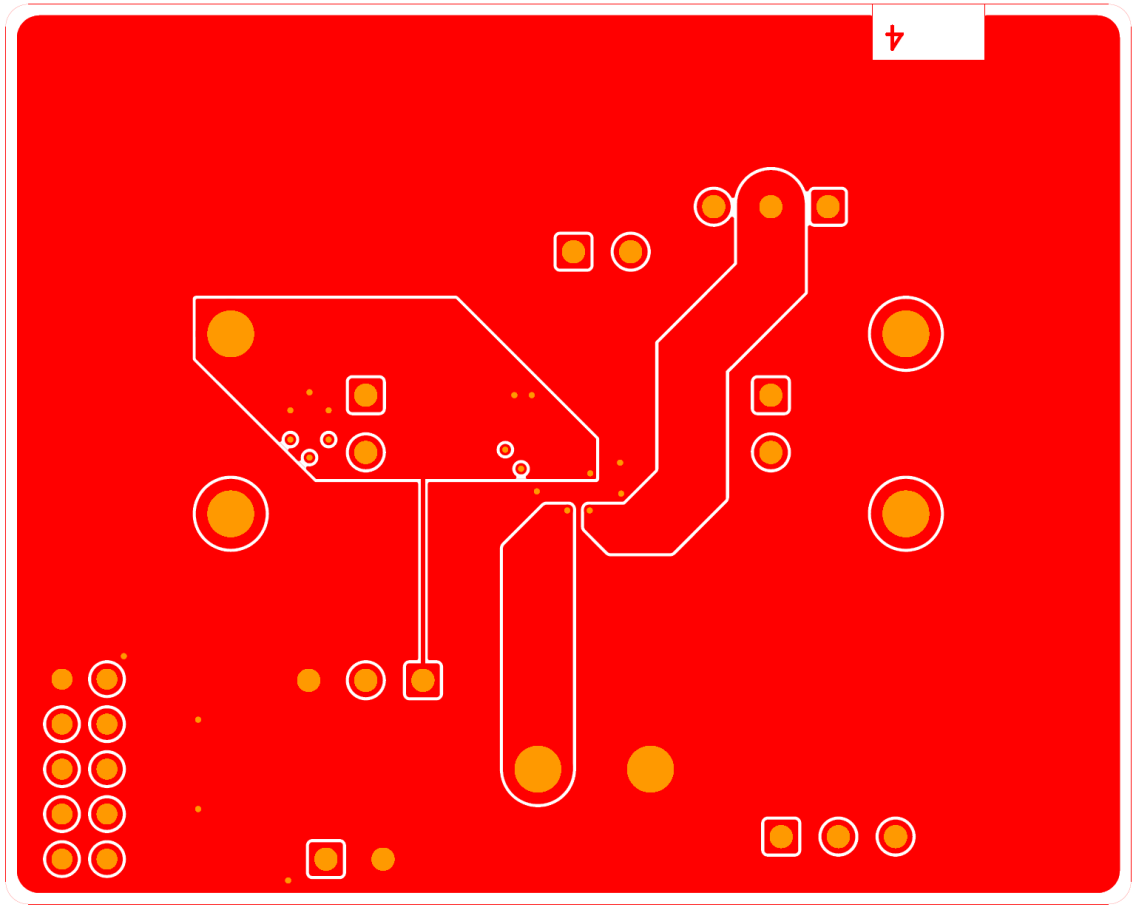

Figure 15: Bottom Layer

5.2 Bill of Materials

Table 5: Bill of Materials of Evaluation Board 342-03-A

QTY	Ref Designator	Description	Value	Tol.	Rating	Dielectric	Pop /Unpop	Manufacturer	Manufacturer Part Number
1	U1	WLCSP12 IC					Populated	Dialog Semiconductor	DA9230, DA9231
2	LNK_J3, LNK_J4	Jumper Link 2.54mm Open Blue	22-3555				Populated	Rapid	22-3555
1	C4	1005 (0402 EIA) SMD Capacitor	4u7	±20%	6V3	X5R	Populated	Murata	GRM155R60J475ME47D
1	C5	1608 (0603 EIA) SMD Capacitor	22u	±20%	10V	X5R	Populated	Murata	GRM188R61A226ME15D
1	C1	1005 (0402 EIA) SMD Capacitor	2u2	±10%	16V	X5R	Populated	TDK	C1005X5R1C225K050BC
1	C8	1005 (0402 EIA) SMD Capacitor	10u	±20%	6V3	X5R	Populated	Murata	GRM155R60J106ME15
2	C6,C7	1005 (0402 EIA) SMD Capacitor	1u	±10%	25V	X5R	Populated	Murata	GRM155R61E105KA12D
1	L1	DFE201610 Series SMD Inductor	2u2	±20%	Isat=2.4A		Populated	Murata	DFE201610E-2R2M
4	J1,J2,J5, J7	1x2 2.54mm pitch PCB Pin Header VERTICAL (2.54mm tail)	TSW-102-07-G-S				Populated	Samtec	TSW-102-07-G-S
3	J3,J4,J6	1x3 2.54mm pitch PCB Pin Header VERTICAL (2.54mm tail)	TSW-103-07-G-S				Populated	Samtec	TSW-103-07-G-S
1	J8	2x5 2.00mm pitch PCB Header Right Angle (3.13mm tail)	TMM-105-01-L-D-RA				Populated	Samtec	TMM-105-01-L-D-RA

DA9231 DA9230 Evaluation Board - 342-03-A

QTY	Ref Designator	Description	Value	Tol.	Rating	Dielectric	Pop /Unpop	Manufacturer	Manufacturer Part Number
6	TP4-TP9	Double Turret Terminal, tail length 2.08mm	1573-2				Populated	Keystone Electronics	1573-2
1	C3	1005 (0402 EIA) SMD Capacitor	10u	±20%	6V3	X5R	Unpop	Murata	GRM155R60J106ME15
1	C2	1005 (0402 EIA) SMD Capacitor	1u	±10%	25V	X5R	Unpop	Murata	GRM155R61E105KA12D
3	R1-R3	1005 (0402 EIA) SMD Resistor	2K2	±1%	63mW		Unpop	Yageo	RC0402FR-072K2L

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Status	Definition
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