SGM38046
Single Inductor Power Supply for Wearable AMOLED Products

GENERAL DESCRIPTION

The SGM38046 is a power source device for biasing small AMOLED panels. It can be powered from a single-cell Lithium-Ion/polymer battery or a DC supply in the range of 2.7V to 5.5V to provide OVDD, OVSS and AVDD voltage sources for the AMOLED panel. Two interim voltage rails (positive and negative) are generated by the integrated buck-boost converter and an inverting charge pump inverter. These rails are regulated by LDOs to get clean and low ripple positive (AVDD and OVDD) and negative (OVSS) outputs. This device is optimized for symmetric output to get the highest efficiency from the charge pump inverter.

The SGM38046 is available in a Green WLCSP-2×2-16B package.

APPLICATIONS

Wearable AMOLED Products
Phones with AMOLED Vice Screen

FEATURES

- **2.7V to 5.5V Input Voltage Range**
- **3.3V AVDD Output Voltage**
- **2.8V to 4.6V OVDD (Default: 3.3V ± 1%, 0.1V/Step)**
- **-4.0V to -0.6V OVSS (Default: -3.3V ± 1%, 0.1V/Step)**
- **Up to 90mA OVDD & OVSS Combined Output Current Capability (V_{OVDD} = 3.3V, V_{OVSS} = -3.3V)**
- **Excellent Line and Load Regulations**
- **Low Ripple and Excellent Transient Response**
- **Soft-Start**
- **True Output Load Disconnect from Input**
- **Protection Features**
    - **Under-Voltage Lockout Protection (UVLO)**
    - **Over-Current Protection (OCP)**
    - **Short-Circuit Protection (SCP)**
    - **Over-Voltage Protection (OVP)**
    - **Over-Temperature Protection (OTP)**
- **Power-Save Mode for Light-Load Efficiency**
- **Less than 1μA Shutdown Current**
- **Available in a Green WLCSP-2×2-16B Package**

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM38046	WLCSP-2×2-16B	-40℃ to +85℃	SGM38046YG/TR	SGM 38046 XXXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.

XXXXX

- Vendor Code
- Trace Code
- Date Code - Year

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

Supply Input Voltage, AVIN, PVIN to AGND........ -0.3V to 6V
VOUT, AVDD, OVDD, SWIRE, AVDDEN, C1P to AGND
.... -0.3V to 6V
VON, OVSS, C1N to AGND.................................. -6V to 0.3V
SW1, SW2 .... -0.3V to 6V
Switch Transient Spike on SW1, SW2, C1P, C1N
.... -1V_{PP} to +1V_{PP}, in 10ns FWHM
Package Thermal Resistance
WLCSP-2×2-16B, θ_{JA} .... 94℃/W
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃
ESD Susceptibility
HBM...1000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Supply Input Voltage..2.7V to 5.5V
Operating Junction Temperature Range......-40℃ to +125℃
Operating Ambient Temperature Range........-40℃ to +85℃

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

ESD SENSITIVITY CAUTION

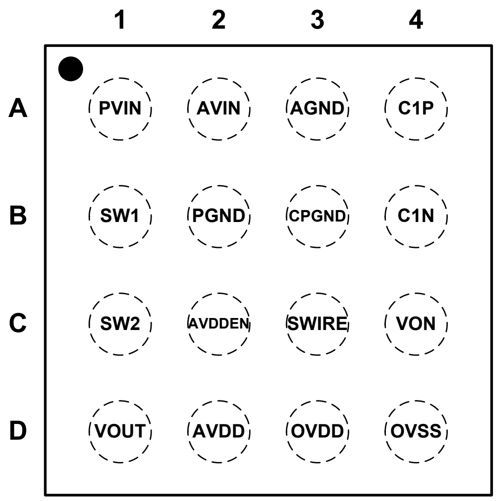
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION

SGM38046 (TOP VIEW)



WLCSP-2×2-16B

PIN DESCRIPTION

PIN	NAME	FUNCTION
A1	PVIN	Power Input Pin for the Internal Buck-Boost Regulator.
A2	AVIN	Analog Power Pin. Place a bypass capacitor between this pin and ground.
A3	AGND	Analog Ground Pin.
A4	C1P	Positive Connection for the Charge Pump Flying Capacitor.
B1	SW1	Buck-Boost Regulator Switching Node 1.
B2	PGND	Buck-Boost Regulator Power Ground Pin.
B3	CPGND	Negative Charge Pump Ground Pin.
B4	C1N	Negative Connection for the Charge Pump Flying Capacitor.
C1	SW2	Buck-Boost Regulator Switching Node 2.
C2	AVDDEN	Active High Enable Input Pin for AVDD.
C3	SWIRE	SWIRE Control Interface Input Pin.
C4	VON	Charge Pump Output Rail (Negative Voltage).
D1	VOUT	Buck-Boost Regulator Output Rail (Positive Voltage).
D2	AVDD	AVDD LDO Output Pin.
D3	OVDD	OVDD LDO Output Pin.
D4	OVSS	OVSS LDO Output Pin.

TYPICAL APPLICATION

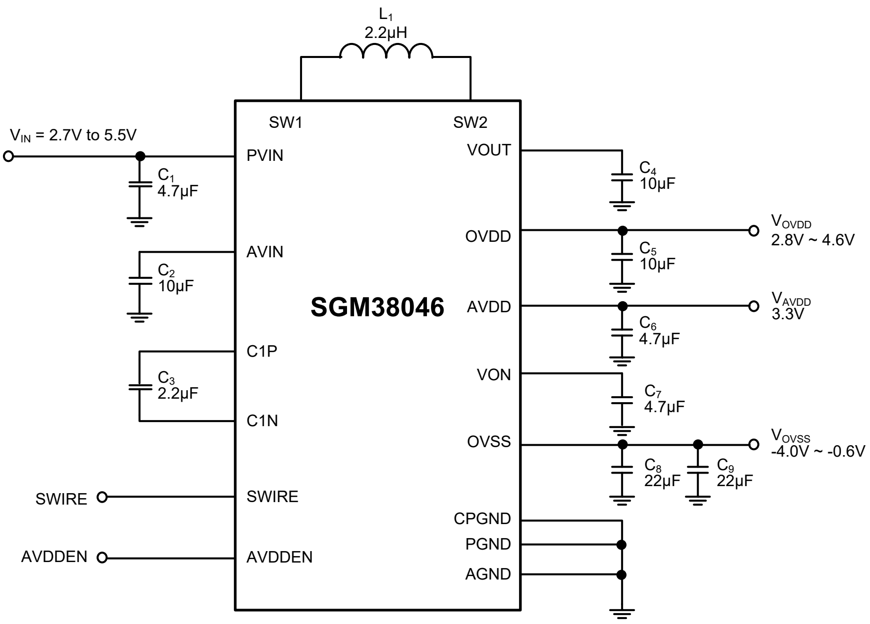


Figure 1. Typical Application Circuit

Table 1. Recommended BOM for Typical Application

Reference	Quantity	Description	Part Number	Package	Supplier
L_1	1	2.2μH	1269AS-H-2R2M=P2	2.5mm × 2.0mm × 1.0mm	Murata
			ZTLF-2016TB-2R2M	2.0mm × 1.6mm × 1.0mm	ZenithTek
C_1, C_6, C_7	3	4.7μF/16V/X5R	GRM188R61C475KAAJD	0603	Murata
C_4, C_5	2	10μF/16V/X5R	GRM188R61C106KAALD	0603	Murata
C_3	1	2.2μF/6.3V/X5R	GRM155R60J225ME15	0402	Murata
C_2	1	10μF/6.3V/X5R	GRM155R60J106ME15	0402	Murata
C_8, C_9	2	22μF/6.3V/X5R	GRM155R60J226ME11D	0402	Murata

Table 2. Recommended BOM for Compact Space and Light Loadings (< 50mA)

Reference	Quantity	Description	Part Number	Package	Supplier
L_1	1	1μH	DFE201208S-1R0M=P2	2.0mm × 1.2mm × 0.8mm	Murata
			HTEK16080H-1R0MSR	1.6mm × 0.8mm × 0.8mm	Cyntec
C_1, C_6, C_7	3	4.7μF/16V/X5R	GRM188R61C475KAAJD	0603	Murata
C_4, C_5	2	10μF/16V/X5R	GRM188R61C106KAALD	0603	Murata
C_3	1	1μF/6.3V/X5R	GRM033R60J105MEA2	0201	Murata
C_2	1	10μF/6.3V/X5R	GRM155R60J106ME15	0402	Murata
C_8	1	22μF/6.3V/X5R	GRM155R60J226ME11D	0402	Murata

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.7V, V_{AVDD} = 3.3V, V_{OVDD} = 3.3V, V_{OVSS} = -3.3V, T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Power Supply						
Input Supply Voltage Range	V_{IN}	T_J = -40℃ to +85℃	2.7	3.7	5.5	V
Quiescent Current	I_Q	V_{IN} = 2.7V to 5.5V, no load, AVDDEN = SWIRE = high		360		μA
		V_{IN} = 2.7V to 5.5V, no load, AVDDEN = high, SWIRE = low		270		
Shutdown Current	I_{SHDN}	AVDDEN = SWIRE = low		0.1	1.0	μA
Under-Voltage Lockout Threshold	V_{UVLOH}	V_{IN} rising		2.50	2.60	V
	V_{UVLOL}	V_{IN} falling	2.20	2.35		V
Thermal Shutdown	T_{SD}	Junction temperature rising		140		℃
Thermal Shutdown Hysteresis	ΔT_{SD}	Junction temperature falling		10		℃
SWIRE						
Logic High-Level Voltage	V_{SRH}	V_{IN} = 2.7V to 5.5V, T_J = -40℃ to +85℃	1.2			V
Logic Low-Level Voltage	V_{SRL}	V_{IN} = 2.7V to 5.5V, T_J = -40℃ to +85℃			0.4	V
Pull-Down Resistor	R_{SR}			550		kΩ
Turn-Off Detection Time	t_{OFF_DLY}		300			μs
Signal Stop Indicate Time	t_{STOP}		300			μs
Rising Time	t_R				200	ns
Falling Time	t_F				200	ns
Pulse High Level Time Period	t_{ON}		2		20	μs
Pulse Low Level Time Period	t_{OFF}		2		20	μs
SWIRE Frequency Range	f_{SWIRE}		25		250	kHz
AVDDEN						
Logic High Level Voltage	V_{IH}	V_{IN} = 2.7V to 5.5V, T_J = -40℃ to +85℃	1.2			V
Logic Low Level Voltage	V_{IL}	V_{IN} = 2.7V to 5.5V, T_J = -40℃ to +85℃			0.4	
Buck-Boost Regulator						
Buck-Boost Output Voltage Range	V_{OUT_RANGE}		3.6		4.9	V
Buck-Boost Switching Frequency	f_{SW}			1.2		MHz
Over-Current Protection Threshold	I_{OCP}		0.8	1.1	1.4	A
Negative Charge Pump						
Negative Output Voltage Range	V_{ON_RANGE}		-4.1		-0.7	V
Switching Frequency	f_{SW_CP}		0.75	0.9	1.05	MHz
AVDD						
AVDD Output Voltage Range	V_{AVDD_RANGE}	Normal operation, default		3.3		V
AVDD Output Voltage Accuracy	AVDD_Acc	V_{AVDD} = 3.3V	-0.6		0.6	%
		V_{AVDD} = 3.3V, T_J = -40℃ to +85℃	-0.9		0.9	%
AVDD Output Current Capability	I_{AVDD}	No load on OVDD and OVSS	50			mA
AVDD Line Regulation	V_{AVDD_LINE}	V_{IN} = 2.7 to 5.5V, I_{AVDD} = 10mA		0.1		%
AVDD Load Regulation	V_{AVDD_LOAD}	I_{AVDD} = 0 to 50mA		0.1		%
AVDD Output Voltage Ripple	V_{AVDD_RIPPLE}			1		mV
AVDD Current Limit	I_{AVDD_LIMIT}		100	135	170	mA
AVDD Discharge Resistance	R_{AVDD_RDIS}			450		Ω
AVDD Short-Circuit Protection	AVDD_SCP	Percentage of nominal V_{AVDD}		80		%

ELECTRICAL CHARACTERISTICS (continued)

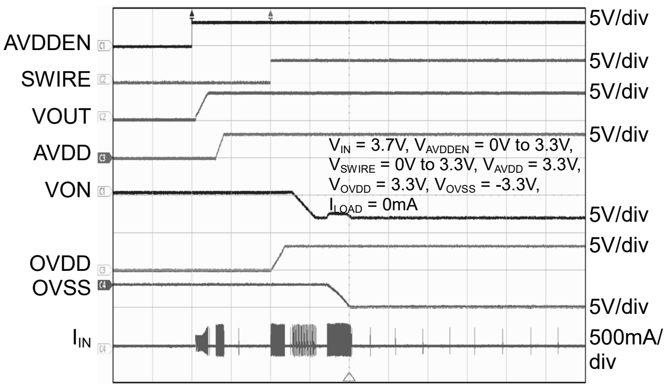
(V_{IN} = 3.7V, V_{AVDD} = 3.3V, V_{OVDD} = 3.3V, V_{OVSS} = -3.3V, T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
OVDD						
OVDD Output Voltage Range	V_{OVDD_RANGE}	2.8V to 4.6V with 0.1V/step, default 3.3V	2.8	3.3	4.6	V
OVDD Output Voltage Accuracy	OVDD_Acc	V_{OVDD} = 3.3V	-0.6		0.6	%
		V_{OVDD} = 3.3V, T_J = -40℃ to +85℃	-0.9		0.9	%
OVDD Output Current Capability	I_{OVDD}	V_{OVDD} = 3.3V, V_{OVSS} = -3.3V	90			mA
OVDD Line Regulation	V_{OVDD_LINE}	V_{IN} = 2.7 to 5.5V, I_{OVDD} = 10mA		0.1		%
OVDD Load Regulation	V_{OVDD_LOAD}	I_{OVDD} = 0 to 90mA		0.1		%
OVDD Output Ripple	V_{OVDD_RIPPLE}			1		mV
OVDD Current Limit	I_{OVDD_LIMIT}		100	135	170	mA
OVDD Discharge Resistance	R_{OVDD_RDIS}			450		Ω
OVDD Short-Circuit Protection	OVDD_SCP	Percentage of nominal V_{OVDD}		80		%
OVSS						
OVSS Output Voltage Range	V_{OVSS_RANGE}	-4.0V to -0.6V with 0.1V/step, default -3.3V	-4.0	-3.3	-0.6	V
OVSS Output Voltage Accuracy	OVSS_Acc	V_{OVSS} = -3.3V	-0.6		0.6	%
		V_{OVSS} = -3.3V, T_J = -40℃ to +85℃	-0.9		0.9	%
OVSS Output Current Capability	I_{OVSS}	V_{OVDD} = 3.3V, V_{OVSS} = -3.3V	90			mA
OVSS Line Regulation	V_{OVSS_LINE}	V_{IN} = 2.7 to 5.5V, I_{OVSS} = 10mA		0.1		%
OVSS Load Regulation	V_{OVSS_LOAD}	I_{OVSS} = 0 to 90mA		0.1		%
OVSS Output Ripple	V_{OVSS_RIPPLE}			5		mV
OVSS Current Limit	I_{OVSS_LIMIT}		90	135	180	mA
OVSS Discharge Resistance	R_{OVSS_RDIS}			450		Ω
OVSS Short-Circuit Protection	OVSS_SCP	Percentage of nominal V_{OVSS}		80		%

TYPICAL PERFORMANCE CHARACTERISTICS

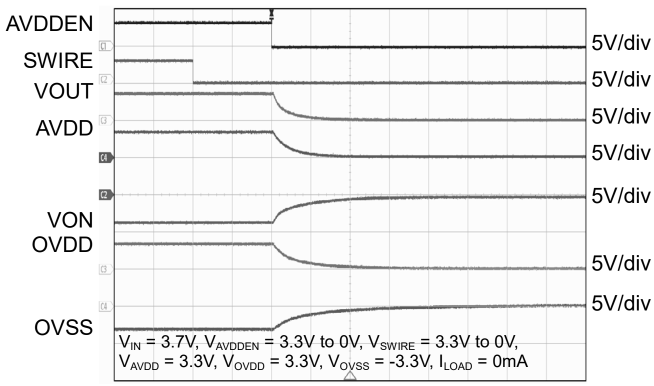
At T_J = +25℃, V_{IN} = 3.7V, V_{AVDD} = 3.3V, V_{OVDD} = 3.3V, V_{OVSS} = -3.3V, unless otherwise noted.

Startup Sequence



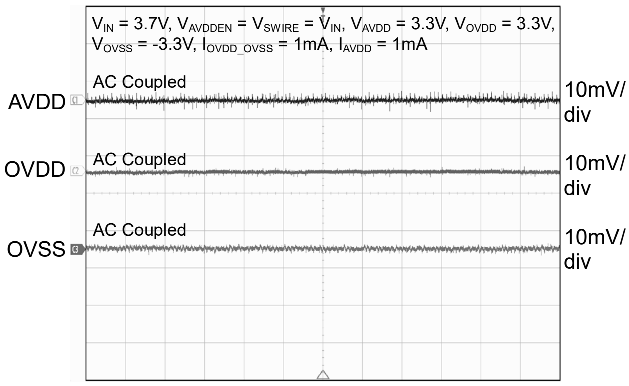
Time (2ms/div)

Shutdown Sequence



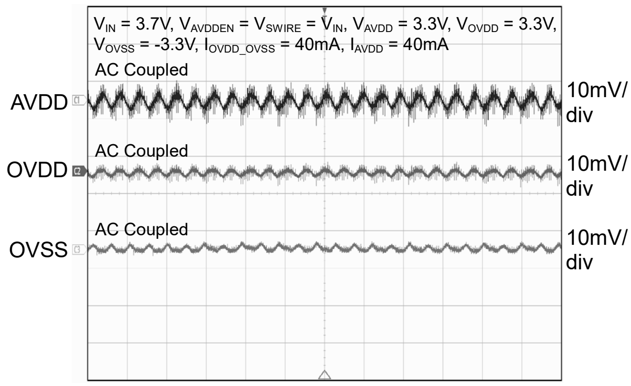
Time (5ms/div)

Output Ripple at Light Load



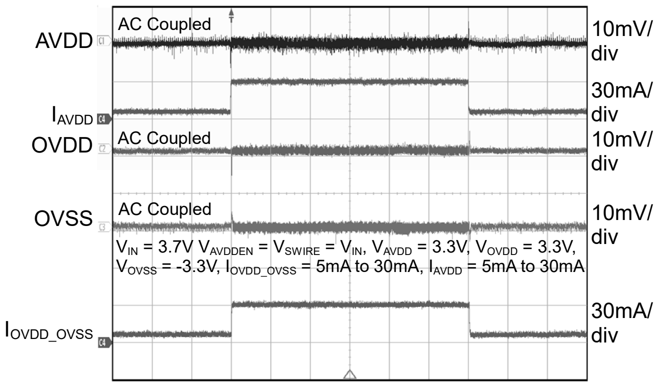
Time (1ms/div)

Output Ripple at Heavy Load



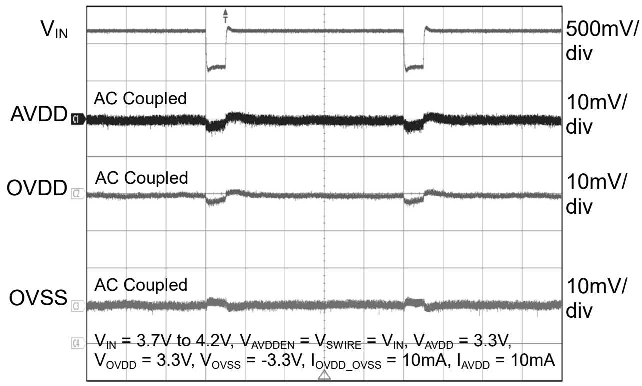
Time (20μs/div)

Load Transient Response



Time (1ms/div)

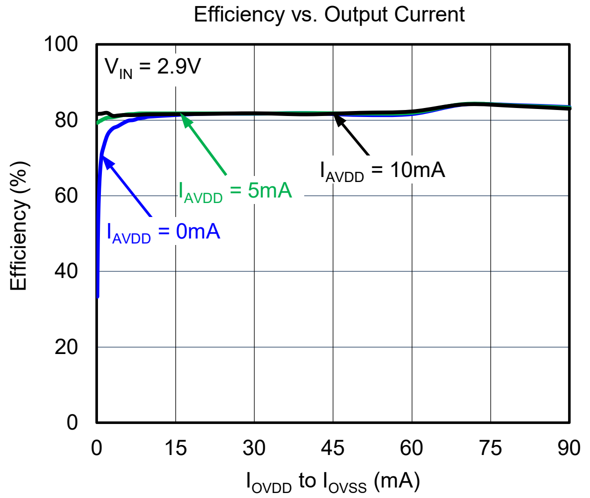
Line Transient Response

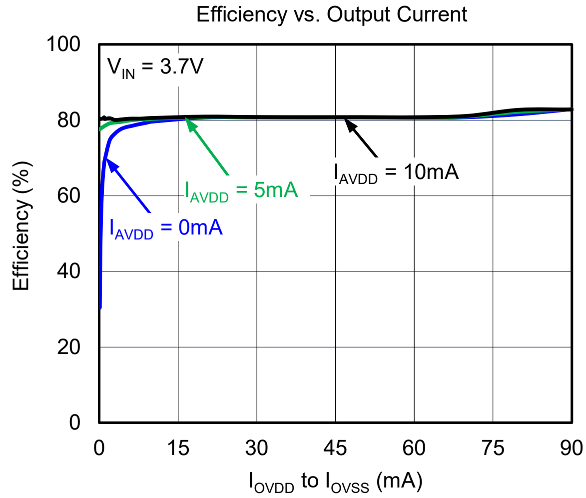


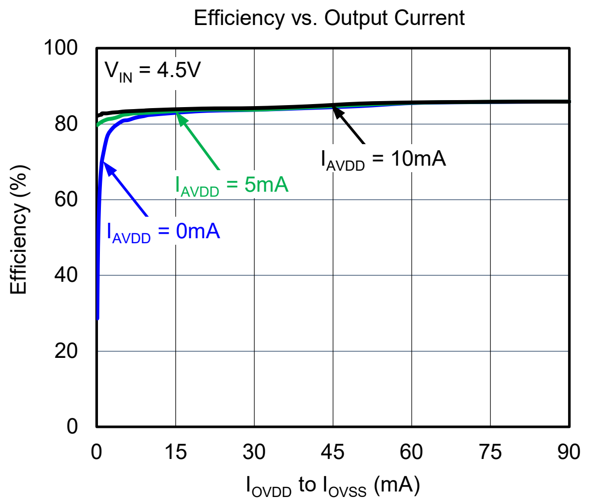
Time (1ms/div)

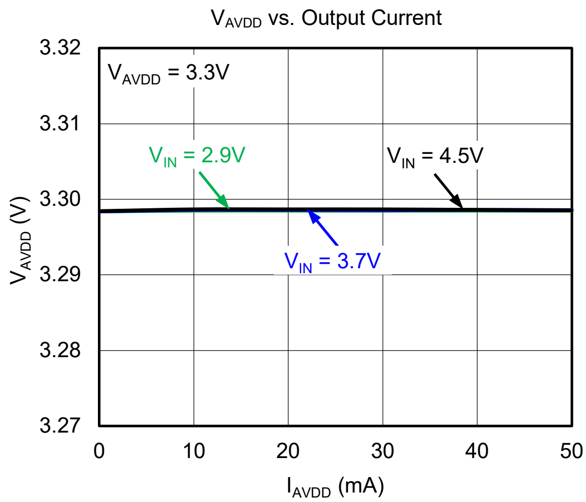
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

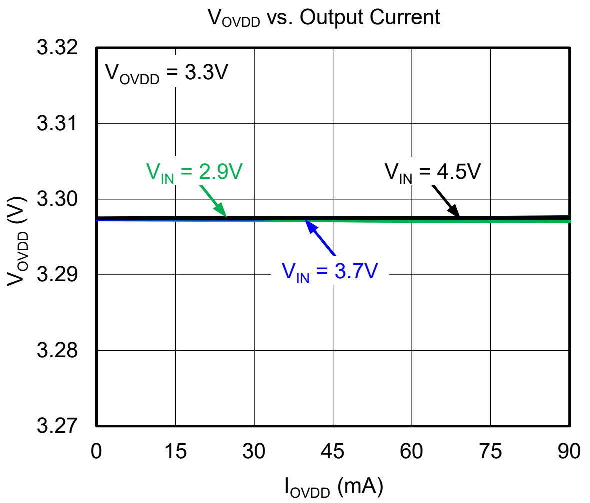
At T_J = +25℃, V_{IN} = 3.7V, V_{AVDD} = 3.3V, V_{OVDD} = 3.3V, V_{OVSS} = -3.3V, unless otherwise noted.

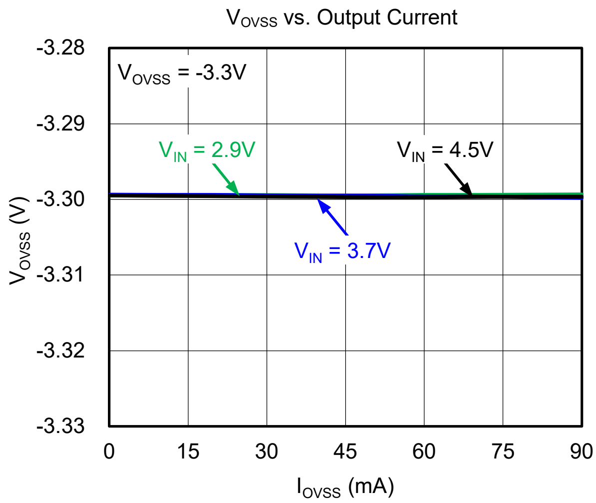






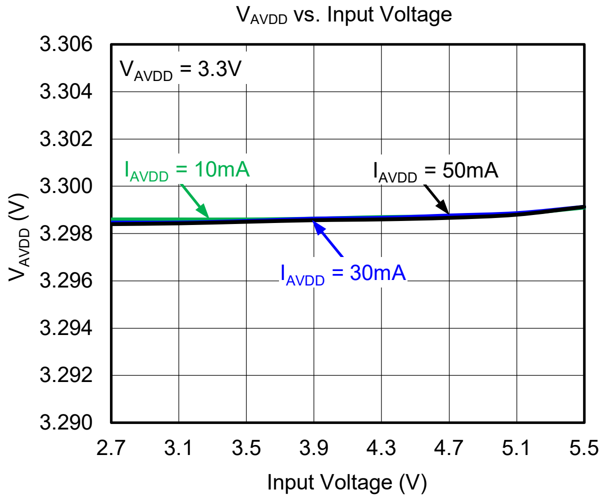


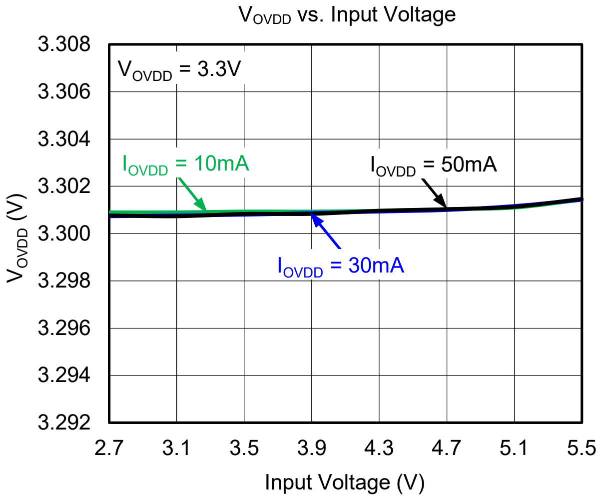


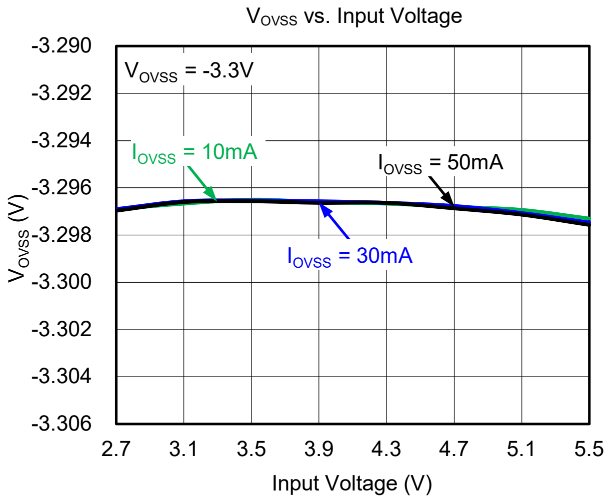


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_J = +25℃, V_{IN} = 3.7V, V_{AVDD} = 3.3V, V_{OVDD} = 3.3V, V_{OVSS} = -3.3V, unless otherwise noted.







TIMING DIAGRAM

Startup and Shutdown Sequence 1

AVDDEN On → SWIRE On → SWIRE Off → AVDDEN Off

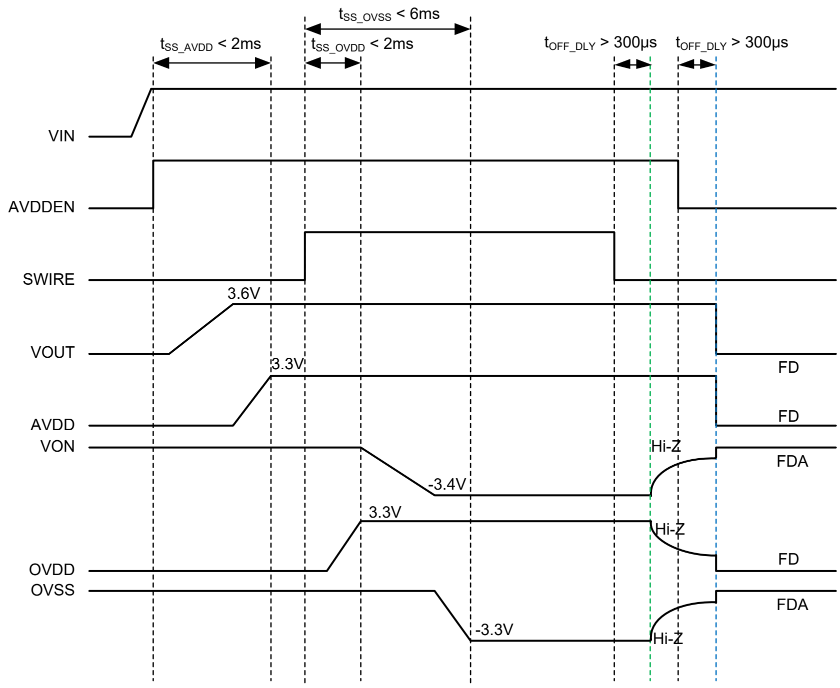


Figure 2. Startup and Shutdown Sequence 1 (FD = Fast Discharge, FDA = Fast Discharge for 30ms)

Startup and Shutdown Sequence 2

AVDDEN On → SWIRE On → AVDDEN Off → SWIRE Off

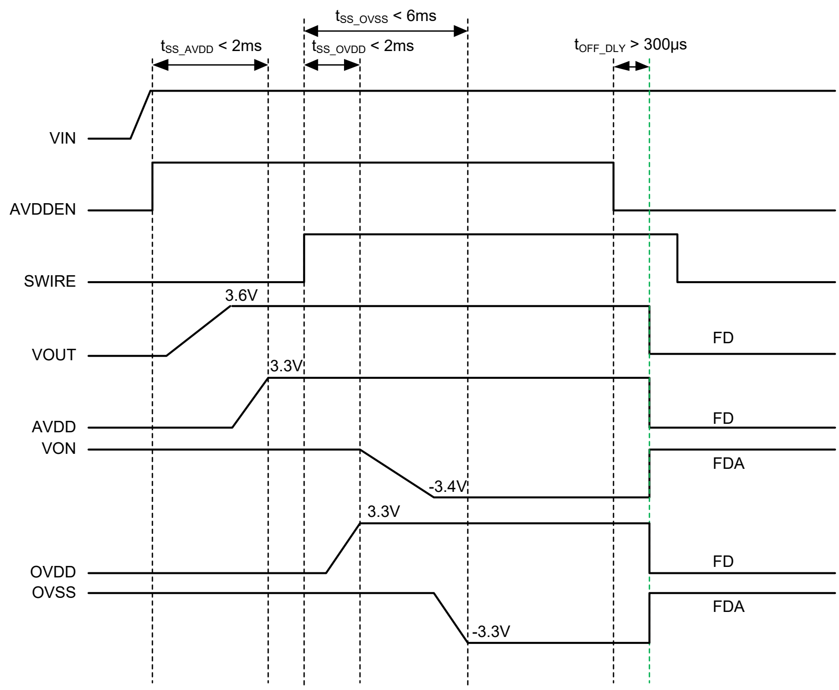


Figure 3. Startup and Shutdown Sequence 2

TIMING DIAGRAM (continued)

Startup and Shutdown Sequence 3

SWIRE On → AVDDEN On → SWIRE Off → AVDDEN Off

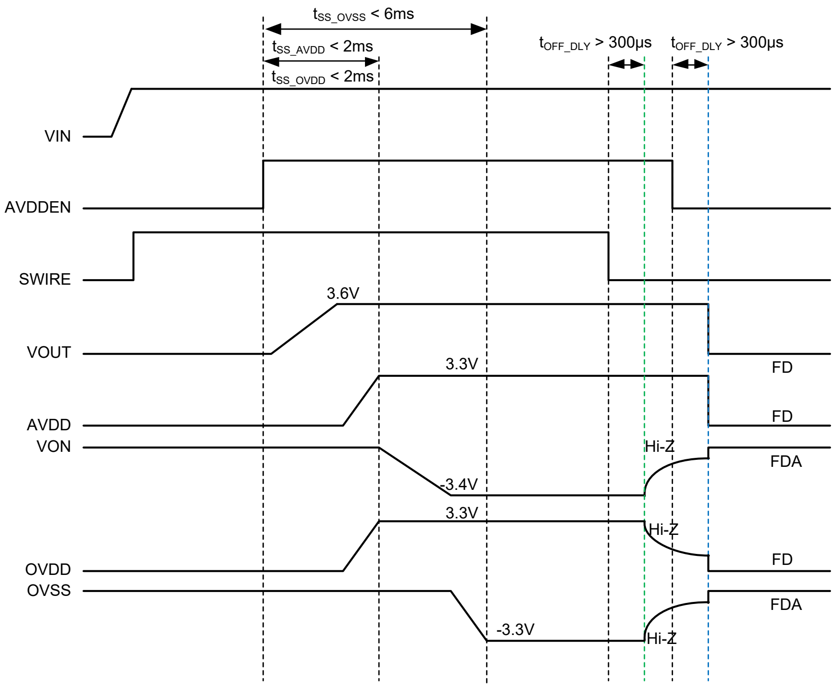


Figure 4. Startup and Shutdown Sequence 3

AVDD Startup and Shutdown Sequence

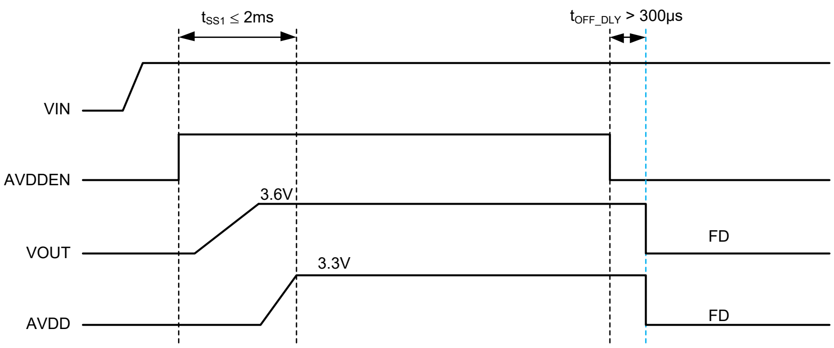


Figure 5. AVDD On/Off Sequence by AVDDEN (SWIRE = Low or High)

TIMING DIAGRAM (continued)

SWIRE Startup and Shutdown Sequence

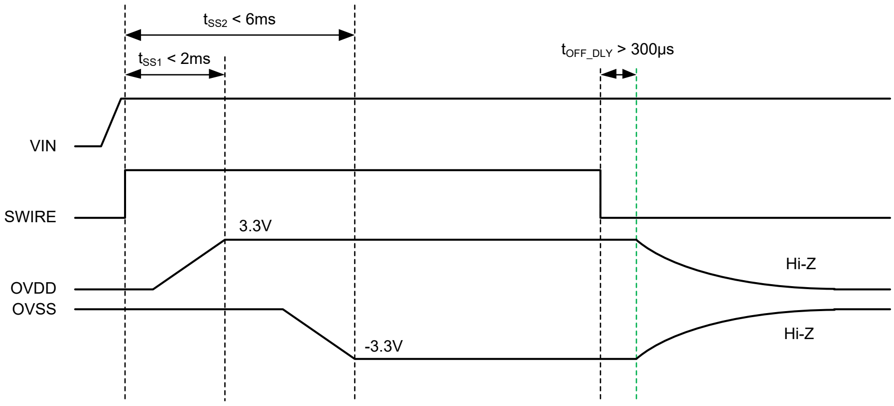


Figure 6. The OVDD and OVSS On/Off Sequence by the SWIRE Input (AVDDEN = High)

SWIRE Command Timing Diagram

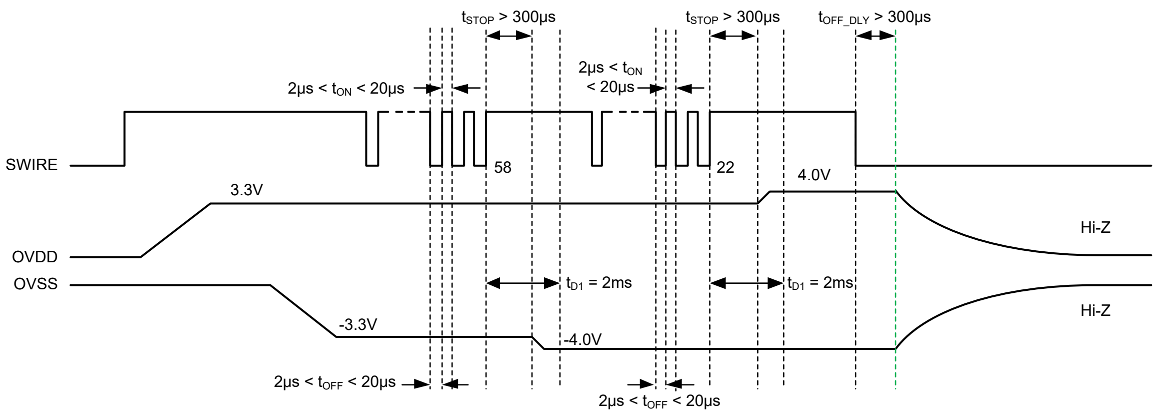


Figure 7. Key Timings of a Command Processing with the SWIRE Interface

Table 2. Shutdown Discharge Table

AVDD_EN	SWIRE	AVDD	OVDD	OVSS
0	0	FD	FD	FDA
0	1	FD	FD	FDA
1	0	NA	Hi-Z	Hi-Z
1	1	NA	NA	NA

NOTE: FDA: Fast discharge is active only 30ms.

FUNCTIONAL BLOCK DIAGRAM

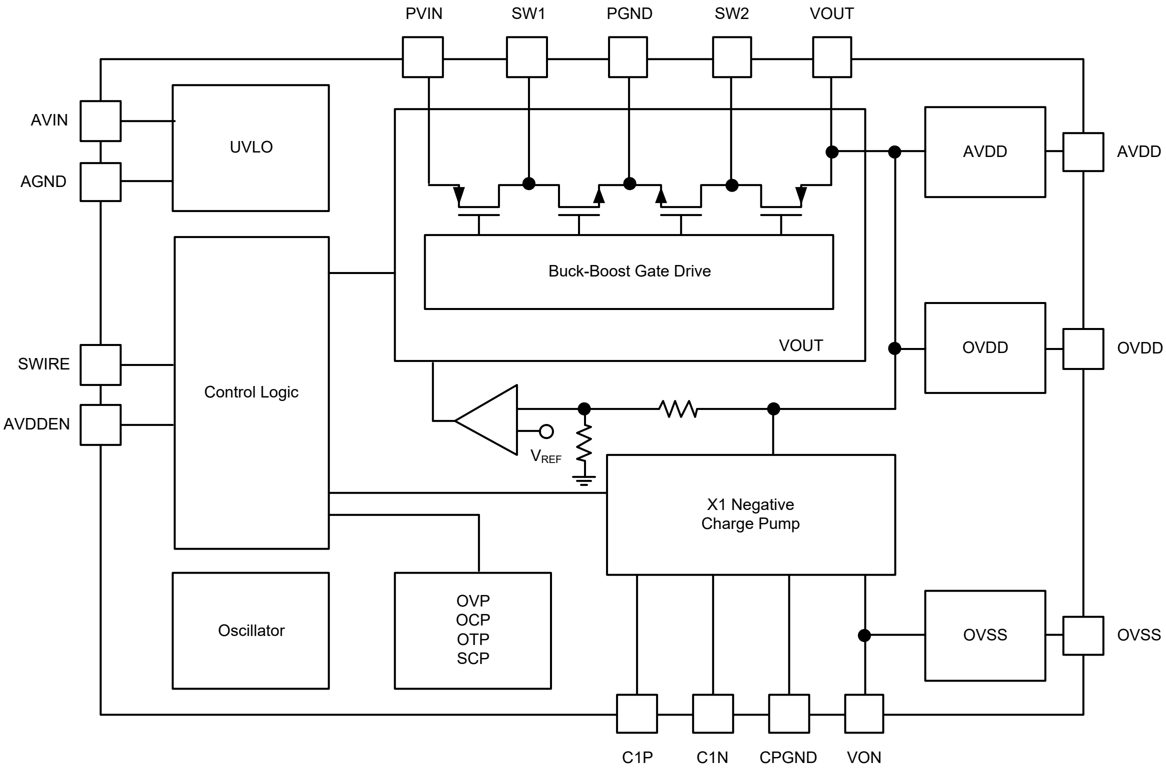


Figure 8. SGM38046 Functional Block Diagram

APPLICATION INFORMATION

Figure 8 shows the internal block diagram of the SGM38046. The main blocks include the buck-boost converter, a charge pump inverter, three LDOs, the sequence control and protection functions. This device provides three power lines needed to drive an AMOLED panel. The power train is optimized for symmetric output voltage on the adjustable OVDD and OVSS. With a symmetric output, the charge pump operates with an excellent efficiency. V_{OVDD} is adjustable from 2.8V to 4.6V and V_{OVSS} can be set from -4.0V to -0.6V, both in 100mV steps. After the device is enabled by pulling the AVDDEN high, the buck-boost converter generates a stable positive rail (VOUT) from the 2.7V to 5.5V power input source (PVIN). Then the charge pump converter generates a stable negative rail (VON) by inverting V_{OUT}. Three LDOs, two positive (AVDD and OVDD) and one negative (OVSS) regulate the converters outputs to get clean voltage sources needed for the AMOLED. The buck-boost output voltage V_{OUT} is automatically based on the headroom needed for maintaining the regulation of the V_{AVDD}, V_{OVDD} and V_{OVSS}, as specified in the following equation:

$$V_{OUT} = MAX(V_{AVDD}, V_{OVDD}, |V_{OVSS}|) + 0.3V$$

The device can be shut down by pulling both AVDDEN and SWIRE inputs to logic low. Supply current is less than 1μA in shutdown state.

Protection Features

UVLO protection is provided for VIN to shut down the device and prevent abnormal operation in case of under voltage.

The inductor current is monitored cycle-by-cycle during each switch ON period for over-current limiting (OCP). When an over-current is detected, it is forced off right away to limit the current and prevent damage.

A short-circuit is detected when an output voltage falls to less than 80% of its programmed value (TYP). Short-circuit protection (SCP) will force all switches off upon detecting short of AVDD, OVDD and OVSS to ground. The device enters the shutdown state after SCP, and the shutdown state is latched. To reset the whole device, either VIN has to cycle below UVLO threshold or AVDDEN and SWIRE have to be low at the same time for t_{OFF_DLY}.

Over-temperature protection (OTP) stops all power converters if the die temperature exceeds +140℃. Device operation will resume when the die is cooled down by 10℃ (approximately).

Over-voltage protection (OVP) stops all power converters if the input voltage exceeds 5.7V. Device operation will resume when the input voltage falls below 5.6V.

The Buck-Boost Converter

The SGM38046 uses four switches to maintain synchronous power conversion under all operating conditions to achieve high efficiency over a wide range of input voltages and output currents. This converter is internally compensated and can change its mode automatically among buck, boost, and buck-boost based on the operating conditions. If $V_{IN} > V_{OUT}$, it operates as a true buck converter. If $V_{IN} < V_{OUT}$, it acts as a true boost. If $V_{IN} \approx V_{OUT}$, operation is as a 4-cycle buck-boost converter. The RMS current through the switches and the inductor is thus kept to a minimum, thereby minimizing switching and conduction losses. Controlling the switches this way lets the converter achieve high efficiency over the whole input voltage range.

Output Current Capability

The SGM38046 is optimized for symmetric output voltage mode. When the absolute output voltage values of all the three outputs are close and $V_{OUT} - |V_{ON}| \leq 0.5V$, the output current capability is up to 90mA within the full range of input voltage. But if $V_{OUT} - |V_{ON}| > 0.5V$, in order to get better OVSS output ripple, the load current capability will be limited to less than 50mA.

Startup and Shutdown Sequences

Figure 2 to Figure 6 show the timing diagrams of the startup and shutdown sequence options for the SGM38046. The startup and shutdown sequence depends on the order of AVDDEN and SWIRE rising and falling edges after V_{IN} reaches to its normal operating range.

APPLICATION INFORMATION (continued)

SWIRE I/F and Voltage/State Programming

SWIRE can also be used for programming the output voltages by an MCU or digital controller. V_{OVDD} and V_{OVSS} can be programmed by the pulse counting in SWIRE timing sequence. V_{OUT} and V_{VON} are adjusted accordingly by the device for the best efficiency and regulation. Figure 7 shows transition timings of the SWIRE in a pulse counting command session. The SWIRE must be kept high for the minimum t_{STOP} time to complete the command and apply that to the device. If the SWIRE is kept low for more than t_{OFF_DLY} time, the relevant converters will shut down, and the OVDD and OVSS outputs go to discharge to ground state or Hi-Z according to Table 2.

Layout and Component Selection

To achieve the best performance of the device, the below layout guidelines must be followed.

To get a good output regulation, place the components as close as possible to the device and use wide and short traces for connections, especially for the high current loops in the outputs. The input and output bypass capacitors should be connected to the PCB ground plane. If the flying capacitor is not placed close to the C1P/C1N pins, it may cause noise radiation. Similarly, the EMI may be increased if the inductor is not placed close to SW1 and SW2 pins with small copper area. Avoid running noise-sensitive signals near SW1 and SW2.

Connect PGND, AGND and CPGND pins on top layer under the device and then connect them to the PCB ground plane.

Refer to Figure 9 for a layout reference. Recommended component values are given in Table 1.

Figure 9. PCB Layout Reference

Thermal Dissipation Constraint

Small size AMOLED panels are typically used in the tiny, space constraint gadgets. They have limited permissible thermal dissipation due to the close contact with the user's body. The thermal shutdown threshold of the device is +140℃, which is way higher than the allowed scald-free temperature. Therefore, careful thermal dissipation analysis and tests are essential for the evaluation of the designs in such applications. The required thermal isolation causes higher operating junction temperature compared to the operation in the open space. Therefore, the device output power capacity must be derated accordingly.

APPLICATION INFORMATION (continued)

SWIRE Setting

Table 3. SWIRE Programming 1

Pulse	Function Description
0 (no pulse programming)	Default: V_{OVDD} = 3.3V, V_{OVSS} = -3.3V.
1 - 9	Reserved.
10 - 28	OVDD output voltage setting (2.8V to 4.6V), as explained in Table 4.
29 - 57	Reserved.
58 - 92	OVSS output voltage setting (-4.0V to -0.6V), as explained in Table 4.
93 - 115	Reserved.
116	OVDD is turned on.
117	VON and OVSS are turned on.
118	OVDD is turned off.
119	VON and OVSS are turned off.
120	VON and OVSS discharge to GND, with slow slew rate then they enter high impendence (Hi-Z) state.
121	Soft-reset. Clear all settings and reset back to default state.

Table 4. SWIRE Programming 2

Pulse	V_{OUT} (V)	V_{OVDD} (V)	Pulse	V_{VON} (V)	V_{OVSS} (V)	Pulse	V_{VON} (V)	V_{OVSS} (V)
0/no pulse	3.6	3.3	0/no pulse	-3.4	-3.3	77	-2.2	-2.1
10	3.6	2.8	58	-4.1	-4.0	78	-2.1	-2.0
11	3.6	2.9	59	-4.0	-3.9	79	-2.0	-1.9
12	3.6	3.0	60	-3.9	-3.8	80	-1.9	-1.8
13	3.6	3.1	61	-3.8	-3.7	81	-1.8	-1.7
14	3.6	3.2	62	-3.7	-3.6	82	-1.7	-1.6
15	3.6	3.3	63	-3.6	-3.5	83	-1.6	-1.5
16	3.7	3.4	64	-3.5	-3.4	84	-1.5	-1.4
17	3.8	3.5	65	-3.4	-3.3	85	-1.4	-1.3
18	3.9	3.6	66	-3.3	-3.2	86	-1.3	-1.2
19	4.0	3.7	67	-3.2	-3.1	87	-1.2	-1.1
20	4.1	3.8	68	-3.1	-3.0	88	-1.1	-1.0
21	4.2	3.9	69	-3.0	-2.9	89	-1.0	-0.9
22	4.3	4.0	70	-2.9	-2.8	90	-0.9	-0.8
23	4.4	4.1	71	-2.8	-2.7	91	-0.8	-0.7
24	4.5	4.2	72	-2.7	-2.6	92	-0.7	-0.6
25	4.6	4.3	73	-2.6	-2.5			
26	4.7	4.4	74	-2.5	-2.4			
27	4.8	4.5	75	-2.4	-2.3			
28	4.9	4.6	76	-2.3	-2.2			

REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

APRIL 2022 – REV.A.2 to REV.A.3	Page
Updated Features and Figure	All

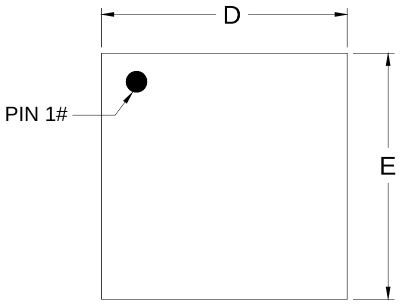
JULY 2021 – REV.A.1 to REV.A.2	Page
Changed HBM	2

JULY 2021 – REV.A to REV.A.1	Page
Added Application Information section	14

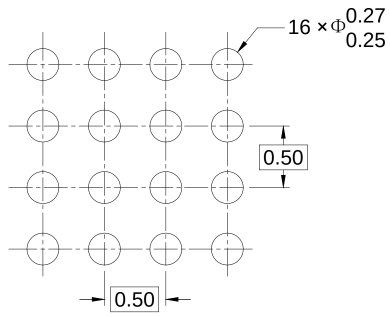
Changes from Original (JUNE 2021) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

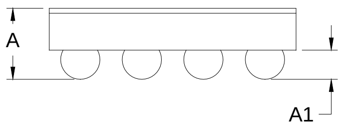
WLCSP-2×2-16B



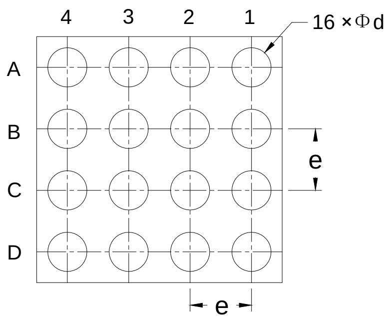
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



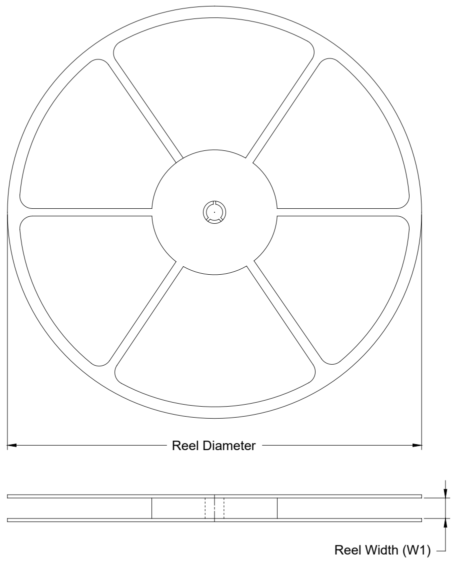
BOTTOM VIEW

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.537	0.575	0.613
A1	0.216	0.236	0.256
D	1.980	2.005	2.030
E	1.980	2.005	2.030
d	0.299	0.319	0.339
e	0.500 BSC		

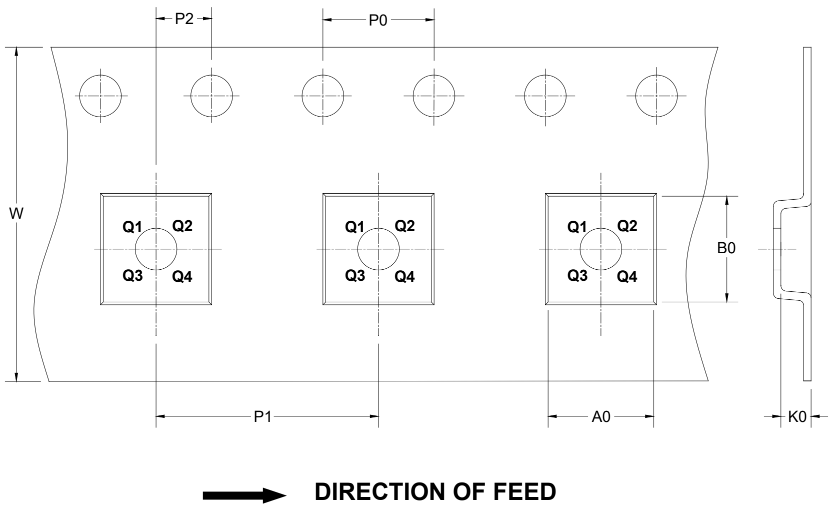
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



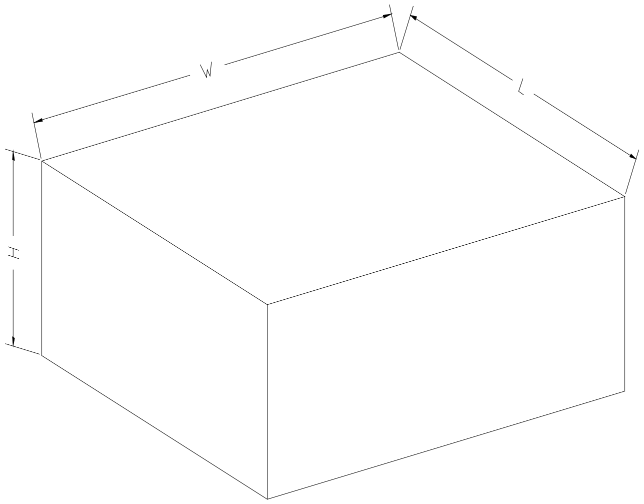
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
WLCSP-2×2-16B	7″	9.5	2.18	2.18	0.81	4.0	4.0	2.0	8.0	Q1

DD0001

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″ (Option)	368	227	224	8
7″	442	410	224	18

DD0002