Product Document

Published by
ams OSRAM Group

AS1383

200mA, 3.5MHz DC-DC Step-Up Converter

General Description

The AS1383 is a synchronous, high efficiency DC-DC boost converter running at a constant frequency of 3.5MHz. This very high oscillator frequency allows the usage of a low profile inductor with only 1µH. This results in a very small board space requirement for the complete solutions including all external components.

AS1383 generates an output voltage range from 2.7V to 5.0V. In adjustable output voltage variant, the output voltage is selected with an external resistor divider. In fixed output voltage variant the V_{OUT} is pre-programmed in 100mV steps, and the external resistor divider is not needed.

AS1383 supports input voltages down to 2.7V. The device provides an output current of 200mA. To support high efficiency across the entire load range the AS1383 is equipped with a synchronous rectifier and features a power save mode for light loads.

To avoid harmful deep discharge of the battery during shutdown the AS1383 is equipped with an output disconnect function.

The AS1383 is available in a 6-pin WL-CSP package with 0.4mm pitch.

Ordering Information and Content Guide appear at end of datasheet.

Key Benefits & Features

The benefits and features of AS1383 are listed below:

Figure 1:
Added Value of Using AS1383

Benefits	Features
Ideal for single Li-Ion battery powered applications	• Wide Input Voltage Range (2.7V to 5.5V)
Extended battery life	• High Efficiency up to 92%
Supports a variety of end applications	• Output Voltage Range: 2.7V to 5.0V (fixed and adjustable variants) • 3.5MHz Fixed-Frequency • Output Current up to 200mA • Automatic Powersave Operation for light Loads • Output Disconnect during Shutdown • Anti-Ringing Control minimizes EMI
Cost effective, small package	• 6-pin WL-CSP with 0.4mm pitch

Applications

The AS1383 is ideal for space critical applications where small size is mandatory as in USB or portable HDMI applications, mobile phones, PDAs, portable media players or digital cameras.

Figure 2:
AS1383 - Typical Application Diagram – Fixed V_{OUT} Variant

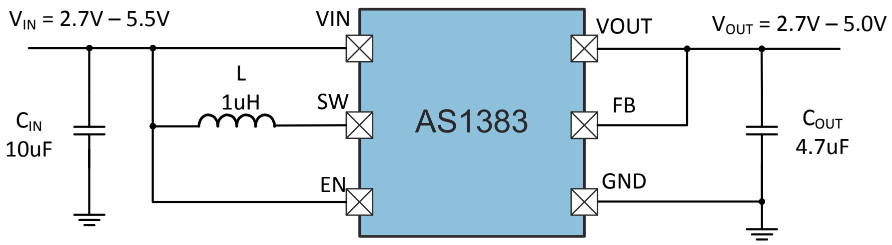
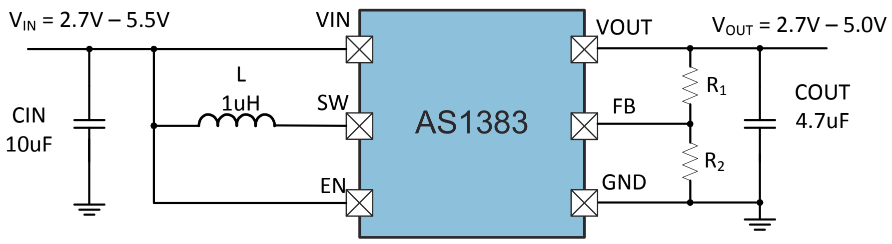


Figure 3:
AS1383 - Typical Application Diagram – Variable V_{OUT} Variant



Pin Assignment

Pin Assignments: Shows the TOP view pin assignment of the AS1383.

Figure 4:
Pin Assignment for WL-CSP

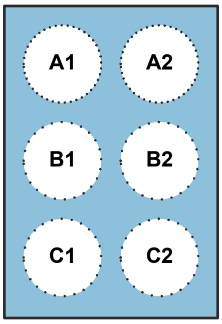


Figure 5:
Pin Description

Pin Number	Pin Name	Description
A1	VIN	**Input Voltage.** The AS1383 gets its start-up bias from VIN unless VOUT exceeds VIN, in which case the bias is derived from VOUT. Thus, once started, operation is completely independent from VIN. Operation is only limited by the output power level and the internal series resistance of the supply.
A2	GND	**Signal and Power Ground**
B1	SW	**Switch Pin.** Connect an inductor between this pin and VIN. Keep the PCB trace lengths as short and wide as is practical to reduce EMI and voltage overshoot. If the inductor current falls to zero, or pin EN is low, an internal 100Ω anti-ringing switch is connected from this pin to VIN to minimize EMI. (1)
B2	VOUT	**Output Voltage.** Bias is derived from VOUT when VOUT exceeds VIN. PCB trace length from VOUT to the output filter capacitor(s) should be as short and wide as is practical.
C1	EN	**Active-High Enable Input.** A logic LOW reduces the supply current to < 1µA. Connect to pin VIN for normal operation.
C2	FB	**Feedback Pin.** Feedback input to the gm error amplifier, connect this pin to VOUT

Note(s) and/or Footnote(s):

1. An optional Schottky diode can be connected between this pin and VOUT.

Absolute Maximum Ratings

Stresses beyond those listed under 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 under Electrical Characteristics is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Figure 6:
Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Units	Comments
Electrical Parameters					
V_{GND}	All pins to GND	-0.3	V_{OUT} + 0.3	V	
I_{SCR}	Input Current (latch-up immunity)	-100	100	mA	Norm: JEDEC 78
Electrostatic Discharge					
ESD_{HBM}	Electrostatic Discharge HBM	±2		kV	Norm: MIL 883 E method 3015
Temperature Ranges and Storage Conditions					
T_{AMB}	Operating Temperature	-40	85	°C	
θ_{JA}	Thermal Resistance		110	°C/W	
T_J	Junction Temperature		150	°C	
T_{STRG}	Storage Temperature Range	-55	125	°C	
T_{BODY}	Package Body Temperature		260	°C	Norm IPC/JEDEC J-STD-020 [1]
RH_{NC}	Relative Humidity non-condensing	5	85	%	
MSL	Moisture Sensitivity Level	1			Represents an unlimited floor life time

Note(s) and/or Footnote(s):

1. The reflow peak soldering temperature (body temperature) is specified according IPC/JEDEC J-STD-020 "Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices"

Electrical Characteristics

All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

Figure 7:
Electrical Characteristics

Symbol	Parameter	Note	Min	Typ	Max	Unit
V_{IN}	Input Voltage	V_{IN}	2.7		5.5	V
Regulation						
V_{OUT}	Output Voltage, Output voltage can be trimmed to any values between Min and Max		2.7		5.0	V
V_{OUT_TOL}	Output Voltage Tolerance		-3		+3	%
V_{O_Ripple}	Output Ripple Voltage	I_{OUT} = 150mA		20		mVpp
Operating Current						
I_{OUT}	Output Current	$V_{IN} \leq 3.0V$ $3.0V < V_{IN} \leq 3.7V$ $V_{IN} > 3.7V$		50 100 200		mA
I_{QSHDN}	Quiescent Current (Shutdown)	EN = GND			1.5	uA
I_{QPWS}	Quiescent Current (Powersave operation)			25		uA
	Line transient response	V_{IN} = Step from 3.0V to 3.5V, V_{OUT}=5.0V I_{OUT} = 100mA		80		mV
	Load transient response	V_{IN} = 3.6V, V_{OUT}=5.0V I_{OUT} = stepping from 10mA to 100mA		100		mV

Symbol	Parameter	Note	Min	Typ	Max	Unit
Switches						
I_{LK}	Leakage current from battery to V_{OUT}	EN = GND			1	uA
R_{ONMOS}	NMOS Switch ON Resistance			0.25		Ω
R_{ONPMOS}	PMOS Switch ON Resistance			0.35		Ω
I_{NMOS}	NMOS Current Limit			650		mA
f_{SW}	Switching Frequency			3.5		MHz
	Start-up time	Time from active EN to start switching, no load until V_{OUT} is stable			300	us
Shutdown						
V_{ENH}	EN Input High	No load	1.2			V
V_{ENL}	EN Input Low	No load			0.25	V
I_{EN}	EN Input Current	Internal pull-down resistor		0.01	1.0	uA
Thermal Protection						
	Thermal shutdown	• 10°C Hysteresis • Thermal protection stops switching, supply disconnect not supported		150		°C

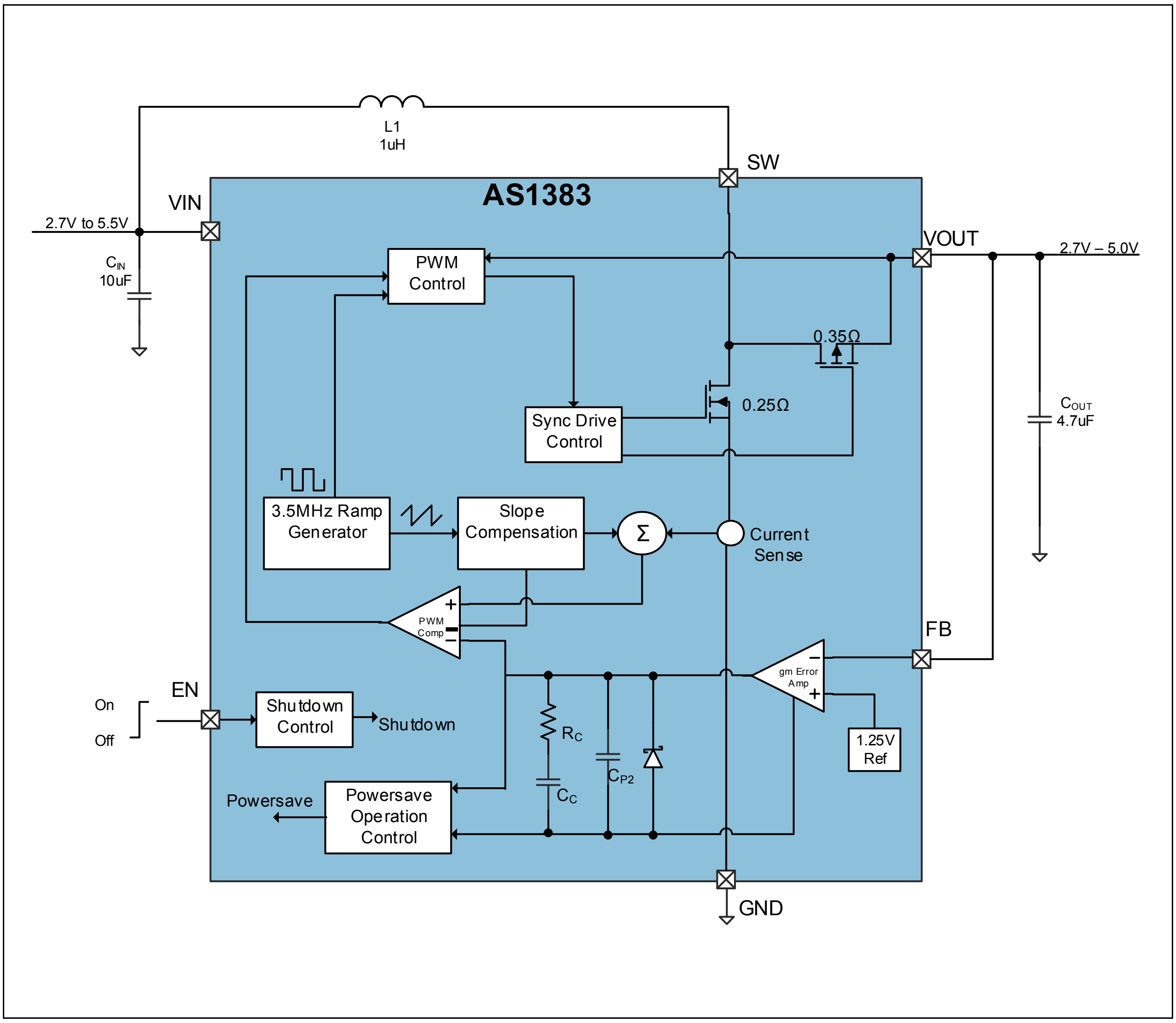
Detailed Descriptions

The AS1383 can operate from 2.7V to 5.5V and features fixed frequency (3.5MHz) and current mode PWM control for exceptional line- and load regulation. With low RDS(ON) and gate charge internal NMOS and PMOS switches, the device maintains high-efficiency from light to heavy loads.

Modern portable devices frequently spend extended time in low-power or standby modes, switching to high power-drain only when certain functions are enabled. The AS1383 is ideal for portable devices since it maintain high-power conversion efficiency over a wide output power range, thus increasing battery life in these types of devices.

In addition to high-efficiency at moderate and heavy loads, the AS1383 includes an automatic powersave mode that improves efficiency of the power converter at light loads. The powersave mode is initiated if the output load current falls below a factory programmed threshold.

Figure 8:
AS1383 Block Diagram



Low-Noise Fixed-Frequency Operation

Oscillator

The AS1383 switching frequency is internally fixed at 3.5MHz allowing the use of very small external components.

Current Sensing

A signal representing the internal NMOS-switch current is summed with the slope compensator. The summed signal is compared to the error amplifier output to provide a peak current control command for the PWM. Peak switch current is limited to approximately 650mA independent of V_{IN} or V_{OUT}.

Zero Current Comparator

The zero current comparator monitors the inductor current to the output and shuts off the PMOS synchronous rectifier once this current drops to 20mA (approx.). This prevents the inductor current from reversing polarity and results in improved converter efficiency at light loads.

Anti-Ringing Control

Anti-ringing control circuitry prevents high-frequency ringing on pin SW as the inductor current approaches zero. This is accomplished by damping the resonant circuit formed by the inductor and the capacitance on pin SW (CSW).

Powersave Operation

In light load conditions, the integrated powersave feature removes power from all circuitry not required to monitor VOUT. When VOUT has dropped approximately 1% from nominal, the device powers up and begins normal PWM operation.

C2 recharges, causing the AS1383 to re-enter powersave mode as long as the output load remains below the powersave threshold. The frequency of this intermittent PWM is proportional to load current; i.e., as the load current drops further below the powersave threshold, the AS1383 turns on less frequently. When the load current increases above the powersave threshold, the AS1383 will resume continuous, seamless PWM operation.

Shutdown

When pin EN is low the AS1383 is switched off and <1µA current is drawn from the battery; when pin EN is high the device is switched on. If EN is driven from a logic-level output, the logic high-level (on) should be referenced to V_{OUT} to avoid intermittently switching the device on. In shutdown the battery input is disconnected from the output.

Thermal Overload Protection

To prevent the AS1383 from short-term misuse the chip includes a thermal overload protection. To block the normal operation the switching of PMOS and NMOS are stopped during the thermal protection, but the V_{OUT} follows the V_{BAT}. The device is in thermal shutdown when the junction temperature exceeds 150°C. To resume the normal operation the temperature has to drop below 140°C.

Note(s): Continuing operation in thermal overload conditions may damage the device and is considered bad practice.

V_{OUT} Programming with External Resistor Divider

In adjustable V_{OUT} variant AS1383 output voltage can be selected with external resistor diver connected to the FB pin as shown in Figure 3. In this case, the V_{OUT} follows the function:

(EQ1)
$$V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) \cdot 1.25V$$

In fixed output voltage variant the V_{OUT} is programmed internally, and the V_{OUT} if connected directly to FB pin.

A higher resistance of R1 and R2 will result in a lower leakage current. Resistance between 10kΩ and 500kΩ is recommended for R2. It is recommended to keep V_{IN} 500mV higher than VOUT.

Typical Operating Characteristics

The following figures are summarizing the AS1383 efficiency as function of load current and input voltage.

Figure 9:
AS1383 Efficiency vs. Load Current

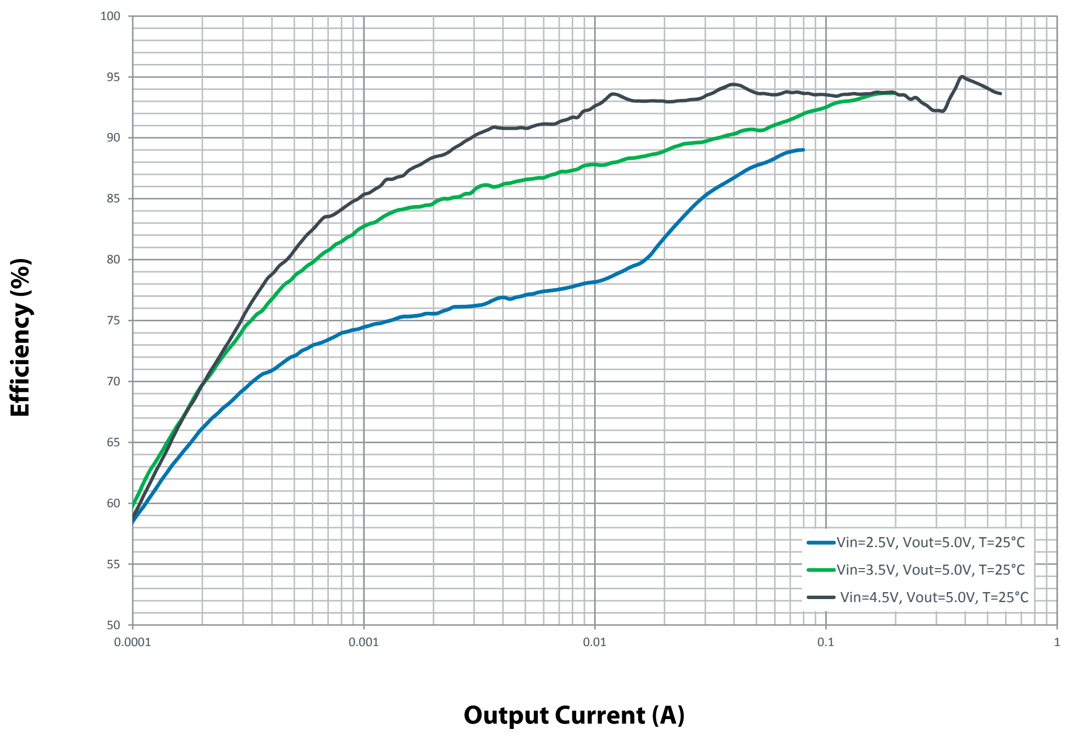


Figure 10:
AS1383 Efficiency vs. Input Voltage (V_{OUT} = 5.0V, I_{LOAD}=100mA)

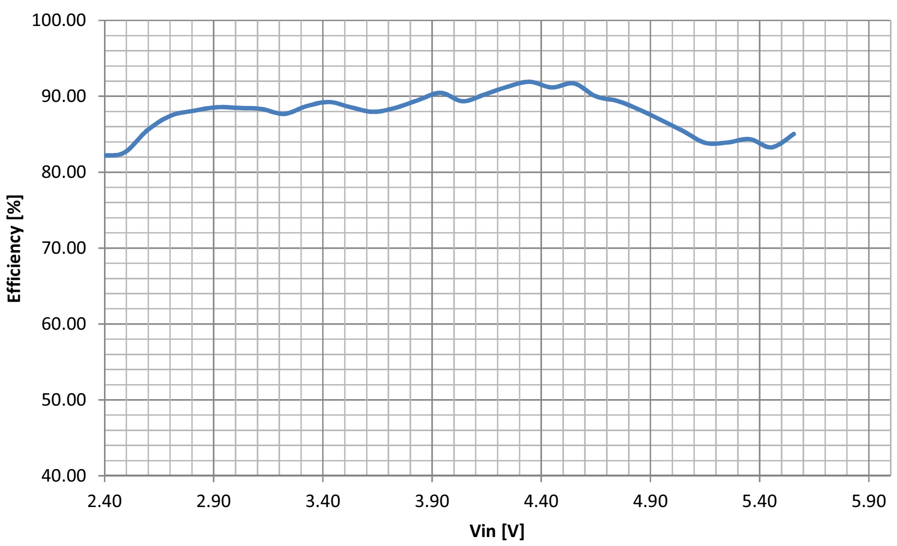


Figure 11:
V_{OUT} Behavior When V_{IN} is Stepped Between 3.0V and 3.5V (I_{LOAD}=100mA, V_{OUT} = 5.0V)

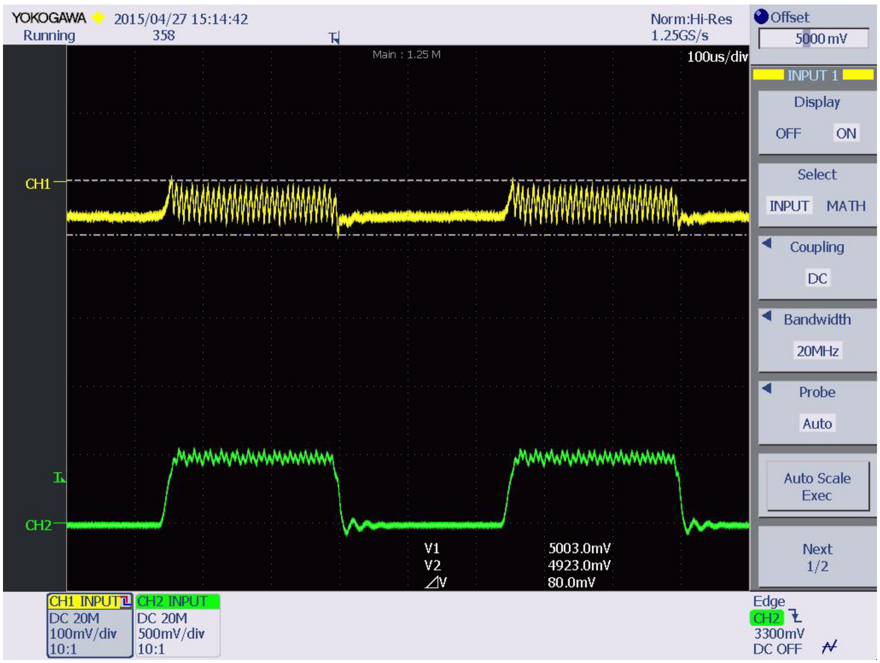


Figure 12:
V_{OUT} Behavior When V_{IN} is Stepped Between 3.0V and 3.5V (I_{LOAD}=100mA, V_{OUT} = 4.5V)

External Component Selection

An external inductor (L) and two capacitors (C_{IN} and C_{OUT}) are needed for the AS1383 functionality. With the adjustable variant also two external resistors are needed to program the V_{OUT} voltage. This section gives recommendations for the components to be used.

Inductor Selection

Figure 13:
Recommended Inductors

Part Number	L	DCR	Current Rating	Dimensions in mm (L / W / H)	Manufacturer
CIG22H1R0MAE	1µH	65mΩ	1.8A	2.5 x 2.0 x 1.0	www.samsungsem.com
XFL4020-102	1µH	11.9mΩ	11A	4.3 x 4.3 x 2.1	www.coilcraft.com
DFE201610E	1µH	96mΩ	2.2A	2.0 x 1.6 x 1.0	www.toko.co.jp
LQM18PW1R0MCH	1µH	288mΩ	0.95A	1.6 x 0.8 x 0.5	www.murata.com

Capacitor Selection

When choosing ceramic capacitors for C_{IN} and C_{OUT}, the X5R or X7R dielectric formulations are recommended. These dielectrics have the best temperature and voltage characteristics for a given value and size. Y5V and Z5U dielectric capacitors, aside from their wide variation in capacitance over temperature, become resistive at high frequencies and therefore should not be used.

Note that the last components in the tables are the ones that are used in the evaluation board instead of the smallest possible components.

Figure 14:
Recommended C_{IN} Capacitors

Part Number	C	TC Code	Voltage Rating	Dimensions in mm (L / W / H)	Manufacturer
GRM219R61A106ME47	10µF	X5R	10V	2.0 x 1.2 x 1.25	www.murata.com
CL10A106KP8NNNC	10µF	X5R	10V	1.6 x 0.8 x 0.8mm	www.samsungsem.com

Figure 15:
Recommended C_{OUT} Capacitors

Part Number	C	TC Code	Voltage Rating	Dimensions in mm (L/W/H)	Manufacturer
GRM21BR61E475MA12	4.7µF	X5R	25V	2.0 x 1.2 x 1.25	www.murata.com
GRM219R61A106ME47	10µF	X5R	10V	2.0 x 1.2 x 1.25	www.murata.com
CL10A475KP8NNNC	4.7µF	X5R	10V	1.6 x 0.8 x 0.8mm	www.samsungsem.com
CL10A106KP8NNNC	10µF	X5R	10V	1.6 x 0.8 x 0.8mm	www.samsungsem.com

Because ceramic capacitors lose a lot of their initial capacitance at their maximum rated voltage, it is recommended that either a higher input capacity or a capacitance with a higher rated voltage is used.

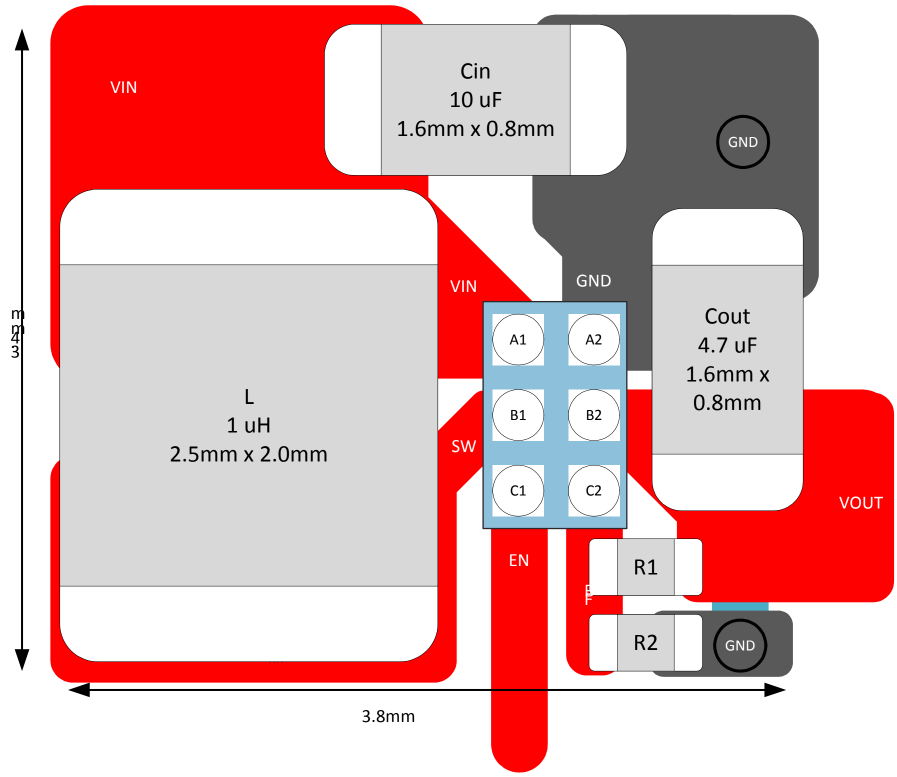
Feedback Resistor Selection

Layout Recommendation

The high-speed operation of the AS1383 requires proper layout for optimum performance. Figure 16 shows the recommended component layout.

- A large ground pin copper area will help to lower the device temperature.
- A multi-layer board with a separate ground plane is recommended.
- Traces carrying large currents should be direct.
- Trace area at pin FB should be as small as is practical.
- The lead-length to the battery should be as short as is practical.

Figure 16:
PCB Layout Recommendation



Package Drawings & Markings

Figure 17:
6 Balls WL-CSP with 0.4mm Pitch

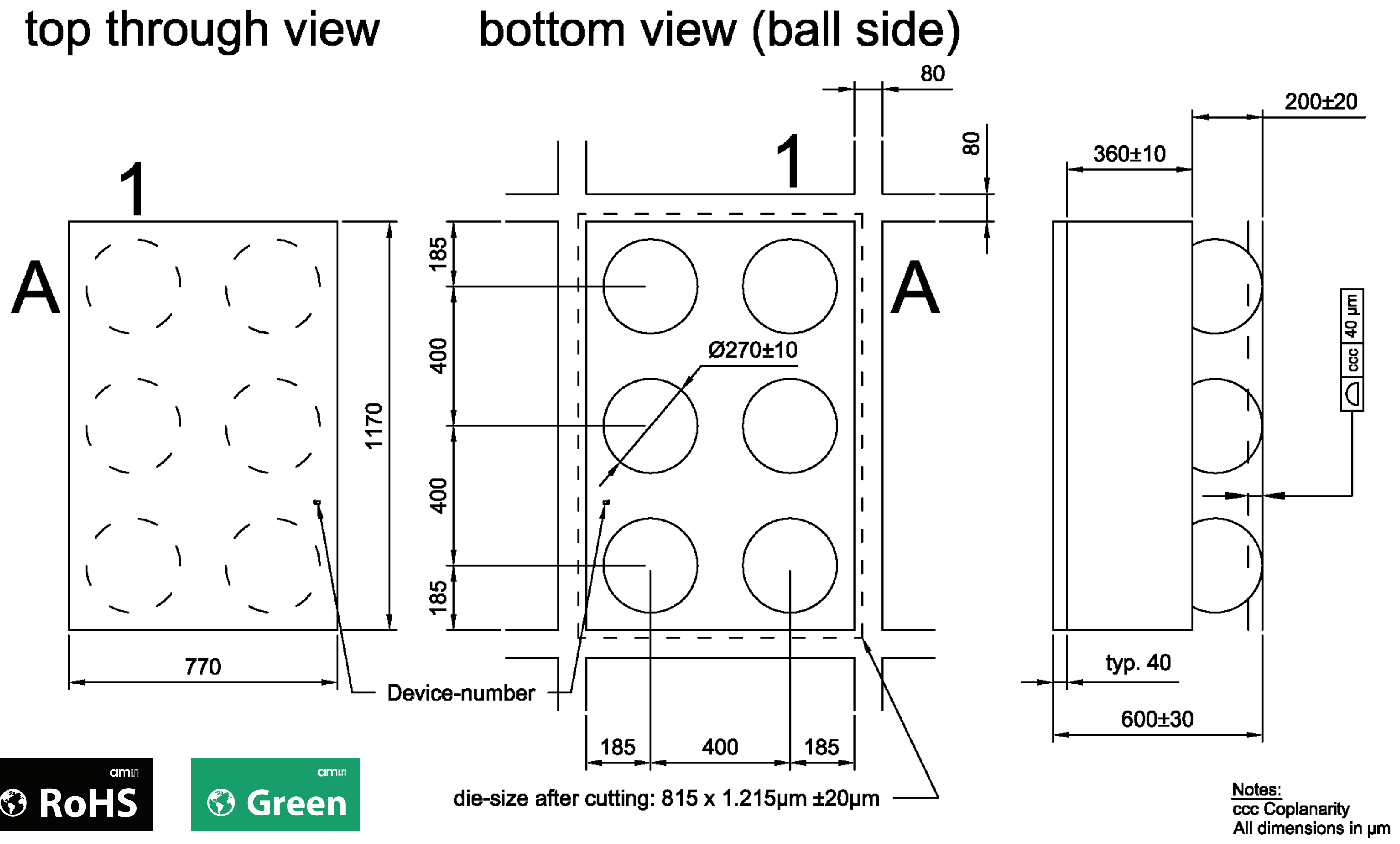
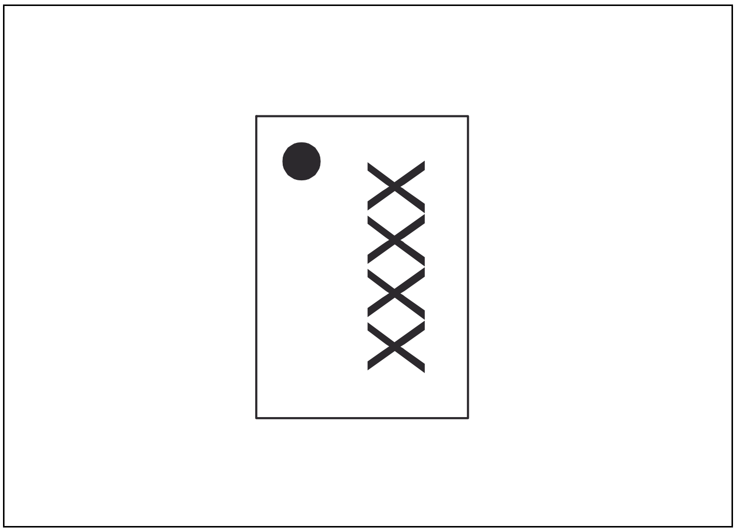


Figure 18:
WL-CSP Marking

AS1383 Marking: Shows the package marking of the WL-CSP product version. Tracecode (XXXX) is a unique code to identify the part and production lot.



Ordering & Contact Information

The figure below shows the ordering codes for Tape & Reel deliveries (suffix **T** in the ordering code). It is also possible to have all the variants on mini reels, when the ordering codes are AS1383-BWLM-xx (where suffix **M** stands for a mini reel). The components are the same in both reel sizes.

Figure 19:
Ordering Information

Ordering Code	V_{OUT}	Delivery Form	Package
AS1383-BWLT-ES	-	Tape & Reel	WL-CSP
AS1383-BWLT-AD	Adjustable	Tape & Reel	WL-CSP
AS1383-BWLT-45	4.5V	Tape & Reel	WL-CSP
AS1383-BWLT-xx		Tape & Reel	WL-CSP
AS1383-BWLT-50	5.0V	Tape & Reel	WL-CSP

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Document Status	Product Status	Definition
Product Preview	Pre-Development	Information in this datasheet is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice
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Datasheet	Production	Information in this datasheet is based on products in ramp-up to full production or full production which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade
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Revision Information

Changes from 1-00 (2015-May-06) to current revision 1-01 (2015-May-22)	Page
Updated Figure 13	12
Updated Figure 19	17

Note(s) and/or Footnote(s):

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

Content Guide