AP938

Flash Microcontroller with LCD Driver for Docking Application

Datasheet

Table of Contents

1. OVERVIEW **1**

2. APPLICATIONS **1**

2.1. TARGET APPLICATIONS 1
2.2. APPLICATION FEATURES 1
2.2.1 DOCKING CONTROL FEATURES 1
2.2.2 CLOCK AND ALARM FEATURES 1
2.2.3 RADIO FEATURES 1
2.2.4 OTHER SYSTEM FEATURES 1

3. ORDERING INFORMATION **1**

4. PIN CONFIGURATION **1**

5. BLOCK DIAGRAM **2**

6. BUILT-IN PERIPHERALS **2**

7. PIN DESCRIPTION **3**

8. ELECTRICAL SPECIFICATION **4**

8.1. ABSOLUTE MAXIMUM RATING 4
8.2. RECOMMENDED OPERATING CONDITION 4
8.3. LEAKAGE CURRENT AND CAPACITANCE 4
8.4. DC ELECTRICAL CHARACTERISTICS 5

9. PACKAGE INFORMATION **6**

10. SOLDERING INDICATION **7**

1. REFLOW SOLDERING 7
2. WAVE SOLDERING 7
3. MANUAL SOLDERING 7
4. SUITABILITY OF SURFACE MOUNT IC PACKAGES FOR WAVE AND REFLOW SOLDERING METHODS 8

1. OVERVIEW

The AP938 is a controller IC for docking application with remote control function and LCD driver. AP938 also supports real time clock with 12/24 hour display format and dual alarm clock timer. Built-in with LCD driver and support for docking system of prevalent music players and mobile phones, AP938 is suitable for a wide range of audio applications that have build-in clock alarm, radio and docking features.

2. APPLICATIONS

2.1. Target Applications

- Docking system
- Clock radio
- Bluetooth application

2.2. Application Features

2.2.1 Docking Control Features

- Docking control through front panel buttons or remote controller
- Device charging through docking system
- Support Apple Authentication Coprocessor

2.2.2 Clock and Alarm Features

- 12/24 hour clock display mode selectable by user
- Dual alarm clocks
- User selectable alarm mode – wake-to-buzzer, wake-to-radio or wake-to-docked device
- Fixed snooze feature
- Programmable sleep timer

2.2.3 Radio Features

- Auto/Manual radio station scanning
- Programmable radio station memory (independent memory slots for FM and AM)

2.2.4 Other System Features

- Support 19 segment x 4 common, 1/3 bias LCD display
- Automatic detection of AC power
- Low standby current

3. ORDERING INFORMATION

ORDERING NUMBER	PINS	PACKAGE
AP938-LQ-L	64	LQFP

4. PIN CONFIGURATION

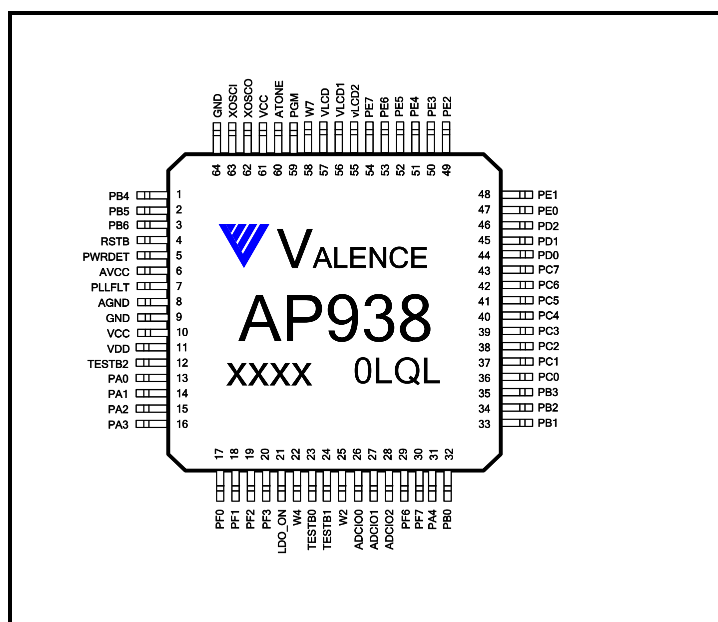


Figure 1 64-Pin LQFP Package of AP938

5. BLOCK DIAGRAM

The following diagram shows the system blocks embedded in AP938.

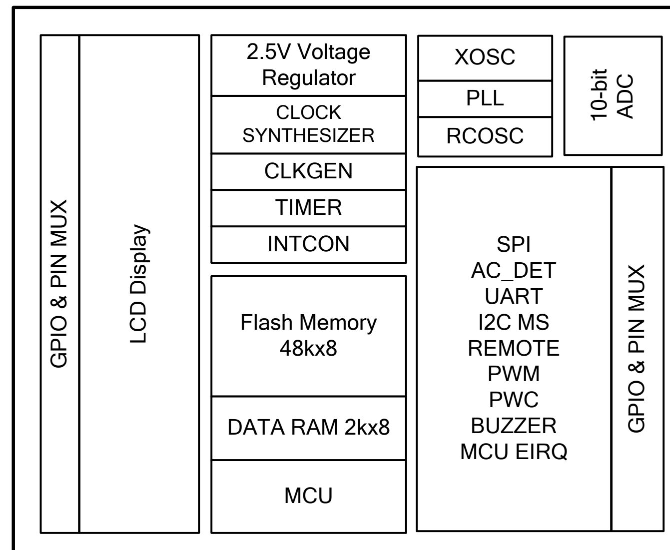


Figure 2 Internal Block Diagram of AP938

6. BUILT-IN PERIPHERALS

- High performance 8 bit CPU
  - Support C language programming
- 48kbyte program flash
- 2kbyte data RAM
- Interrupt controller
  - 13 interrupt sources
- Watchdog reset
- Real time clock
- Embedded RC oscillator
- Programmable timer
  - 3 units
- Pulse width modulation
  - 2 units
- LCD driver
  - 19 segment x 4 common, 1/3 bias LCD display
- 10-bit ADC
  - 3 channels
- AC line frequency detection unit
- IR remote transmit and receive control unit
- Pulse width counter
  - 1 unit
- Buzzer unit
  - output level control available
- UART interface
  - 2 unit
- I2C interface
  - 2 channels
- SPI interface
  - 1 channel
- Selectable oscillator option
  - XOSC : low speed 32.768kHz
  - RCOSC: 8MHz internal RC oscillator

7. PIN DESCRIPTION

Pin	Name	Alternative Function	Type	Pullup /down	Descriptions
1	PB4	SPIDIO	IO,S	PU	General purpose IO port / SPI data IO
2	PB5	SPICLK	IO,S	PU	General purpose IO port / SPI clock IO
3	PB6	SPIDI	IO,S	PU	General purpose IO port / SPI data input
4	RSTB		I,S	U	Active low chip reset input
5	PWRDET		IA	-	Low-voltage detect
6	AVCC				Analog supply voltage
7	PLLFLT		OA		PLL filter
8	AGND				Analog ground
9	GND				Ground
10	VCC				3.3V Power supply
11	VDD				LDO output
12	TESTB2		IO		Active low chip test enable / Flash Program SDO
13	PA0	I2C0CLK	IO,S	PU	General purpose IO port / I2C0 clock output
14	PA1	I2C0DAT	IO,S	PU	General purpose IO port / I2C0 data IO port
15	PA2		IO,S	PU	General purpose IO port
16	PA3	REMO/PWCI	IO,S	PU	General purpose IO port / Remote receiver input / PWC input
17	PF0	TX0	IO,S	PU	General purpose IO port or UART0 TX output
18	PF1	RX0	IO,S	PU	General purpose IO port or UART0 RX input
19	PF2	BOUT0	IO,S	PU	General purpose IO port or UART0 clock output
20	PF3	PWMO1	IO,S	PU	General purpose IO port / PWM 1 output
21	LDO_ON		I,S		LDO Enable
22	W4	PWCI	IO,S	PU	General purpose IO port / external interrupt / PWC input
23	TESTB0		I,S	PU	Active low chip test enable / Flash Program SDI
24	TESTB1		I,S	PU	Active low chip test enable / Flash Program SCLK
25	W2		IO,S	PU	General purpose IO port / external interrupt
26	ADCIO0		IO,S		ADC input channel 0 / General purpose IO port
27	ADCIO1		IO,S		ADC input channel 1 / General purpose IO port
28	ADCIO2		IO,S		ADC input channel 2 / General purpose IO port
29	PF6	I2C1CLK	IO,S	PU	General purpose IO port / I2C1 clock output
30	PF7	I2C1DAT	IO,S	PU	General purpose IO port / I2C1 data IO port
31	PA4	TONE/TX1	IO,S	PU	General purpose IO port / buzzer output/UART1 TX output
32	PB0	COM4/RX1	IO,S,L	PU	General purpose IO port / LCD common 4/UART1 RX input
33	PB1	COM3	IO,S,L	PU	General purpose IO port / LCD common 3
34	PB2	COM2	IO,S,L	PU	General purpose IO port / LCD common 2
35	PB3	COM1	IO,S,L	PU	General purpose IO port / LCD common 1
36	PC0	SEG1	IO,S,L	PU	General purpose IO port / LCD segment 1
37	PC1	SEG2	IO,S,L	PU	General purpose IO port / LCD segment 2
38	PC2	SEG3	IO,S,L	PU	General purpose IO port / LCD segment 3
39	PC3	SEG4	IO,S,L	PU	General purpose IO port / LCD segment 4
40	PC4	SEG5	IO,S,L	PU	General purpose IO port / LCD segment 5
41	PC5	SEG6	IO,S,L	PU	General purpose IO port / LCD segment 6
42	PC6	SEG7	IO,S,L	PU	General purpose IO port / LCD segment 7
43	PC7	SEG8	IO,S,L	PU	General purpose IO port / LCD segment 8
44	PD0	SEG9	IO,S,L	PU	General purpose IO port / LCD segment 9
45	PD1	SEG10	IO,S,L	PU	General purpose IO port / LCD segment 10
46	PD2	SEG11	IO,S,L	PU	General purpose IO port / LCD segment 11
47	PE0	SEG17	IO,S,L	PU	General purpose IO port / LCD segment 17
48	PE1	SEG18	IO,S,L	PU	General purpose IO port / LCD segment 18
49	PE2	SEG19	IO,S,L	PU	General purpose IO port / LCD segment 19
50	PE3	SEG20	IO,S,L	PU	General purpose IO port / LCD segment 20
51	PE4	SEG21	IO,S,L	PU	General purpose IO port / LCD segment 21
52	PE5	SEG22	IO,S,L	PU	General purpose IO port / LCD segment 22
53	PE6	SEG23	IO,S,L	PU	General purpose IO port / LCD segment 23
54	PE7	SEG24	IO,S,L	PU	General purpose IO port / LCD segment 24
55	VLCD2				1/3 x VLCD voltage
56	VLCD1				2/3 x VLCD voltage
57	VLCD				LCD driver supply voltage
58	W7	ACIN	I,S	U	AC detection input / General purpose IO port / external interrupt
59	PGM		I,S	D	Flash Program Enable / Flash Program SCLR
60	ATONE	SDO	OA		Tone output with level control
61	VCC				3.3V Power supply

Pin	Name	Alternative Function	Type	Pullup /down	Descriptions
62	XOSCO		O		32.768kHz oscillator output
63	XOSCI		I		32.768kHz oscillator input
64	GND				Ground

I - Input pin
O - Output pin
IO - Bidirectional pin
IA - Analog input pin
OA - Analog output pin
S - CMOS Schmitt Trigger
(P)U - (Programmable) Pull-up
(P)D - (Programmable) Pull-down
L - LCD Pad
0,1,Z - Logic state 0, Logic state 1,High impedance

8. ELECTRICAL SPECIFICATION

8.1. Absolute Maximum Rating

Item	Symbol	Rating	Unit
Power Supply Voltage (logic)	VCC	-0.5 to 6.0	V
Power Supply Voltage (analog)	AVCC	-0.5 to 6.0	V
Power Supply Voltage (LCD)	VLCD/VLCD1/VLCD2	-0.5 to 6.0	V
Input Voltage	V_{IN}	-0.5 to VCC+0.5	V
Power Dissipation (Ta = 70°C)	Pd	TBD	mW
Storage Temperature	T_{STG}	-20 to 125	°C
Operating Temperature	Topr	0 to 70	°C

8.2. Recommended Operating Condition

Item	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage (logic)	VCC	2.7	-	3.6	V
Power Supply Voltage (analog)	AVCC	2.7	-	3.6	V
Power Supply Voltage (LCD)	VLCD VLCD1 VLCD2	- VLCD2 0	- - -	VCC VLCD VLCD1	V
Input Voltage (digital)	V_{IN}	0	-	VCC	V
Input Voltage (analog)	V_{IN}	0	-	VCC	V
Operating Temperature	T_{OPR}	0	-	70	°C

8.3. Leakage Current and Capacitance

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I_{IN}	Input current	No pull-up or pull-down	-10	-	10	μA
I_{OZ}	Tri-state leakage current		-10	-	10	μA
C_{IN}	Input capacitance *Note1		-	-	5	pF
C_{IN}	Output capacitance *Note1		-	-	5	pF
C_{BID}	Bidirectional buffer capacitance *Note1		-	-	5	pF

*Note1: capacitance value are specified without the package

8.4. DC Electrical Characteristics

(VCC=3.3V±10%, AVCC=3.3V±10%, operating temperature = 0°C - 70°C unless specified otherwise)

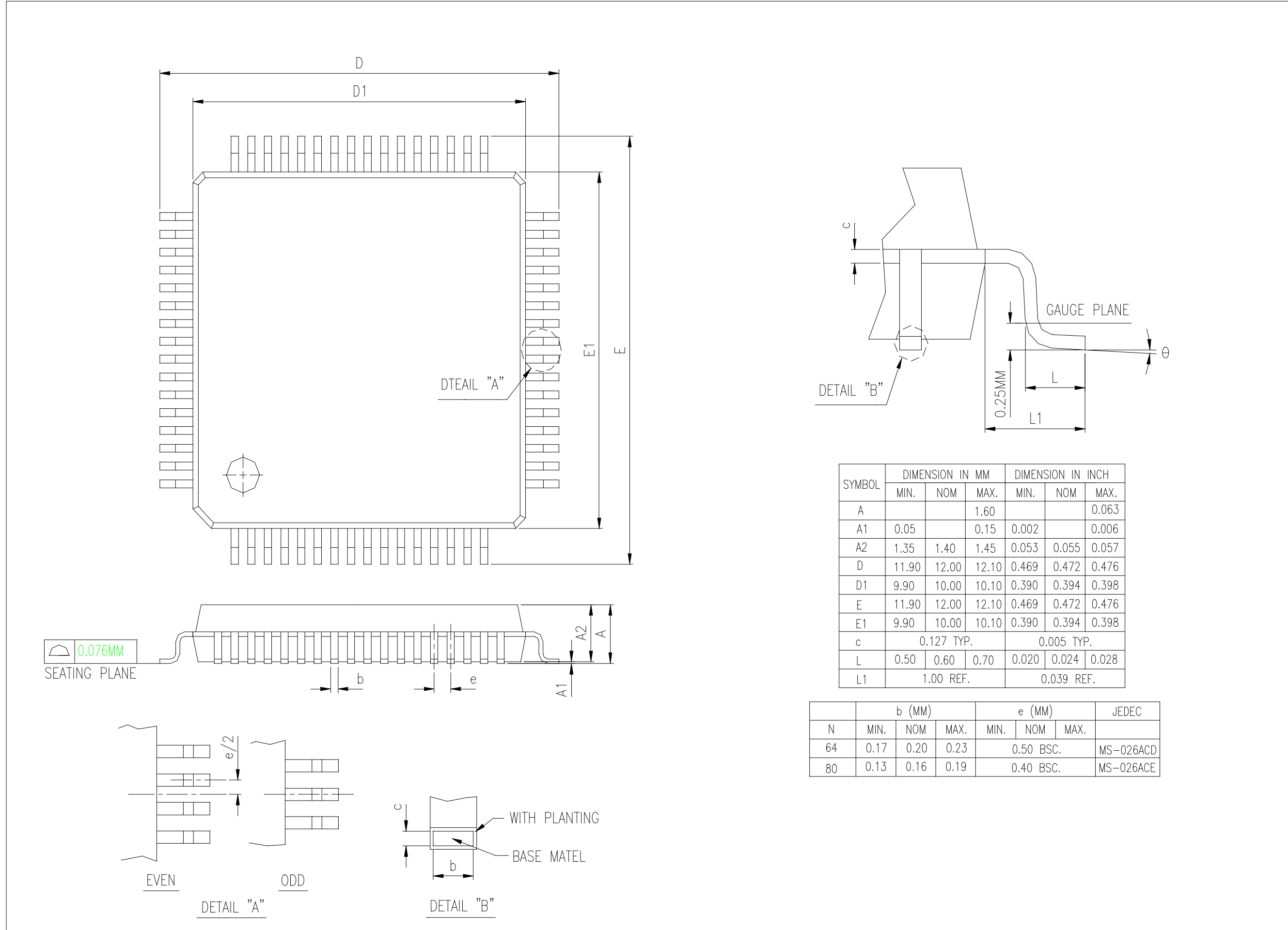
Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V_{CC}	Supply Voltage (logic)	Core operating mode Clock mode	2.7 2.4	-	3.6 3.6	V
AVCC	Supply Voltage (analog)	Core operating mode Clock mode	2.7 2.4	-	3.6 3.6	V
V_{IH}	Input high voltage		0.7*VCC	-	-	V
V_{IL}	Input low voltage		-	-	0.3*VCC	V
R_{PU}	Pull-up resistance except SEG/LCD pads	V_{IN} = 0V	115	160	240	kΩ
R_{PU2}	Pull-up resistance for SEG/LCD pads	V_{IN} = 0V	38	50	80	kΩ
R_{PD}	Pull-down resistance	V_{IN} = VCC	92	140	240	kΩ
I_{OL}	Output low current	VOL = 0.4V *Note4	4.3	5.7	-	mA
I_{OH}	Output high current	VOH = VCC-0.4V *Note4	2.2	2.9	-	mA
Idd_opr	Core operating current	*Note2	-	7	10	mA
Idd_idle	Clock Mode current	VCC=3.3V, T=25°C *Note3	-	80	100	µA

*Note2: LCD is ON. The CPU clock source is from the internal PLL clock. No active load is being driven. All inputs = 0V or VCC.

*Note3: LCD is ON. The CPU clock source is from the 32kHz oscillator pads. No active load is being driven. All inputs = 0V or VCC.

*Note4: Excluding PLLFLT, ATONE, XOSC.

9. PACKAGE INFORMATION



SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM	MAX.	MIN.	NOM	MAX.
A			1.60			0.063
A1	0.05		0.15	0.002		0.006
A2	1.35	1.40	1.45	0.053	0.055	0.057
D	11.90	12.00	12.10	0.469	0.472	0.476
D1	9.90	10.00	10.10	0.390	0.394	0.398
E	11.90	12.00	12.10	0.469	0.472	0.476
E1	9.90	10.00	10.10	0.390	0.394	0.398
c	0.127 TYP.			0.005 TYP.		
L	0.50	0.60	0.70	0.020	0.024	0.028
L1	1.00 REF.			0.039 REF.		

	b (MM)			e (MM)			JEDEC
N	MIN.	NOM	MAX.	MIN.	NOM	MAX.	
64	0.17	0.20	0.23	0.50 BSC.			MS-026ACD
80	0.13	0.16	0.19	0.40 BSC.			MS-026ACE

10. SOLDERING INDICATION

This section gives a very brief insight to a complex technology. There is no soldering method that is ideal for all surface mount IC packages. Wave soldering can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

1. Reflow Soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stenciling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, convection or convection/infrared heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250°C. The top-surface temperature of the packages should preferable be kept below 220 °C for thick/large packages, and below 235 °C for small/thin packages.

2. Wave Soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used, the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch:
  – larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  – smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250°C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

3. Manual Soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

4. *Suitability of Surface Mount IC Packages for Wave and Reflow Soldering Methods*

Package	Soldering Method	
	Wave	Reflow (1)
BGA, HBGA, LFBGA, SQFP, TFBGA	Not suitable (2)	Suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, SMS	Not suitable	Suitable
PLCC (3), SO, SOJ	Suitable	Suitable
LQFP, QFP, TQFP	Not recommended (3)(4)	Suitable
SSOP, TSSOP, VSO	Not recommended (5)	Suitable

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect).
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, the package must be placed at a 45□. angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch equal to or smaller than 0.5 mm.

Valence Semiconductor Design Limited
Unit 2001, 20/F, APEC Plaza,
49 Hoi Yuen Road, Kwun Tong, Hong Kong
Tel: (852) 2797 3288
Fax: (852) 2776 7770
Email: inquiry@valencetech.com
Website: http://www.valencetech.com

IMPORTANT NOTICE
"Preliminary" product information describes products that are in production, but for which full characterization data is not yet available. ValenceTech Ltd. and its affiliates ("Valence") believe that the information contained in this document is accurate and reliable. However, the information is subject to change without notice and is provided "AS IS" without warranty of any kind (express or implied). Customers are advised to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability. No responsibility is assumed by Valence for the use of this information, including use of this information as the basis for manufacture or sale of any items, or for infringement of patents or other rights of third parties. This document is the property of Valence and by furnishing this information, Valence grants no license, express or implied under any patents, mask work rights, copyrights, trademarks, trade secrets or other intellectual property rights. Valence owns the copyrights associated with the information contained herein and gives consent for copies to be made of the information only for use within your organization with respect to Valence integrated circuits or other products of Valence. This consent does not extend to other copying such as copying for general distribution, advertising or promotional purposes, or for creating any work for resale. An export permit needs to be obtained from the competent authorities of the Japanese Government if any of the products or technologies described in this material and controlled under the "Foreign Exchange and Foreign Trade Law" is to be exported or taken out of Japan. An export license and /or quota needs to be obtained from the competent authorities of the Chinese Government if any of the products or technologies described in this material is subject to the PRC Foreign Trade Law and is to be exported or taken out of the PRC. CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). VALENCE PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED FOR USE IN AIRCRAFT SYSTEMS, MILITARY APPLICATIONS, PRODUCTS SURGICALLY IMPLANTED INTO THE BODY, LIFE SUPPORT PRODUCTS OR OTHER CRITICAL APPLICATIONS (INCLUDING MEDICAL DEVICES, AIRCRAFT SYSTEMS OR COMPONENTS AND PERSONAL OR AUTOMOTIVE SAFETY OR SECURITY DEVICES). INCLUSION OF VALENCE PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK AND VALENCE DISCLAIMS AND MAKES NO WARRANTY, EXPRESS, STATUTORY OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WITH REGARD TO ANY VALENCE PRODUCT THAT IS USED IN SUCH A MANNER. IF THE CUSTOMER OR CUSTOMER'S CUSTOMER USES OR PERMITS THE USE OF VALENCE PRODUCTS IN CRITICAL APPLICATIONS, CUSTOMER AGREES, BY SUCH USE, TO FULLY INDEMNIFY VALENCE, ITS OFFICERS, DIRECTORS, EMPLOYEES, DISTRIBUTORS AND OTHER AGENTS FROM ANY AND ALL LIABILITY, INCLUDING ATTORNEYS' FEES AND COSTS, THAT MAY RESULT FROM OR ARISE IN CONNECTION WITH THESE USES.