HPM10

Power Management IC for Hearing Aids

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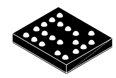
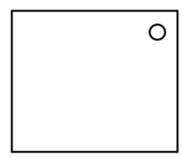


WLCSP29
CASE 567MK

MARKING DIAGRAM



Introduction

HPM10 is a Power Management IC (PMIC) that provides a high−performance solution for rechargeable batteries in hearing aids and hearing implant devices. Responsible for generating the voltage needed by the hearing aid, it manages the charging algorithms such that the battery autonomy and the number of charging cycles are optimized. The rechargeable chemistries supported include silver−zinc (AgZn), and lithium−ion (Li−Ion). HPM10 also detects zinc−air (Zn−Air) and nickel−metal hydride (Ni−MH) batteries but doesn't charge them.

HPM10 includes a Charger Communication Interface (CCIF) to inform the hearing aid charger about the charging progress. Other battery information such as voltage levels, current levels, temperature, and different types of battery failures can also be communicated.

HPM10 has the flexibility that allows easy integration into various types of hearing aids. It can be used without any connection to the main hearing aid digital signal processing (DSP), and manage the switch on and off operation, as well as the battery EOL control by−itself. Closer integration and communication with the main hearing aid DSP can also be obtained.

ORDERING INFORMATION

Device	Package	Shipping†
HPM10−W29A100G	WLCSP29 (Pb−Free)	5,000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

KEY FEATURES

Supports Multiple Battery Types: Can charge and manage the power of multiple battery chemistries, including rechargeable Li−ion and AgZn batteries. Ni−MH batteries and disposable Zn−Air batteries can be detected as well. An automatic chemistry detection system recognizes the battery type.

Flexibility to Support Multiple Battery Sizes: The charging parameters should be updated depending on the battery size. Parameters corresponding to one battery size can be stored in an One−Time Programmable (OTP) memory at customer site.

Power Supply: Provides a clean supply to the hearing aid DSP. When a Li−ion battery is used, a step−down capacitive divider or Charge Pump is used, providing a voltage between ~1.4 V and ~0.95 V. When a AgZn battery is used, a linear regulator can be used, providing a 1.5 V max. HPM10 can also directly provide the battery voltage to the hearing aid DSP. Eg., when a Zn−Air battery is used or if the DSP can handle the voltage of a AgZn battery.

Charger Communication Interface: Communicates the status of the charging process and battery voltage to the hearing aid charger and allows user interaction with HPM10.

Information sent in this mode includes:

- Battery voltage level and charge current
- Charge Mode phase
- Battery chemistry type
- Fault conditions

Battery Life Optimization: High−precision current and voltage sources are used to manage the battery charge curves with the precision required to optimize battery life duration.

Battery Supervision: Ensures that the battery doesn't fall below critical levels. This helps to maximize battery life.

Non−Volatile Memory (OTP): Stores charging parameters, trim codes, and general product specific settings.

Power On and Off Management: Based on a smart method between HPM10 and the hearing aid DSP.

SPECIFICATION

Table 1. ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Min	Max	Unit
VDDP	DC Supply Voltage for charging	−0.5	5.7	V
VDDIO	Digital I/O supply	−0.5	5.5	V
VDD_OTP	OTP Supply	−0.5	6.0	V
DVREG	Regulated supply for HPM10	−0.5	2.0	V
VBAT	DC supply voltage, battery connection	−0.5	5.5	V
VSSA	Analog ground	−0.5		V
VSS	Digital Ground	−0.5		V
VDDIO I/O pins	SCL, SDA, CCIF	−0.5	VDDIO+0.3	V
VBAT I/O pins	SWIN, CP1A, CP1B, CP2A, CP2B	−0.5	VBAT+0.3	V
VHA I/O pins	VHA, SWOUT, DS_EN, EXT_CLK, CLKDIV[2:0], AGZN_REG_EN, WARN	−0.5	2.0 (Note 1)	V
I_{REG}	Max DVREG Load Current		20	mA
I_{VDDP}	Max VDDP Source Current		30	mA
Temp	Storage temperature	−50	85	

ELECTRICAL PERFORMANCE SPECIFICATIONS

Table 3. ELECTRICAL SPECIFICATIONS

Table 3. ELECTRICAL SPECIFICATIONS

Description	Symbol	Conditions	Min	Typ	Max	Units	Screened
DIGITAL INPUT THRESHOLDS							
EXT_CLK	HA_logic_th	Hearing Aid Mode, VBAT=3.8 V		VHA/2		V	
DS_EN, CLKDIV[2:0], AGZN_REG_EN	agzn_en_th	Hearing AidMode, VBAT=3.8 V		0.6		V	
SWIN	swin_th	Hearing Aid Mode		VBAT/2		V	
DS_EN Minimum Triggerable Pulse Width	ds_pw_min	Hearing Aid Mode, VBAT = 3.8 V		20	100 (Note 5)	μs	
SCL,SDA, ATST_EN	logic_th	CM mode		VDDIO/2		V	
HEARING AID MODE CURRENT							
HA_Current_Li_Ion	I_HA_Li	Hearing Aid Mode, VBAT=3.8 V		68		μA	✓
HA_Current_AgZn	I_HA_AgZn	Hearing Aid Mode, VBAT=1.8 V		30		μA	✓

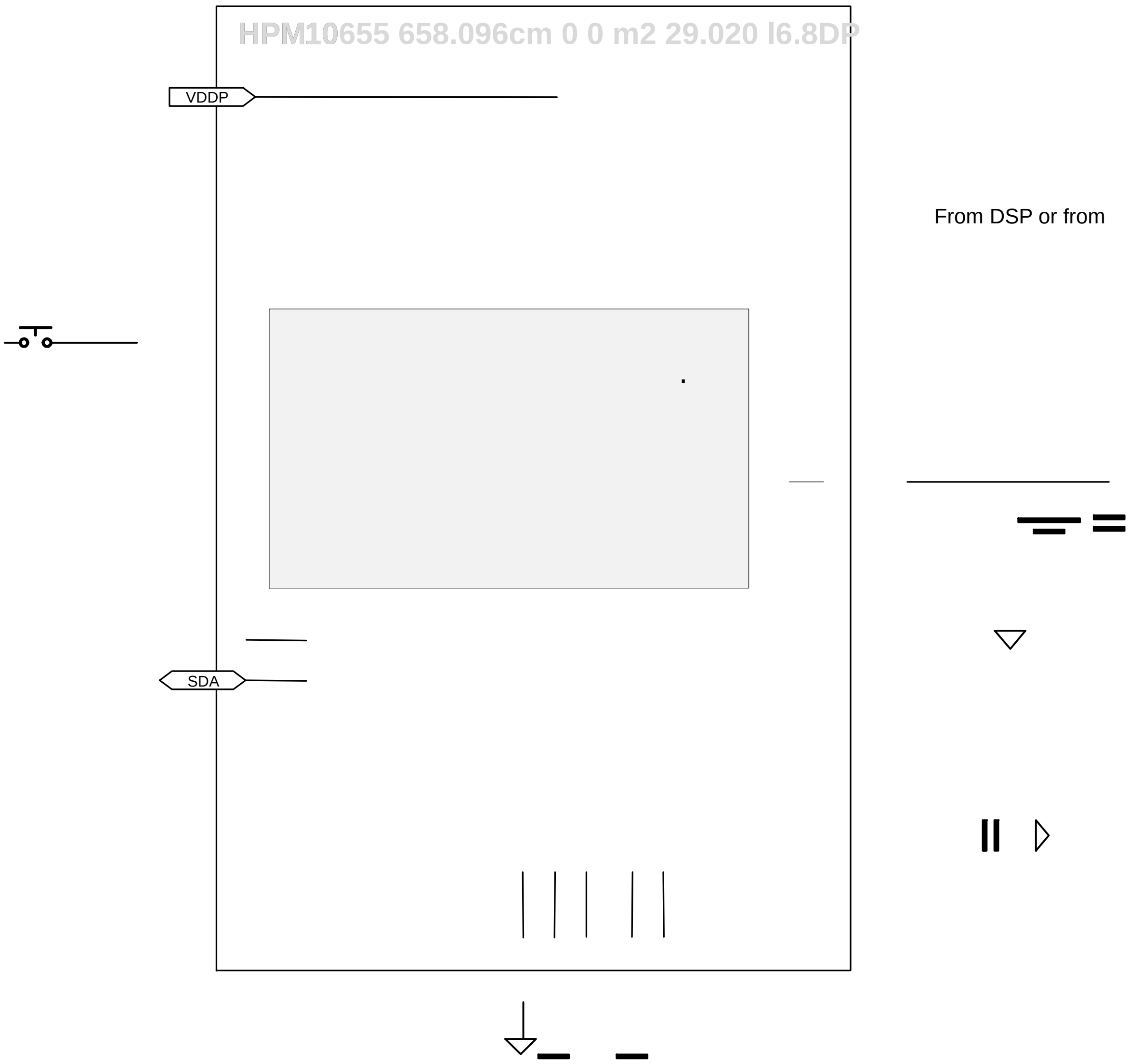
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. During OTP programming, the maximum VDDP value is 5.7 V. This allows VDDP to be tied to VDD_OTP.
4. HPM10 is functional in this range, but is not supposed to meet specification in terms of voltages, currents, thresholds and precision.
5. We ensure that all parts will go into Deep Sleep Mode with a duration of the DS_EN signal longer than 100 us. However, 20 μs is the typical minimum duration value, which means a typical part will trigger with a 20 us duration of DS_EN.

Table 4. EFFICIENCY OF THE STEP DOWN CHARGE PUMP (DIV3) VS LOAD, AT 25°C, V

HPM10 INTERNAL ARCHITECTURE

The architecture of the HPM10 chip is shown in Figure 1.



EXTERNAL COMPONENTS

HPM10 requires six external components listed in Table 4. Depending which type of rechargeable battery is used, some of the decoupling caps are not needed.

Table 5. EXTERNAL COMPONENTS

Component	Function	Typ. Value	Tol.	Units	Notes
Cp1	Capacitor 1 for charge pump	2.2	20%	μF	Required for Lithium−Ion For other batteries, CP1A and CP1B pins can be floating
Cp2	Capacitor 2 for charge pump	2.2	20%	μF	Required for Lithium−Ion For other batteries, CP2A and CP2B pins can be floating
Cha	VHA decoupling capacitor	0.1	20%	μF	
Cvbat	Battery decoupling cap	1	20%	μF	Cvbat should always be 5*Cha to ensure reliable startup
Creg	Voltage and current ref decoupling cap	6.8	20%	μF	
button	Button to interact with the system	–		–	Intermittent

HPM10 USAGE IN A HEARING AID

HPM10 has the built−in flexibility to allow integration within various sorts of hearing instruments. The battery door can be sealed or unsealed. The hearing aid may have a pushbutton or may not. HPM10 can be integrated with the hearing aid DSP though dedicated communication lines, or it can work independently from the hearing aid DSP. The following list gives a few possible scenarios of integration:

Hearing Aid with a Push Button and Sealed Battery Door:

Cradle Charging

- When the hearing aid is inserted to the cradle, it will charge. While charging, the hearing aid will turn off.
- When the hearing aid is taken out from the cradle, it will go into Deep Sleep Mode (HPM10 in Deep Sleep Mode).

Power On/Off

- To turn on the hearing aid, use the pushbutton.
  - ♦

Cradle Charging

- When the hearing aid is inserted to the cradle, it will charge. While charging, the hearing aid will turn off.
- When the hearing aid is taken out from the cradle, it will turn on.

Power On/Off

- When the battery is removed, the hearing aid will shut down
- When the battery is inserted, the hearing aid will turn on

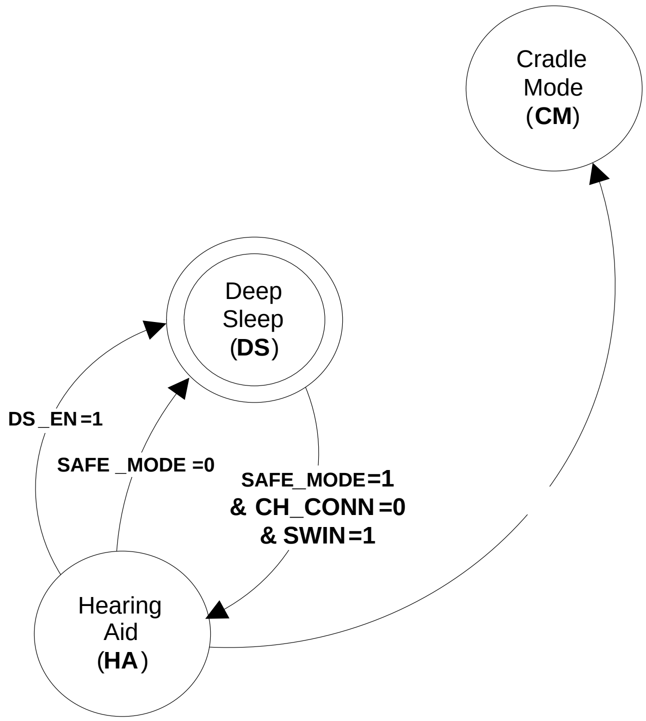
Battery

- When the battery goes EOL, the hearing aid will automatically turn off (HPM10 in Deep Sleep Mode) through two possible mechanisms:
  - HPM10 goes into Deep Sleep Mode to protect the battery from over discharge
  - DSP detects low battery voltage and puts HPM10 in Deep Sleep Mode through the DS_EN pin

In all modes, when the device is removed from the cradle, it will either immediately turn on or wait until the pushbutton is pushed. This means that for the first and second use cases (Hearing Aid with a Pushbutton and Sealed Battery Door

HPM10 WORKING MODES

HPM10 has three working modes represented in the state machine below.



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load on the VDDP wired supply. This current modulation is superimposed on the existing current that is used to charge the battery. State transitions will cause short current transient steps that need to be ignored by the Primary Charger data detector. To support the HPM10 usage in a wireless recharging device, an alternate interface has been provided. It is composed of pad “CCIF” that is a digital output duplicating the raw UART signal (i.e. not the differential encoded data).

The CCIF pin can be configured in the OTP to provide a static signal that can be used by the system to provide information on the battery charge as follow:

CCIF Pin State	Corresponding Information
HI	Charge Complete
LO	Fault
HI–Z	Neither

In OTP Burn mode (ATST_EN=HIGH), the CCIF pin is used as an external reset input active LOW. This reset is necessary during the OTP READ procedure and it is to ensure that digital is in a known good state and the OTP contents have been loaded before doing the read. The CCIF pin, when in input mode, does not have a pull−up or pull−down resistor so it should not be left floating.

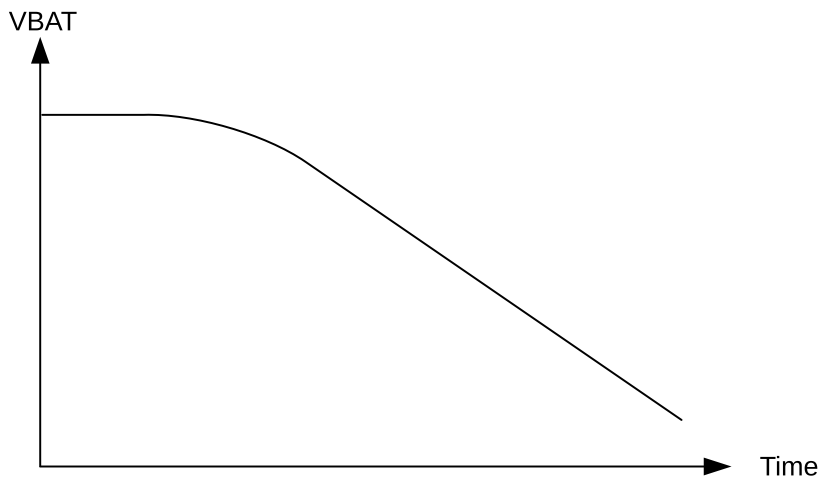
Primary Charger to HPM10 (Receive): The Primary Charger can use voltage modulation of VDDP to transmit data to the HPM10. HPM10 uses edge detection and AC coupling to extract the data easily without a precise amplitude requirement. This helps relax the requirements on the drive signal and the loading of the VDDP line by the Charge Control block. For robust pulse detection, the rise/fall time of the 200 mV modulation should be less than 100 μs.

Battery Monitoring

HPM10 employs two methods of battery monitoring:

1. In Cradle Mode, the high−precision 10 bit ADC continuously measures voltage and current to the battery.
2. In Hearing Aid Mode, the system uses instantaneous voltage to analog comparators to perform simple detection of battery chemistry. Refer to the Hearing Aid Mode section on page 19 for more information.

Figure 5 illustrates how the battery monitoring is done in a hearing aid system using HPM10.



As shown in Figure 6, a charger state machine operates in five phases to manage the charging process:

- Start−up (**SU**):
  - Battery type detection
  - OTP boot and CRC checking
- Initialization (**INIT**):
  - Li−ion pre−charge (trickle)
  - Li−ion advanced charging algorithms
  -

- **Step**

Table 8. HPM10 Pin Arrangement

	1	2	3	4	5
A	SDA	RESERVED	VDDIO	CCIF	VDDP
B	SCL	RESERVED	DS_EN	VSS	DVREG
C		VDD_OTP	CLKDIV[2]	ATST_EN	WARN
D	EXT_CLK	SWOUT	CLKDIV[1]	RESERVED	AGZN_REG_EN
E	VSSA	CLKDIV[0]	CP2B	SWIN	CP1B
F	VHA	VSSCP	CP2A	VBAT	CP1A

Table 9. MISC DIE SPECIFICATION

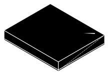
Subject	Specification
Bump metallization	Lead Free (Sn/Ag/Cu)
Backside coating specification	Adwill LC2850
Backside coating thickness	40 μm ± 3 μm

LQFP 32 Pin List

The HPM10 version used on development boards is packaged in a LQFP package of 32 pins. The following table shows the allocation of the IOs:

Table 10. LQFP PIN LIST

Pin #	Pin Name	I/O	Pin #	Pin Name	I/O
1	SDA	I/O	17	CP1A	O



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CASE 567MK
ISSUE A

DATE 31 MAY 2023