DATA SHEET

# GPC3LXXXX

## Low Power 3-Channel Sound Controller

Jun. 02, 2017

Version 1.2

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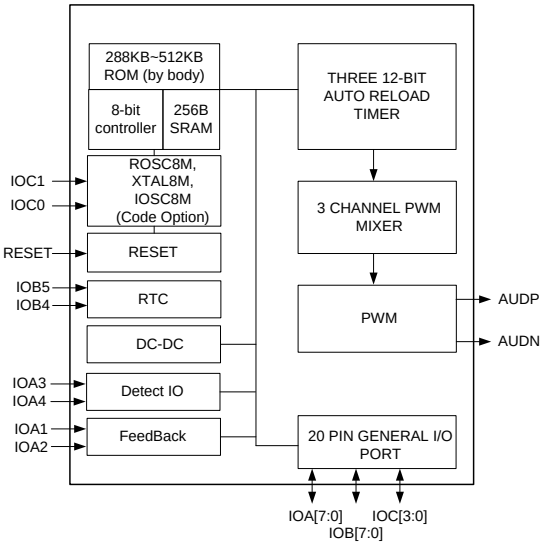
# LOW POWER 3-CHANNEL SOUND CONTROLLER

## 1. GENERAL DESCRIPTION

GPC3LXXXX is embedded with an 8-bit processor, 288K~512K bytes ROM and 256-byte working SRAM, three 12-bit timer/counters, 20 general I/Os, a 3-channel mixer, a pair of 12-bit PWM outputs and a Real Time Clock(RTC). GPC3LXXXX is designed for wide input voltage (1.0V~1.8V; 1.3V~3.6V), and the circuit works at a programmable pumped voltage (2.7V~4.5V). In audio processing, both melody and speech is capable of being mixed together into one output. Furthermore, it contains a Low Voltage Reset to assure system operating appropriately under low voltage condition and a sleep mode to save power while system is standing by. With a high cost/performance ratio characteristic, GPC3LXXXX is one of the most suitable engines in the industry for vocal applications.

## 2. BLOCK DIAGRAM




## 3. FEATURES

- 8-bit microprocessor
- 288K ~ 512K bytes ROM (by body).
- 256-byte working SRAM
- Wide input voltage (Code Option) : 1.0V~1.8V (one-battery)
  1.3V~3.6V (two-battery)
  *Lower input voltage can drive lighter loading only.
- Pumped voltage (DC-DC) for core power:2.7V~4.5V;Step:0.3V
  *The output pumped voltage is greater than or equal to input voltage
- Operating clock : 8.0MHz
- Three system clock sources: IOSC(8MHz), ROSC and XTAL (Code option)
- Standby mode (Clock Stop mode) for power savings.
  Max. 5.0μA @1.5V (one-battery)
  Max. 10.0μA @ 3.0V (two-battery)
- 20 general I/Os
- Low Voltage Reset (LVR) function
- Three 12-bit timer/counters
- 9 IRQs & 1 NMI interrupts
- Three wake-up sources
- Watchdog function
- RTC function
- IR function
- Four sets of 256-level PWMIO outputs
- Feedback function
- Detect IO function
- A 3-channel mixer with melody or ADPCM/PCM input
- A pair of PWM outputs with volume control
- BVD (battery voltage detection) function.

## 4. APPLICATION FIELD

- Talking instrument controller
- General music synthesizer
- High-end toy controller
- Intelligent education toys
- And more

## 5. GPC3LXXXX FAMILY AND FEATURE LIST

| Body | GPC3L170A | GPC3L128A | GPC3L112A | GPC3L096A |
|---|---|---|---|---|
| Voice Duration | 170 Sec. | 128 Sec. | 112 Sec. | 96 Sec. |
| Working Voltage (Code Option) | 1.0V~1.8V (one-battery)<br>1.3V~3.6V (two-battery) | 1.0V~1.8V<br>(one-battery)<br>1.3V~3.6V<br>(two-battery) | 1.0V~1.8V<br>(one-battery)<br>1.3V~3.6V<br>(two-battery) | 1.0V~1.8V<br>(one-battery)<br>1.3V~3.6V<br>(two-battery) |
| RAM Size | 256B | 256B | 256B | 256B |
| ROM Size | 512KB | 384KB | 352KB | 288KB |
| Clock Source (Code Option) | IROSC(8MHz)<br>ROSC<br>XTAL | IROSC(8MHz)<br>ROSC<br>XTAL | IROSC(8MHz)<br>ROSC<br>XTAL | IROSC(8MHz)<br>ROSC<br>XTAL |
| IO Pin | 20 (IOA/B/C) | 20 (IOA/B/C) | 20 (IOA/B/C) | 20 (IOA/B/C) |
| Hardware PWMIO | V | V | V | V |
| IR | V | V | V | V |
| RTC | V | V | V | V |
| PWM Volume control | V | V | V | V |
| Feedback function | V | V | V | V |
| IRQ Interrupt | 9 | 9 | 9 | 9 |
| NMI interrupt | 1 | 1 | 1 | 1 |
| Wakeup source | 3 | 3 | 3 | 3 |

## 6. SIGNAL DESCRIPTIONS

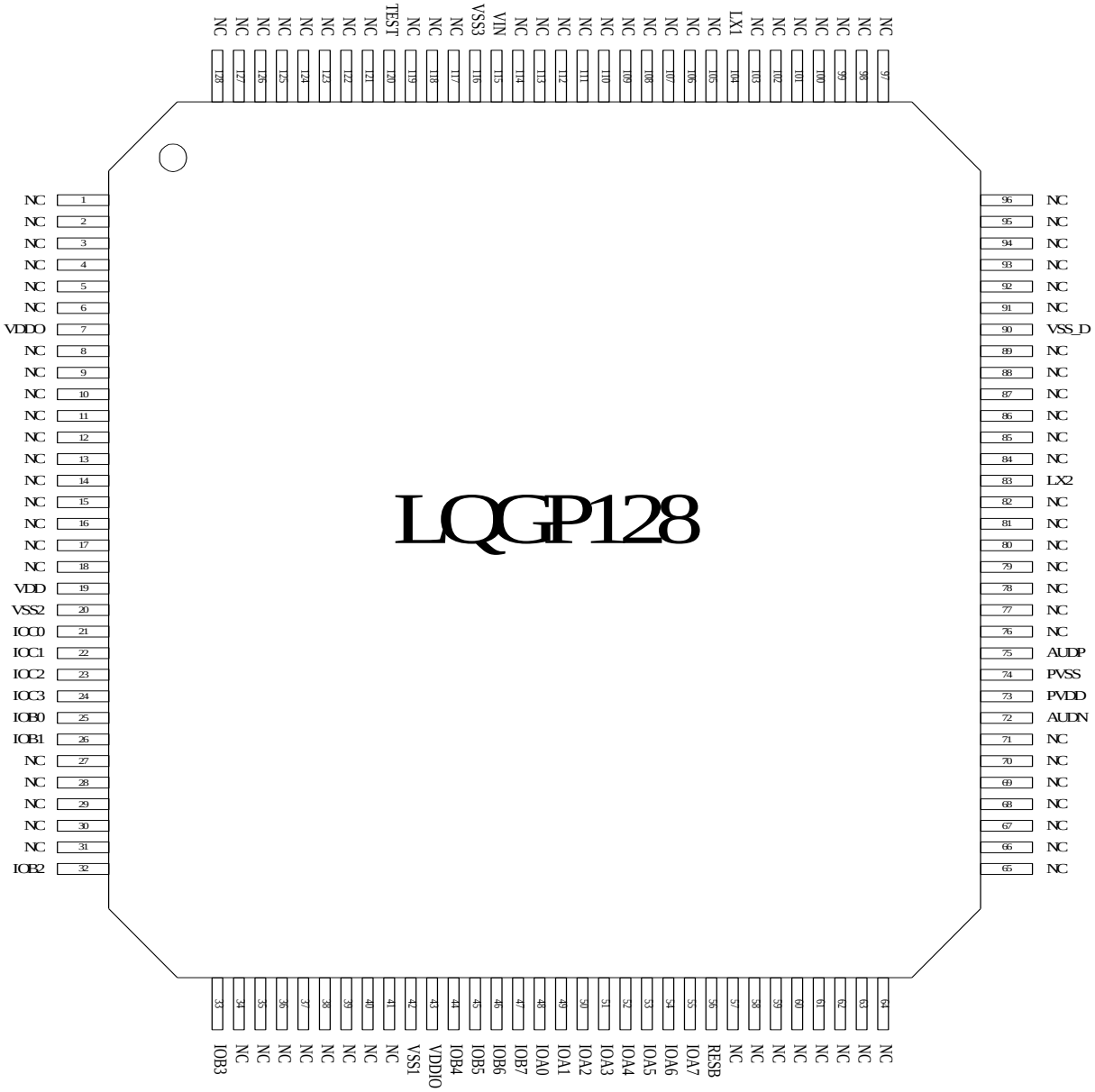
### 6.1. Signal Descriptions for GPC3L170A~GPC3L096A

| PIN Name | Type | Description |
|---|---|---|
| IOA[7:0] | I/O | IOA[7:0] is a bi-directional I/O port, which can be software programmed as a wakeup I/O with 1Mohm or 100Kohm pull low resistor.<br>IOA7 shares its pad with IR output.<br>IOA[4:3]shares its pad with detecting IO function.<br>IOA[2:1] shares its pad with feedback function.<br>IOA1 shares its pad with external clock input.<br>IOA0 shares its pad with external interrupt input. |
| IOB[7:0] | I/O | IOB[7:0] is a bi-directional I/O port, which can be software programmed as a wakeup I/O with 1Mohm or 100Kohm pull low resistor.<br>IOB5 shares its pad with XTAL 32KHz inputs<br>IOB4 shares its pad with XTAL 32KHz outputs<br>IOB[3:0] shares its pad with 256-level PWM outputs |
| IOC[3:0] | I/O | IOC[3:0] is a bi-directional I/O port, which can be software programmed as wakeup I/O with 1Mohm or 100Kohm pull low resistor.<br>IOC1 shares its pad with XTAL8M output.<br>IOC0 shares its pad with ROSC8M or XTAL8M input. |
| VDD15 | P | Power PAD for DC-DC . |
| VSS15 | G | Ground PAD for DC-DC. |
| LX1 | I | This pin must short with LX2 externally.<br>Inductance input of DC-DC(Inductance must be connected to VDD15) |
| LX2 | I | This pin must short with LX1 externally.<br>Inductance input of DC-DC(Inductance must be connected to VDD15) |
| VDDO | O | DC-DC Pumped voltage output |
| VDD | P | Power supply voltage input for logic circuit |
| VSS2 | G | Ground reference for logic circuit |
| VSS3 | G | Ground reference for logic circuit |
| VDDIO | P | Power supply voltage input for IO PAD |
| VSS1 | G | Ground reference for IO PAD |
| PVDD | P | PWM driver power |
| PVSS | G | PWM driver ground reference |
| RESB | I | System reset input, low active (with pull high) |
| TEST | I | Test pin, high active (with pull low) |
| AUDP, AUDN | O | PWM output |

Total: 36 pins

Legend: I=Input, O=Output, P=Power, G=Ground

### 6.2. LQFP128 pin map for GPC3L170A~GPC3L096A



# 7. FUNCTIONAL DESCRIPTIONS

## 7.1. CPU

The microprocessor inside the GPC3LXXXX is an 8-bit high performance processor equipped with Accumulator, Program Counter, X and Y Register, Stack pointer and Processor Status Register (the same as CPU6502 instruction structure). The maximum CPU speed of 8.0MHz is capable of generating clearer speech, pleasant music as well as achieving the best performance.

## 7.2. RAM Area

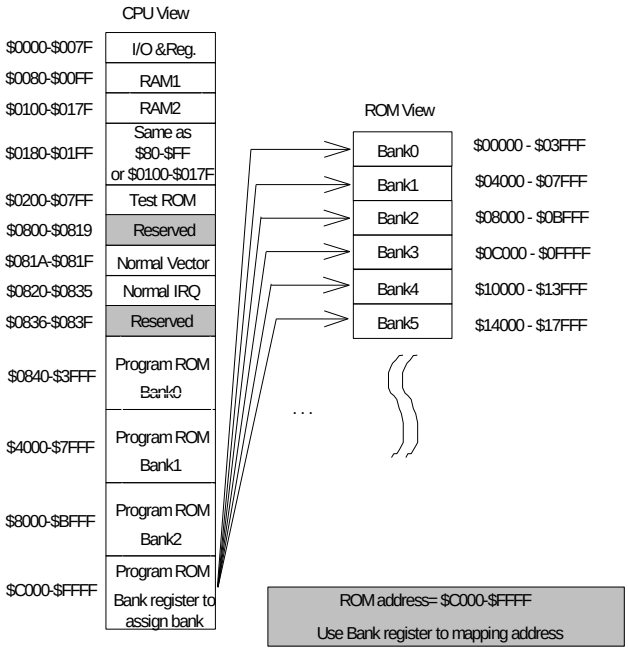
The RAM size in GPC3LXXXX is **256-byte** (including Stack), in which address starts from $0080 through $017F ($0100 - $017F mapping to $0180 - $01FF).

## 7.3. ROM Area

GPC3LXXXX builds a 288K~512K bytes of ROM, which can be defined as the program area, audio data area, or both. To access ROM, users shall program the BANK SELECT register, choose bank, and access address to fetch data.

| Body | ROM size | ROM Address |
|---|---|---|
| GPC3L170A | 512KB | 0x00840~0x07FFFF |
| GPC3L128A | 384KB | 0x00840~0x05FFFF |
| GPC3L112A | 352KB | 0x00840~0x057FFF |
| GPC3L096A | 288KB | 0x00840~0x047FFF |

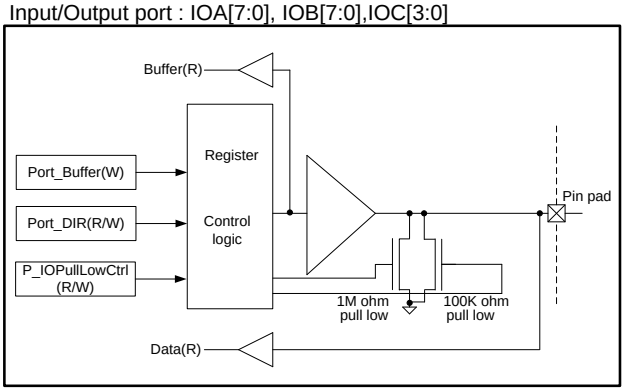
## 7.4. Map of Memory and I/Os




## 7.5. I/O Port

There are 20 IOs (IOA[7:0], IOB[7:0] and IOC[3:0] in GPC3LXXXX, which are bit-control IOs. They can be programmed as input (pure input or pull-low) or output buffer. As pull-low input, they keep a less impedance to get better noise immunity. While pressing the key (IOs to VDD), a less or large impedance can be selected at different conditions. IOA7 can be programmed as an IR transmitter. IOA[4:3] can be programmed as Detect IO. IOA[2:1] can also be programmed as feedback function with IOA2 connecting to the input of inverter and IOA1 connecting to the output of inverter. With feedback function, RC or XTAL oscillation can be implemented. For more flexible application, IO wakeup and ECK as TMA clock source are also available when feedback function enable. Please refer to programming guide for more detailed information about feedback function. IOA1 can be programmed as an external clock source. IOA0 is programmable as an external interrupt source. IOB5 and IOB4 can be programmed as a 32KHz crystal clock generator by adding external components. IO port configuration:

Input/Output port : IOA[7:0], IOB[7:0],IOC[3:0]




## 7.6. DC-DC

GPC3LXXXX can work with wide input voltage (1.0V~1.8V; 1.3V~3.6V). Inside the chip, it is implemented with a high efficient DC-DC circuit. The DC-DC circuits pump input voltage to programmed voltage that supplies chip as working voltage.

## 7.7. Power Saving Mode

GPC3LXXXX features a power saving mode (standby mode) for those applications requiring low standby current. To enter standby mode, the Wake-up Register must be enabled and then stop the CPU clock by writing the STOP CLOCK Register to enter standby mode. In such mode, RAM and I/Os will remain in their prior states until being awakened. All 20 IOs, RTC (8Hz/2Hz), and external interrupt (IOA0) are wake-up sources in GPC3LXXXX. After GPC3LXXXX wakes up, the internal CPU will proceed to execute the program.

### 7.8. RTC (Real Time Clock)

GPC3LXXXX provides two RTC (real time clock) sources: 2Hz, 8Hz. The RTC sources can be used for time counting or system awaking function. Each RTC occurs, system wakes up and users can use this signal for time counting. In addition, GPC3LXXXX supports 32768Hz OSC in auto mode; the first one second, it runs at strong mode (consumes the highest power) and then switches to weak mode automatically to save power.

### 7.9. Watchdog

The purpose of watchdog is to monitor whether the system operates normally. Within a certain period, watchdog must be cleared. It prevents system from incorrect code execution by generating a system reset when software fails to clear watchdog flag within 1 second. Watchdog function can be removed by option in GPC3LXXXX series.

### 7.10. Low Voltage Reset

GPC3LXXXX has a Low Voltage Reset (LVR) function. In general, CPU becomes unstable and abnormal under low voltage condition. With the unique design of Low Voltage Reset in GPC3LXXXX, it is able to reset all functions to the initial operational (stable) state if the power voltage drops below certain operation voltage.

### 7.11. Interrupt

GPC3LXXXX has two interrupt (INT) modes: IRQ (interrupt Request) and NMI (Non-Mask Interrupt Request). The interrupt controller provides 9 IRQs and 1 NMI. A NMI cannot be interrupted by any other IRQs.

| Interrupt Source | Priority |
|---|---|
| TIMER A | NMI |
| TIMER A | IRQ1 |
| TIMER B | IRQ2 |
| TIMER C | IRQ3 |
| TB1 | IRQ4 |
| TB2 | IRQ5 |
| RTC | IRQ6 |
| KEY | IRQ7 |
| EXT | IRQ8 |
| DETIO | IRQ9 |

### 7.12. Timer/Counter

GPC3LXXXX has three 12-bit timer/counters: TMA, TMB, and TMC respectively. In timer mode, TMA, TMB, and TMC are re-loadable up-counters. When timer overflows from $0FFF to $0000, the carry (overflow) signal will make the user's pre-set value to be loaded into timer automatically and count up again. At the same time, the carry signal will generate an INT signal if the corresponding bit in the INT ENABLE Register is enabled. Suppose TMB is specified as a counter, users can reset it by loading #0 into the counter. After the counter is activated, the counter value can also be read at the same time. The read instruction will not affect the counter value nor reset it.

### 7.13. Speech and Melody

In speech synthesis, the GPC3LXXXX can use NMI for accurate sampling frequency. User can store the speech data in ROM and play it back with realistic sound quality. Several algorithms are recommended for high fidelity and compression of sound: PCM, ADPCM, SACMA3400 and A3400Pro.

### 7.14. Battery voltage detect function

GPC3LXXXX has Battery Voltage Detection (BVD) function. There are four detecting levels can be chosen for 1-battery and 2-battery application respectively. Please refer to programming guide for more detailed information about BVD function.

# 8. ELECTRICAL SPECIFICATIONS

## 8.1. Absolute Maximum Ratings

| Characteristics | Symbol | Ratings |
|---|---|---|
| DC Supply Voltage | $V_+$ | < 7.0V |
| Input Voltage Range | $V_{IN}$ | (VSS-0.3V) to ($V_+$ + 0.3V) |
| Operating Temperature | $T_A$ | 0℃ to +70℃ |
| Storage Temperature | $T_{STO}$ | -65℃ to +150℃ |

**Note:** Stresses beyond those given in the Absolute Maximum Rating table may cause permanent damage to the device.

## 8.2. Power Characteristics (One-Battery , TA = 25℃)

| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input Voltage (Min.) * | VDD15 | 1.0 | - | - | V | I(VDD)=40mA@VDD=3.3V, L=22uH/0.5W , ESR =1 ohm (Color Code Inductance) |
| Input Voltage (Max.) | VDD15 | - | - | 1.8 | V | - |
| Operating Voltage** | VDD | $V_{LVR}$ *** | - | 3.9 | V | - |
| Low Voltage Reset Level | $V_{LVR}$ | 2.3 | 2.4 | 2.5 | V | - |
| Operating Current | $I_{OP}$ | - | 10 | - | mA | $F_{OSC}$=8.0MHz @ VDD=3.3V(no load) VDD15=1.5V |
| Halt Current | $I_{HALT}$ | - | 5 | - | μA | VDD15=1.5V |
| Standby Current | $I_{STBY}$ | - | - | 5.0 | μA | VDD15=1.5V |

*As I(VDD) is larger than the value of test condition; VDD can be observed voltage drop.

**VDD is the pumped voltage. It is greater than or equal to input voltage. It is possible to be lower with heavy loading under operating condition.

*** $V_{LVR}$ is 2.4V +/- 5%.

## 8.3. Power Characteristics (Two-Battery , TA = 25℃)

| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input Voltage (Min.) * | VDD15 | 1.3 | - | - | V | I(VDD)=40mA@VDD=3.3V, L=22uH/0.5W , ESR =1 ohm (Color Code Inductance) |
| Input Voltage (Max.) | VDD15 | - | - | 3.6 | V | - |
| Operating Voltage** | VDD | $V_{LVR}$ *** | - | 4.5 | V | - |
| Low Voltage Reset Level | $V_{LVR}$ | 2.3 | 2.4 | 2.5 | V | - |
| Operating Current | $I_{OP}$ | - | 5 | - | mA | $F_{OSC}$=8.0MHz @ VDD=3.3V(no load) VDD15=3.0V |
| | | - | 10 | - | mA | $F_{OSC}$=8.0MHz @ VDD=4.5V(no load) VDD15=3.0V |
| Halt Current | $I_{HALT}$ | - | 15 | - | μA | VDD15=3.0V |
| Standby Current | $I_{STBY}$ | - | - | 10.0 | μA | VDD15=3.0V |

*As I(VDD) is larger than the value of test condition; VDD can be observed voltage drop.

**VDD is the pumped voltage. It is greater than or equal to input voltage. It is possible to be lower with heavy loading under operating condition.

*** $V_{LVR}$ is 2.4V +/- 5%.

### 8.4. DC Characters (TA = 25℃)

| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| GPIO Input High Level (IOA, IOB, IOC) | $V_{IH}$ | 0.7VDD | - | - | V | VDD = 3.3V |
| | | 0.7VDD | - | - | V | VDD = 4.5V |
| GPIO Input Low Level (IOA, IOB, IOC) | $V_{IL}$ | - | - | 0.3VDD | V | VDD = 3.3V |
| | | - | - | 0.3VDD | V | VDD = 4.5V |
| Output High Current (IOA, IOB, IOC) | $I_{OH}$ | - | 5 | - | mA | VDD = 3.3V, $V_{OH}$ = 0.7*VDD |
| | | - | 10 | - | mA | VDD = 4.5V, $V_{OH}$ = 0.7*VDD |
| Output Low Current (IOA, IOB, IOC) | $I_{OL}$ | - | 10 | - | mA | VDD = 3.3V, $V_{OL}$ = 0.3*VDD |
| | | - | 20 | - | mA | VDD =4.5V, $V_{OL}$ = 0.3*VDD |
| Input 1M Ohm Pull Low Resistor (IOA, IOB, IOC) | $R_{PLM}$** | - | 1000 | - | Kohm | VDD = 1.5V, IO = 1.5V |
| | | - | 200 | - | Kohm | VDD = 3.3V, IO = 3.3V |
| | | - | 120 | - | Kohm | VDD = 4.5V, IO = 4.5V |
| Input 100K Ohm Pull Low Resistor(IOA, IOB, IOC) | $R_{PL100K}$*** | - | 100 | - | Kohm | VDD = 3.3V, IO = 0V or VDD |
| | | - | 100 | - | Kohm | VDD = 4.5V, IO = 0V or VDD |
| PWM Driver Current | $I_{PWM}$ | - | 200 | - | mA | VDD = 3.3V, 8 Ohms load (bypass DC-DC) |
| | | - | 300 | - | mA | VDD = 4.5V, 8 Ohms load (bypass DC-DC) |
| Frequency deviation by voltage drop | ⊿F/F | -2 | - | 2 | % | $\frac{Fosc(4.5v) - Fosc(3.0v)}{Fosc(4.5v)}$ $F_{CPU}$ = 8MHz, For IOSC |
| | | -2 | - | 2 | % | $\frac{Fosc(4.5v) - Fosc(3.0v)}{Fosc(4.5v)}$ $F_{CPU}$ = 8MHz, For ROSC |
| Frequency lot deviation | ⊿F/F | -3 | - | 3 | % | $\frac{Fmax(3.6v) - Fmin(3.6v)}{Fmax(3.6v)}$ $F_{CPU}$ = 8MHz @ 3.6V,For IOSC |
| | | -7 | - | 7 | % | $\frac{Fmax(3.6v) - Fmin(3.6v)}{Fmax(3.6v)}$ $F_{CPU}$ = 8MHz @ 3.6V,For ROSC |

***** VDD is the pumped voltage. It is greater than or equal to input voltage. It is possible to be lower with heavy loading under operating condition.

**$R_{PLM}$ increases enormously while VDD drops.

***RPL100K keeps remain while VDD drops.

### 8.5. Pump Efficiency (One-Battery , $T_A$ = 25℃)

| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pump Efficiency (Color Code Inductance L=22uH/0.5W , ESR =1 ohm) | Eff. | - | 86 | - | % | I(VDD)=30mA;VDD15=1.5V; VDD=3.3V |
| | | - | 78 | - | % | I(VDD)=60mA;VDD15=1.5V; VDD=3.3V |
| | | - | 86 | - | % | I(VDD)=30mA;VDD15=1.5V; VDD=3.9V |
| | | - | 76 | - | % | I(VDD)=60mA;VDD15=1.5V; VDD=3.9V |

### 8.6. Pump Efficiency (Two-Battery , $T_A$ = 25℃)

| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pump Efficiency (Color Code Inductance L=22uH/0.5W , ESR =1 ohm) | Eff. | - | 91 | - | % | I(VDD)=50mA;VDD15=3.0V; VDD=3.9V |
| | | - | 88 | - | % | I(VDD)=100mA;VDD15=3.0V; VDD=3.9V |
| | | - | 92 | - | % | I(VDD)=50mA;VDD15=3.0V; VDD=4.5V |
| | | - | 87 | - | % | I(VDD)=100mA;VDD15=3.0V; VDD=4.5V |

### 8.7. VDD15 v.s. Max. Supplied Current (I(VDD)) (One-Battery , TA = 25℃)

| VIN (V) | I(VDD) (mA) | Condition |
|---|---|---|
| 1.0 | 50 | VDD=3.3V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductor) |
| | 30 | VDD=3.9V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductor) |
| 1.2 | 70 | VDD=3.3V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductor) |
| | 50 | VDD=3.9V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductor) |
| 1.5 | 110 | VDD=3.3V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductor) |
| | 90 | VDD=3.9V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductor) |

***** VDD drops about 0.3V in max supplied current condition.

### 8.8. VDD15 v.s. Max. Supplied Current (I(VDD)) (Two-Battery , TA = 25℃)

| VIN (V) | I(VDD) (mA) | Condition |
|---|---|---|
| 1.5 | 40 | VDD=3.9V ; L=22uH/0.5W, ESR = 1 ohm (Color Code Inductance) |
| | 10 | VDD=4.5V ; L=22uH/0.5W, ESR = 1 ohm (Color Code Inductance) |
| 1.8 | 90 | VDD=3.9V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductance) |
| | 70 | VDD=4.5V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductance) |
| 2.4 | 140 | VDD=3.9V ; L=22uH/0.5W , ESR = 1 ohm (Color Code Inductance) |
| | 140 | VDD=4.5V ; L=22uH/0.5W, ESR = 1 ohm (Color Code Inductance) |
| 3.0 | 250 | VDD=3.9V ; L=22uH/0.5W, ESR = 1 ohm (Color Code Inductance) |
| | 190 | VDD=4.5V ; L=22uH/0.5W, ESR = 1 ohm (Color Code Inductance) |

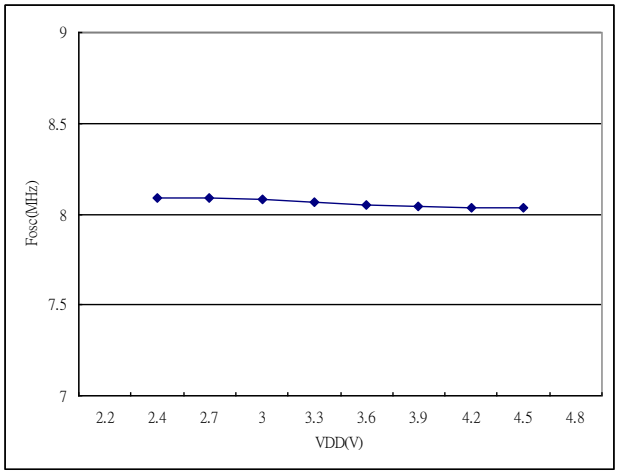
***** VDD drops about 0.3V in max supplied current condition.

### 8.9. (3volt) External Oscillator R Relative $F_{osc}$ (the table is for reference only).

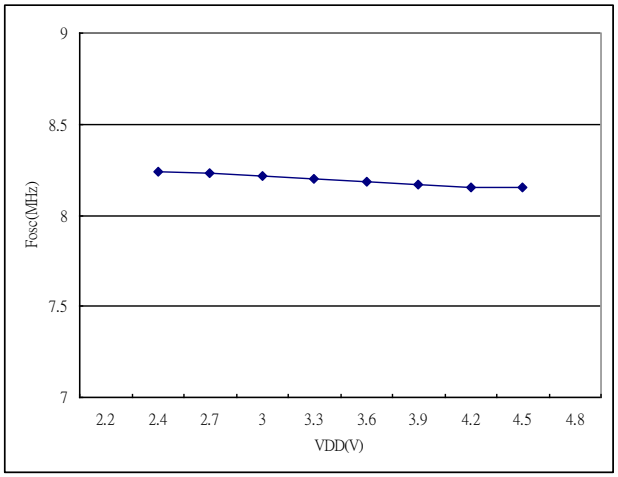
| R(Kohm) | 39 | 51 | 75 |
|---|---|---|---|
| $F_{osc}$ (MHz) | 8 | 6 | 4 |

## 8.10. The Relationship between the FOSC and VDD

### 8.10.1. Frequency vs. VDD (external $R_{OSC}$)

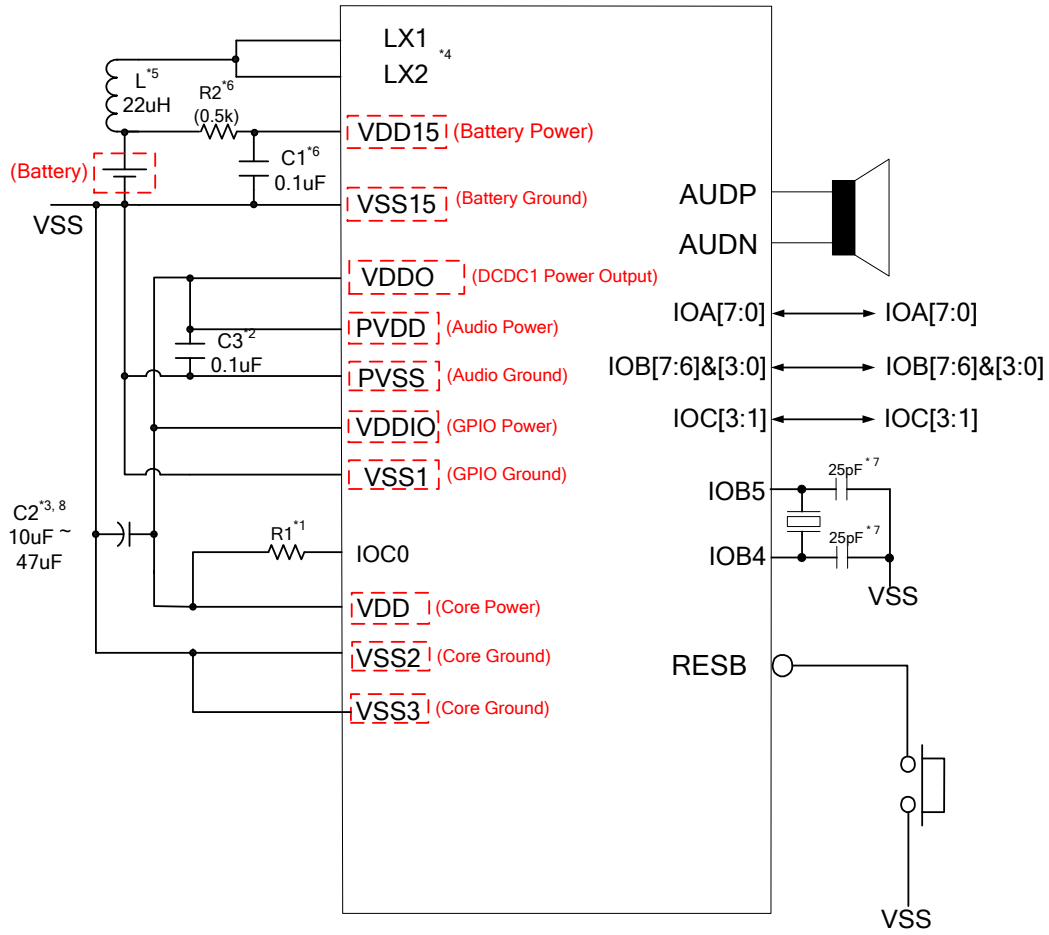



### 8.10.2. Frequency vs. VDD (build-in 8MHz ROSC)



## 9. APPLICATION CIRCUITS

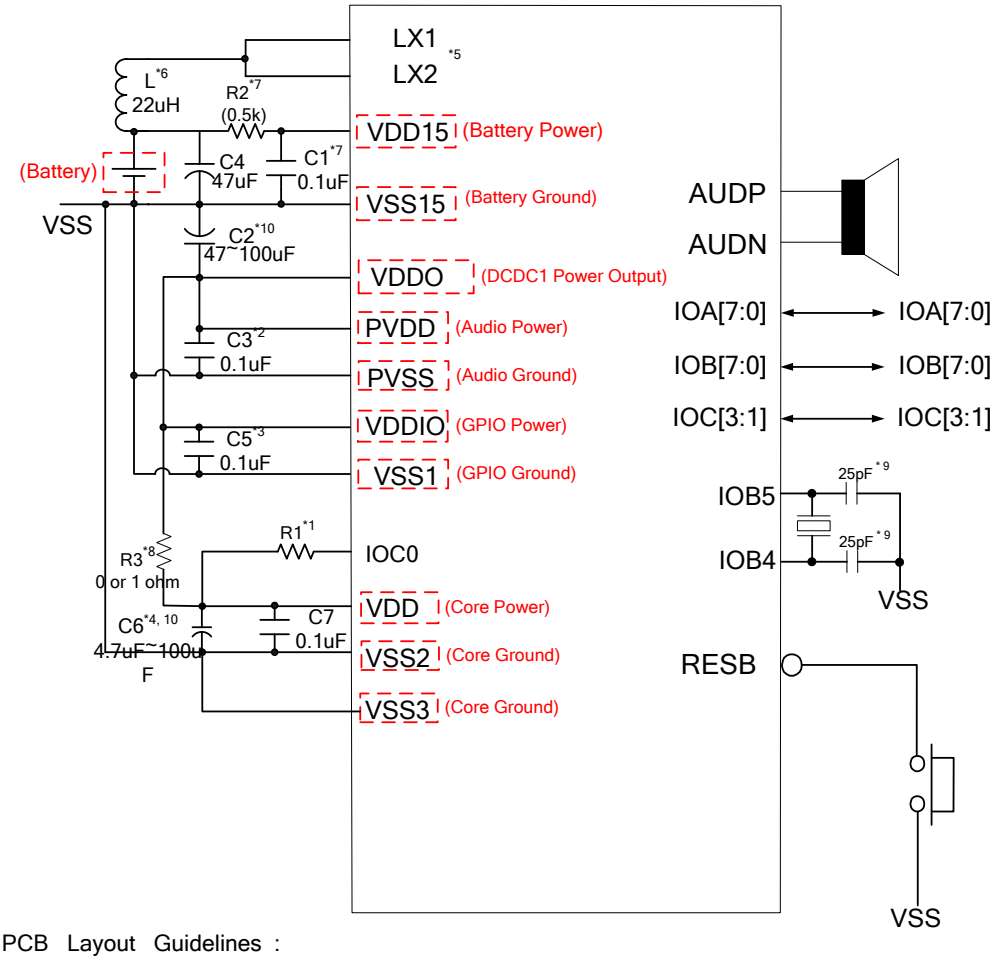
### 9.1. Light Loading and Circuit without Noise for GPC3L170A~GPC3L096A




PCB Layout Guidelines :

1. R1 (used for ROSC) should be as close as possible to IOC0 pin.
2. C3 should be as close as possible to PVDD/PVSS, and C3 can be removed if there is good power line layout on PCB that no harm to sound quality.
3. The value of C2 depends on the loading. 10uF~47uF is the suggested value range. One end of C2 should be placed between VSS1, VSS2, VSS3 and VSS15. The other end of C2 should be placed between VDDO, VDDIO and VDD. C2 should be as close as possible to VDDO/VDDIO/VDD
4. Net between LX1 and LX2 should be as short as possible.
5. L should be as close as possible to VDD15/LX1/LX2. **Please use inductance with lower resistance to gain higher efficiency, 22uH/0.5W@IDC(max)>250mA, DCR<1 ohm is the suggested inductance spec.**
6. R2 and C1 could be removed if do not care BVD flag vibration due to VDD15 bouncing.
7. These capacitor values are for design guidance only. The recommended 32K XTAL features are ESR=11.2~60K and CL1=CL2 =26~36pF (including PCB parasitic loading, for example, user should apply additional 20~30pF on X32I and X32O if PCB parasitic loading is 6pF).
8. **Please use capacitor (C2) with lower resistance to reduce noise, ESR<2 ohm in 0~70C is suggested.**

### 9.2. Heavy Loading or Circuit with Noise for GPC3L170A~GPC3L096A




PCB Layout Guidelines :

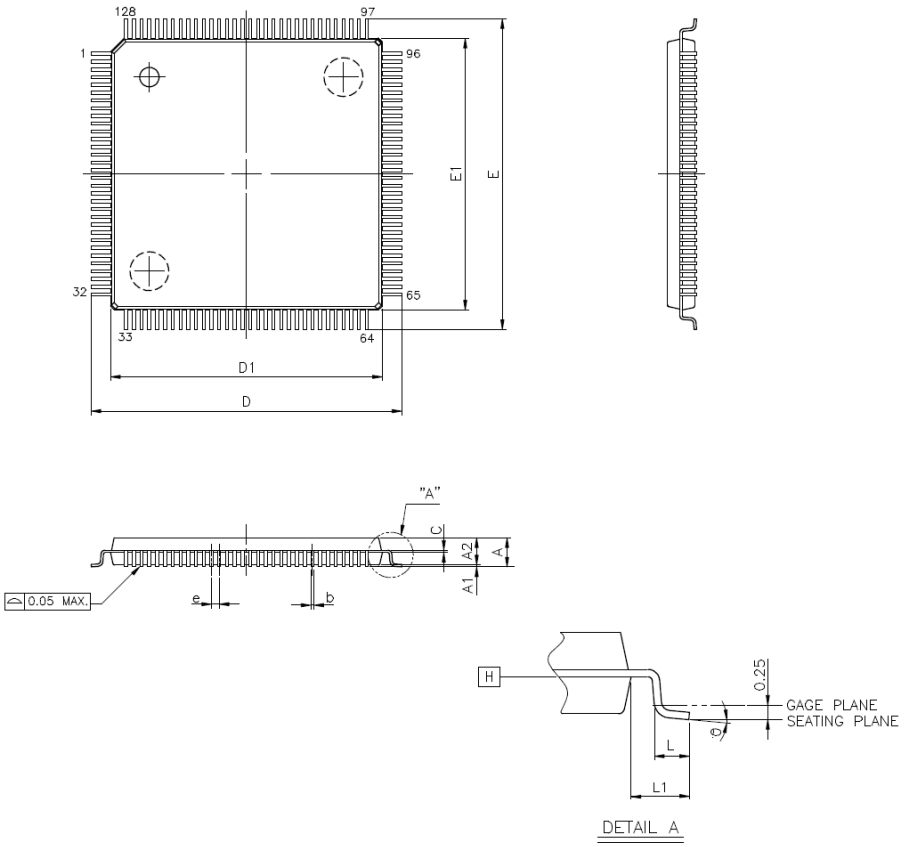
1. R1 (used for ROSC) should be as close as possible to IOC0 pin.
2. C3 should be as close as possible to PVDD/PVSS, and C3 can be removed if there is good power line layout on PCB that no harm to sound quality.
3. C5 should be as close as possible to VDDIO/VSS1, and C5 can be removed if there is good power line layout on PCB that the power stable enough.
4. The value of C6 depends on the loading. 4.7uF~100uF is the suggested value range. C6 should be as close as possible to VDD/VSS2, and C6 can be smaller if there is good power line layout on PCB that the power stable enough.
5. Net between LX1 and LX2 should be as short as possible.
6. L should be as close as possible to VDD15/LX1/LX2. **Please use inductance with lower resistance to gain higher efficiency, 22uH/0.5W@IDC(max)>250mA ,DCR<1 ohm is the suggested inductance spec.**
7. R2 and C1 could be removed if do not care BVD flag vibration due to VDD15 bouncing.
8. R3 with 0 Ohm is suggested for 2 batteries or C6 > 10uF and with 1 Ohm is suggested for 1 battery and C6 < 10uF.
9. These capacitor values are for design guidance only. The recommended 32K XTAL features are ESR=11.2~60K and CL1=CL2 =26~36pF (including PCB parasitic loading, for example, user should apply additional 20~30pF on X32I and X32O if PCB parasitic loading is 6pF).
10. **Please use capacitors (C2 and C6) with lower resistance to reduce noise, ESR<2 ohm in 0~70C is suggested.**

## 10. PACKAGE/PAD LOCATIONS

### 10.1. Ordering Information

| Product Number | Package Type |
|---|---|
| GPC3LXXXX - C | Chip form |
| GPC3LXXXX - NnnV – QL09X | Halogen free LQFP128 package |

### 10.2. Package LQFP128 Information




VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

| SYMBOLS | MIN. | NOM. | MAX. |
|---|---|---|---|
| A | -- | -- | 1.60 |
| A1 | 0.05 | -- | 0.15 |
| A2 | 1.35 | 1.40 | 1.45 |
| b | 0.13 | 0.16 | 0.23 |
| c | 0.09 | -- | 0.20 |
| D | 16.00 BSC | | |
| D1 | 14.00 BSC | | |
| E | 16.00 BSC | | |
| E1 | 14.00 BSC | | |
| e | 0.40 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L1 | 1.00 REF | | |
| θ | 0° | 3.5° | 7° |

NOTES:

1. DATUM PLANE H IS LOCATED AT THE BOTTOM OF THE MOLD PARTING LINE COINCIDENT WITH WHERE THE LEAD EXITS THE BODY.
2. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 mm PER SIDE. DIMENSIONS D1 AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION.

## 11. DISCLAIMER

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## 12. REVISION HISTORY

| Date | Revision # | Description | Page |
|---|---|---|---|
| Jun. 02, 2017 | 1.2 | 1.Add LQFP128 information. | 7, 16 |
| Dec. 20, 2013 | 1.1 | 1.Add notice to capacitors in application circuits.<br>2.Modify “ESR” to “DCR” for inductor impedance.<br>3.Modify VDD max supplied current. | 10, 11, 12,<br>14, 15 |
| Oct. 07, 2013 | 1.0 | Original | |