

Compressed Audio Signal Processor IC with USB Host Controller and Bluetooth

LC786821E

Overview

The LC786821E integrates Arm7TDMI-S[®], USB host processing, SD memory card host processing, compressed audio decode processing, audio signal processing and a flash memory which stores the program for Arm7TDMI-S and the various data. The sophisticated programs in the flash memory for the USB host processing for the SD memory card processing or audio signal processing etc. make the process of external main microcontroller easier and very helpful to develop a much features/high performance audio player system.

Main Features

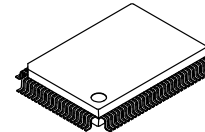
- USB Host/Device Function (Full Speed: 12 Mbps), SD Memory Card Host Function
 - MP3*, WMA*, AAC*, FLAC*, SBC* Decoder Processing Function
 - Audio Input Functions such as Analog (Stereo 3ch)/Digital 3ch Input (Sampling Rate Convertible)
 - Audio Processing Functions such as 20 Bands Equalizer (Stereo 1ch), Subwoofer Processing, High-frequency Range Extendable Filter and etc.
 - Audio Output Functions such as Electrical Volume Output 5 ch (for LF, LR, RF, RR, SW), or DAC Output 3ch (Lch, Rch, SW)
 - Arm7TDMI-S as Internal CPU Core, Flash Memory for Program and Various Data Storage
 - Bluetooth* Audio Processing/Hands-free Function
 - Operational Voltage Source: 3.3 V Single Power Supply
 - Operational Temperature: -40 to +85°C
 - Package: QIP100E (14×20) Pb-Free and Halogen Free type
 - This Device is Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

 - MP3
MPEG Layer-3 Audio Coding
 - WMA
Windows Media Audio
 - AAC
Advanced Audio Coding
 - FLAC
Free Lossless Audio Codec
 - SBC
SubBand Codec
 - Bluetooth profile
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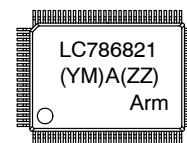
ON Semiconductor[®]

www.onsemi.com



PQFP100 14x20
CASE 122BV

MARKING DIAGRAM



| | |
|----------|------------------------|
| LC786821 | = Specific Device Code |
| Y | = Year of Production |
| M | = Assembly Operation |
| A | = Assembly Site |
| ZZ | = Assembly Lot Number |

The logo for Arm, consisting of the lowercase letters "arm" in a bold, blue, sans-serif font.

Detail Functions

[Compressed Audio Functions]

<Audio Processing Block>

- ◆ MP3 decode (ISO/IEC 11172-3, ISO/IEC 13818-3)
 - Supported sampling rate : MPEG1-Layer1/2/3 (32 kHz, 44.1 kHz, 48 kHz)
MPEG2-Layer1/2/3 (16 kHz, 22.05 kHz, 24 kHz)
MPEG2.5-Layer3 (8 kHz, 11.025 kHz, 12 kHz)
 - Supported bit rate : All Bit Rate (Variable Bit Rate support)
 - MPEG header read supported
- ◆ WMA decode (Version 9.2 standard)
 - Supported sampling rate : 8 kHz to 48 kHz
 - Supported bit rate : 5 kbps to 384 kbps (Variable Bit Rate support)
- ◆ AAC decode (ISO/IEC 14496-3, ISO/IEC 13818-7)
 - Profile : MPEG4-AAC-LowComplexity
 - Supported sampling rate : 8 kHz to 48 kHz
 - Supported bit rate : Monaural 8 kbps to 160 kbps (Variable bit rate support)
Stereo 16 kbps to 320 kbps (Variable bit rate support)

*Depending on the condition, sampling rate can be supported up to 96kHz.
- ◆ FLAC decode (FLAC 1.3.0)
 - Supported format : Block size: up to 4608
Quantized number of bits: 8/16/24 bit per sample
 - Supported sampling rate : 8 kHz to 48 kHz
 - Supported channel : 1/2ch
- ◆ SBC decode (Bluetooth A2DP Ver1.2)
 - Supported format : Block length: 4/8/12/16, Sub-band : 4/8, SNR/Loudness
 - Supported sampling rate : 16 kHz, 32 kHz, 44.1 kHz and 48 kHz
 - Supported bit rate : up to 512 kbps
- ◆ modifiedSBC (mSBC)
 - Capable of voice processing with WBS (WideBandSpeech): Fx = 16 kHz by supporting the mSBC encode/decode function

[Audio Processing Functions]

<Audio Data Digital Processing Block>

- ◆ Equalizer function
 - Supports max of 20-band (stereo 1ch) and unused band can be used for not only the voice output but also used for other processing
- ◆ Supports signal processing for subwoofer
- ◆ Sampling conversion (Fs = 32/44.1/48 kHz) when playing compressed audio, High band extended processing supported
- ◆ Mute ($-\infty$ /-12 dB), attenuator
- ◆ De-emphasis filter
- ◆ Embedded level/peak hold circuit and can hold up to 8 data
- ◆ Noise cancel/Echo cancel function
 - Supports noise cancel/echo cancel at Fs = 8 kHz
- ◆ Supports input/output of Fs = 16 kHz voice data

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<Audio Input Processing Block>

- ◆ Analog Audio data input (3-channels by stereo)
 - Single Ended input : 2 channels
 - Differential input : 1 channel
 - Input Gain : -12.5 dB to +18.5 dB (1 dB step)
 - 24 bit accuracy AD converter
- ◆ Digital audio input (Stereo input: Max of 3 channels)
 - Supports digital 3-line (LR clock, bit clock, audio data) connection and clock can be master or slave
 - Data format supports IIS/MSB first right justified and etc.
 - Input data can support 8 kHz to 96 kHz, and by sampling conversion, converts to the suitable Fs (Playback Fs = 32/44.1/48 kHz etc.)

<Audio Output Processing Block>

- ◆ Analog Audio data output (One channel for stereo, and one channel for Sub-Woofer)
 - Eight-fold over-sampling digital filter (24 bit)
 - Secondary LPF for audio output
- ◆ Electronic Volume/Fader
 - 5ch outputs (Lch-Front (LF)/Rear (LR), Rch-Front (RF)/Rear (RR), Sub-Woofer)
 - Output Range: 0dB to -0dB, -∞
 - 0 dB to -32 dB : Analog control, 0.25 dB step
 - 32 dB to -70 dB : Analog control, 1.0 dB step
 - 70 dB to -90 dB : Digital attenuator control
 - Decrease the noise at the volume change timing by the digital and analog composite control.
 - Individual output for 5 channels control is available
- ◆ Digital Audio data output
 - Digital 3-line interface with IIS/MSB first right justification and etc.
 - LR clock, Bit clock, Data 1
 - Clock can be master or slave
 - Capable of outputting 384 Fs clock

[External Interface Functions]

<USB Host/Device Control Block>

- ◆ Open Host Controller Interface 1.0a
- ◆ Universal Serial Bus Specification 2.0 Full Speed
- ◆ Supports four kinds of transfer type (Control/Bulk/Interrupt/Isochronous)
- ◆ Supports 2 Ports. USB1 = Host or Device, USB2 = Host only
- ◆ USB Charger (USB1 only)
 - Supports detection of CDP (Charging Downstream Port) of USB Charger Specification 1.2
 - Charge (supplying current) is not supported
- ◆ PHY block: Internal Pull-Down/Pull-Up resistors built-in

<SD Memory Card Host Control Block>

- ◆ Multimedia Card Specification v2.11
- ◆ Secure Digital Memory Card Physical Layer Specification v0.96
 - * Individual contract is necessary to use SD memory card controller.

[Internal Microcontroller Functions]

<Sequencer Control>

- ◆ USB, SD memory card playback/write control
USB/SD files analysis, etc.
- ◆ Audio playback control
Compressed audio playback control, various filter control and etc.

<Communication Control between Main Controller>

- ◆ Main communication format is SIO (4-line)
- ◆ Capable of direct control of oscillation stop/start from main microcontroller
- ◆ Capable of some special command can be used even when oscillation is stopped

<Peripheral Interface Block>

- ◆ GPIO ports 37 ports maximum
(Shared with other functions. Some part of pins can be used even when the clock is halted)
- ◆ External interrupt pins 4 pins maximum (Shared with other functions)
- ◆ Serial interface

| | | |
|------|------------------------------------------|------------|
| SIO | clock synchronized full duplex (3 lines) | 3 channels |
| UART | full duplex | 2 channels |
| IIC | master function | 1 channel |

<Program Memory Block>

- ◆ Program memory for the internal sequencer built-in
Program version up from the external media (USB and etc.) or main controller is available.

<Others>

- ◆ Watch Dog Timer
Notify to outside from the pin or internal reset.
- ◆ Sleep Mode (2 kinds)
 - (1) Only CPU core operates at slow clock and clocks for other blocks are stopped.
 - (2) All clocks are stopped by the main microcontroller control.

[Useful Functions for CD-DSP IC Connection Usage]

<CD TEXT Processing Block>

- ◆ Buffers CD-TEXT data
- ◆ Starts buffering from desired ID3/ID4 of CD-TEXT data.
* Needs to connect subcode synchronization signals (SBSY and SFSY), shift clock (SBCK) and data (PW).

<CD-ROM Processing Block>

- ◆ Up to 4× speed operation available
- ◆ Supports CD-ROM decoding (Mode1, Mode2 <form1, form2>)
- ◆ Supports output of CD-ROM decoded data
* Needs to connect three signals (LRCK, BCK and DATA).
It is possible to connect C2 error flag if needed.

[Others]

<Internal Power Supply>

- ◆ Regulator for internal blocks (V_{DD} for internal = 1.2 V, V_{DD} for Flash = 1.8 V) built-in

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ABSOLUTE MAXIMUM RATINGS at $T_A = 25^\circ\text{C}$, $DVSS = AVSS1 = AVSS2 = XVSS = 0\text{ V}$

| Item | Symbol | Pin Name | Condition | Ratings | Unit |
|-----------------------------|---------------------|--------------------------------------|---------------------------------------------------------|------------------|------------------|
| Maximum supply voltage | $V_{DD\text{ max}}$ | DVDD, AVDD1, AVDD2, XVDD, VVDD2 | | -0.3 to +3.95 | V |
| Input voltage | V_{IN} | All digital input pins | | -0.3 to DVDD+0.3 | |
| Output voltage | V_{OUT} | All digital output/input-output pins | | -0.3 to DVDD+0.3 | |
| Allowable power dissipation | $P_d\text{ max}$ | | $T_a \leq 85^\circ\text{C}$ Mounted reference PCB(*) | 519 | mW |
| Operating temperature | T_{opr} | | | -40 to +85 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | | -40 to +125 | |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

*Reference PCB: 114.3mm × 76.1mm × 1.6mm, glass epoxy resin.

ALLOWABLE OPERATING RANGES at $T_A = -40^\circ\text{C}$ to 85°C , $DVSS = AVSS1 = AVSS2 = XVSS = 0\text{ V}$

| Item | Symbol | Pin Name | Condition | MIN | TYP | MAX | Unit |
|--------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------|---------|-----------|------|
| Supply voltage | V_{DD1} | DVDD, AVDD1, AVDD2, XVDD, VVDD2 | | 3.00 | | 3.60 | V |
| High-level input voltage | V_{IH} | RESB, SIFCK, SIFDI, SIFDO, SIFCE, BUSYB, GP03, GP04, GP05, GP06, GP07, GP10, GP11, GP12, GP13, GP14, GP15, JTMS, JTRSTB, JTCK, JTDI, GP30, GP31, GP32, GP33, GP34, GP35, GP36, GP37, GP40, GP41, GP42, GP43, GP44, GP45, GP46, GP47, GP50, GP51, GP52, GP53 | Schmitt | 2.00 | | V_{DD1} | |
| Low-level input voltage | V_{IL} | RESB, SIFCK, SIFDI, SIFDO, SIFCE, BUSYB, GP03, GP04, GP05, GP06, GP07, GP10, GP11, GP12, GP13, GP14, GP15, JTMS, JTRSTB, JTCK, JTDI, GP30, GP31, GP32, GP33, GP34, GP35, GP36, GP37, GP40, GP41, GP42, GP43, GP44, GP45, GP46, GP47, GP50, GP51, GP52, GP53, TEST0, TEST1 | Schmitt | 0.00 | | 0.80 | |
| Oscillator Frequency | FX | XIN XOUT | Oscillator circuit | | 12.0000 | | MHz |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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ELECTRICAL CHARACTERISTICS at $T_A = -40^{\circ}\text{C}$ to 85°C , $V_{DD1} = 3.0\text{ V}$ to 3.6 V , $DVSS = AVSS1 = AVSS2 = XVSS = 0\text{ V}$

| Item | Symbol | Pin Name | Condition | MIN | TYP | MAX | Unit |
|-----------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|-------------------|-----|-------|------------------|
| Current drain | I_{DD1} | DVDD, AVDD1, AVDD2, XVDD, VVDD2 | | | 100 | 150 | mA |
| High-level input current | I_{IH} | RESB, SIFCK, SIFDI, SIFDO, SIFCE, BUSYB, GP03, GP04, GP05, GP06, GP07, GP10, GP11, GP12, GP13, GP14, GP15, JTMS, JTRSTB, JTCK, JTDI, GP30, GP31, GP32, GP33, GP34, GP35, GP36, GP37, GP40, GP41, GP42, GP43, GP44, GP45, GP46, GP47, GP50, GP51, GP52, GP53 | Schmitt $V_{IN} = V_{DD1}$ Built-in Pull-down resistor OFF | | | 10.00 | μA |
| Low-level input current | I_{IL} | RESB, SIFCK, SIFDI, SIFDO, SIFCE, BUSYB, GP03, GP04, GP05, GP06, GP07, GP10, GP11, GP12, GP13, GP14, GP15, GP30, GP31, GP32, GP33, GP34, GP35, GP36, GP37, GP40, GP41, GP42, GP43, GP44, GP45, GP46, GP47, GP50, GP51, GP52, GP53, JTMS, JTRSTB, JTCK, JTDI, TEST0, TEST1 | Schmitt $V_{IN} = 0.0\text{ V}$ | -10.00 | | | |
| High-level output voltage | $V_{OH(1)}$ | GP04, GP05, GP06, GP07, GP12, GP13, GP14, GP15, GP30, GP31, GP32, GP33, GP34, GP35, GP36, GP37, GP40, GP41, GP42, GP43, GP44, GP45, GP46, GP47, GP50, GP51, GP52, GP53 | CMOS $I_{OH} = -2\text{ mA}$ | V_{DD1} -0.6 | | | V |
| | $V_{OH(2)}$ | SIFDI, SIFDO, SIFCE, BUSYB, GP03, GP10, GP11, JTDO, JTRTCK | CMOS $I_{OH} = -4\text{ mA}$ | | | | |
| Low-level output voltage | $V_{OL(1)}$ | GP04, GP05, GP06, GP07, GP12, GP13, GP14, GP15, GP30, GP31, GP32, GP33, GP34, GP35, GP36, GP37, GP40, GP41, GP42, GP43, GP44, GP45, GP46, GP47, GP50, GP51, GP52, GP53 | CMOS $I_{OL} = 2\text{ mA}$ | | | 0.40 | V |
| | $V_{OL(2)}$ | SIFDI, SIFDO, SIFCE, BUSYB, GP03, GP10, GP11, JTDO, JTRTCK | CMOS $I_{OL} = 4\text{ mA}$ | | | 0.40 | V |
| Built-in Pull-down resistor | RPD | SIFDO, SIFCE, BUSYB, GP03, GP04, GP05, GP06, GP07, GP10, GP11, GP12, GP13, GP14, GP15, GP30, GP31, GP32, GP33, GP34, GP35, GP36, GP37, GP40, GP41, GP42, GP43, GP44, GP45, GP46, GP47, GP50, GP51, GP52, GP53 | | 50 | 100 | 200 | $\text{k}\Omega$ |

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ELECTRICAL CHARACTERISTICS at $T_A = -40^{\circ}\text{C}$ to 85°C , $V_{DD1} = 3.0\text{ V}$ to 3.6 V , $DVSS = AVSS1 = AVSS2 = XVSS = 0\text{ V}$
(continued)

| Item | Symbol | Pin Name | Condition | MIN | TYP | MAX | Unit |
|----------------------------|----------|----------|-----------|--------|-------|-------|---------------|
| Output off-leakage current | IOFF (1) | AFILT | Hi-Z Out | -10.00 | | 10.00 | μA |
| | IOFF (2) | SIFDO | Hi-Z Out | -10.00 | | 10.00 | |
| Charge pump output current | IAFH | AFILT | | | 195.0 | | μA |
| | IAFL | AFILT | | | 195.0 | | |

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.

NOTE: Place an internal pull-down resistor or external pull-down resistor or external pull-up resistor to the SIFDO pin if its output condition is set to 3-State mode.

PIN ASSIGNMENT

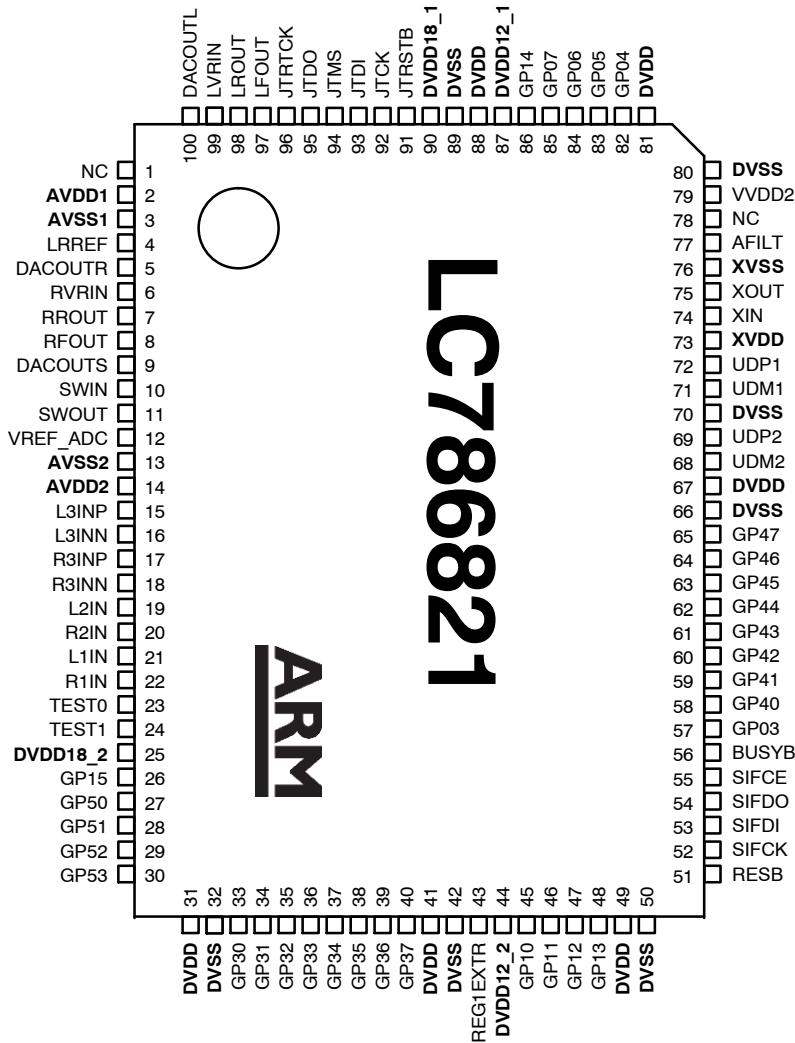


Figure 1. Pin Assignment

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PIN DESCRIPTION

| Pin No. | Pin name | I/O | State when "Reset" | Function |
|---------|----------|-----|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | NC | – | – | NC pin. This pin must be left open |
| 2 | AVDD1 | – | – | Analog system (ADC) power supply |
| 3 | AVSS1 | – | – | Analog system (ADC) ground. This pin must be connected to the 0 V level |
| 4 | LRREF | AO | AVDD1/2 | Capacitor connection pin for reference voltage for Audio DAC and Electronic Volume |
| 5 | DACOUTR | AO | Unknown | Audio DAC : Right channel output |
| 6 | RVRIN | AI | Input | Electronic Volume : Right channel volume input |
| 7 | RROUT | AO | Unknown | Electronic Volume : Right channel Rear output |
| 8 | RFOUT | AO | Unknown | Electronic Volume : Right channel Front output |
| 9 | DACOUTS | AO | Unknown | Audio DAC : Sub-Woofer output |
| 10 | SWIN | AI | Input | Electronic Volume : Sub-Woofer volume input |
| 11 | SWOUT | AO | Unknown | Electronic Volume : Sub-Woofer output |
| 12 | VREF_ADC | AO | AVDD2/2 | Capacitor connection pin for audio ADC reference voltage |
| 13 | AVSS2 | – | – | Analog system (ADC) ground. This pin must be connected to the 0V level |
| 14 | AVDD2 | – | – | Analog system (ADC) power supply |
| 15 | L3INP | AI | Input | Analog stereo Left channel Differential input (Positive) / Analog stereo Left channel Single Ended input |
| 16 | L3INN | AI | Input | Analog stereo Left channel Differential input (Negative) |
| 17 | R3INP | AI | Input | Analog stereo Right channel Differential input (Positive) / Analog stereo Right channel Single Ended input |
| 18 | R3INN | AI | Input | Analog stereo Right channel Differential input (Negative) |
| 19 | L2IN | AI | Input | Analog stereo Left channel Single Ended input |
| 20 | R2IN | AI | Input | Analog stereo Right channel Single Ended input |
| 21 | L1IN | AI | Input | Analog stereo Left channel Single Ended input |
| 22 | R1IN | AI | Input | Analog stereo Right channel Single Ended input |
| 23 | TEST0 | I | Input | Test input. This pin must be connected to the 0 V level. |
| 24 | TEST1 | I | Input | Test input. This pin must be connected to the 0 V level. |
| 25 | DVDD18_2 | AO | H | Capacitor connection pin for internal regulator (1.8 V for Flash) |
| 26 | GP15 | I/O | Input(L) | General purpose I/O port with pull down resistor Various signal monitoring output |
| 27 | GP50 | I/O | Input(L) | General purpose I/O port with pull down resistor LR clock input/output 1 for Audio interface LR clock input 1 for Stream data interface Transmit data output for serial communication 3 (exclusive with GP34) Over current detection signal input for USB 1 (exclusive with GP44) |
| 28 | GP51 | I/O | Input(L) | General purpose I/O port with pull down resistor Bit clock input/output 1 for Audio interface Bit clock input/output 1 for Stream data interface Master clock output for serial communication 3 (exclusive with GP35) Power supply signal output for USB 1 (exclusive with GP45) |
| 29 | GP52 | I/O | Input(L) | General purpose I/O port with pull down resistor Data input/output 1 for Audio interface Data input 1 for Stream data interface Receive data input for serial communication 3 (exclusive with GP36) Over current detection signal input for USB 2 (exclusive with GP46) |
| 30 | GP53 | I/O | Input(L) | General purpose I/O port with pull down resistor Clock (Fs384) input/output 1 for Audio DAC Request flag input/output 1 for Stream data interface Power supply signal output for USB 2 (exclusive with GP47) |

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PIN DESCRIPTION (continued)

| Pin No. | Pin name | I/O | State when "Reset" | Function |
|---------|----------|-----|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31 | DVDD | – | – | Digital system power supply |
| 32 | DVSS | – | – | Digital system ground. This pin must be connected to the 0V level |
| 33 | GP30 | I/O | Input(L) | General purpose I/O port with pull down resistor UART2 data transmit (exclusive with GP46) External interruption function 3 (exclusive with GP13, GP31, GP43 and GP47) LR clock input/output 2 for Audio interface LR clock input 2 for Stream data interface Data output of PCM for Bluetooth module communication |
| 34 | GP31 | I/O | Input(L) | General purpose I/O port with pull down resistor UART2 data receive (exclusive with GP47) External interruption function 3 (exclusive with GP13, GP30, GP43 and GP47) Bit clock input/output 2 for Audio interface Bit clock input/output 2 for Stream data interface LRCK input/output of PCM for Bluetooth module communication |
| 35 | GP32 | I/O | Input(L) | General purpose I/O port with pull down resistor Data 1 input/output for SD memory card Data input/output 2 for Audio interface Data input/output 2 for Stream data interface BCK input/output of PCM for Bluetooth module communication |
| 36 | GP33 | I/O | Input(L) | General purpose I/O port with pull down resistor Data 0 input/output for SD memory card Clock(Fs384) input/output 2 for Audio DAC Request flag input/output 2 for Stream data interface Data input of PCM for Bluetooth module communication |
| 37 | GP34 | I/O | Input(L) | General purpose I/O port with pull down resistor Clock output for SD memory card Transmit data output for serial communication 3 (exclusive with GP50) Block synchronization signal (SBSY) input for CD subcode (exclusive with GP44) |
| 38 | GP35 | I/O | Input(L) | General purpose I/O port with pull down resistor Command input/output for SD memory card Master clock output for serial communication 3 (exclusive with GP51) Frame synchronization signal (SFSY) input for CD subcode (exclusive with GP45) |
| 39 | GP36 | I/O | Input(L) | General purpose I/O port with pull down resistor Data 3 input/output for SD memory card Receive data input for serial communication 3 (exclusive with GP52) Data (PW) input for CD subcode (exclusive with GP46) |
| 40 | GP37 | I/O | Input(L) | General purpose I/O port with pull down resistor Data 2 input/output for SD memory card Data transmit clock (SBCK) output for CD subcode (exclusive with GP47) |
| 41 | DVDD | – | – | Digital system power supply |
| 42 | DVSS | – | – | Digital system ground. This pin must be connected to the 0V level. |
| 43 | REG1EXTR | AO | Unknown | Reserved pin for internal regulator. This pin must be left open. |
| 44 | DVDD12_2 | AO | H | Capacitor connection pin for internal regulator (1.2 V for internal) |
| 45 | GP10 | I/O | Input(L) | General purpose I/O port with pull down resistor UART1 data transmit (exclusive with GP06) IIC (master) clock output (exclusive with GP04 and GP40) |

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PIN DESCRIPTION (continued)

| Pin No. | Pin name | I/O | State when "Reset" | Function |
|---------|----------|-----|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46 | GP11 | I/O | Input(L) | General purpose I/O port with pull down resistor UART1 data receive (exclusive with GP07) IIC (master) data input/output (exclusive with GP05 and GP41) |
| 47 | GP12 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 2 (exclusive with GP42 and GP46) Clock control input 1 Watch Dog Timer state monitor output |
| 48 | GP13 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 3 (exclusive with GP30, GP31, GP43 and GP47) Clock control input 2 Watch Dog Timer state monitor output |
| 49 | DVDD | – | – | Digital system power supply |
| 50 | DVSS | – | – | Digital system ground. This pin must be connected to the 0 V level |
| 51 | RESB | I | – | IC reset input ("L"–active) This pin must be set low once after power is first applied. |
| 52 | SIFCK | I | Input | Host–I/F Data transmit clock input for serial communication 1 Data transmit clock input for IIC communication |
| 53 | SIFDI | I/O | Input | Host–I/F Data input for serial communication 1 Data input/output for IIC communication |
| 54 | SIFDO | I/O | Input | Host–I/F Data output for serial communication 1 (CMOS or 3–State output) General purpose I/O port with pull down resistor (GP00) |
| 55 | SIFCE | I/O | Input | Host –I/F Enable signal input for serial communication 1 ("H"–active) General purpose I/O port with pull down resistor (GP01) |
| 56 | BUSYB | I/O | Input(L) | Host –I/F System busy signal output ("L"–active) General purpose I/O port with pull down resistor (GP02) External interruption function 0 (exclusive with GP40 and GP44) |
| 57 | GP03 | I/O | Input(L) | General purpose I/O port with pull down resistor Watch Dog Timer state monitor output USB device detection flag output External interruption function 1 (exclusive with GP14, GP41 and GP45) |
| 58 | GP40 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 0 (exclusive with GP02 and GP44) IIC (master) clock output (exclusive with GP04 and GP10) LR clock input/output 3 for Audio interface LR clock input 3 for Stream data interface |
| 59 | GP41 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 1 (exclusive with GP03, GP14 and GP45) IIC (master) data input/output (exclusive with GP05 and GP11) Bit clock input/output 3 for Audio interface Bit clock input/output 3 for Stream data interface |
| 60 | GP42 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 2 (exclusive with GP12 and GP46) Watch Dog Timer state monitor output Data input/output 3 for Audio interface Data input/output 3 for Stream data interface |

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PIN DESCRIPTION (continued)

| Pin No. | Pin name | I/O | State when "Reset" | Function |
|---------|----------|-----|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 61 | GP43 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 3 (exclusive with GP13, GP30, GP31 and GP47) Clock (Fs384) input/output 3 for Audio DAC Request flag input/output 3 for Stream data interface |
| 62 | GP44 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 0 (exclusive with GP02 and GP40) Over current detection signal input for USB 1 (exclusive with GP50) Block synchronization signal (SBSY) input for CD subcode (exclusive with GP34) |
| 63 | GP45 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 1 (exclusive with GP03, GP14 and GP41) Power supply signal output for USB 1 (exclusive with GP51) Frame synchronization signal (SFSY) input for CD subcode (exclusive with GP35) |
| 64 | GP46 | I/O | Input(L) | General purpose I/O port with pull down resistor UART2 data transmit (exclusive with GP30) External interruption function 2 (exclusive with GP12 and GP42) Over current detection signal input for USB 2 (exclusive with GP52) Emphasis flag input/output for Audio (exclusive with GP14) Data (PW) input for CD subcode (exclusive with GP36) |
| 65 | GP47 | I/O | Input(L) | General purpose I/O port with pull down resistor UART2 data receive (exclusive with GP31) External interruption function 3 (exclusive with GP13, GP30, GP31 and GP43) Power supply signal output for USB 2 (exclusive with GP53) CD_C2 error flag input (exclusive with GP14) Data transmit clock (SBCK) output for CD subcode (exclusive with GP37) |
| 66 | DVSS | - | - | Digital system ground. This pin must be connected to the 0V level. |
| 67 | DVDD | - | - | Digital system power supply |
| 68 | UDM2 | I/O | - | USB data input/output 2 D- signal connection |
| 69 | UDP2 | I/O | - | USB data input/output 2 D+ signal connection |
| 70 | DVSS | - | - | Digital system ground. This pin must be connected to the 0 V level |
| 71 | UDM1 | I/O | - | USB data input/output 1 D- signal connection Charge detection (CDP detection) input/output 1 |
| 72 | UDP1 | I/O | - | USB data input/output 1 D+ signal connection Charge detection (CDP detection) input/output 1 |
| 73 | XVDD | - | - | Oscillator power supply |
| 74 | XIN | I | Oscillation | X'tal oscillator connection |
| 75 | XOUT | O | Oscillation | X'tal oscillator connection |
| 76 | XVSS | - | - | Oscillator ground. This pin must be connected to the 0 V level |
| 77 | AFILT | AO | Unknown | PLL2 charge pump output (for filter connection) |
| 78 | NC | - | - | NC pin. This pin must be left open. |
| 79 | VVDD2 | - | - | PLL2 power supply |
| 80 | DVSS | - | - | Digital system ground. This pin must be connected to the 0 V level |
| 81 | DVDD | - | - | Digital system power supply |
| 82 | GP04 | I/O | Input(L) | General purpose I/O port with pull down resistor Master clock output for serial communication 2 IIC (master) clock output (exclusive with GP10 and GP40) |

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PIN DESCRIPTION (continued)

| Pin No. | Pin name | I/O | State when "Reset" | Function |
|---------|----------|-----|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 83 | GP05 | I/O | Input(L) | General purpose I/O port with pull down resistor Receive data input for serial data communication 2 IIC (master) data input/output (exclusive with GP11 and GP41) |
| 84 | GP06 | I/O | Input(L) | General purpose I/O port with pull down resistor Transmit data output for serial communication 2 UART1 data transmit (exclusive with GP10) |
| 85 | GP07 | I/O | Input(L) | General purpose I/O port with pull down resistor UART1 data receive (exclusive with GP11) |
| 86 | GP14 | I/O | Input(L) | General purpose I/O port with pull down resistor External interruption function 1 (exclusive with GP03, GP41 and GP45) Watch Dog Timer state monitor output USB device detection flag output Emphasis flag input/output for Audio (exclusive with GP46) CD_C2 error flag input (exclusive with GP47) |
| 87 | DVDD12_1 | AO | H | Capacitor connection pin for internal regulator (1.2 V for internal) |
| 88 | DVDD | - | - | Digital system power supply |
| 89 | DVSS | - | - | Digital system ground. This pin must be connected to the 0 V level |
| 90 | DVDD18_1 | AO | H | Capacitor connection pin for internal regulator (1.8 V for Flash) |
| 91 | JTRSTB | I | Input | JTAG reset input (Connect to pull-down resistor or 0 V level in normal mode) |
| 92 | JTCK | I | Input | JTAG clock input (Connect to pull-down resistor or 0 V level in normal mode) |
| 93 | JTDI | I | Input | JTAG data input (Connect to pull-down resistor or 0 V level in normal mode) |
| 94 | JTMS | I | Input | JTAG mode input (Connect to pull-down resistor or DVDD level in normal mode) |
| 95 | JTDO | O | L | JTAG data output (Leave open in normal mode) |
| 96 | JTRTCK | O | L | JTAG return clock output (Leave open in normal mode) |
| 97 | LFOUT | AO | Unknown | Electronic Volume : Left channel Front output |
| 98 | LROUT | AO | Unknown | Electronic Volume : Left channel Rear output |
| 99 | LVRIN | AI | Input | Electronic Volume : Left channel volume input |
| 100 | DACOUTL | AO | Unknown | Audio DAC : Left channel output |

NOTES:

1. For unused pins :

- ◆ The unused input pins must be connected to the GND (0 V) level if there is no individual note in the above table.
- ◆ The unused output pins must be left open (No connection) if there is no individual note in the above table.
- ◆ The unused input/output pins must follow the below conditions if there is no individual note in the above table:

Input setting

Leave open with internal pull-down resistor ON.

With using internal pull-down resistor OFF, connect to GND (0 V) or connect to power pins for I/O.

However, use of individual pull-up or pull-down resistor is recommended as fail-safe.

Output setting

Leave them open.

2. For power supply pins:

- ◆ Same voltage level must be supplied to DVDD, AVDD1, AVDD2, XVDD and VVDD2 power supply pins.
(Refer to "Allowable operating ranges")

3. For "Reset" condition:

- ◆ This IC is not reset only by making the RESB pin "Low".
Refer to "Power on and Reset control" for detail of "Reset" condition.

4. For "Analog Source" unused pins (15 pin to 22 pin) :

- ◆ The "Analog Source" unused pins (15 pin to 22 pin) must be connected to the GND (0V) level through the input coupling capacitor or be left open (No connection).

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BLOCK DIAGRAM

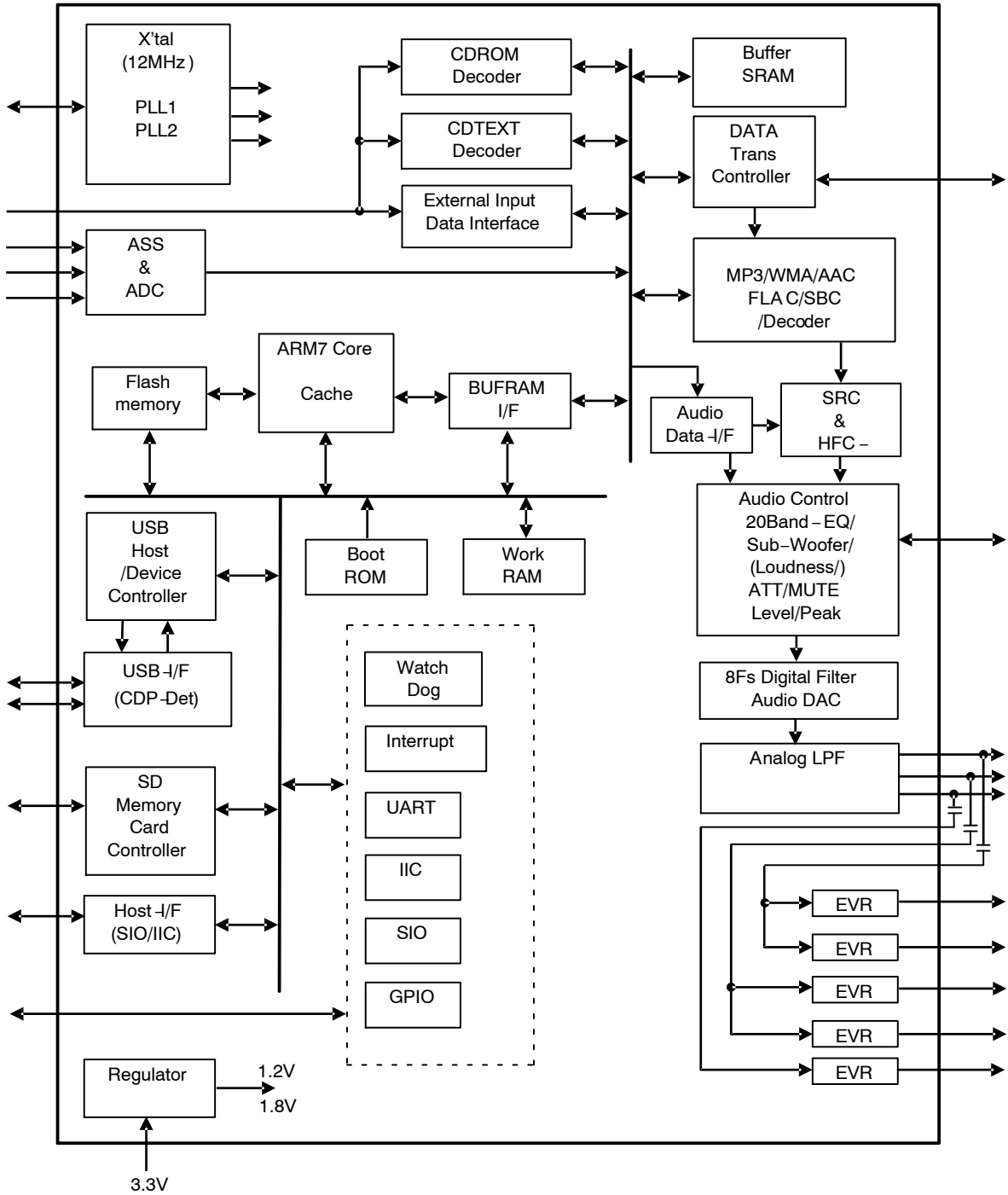


Figure 2. Block Diagram

Power-On/Reset Control

• Notes on Power-On

1. Regarding Reset Pin

To stabilize the operation condition of the internal FlashROM, RESB pin must need to be “L”.

If RESB pin is “H” at the Power-On, operation condition of the Flash memory becomes unstable and the operation of this LSI becomes unstable. In this case, Reset by RESET pin control does not return to the normal state, RESB pin must be “L” at the Power-On

2. Regarding Volume Out

Volume output becomes unknown state when Power-On, external circuit must care by muting/etc. from external circuit

Power-On/Power-Down/Reset Timing

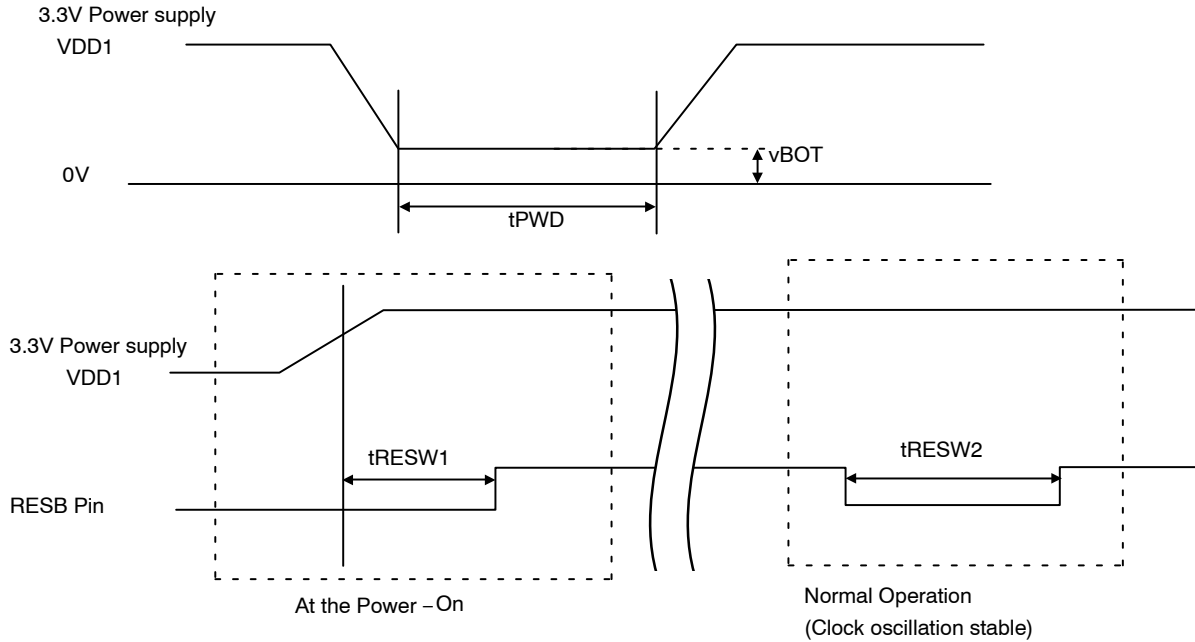


Figure 3.

| Parameter | Symbol | Min | Typ | Max | Unit |
|-----------------------------------------------|-------------|-----|-----|-----|------|
| Power-On rise time | t_{PWD} | 10 | | | ms |
| Power-Down fall time | v_{BOT} | 0 | | 0.2 | V |
| Reset period (at Power-On) | t_{RESW1} | 20 | | | ms |
| Reset period (When normal operation) (Note 5) | t_{RESW2} | 1 | | | ms |

5. Reset period at normal operation is the period that clock is stably oscillating. Need to care about clock stable time when making clock OFF by commands.

– Regarding RESB pin control and internal Flash memory

As stated above, reset of the operation state of the flash memory in this LSI cannot be controlled by only RESB pin, and needs Power-On-Reset. Therefore, when flash memory goes to runaway state during the power is on, Power-On-Reset must be done. In this case, users must power off the LSI and execute the Power-On-Reset.

On the other hand, reset control by RESB pin is effective to the circuit other than the flash memory. By making RESB pin to “L” for the time period stated above with the stable clock, the circuit except flash memory is initialized. Also, by this operation, flash memory becomes stand-by state and states of the memory cells are kept

Microcontroller Interface

Reception/Transmission from the host microcontroller is done by the SPI synchronous SIO communication.

The format of the data transmission is as below

- Code of M5 to M0 at the ModeCode transmission must be followed by the specification of the internal software inside this LSI.

When data input in M5 to M0 and value in the internal register matches, SIFDO becomes “L” (Ack) and communication will be enabled. If no match, SIFDO becomes “H” (Nack) and communication will not be enabled.

- Judgement whether command transmission or reception will be done by the 7th bit data of the ModeCode transmission. “L” means command transmission and “H” means data reception
- Need to care the communication timing specification because the specification differs by operational mode (normal / low speed) of the internal microcontroller

Communication Interface with the Host Microcontroller

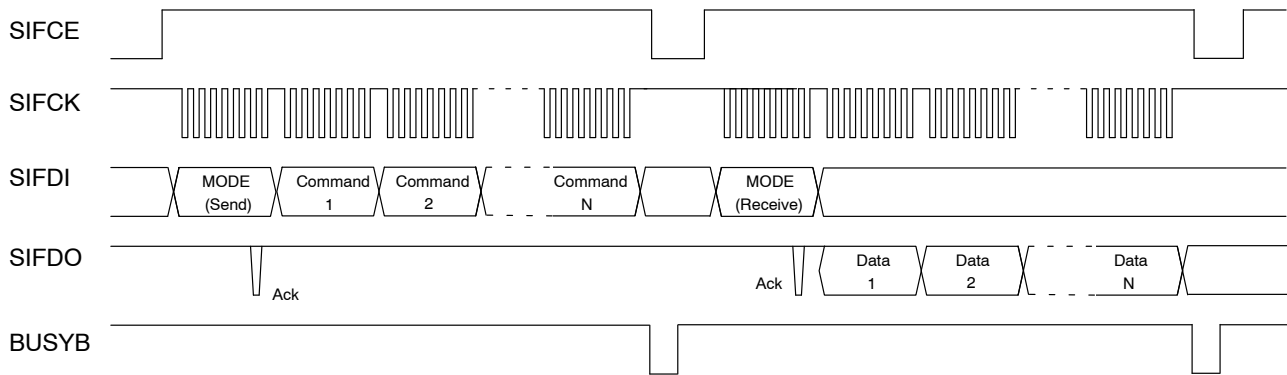


Figure 4.

Transmission/Reception Format with the Host Microcontroller

1. Host: Command Transmission

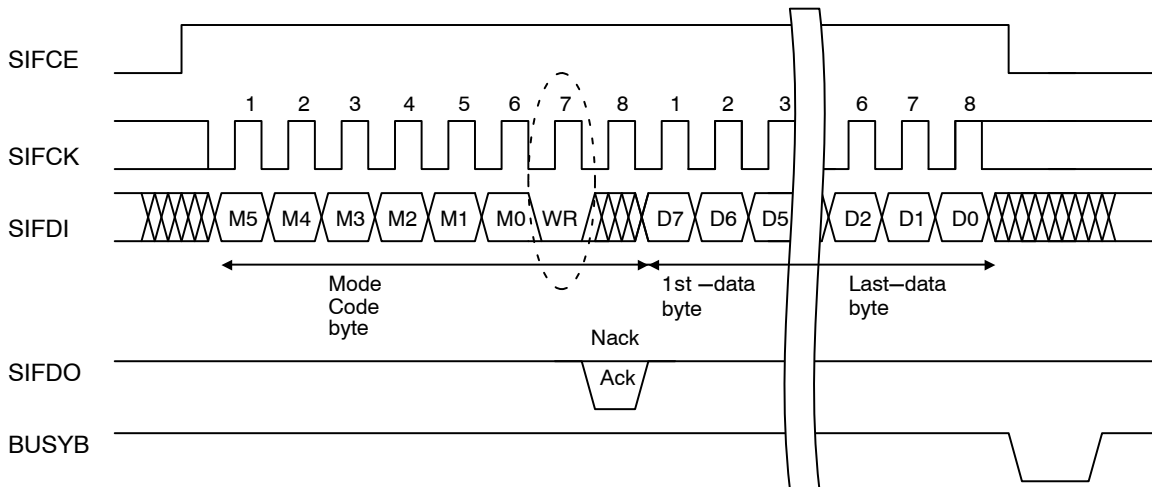


Figure 5.

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2. Host: Data reception

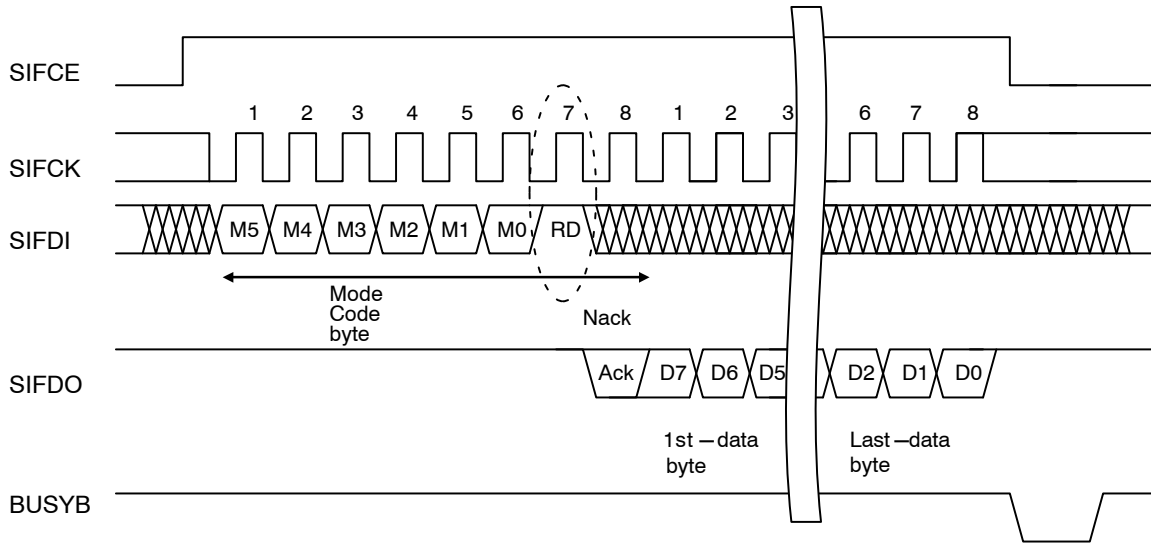


Figure 6.

LC786821E

Characteristics of Communication Timing With Host Microcontroller

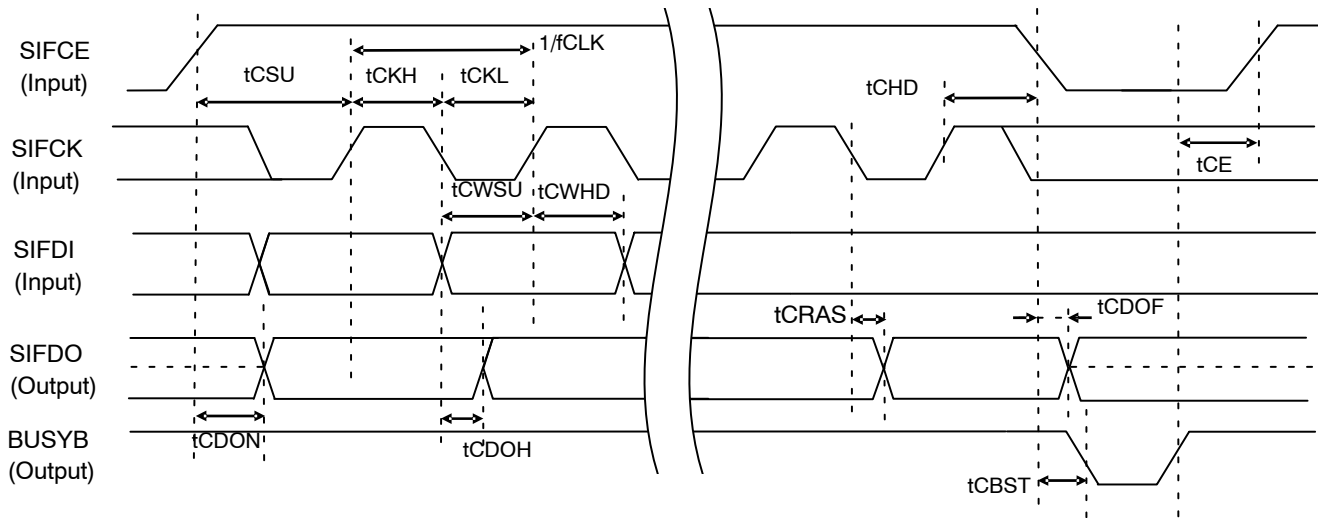


Figure 7.

| Parameter | Symbol | Pin Names | Min | Typ | Max | Unit |
|------------------------------------|--------|-----------------|------------|-----|--------------|------|
| Communication Clock Frequency | fCLK | SIFCK | | | 3.3 0.725 | MHz |
| Communication Clock "H" Period | tCKH | SIFCK | 150 690 | | | ns |
| Communication Clock "L" Period | tCKL | SIFCK | 150 690 | | | |
| Communication Start Allowable Time | tCE | BUSYB, SIFCE | 0 0 | | | |
| Communication Start Set Up Time | tCSU | SIFCE, SIFCK | 100 200 | | | |
| Communication End Hold Time | tCHD | SIFCE, SIFCK | 100 200 | | | |
| Data Input Set Up Time | tCWSU | SIFDI, SIFCK | 75 75 | | | |
| Data Input Hold Time | tCWHD | SIFDI, SIFCK | 75 200 | | | |
| Data Output "H" Level Rise Time | tCDOH | SIFDO, SIFCK | | | 100 350 | |
| Data Output Settle Time | tCRAS | SIFDO, SIFCK | | | 100 350 | |
| Output ON Settle Timer * (Note 6) | tCDON | SIFDO, SIFCE | | | 100 100 | |
| Output OFF Settle Timer * (Note 6) | tCDOF | SIFDO, SIFCE | | | 150 150 | |
| BUSYB "L" Level Settle Time | tCBST | BUSYB | | | 150 350 | |

*Internal Microcontroller Operation Mode

Upper Value:

Normal Mode

Lower Value: Low Speed Mode

6. tCDON/tCDOF are available only when setting SIFDO pin to 3-State output.

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IIC can be used for the transmission/reception from the host microcontroller.

Supported modes are;

Normal Mode : 100 kbps

High Speed Mode : 400 kbps

Slave address is 0x16 (7 bit value).

Condition for Communication(IIC) Timing With Host Microcontroller

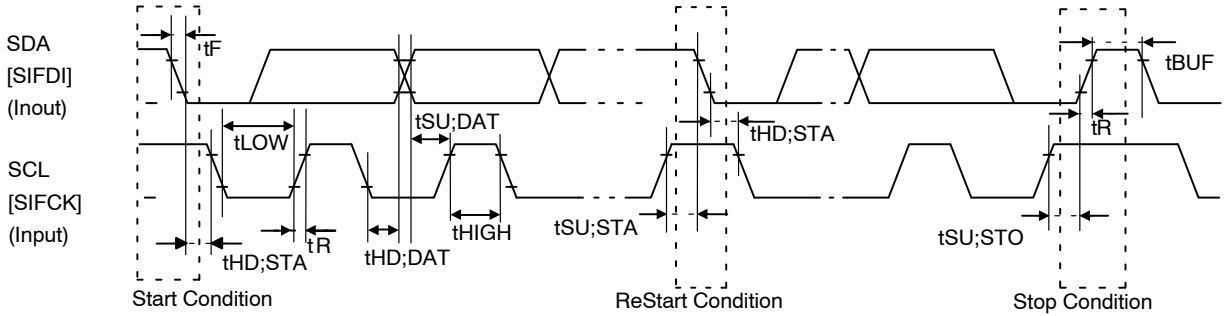


Figure 8.

| Parameter | Symbol | Normal (100 kbps) | | High Speed (400 kbps) | | Unit |
|-------------------------------------|---------|-------------------|------|-----------------------|-----|------|
| | | Min | Max | Min | Max | |
| SCL Frequency | fSCL | 0 | 100 | 0 | 400 | kHz |
| Bus Open Time | tBUF | 4.7 | | 1.3 | | μs |
| SCL "L" Period | tLOW | 4.7 | | 1.3 | | μs |
| SCL "H" Period | tHIGH | 4.0 | | 0.6 | | μs |
| Start/ReStart Condition Hold Time | tHD;STA | 4.0 | | 0.6 | | μs |
| Start/ReStart Condition Set-Up Time | tSU;STA | 4.7 | | 0.6 | | μs |
| SDA Hold Time | tHD;DAT | 0 | | 0 | | s |
| SDA Set-Up Time | tSU;DAT | 250 | | 100 | | ns |
| SDA, SCL Rise Time | tR | | 1000 | 20+0.1Cb | 300 | ns |
| SDA, SCL Fall Time | tF | | 300 | 20+0.1Cb | 300 | ns |
| Stop Condition Set-Up Time | tSU;STO | 4.0 | | 0.6 | | μs |

NOTE: Cb is the total capacity added to each bus (Unit: pF)

When using IIC, SIFDO/SIFCE/BUSYB pins can be used as GPIOs as below;

SIFDO : GP00

SIFCE : GP01

BUSYB : GP02

Serial Communication Ports

Characteristics of Serial Communication (SIO) Master Mode Input/Output Timing

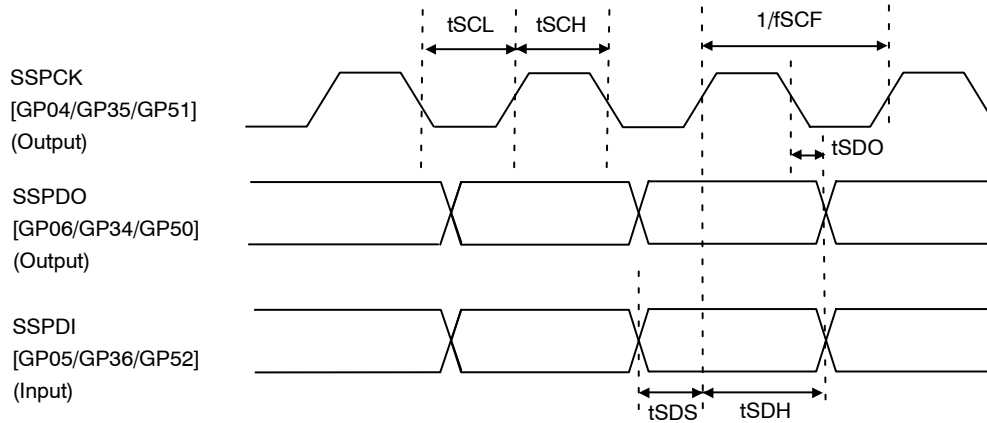


Figure 9.

| Parameter | Symbol | Signal Names | Min | Typ | Max | Unit |
|-------------------------|-----------|--------------|-------|-----|-------|------|
| SIO Clock Frequency | f_{SCF} | SSPCK | 0.008 | | 5.0 | MHz |
| SIO Clock "H" Period | t_{SCH} | SSPCK | 100 | | 62500 | ns |
| SIO Clock "L" Period | t_{SCL} | SSPCK | 100 | | 62500 | |
| Data Output Settle Time | t_{SDO} | SSPDO, SSPCK | | | 90 | |
| Data Input Set-Up Time | t_{SDS} | SSPDI, SSPCK | 50 | | | |
| Data Input Hold Time | t_{SDH} | SSPDI, SSPCK | 75 | | | |

NOTE: In the case that internal microcontroller operates in normal mode.

Conditions for Input/Output Timing of Serial Communication (IIC) Master Mode

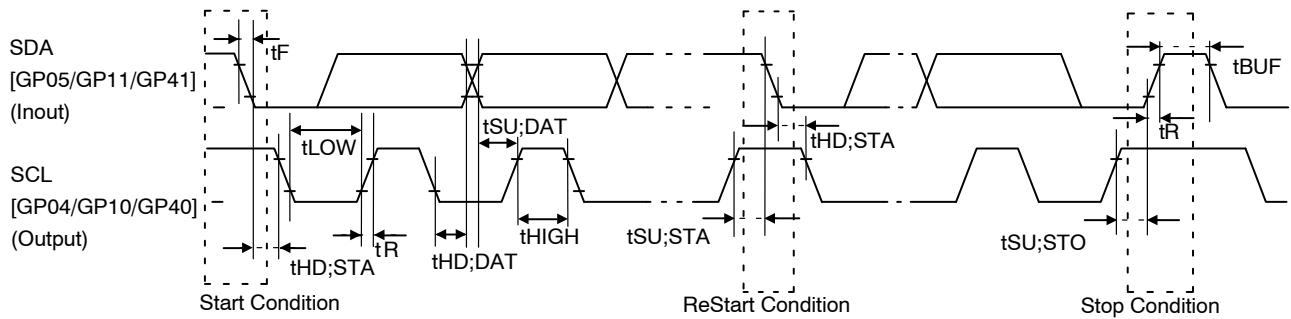


Figure 10.

LC786821E

| Parameter | Symbol | Normal (100 kbps) | | High Speed (400 kbps) | | Unit |
|-------------------------------------|---------|-------------------|------|-----------------------|-----|------|
| | | Min | Max | Min | Max | |
| SCL Frequency | fSCL | 0 | 100 | 0 | 400 | kHz |
| Bus Open Time | tBUF | 4.7 | | 1.3 | | μs |
| SCL "L" Period | tLOW | 4.7 | | 1.3 | | μs |
| SCL "H" Period | tHIGH | 4.0 | | 0.6 | | μs |
| Start/ReStart Condition Hold Time | tHD;STA | 4.0 | | 0.6 | | μs |
| Start/ReStart Condition Set-Up Time | tSU;STA | 4.7 | | 0.6 | | μs |
| SDA Hold Time | tHD;DAT | 0 | | 0 | | μs |
| SDA Set-Up Time | tSU;DAT | 250 | | 100 | | ns |
| SDA,SCL Rise Time | tR | | 1000 | 20+0.1Cb | 300 | ns |
| SDA,SCL Fall Time | tF | | 300 | 20+0.1Cb | 300 | ns |
| Stop Condition Set-Up Time | tSU;STO | 4.0 | | 0.6 | | μs |

NOTE: Cb is the total capacity added to each bus (Unit: pF)

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USB SPECIFICATION at $T_A = -40$ to 85°C , $V_{DD1} = 3.0$ to 3.6 V, $DVSS = AVSS1 = AVSS2 = XVSS = 0$ V

| Parameter | Symbol | Pin Names | Conditions | MIN | TYP | MAX | Unit | |
|---------------------------------|----------|---------------------------------|--------------------|-------|-------|------|---------------|------------|
| High-level input voltage | VIH(USB) | UDM1, UDP1, UDM2, UDP2 | | 2.0 | | | V | |
| Low-level input voltage | VIL(USB) | | | | | 0.8 | | |
| Input leakage current | ILI | | Output : OFF | -10.0 | | 10.0 | μA | |
| Differential input sensitivity | VDI | | $ (UDP) - (UDM) $ | 0.2 | | | V | |
| Common mode voltage range | VCM | | Includes VDI range | 0.8 | | 2.5 | V | |
| High-level output voltage | VOH(USB) | | | | 2.8 | | 3.6 | V |
| Low-level output voltage | VOL(USB) | | | | 0.0 | | 0.3 | V |
| Output signal Crossover voltage | VCR | | | | 1.3 | | 2.0 | V |
| USB data rising time | TUR | | CL = 50pF | | 4.0 | | 20.0 | ns |
| USB data falling time | TUF | | | | 4.0 | | 20.0 | |
| D+/D- Pull-Down resistor | RPD | | | | 14.25 | | 24.8 | k Ω |
| D+ Pull-Up resistor | RPUI | | UDP1 | Idle | 0.9 | | 1.575 | k Ω |
| | RPUR | Reception | | 1.425 | | 3.09 | | |
| D- source voltage | VDMSRC | UDM1 | | 0.5 | | 0.7 | V | |
| | VLGC_SRC | | | 0.8 | | 2.0 | V | |

- USB port peripheral circuit application

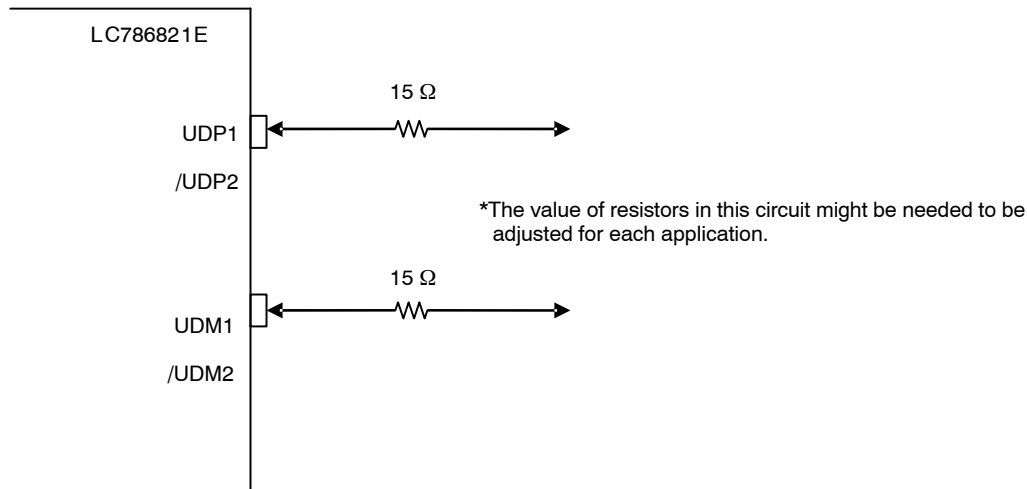


Figure 11.

LC786821E

SD Memory Card Interface

Characteristics of SD Memory Card Input/Output Timing

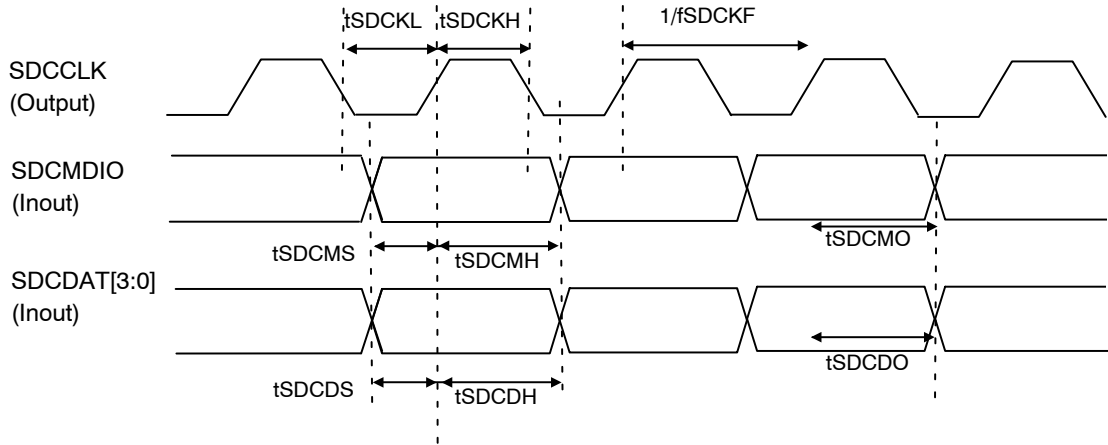


Figure 12.

*Relationship between signal name and pin

SDCCLK : GP34 SDCMDIO : GP35 SDCDAT[3] : GP36
 SDCDAT[2] : GP37 SDCDAT[1] : GP32 SDCDAT[0] : GP33

| Parameter | Symbol | Signal Names | Min | Typ | Max | Unit |
|----------------------------|--------|---------------------|------|------|------|------|
| SDCCLK Clock Frequency | fSDCKF | SDCCLK | | 6.0 | | MHz |
| SDCCLK "H" Period | tSDCKH | SDCCLK | | 83.3 | | ns |
| SDCCLK "L" Period | tSDCKL | SDCCLK | | 83.3 | | |
| Command Input Set-Up Time | tSDCMS | SDCMDIO, SDCCLK | 30.0 | | | |
| Command Input Hold Time | tSDCMH | SDCMDIO, SDCCLK | 30.0 | | | |
| Command Output Settle Time | tSDCMO | SDCMDIO, SDCCLK | | | 30.0 | |
| Data Input Set-Up Time | tSDCDS | SDCDAT[3:0], SDCCLK | 30.0 | | | |
| Data Input Hold Time | tSDCDH | SDCDAT[3:0], SDCCLK | 30.0 | | | |
| Data Output Settle Time | tSDCDO | SDCDAT[3:0], SDCCLK | | | 30.0 | |

NOTE: Internal microcontroller (Arm7) must be used in normal mode. It cannot be used in low speed mode.

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AUDIO DATA INPUT/OUTPUT FUNCTION

AC ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$, $V_{DD1} = 3.3\text{ V}$, $DVSS = AVSS1 = AVSS2 = XVSS = 0\text{ V}$
 $F_s = 44.1\text{ kHz}$, Audio Signal Frequency: 1 kHz, Measurement Range: 10 Hz to 20 kHz

| Parameter | Symbol | Pin Names | Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------|------------|-----|-----|-----|------|
|-----------|--------|-----------|------------|-----|-----|-----|------|

(INPUT SELECTOR + ADC)

| | | | | | | | | |
|-------------------------------|-------|-------------------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------|-------|------------|----|
| Full scale Analog Input Level | | L1IN, R1IN, L2IN, R2IN, L3INP, R3INP, R3INN, R3INN | | 2.605 | 2.805 ($0.85 \times V_{DD1}$) | 3.005 | Vpp | |
| Input Impedance | | | | 20 | 30 | | k Ω | |
| Gain Setting Level | | | | -12 | | 19 | dB | |
| Gain Setting Step | | | | | | 1 | dB | |
| Gain Setting Step Error | | | | -0.5 | | 0.5 | dB | |
| Signal to Noise Ratio | S/N | | | 0 dB Data, 20 kHz-LPF, A-filter | 90 | 95 | | dB |
| Dynamic Range | DR | | | -60 dB Data, 20 kHz-LPF, A-filter | 90 | 95 | | dB |
| Total Harmonic Distortion | THD+N | | | Input condition : -3 dBFS | | -85 | -80 | dB |
| Cross Talk1 | CT1 | | | Between Channels | | -100 | -85 | dB |
| Cross Talk2 | CT2 | | Between Sources | | -100 | -85 | dB | |

(ADC DIGITAL FILTER)

| | | | | | | | |
|-------------------------------------------------|--|--|----------------------|--------|---------|------------|----|
| Passband Frequency | | | $\pm 0.04\text{ dB}$ | 0 | | 0.4535 | Fs |
| Stopband Frequency | | | | 0.5465 | | | Fs |
| Passband Ripple | | | | | | ± 0.04 | dB |
| Stopband Attenuation | | | >24.1 kHz | -69 | | | dB |
| HPF Cut Off Frequency for DC Offset cancelation | | | | | 0.00002 | | Fs |

(AUDIO DAC)

| | | | | | | | | |
|--------------------------------|-------|---------------------------------|--|-----------------------------------------|-----------------------------------|-------|-----|----|
| Full scale Analog Output Level | | DACOUTL, DACOUTR, DACOUTS | | 2.605 | 2.805 ($0.85 \times V_{DD}$) | 3.005 | Vpp | |
| Signal to Noise Ratio | S/N | | | 0 dB Data, 20 kHz-LPF, A-filter | | 106 | | dB |
| Dynamic Range | DR | | | -60 dB Data, 20 kHz-LPF, A-filter | | 106 | | dB |
| Total Harmonic Distortion | THD+N | | | 0 dB Data, 20 kHz-LPF | | -85 | -80 | dB |
| Cross Talk | CT | | | 0 dB Data, 20 kHz-LPF | | -100 | -85 | dB |

(DAC DIGITAL FILTER)

| | | | | | | | |
|--------------------|--|--|-----------------------|--------|--|--------|----|
| Passband Frequency | | | $\pm 0.015\text{ dB}$ | 0 | | 0.4535 | Fs |
| Stopband Frequency | | | | 0.5465 | | | Fs |

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AC ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$, $V_{DD1} = 3.3\text{ V}$, $DVSS = AVSS1 = AVSS2 = XVSS = 0\text{ V}$
 $F_s = 44.1\text{ kHz}$, Audio Signal Frequency: 1 kHz, Measurement Range: 10 Hz to 20 kHz (continued)

| Parameter | Symbol | Pin Names | Conditions | Min | Typ | Max | Unit |
|-------------------------------------------------|--------|-----------|------------|-----|-----------|-------------|------|
| (DAC DIGITAL FILTER) | | | | | | | |
| Passband Ripple | | | | | | ± 0.015 | dB |
| Stopband Attenuation | | | | -62 | | | dB |
| HPF Cut Off Frequency for DC Offset cancelation | | | -3 dB | | 0.0000385 | | Fs |

(ELECTRONIC VOLUME)

| | | | | | | | | |
|---------------------------|--|-----------------------------------------------|---------------|--------|----|------|------------|----|
| Input Impedance | | LVRIN, RVRIN, | | 7.5 | 10 | | k Ω | |
| | | SWIN | | 15 | 20 | | k Ω | |
| Volume Setting range | | LFOUT, LROUT, RFOUT, RROUT, SWOUT | | -70 | | 0 | dB | |
| Mute Level | | | | 80 | 90 | | dB | |
| Volume Setting Step | | | 0 to -32 dB | | | 0.25 | | dB |
| | | | -32 to -70 dB | | | 1.0 | | dB |
| Volume Setting Step Error | | | 0 to -32 dB | -0.125 | | | 0.125 | dB |
| | | | -32 to -70 dB | -5 | | | 0.5 | dB |

Audio Digital Data Input/Output Function

AUDIO INPUT/OUTPUT SUPPORTED FORMAT

| | Mode | Bit Length | Slot Length | Fs384 Clock |
|--------|-------------------------|------------|---------------------|----------------------------------|
| Input | IIS | 16 bit | 32 fs, 48 fs, 64 fs | Internal Clock External Clock |
| | MSB First Right Aligned | 24 bit | | |
| | MSB First Left Aligned | | | |
| Output | IIS | 16 bit | 32 fs, 48 fs, 64 fs | Fs384 Clock Output |
| | MSB First Right Aligned | 24 bit | | |
| | MSB First Left Aligned | | | |

APPLIED PINS

| | LRCK | BCK | DATA | Fs384 Clock |
|--------|------|------|------|-------------|
| Input | GP30 | GP31 | GP32 | GP33 |
| | GP40 | GP41 | GP42 | GP43 |
| | GP50 | GP51 | GP52 | GP53 |
| Output | GP30 | GP31 | GP32 | GP33 |
| | GP40 | GP41 | GP42 | GP43 |
| | GP50 | GP51 | GP52 | GP53 |

NOTE: When each pin is set as audio input simultaneously, they will be processed as below priority;

(1) GP30 to 33, (2) GP40 to 43, (3) GP50 to 53

For example, if set all pins to audio input mode, audio data will be processed on only data in GP30 to 33. Data in GP40 to 43, GP 50 to 53 will not be processed in the LSI.

Other

- ◆ Audio output can be supported in 3 kinds of Fs (32 kHz/44.1 kHz/48 kHz)
- ◆ When inputting external audio, GP14/GP46 can support input of emphasis signals

LC786821E

Characteristics of Audio Data Input Timing

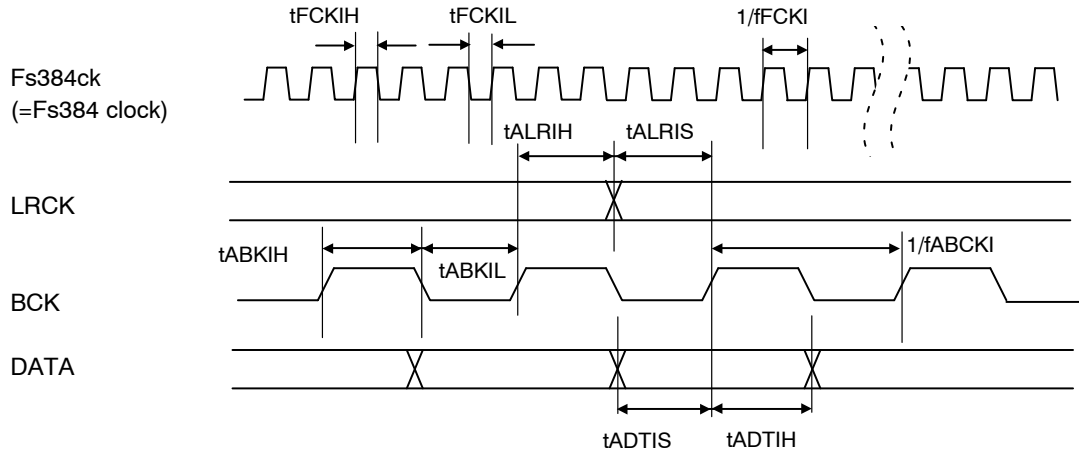


Figure 13.

| Parameter | Symbol | Signal Names | Min | Typ | Max | unit |
|------------------------|-------------|--------------|-----|-----|------|------|
| Fs384 Clock Frequency | f_{CKI} | Fs384ck | | | 20.0 | MHz |
| Fs384 Clock "H" Period | t_{FCKIH} | Fs384ck | 20 | | | ns |
| Fs384 Clock "L" Period | t_{FCKIL} | Fs384ck | 20 | | | ns |
| Bit Clock Frequency | f_{ABCKI} | BCK | | | 3.3 | MHz |
| Bit Clock "H" Period | t_{ABKIH} | BCK | 120 | | | ns |
| Bit Clock "L" Period | t_{ABKIL} | BCK | 120 | | | ns |
| LRCK Input Set-Up Time | t_{ALRIS} | LRCK, BCK | 30 | | | ns |
| LRCK Input Hold Time | t_{ALRIH} | LRCK, BCK | 30 | | | ns |
| DATA Input Set-Up Time | t_{ADTIS} | DATA, BCK | 30 | | | ns |
| DATA Input Hold Time | t_{ADTIH} | DATA, BCK | 30 | | | ns |

Characteristics of Audio Data Output Timing

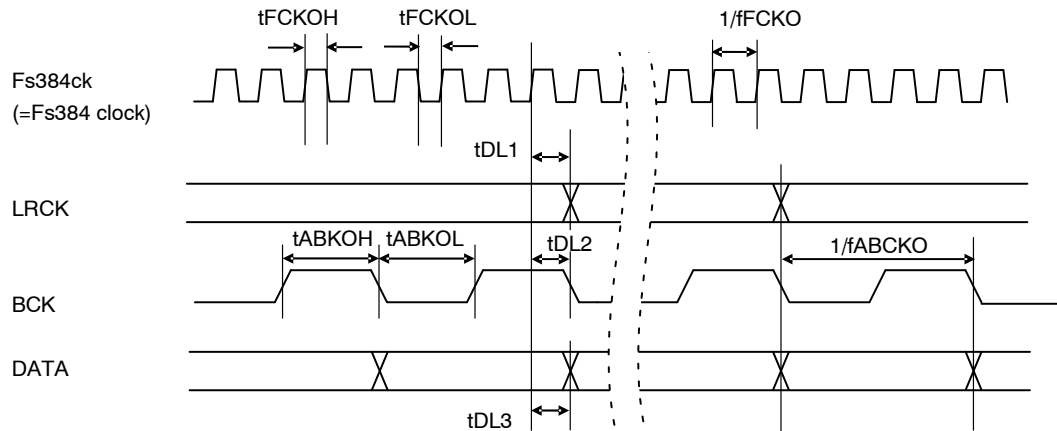


Figure 14.

LC786821E

| Parameter | Symbol | Signal Names | Min | Typ | Max | unit |
|------------------------|--------|---------------|-----|----------|-----|------|
| Fs384 Clock Frequency | fFCKO | Fs384ck | | 16.9344* | | MHz |
| Fs384 Clock "H" Period | tFCKOH | Fs384ck | | 29.5* | | ns |
| Fs384 Clock "L" Period | tFCKOL | Fs384ck | | 29.5* | | ns |
| Bit Clock Frequency | fABCKO | BCK | | 2.1168* | | MHz |
| Bit Clock "H" Period | tABKOH | BCK | | 236.2* | | ns |
| Bit Clock "L" Period | tABKOL | BCK | | 236.2* | | ns |
| LRCK Output Delay Time | tDL1 | LRCK, Fs384ck | 0 | | 50 | ns |
| BCK Output Delay Time | tDL2 | BCK, Fs384ck | 0 | | 50 | ns |
| DATA Output Delay Time | tDL3 | DATA, Fs384ck | 0 | | 50 | ns |

*In the case that output Fs = 44.1 kHz and slot length of output format 48 fs.

Stream Data Input/Output Function

There are 2 ways to input/output the stream data.

1. 4-wire method

Stream Input

: During STREQO = "H" output, input STLCKI/STBCKI/STDATI.

In the case of 4-wire method, STLCKI/STBCKI/STDATI (input state) are normal audio inputs/outputs. As same as the format, 4 byte (32 bit) data transmission/reception is done in one period of STLCKI (input state).

2. 3-wire method

Stream Input

: Input STBCKI/STDATI while STREQO = "H" output.

Stream Output

: Output STBCKO/STDATO while STREQI = "H" input.

In the case of 3-wire method, depending on the state of STREQO, only inputs the bit clock and data, or depending on the state of STREQI, only outputs the bit clock and data, and data communication unit becomes 2 byte (16 bit). Also in the 3-wire method of the stream output, it is possible that users just input the clock (STBCKI) and it will output the data only.

Characteristics of Stream Data Input Timing

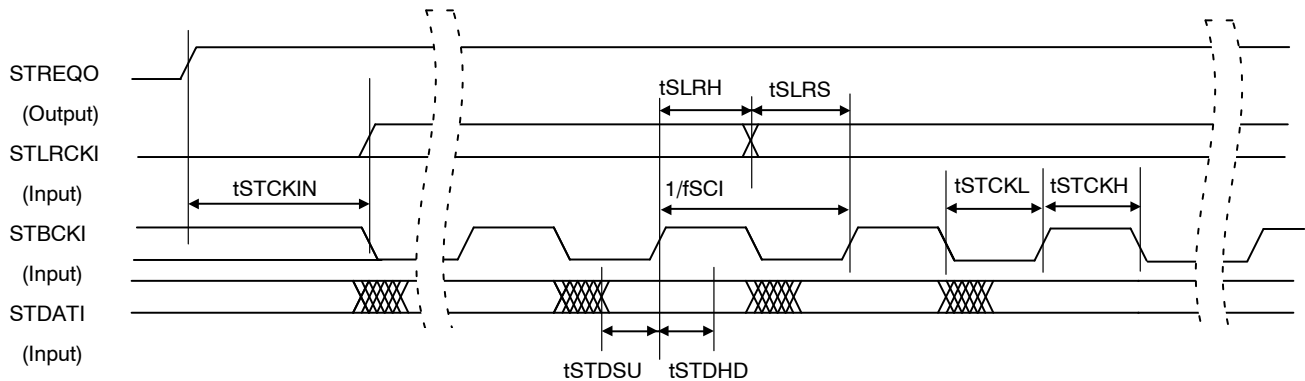


Figure 15.

*Relationship between signal name and pin

STREQO : GP33/GP43/GP53

STLCKI : GP30/GP40/GP50

STBCKI : GP31/GP41/GP51

STDATI : GP32/GP42/GP52

NOTE: When each pin is set as stream input simultaneously, they will be processed as below priority;

(1) GP30 to 33, (2) GP40 to 43, (3) GP50 to 53

For example, if set all pins to stream input mode, stream data will be processed on only data in GP30 to 33. Data in GP40 to 43, GP 50 to 53 will not be processed in the LSI.

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| Parameter | Symbol | Signal Names | Min | Typ | Max | unit |
|-------------------------|---------|----------------------------|-----|-----|------|------|
| STBCKI Clock Frequency | fSCI | STBCKI | | | 4.24 | MHz |
| Stream Input Start Time | tSTCKIN | STREQO, STBCKI, STLRCKI | 50 | | | ns |
| STBCKI "H" Period | tSTCKH | STBCKI | 100 | | | ns |
| STBCKI "L" Period | tSTCKL | STBCKI | 100 | | | ns |
| STLRCKI Set-Up Time | tSLRS | STLRCKI, STBCKI | 75 | | | ns |
| STLRCKI Hold Time | tSLRH | STLRCKI, STBCKI | 75 | | | ns |
| STDATI Set-Up Time | tSTDSU | STDATI, STBCKI | 75 | | | ns |
| STDATI Hold Time | tSTDHD | STDATI, STBCKI | 75 | | | ns |

NOTE: Above diagram shows the case of data input at rising edge of STBCKI. The timing is the same if using falling edge synchronization.

Characteristics of Stream Data Output Timing: STBCK Output Mode

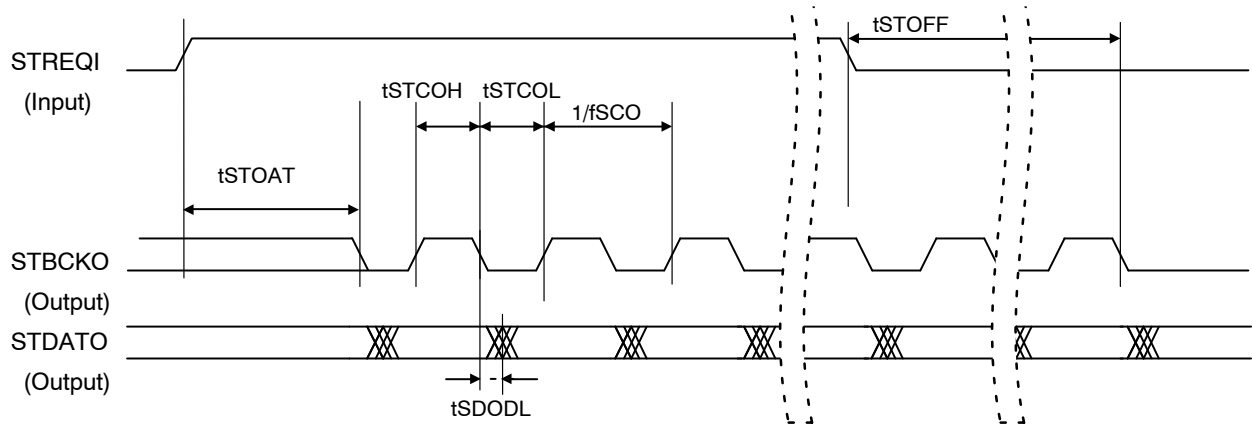


Figure 16.

*Relationship between signal name and pin

STREQI : GP33/GP43/GP53

STBCKO : GP31/GP41/GP51

STDATO : GP32/GP42/GP52

| Parameter | Symbol | Signal Names | Min | Typ | Max | unit |
|--------------------------|--------|----------------|-----|-----|----------------------|------|
| STBCKO Clock Frequency | fSCO | STBCKO | | | 4.24 | MHz |
| Stream Output Start Time | tSTOAT | STREQI, STBCKO | | | $(1/fSCO) \times 48$ | ns |
| Stream Output Stop Time | tSTOFF | STREQI, STBCKO | | | $(1/fSCO) \times 48$ | ns |
| STBCKO "H" Period | tSTCOH | STBCKO | 100 | | | ns |
| STBCKO "L" Period | tSTCOL | STBCKO | 100 | | | ns |
| STDATO Output Delay Time | tSDODL | STDATO, STBCKO | 0 | | 50 | ns |

NOTE: Above diagram shows the case of data input at rising edge of STBCKO. The timing is the same if using falling edge synchronization.

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Characteristics of Stream Data Output Timing: STBCK Input Mode

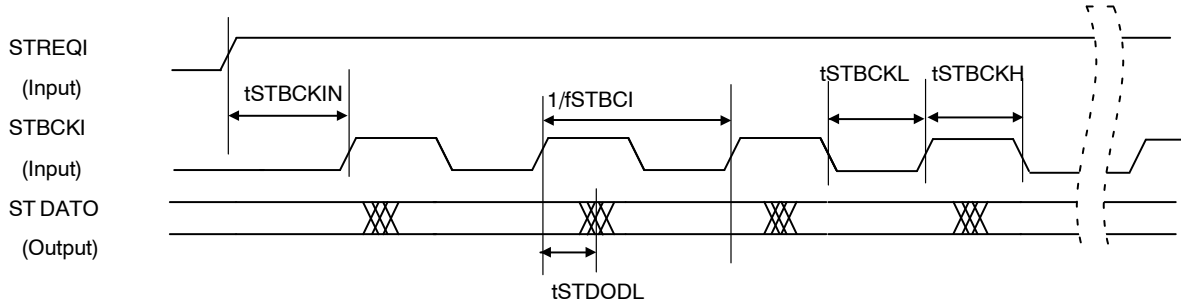


Figure 17.

*Relationship between signal name and pin

STREQI : GP33/GP43/GP53

STBCKI : GP31/GP41/GP51

STDATO : GP32/GP42/GP52

| Parameter | Symbol | Signal Names | Min | Typ | Max | unit |
|--------------------------|----------|----------------|------|-----|------|------|
| STBCKI Clock Frequency | fSTBCI | STBCKI | | | 1.25 | MHz |
| STBCKI Input Start Time | tSTBCKIN | STREQI, STBCKI | 1000 | | | ns |
| STBCKI "H" Period | tSTBCKH | STBCKI | 400 | | | ns |
| STBCKI "L" Period | tSTBCKL | STBCKI | 400 | | | ns |
| STDATO Output Delay Time | tSTDODL | STBCKI, STDATO | | | 250 | ns |

NOTE: Above diagram shows STBCKI is starting from "L".

<Additional Information>

Clock input mode supports 2 types and data output timing changes as below accordingly;

1. Starting from STBCKI = "L"

STDATO will be output synchronizing with the rising edge of STBCKI.

2. Starting from STBCKI = "H".

STDATO will be output synchronizing with the falling edge of SBCKI.

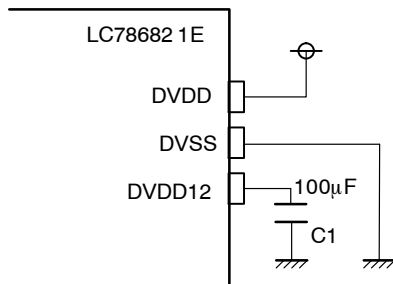
Using each mode of (1) or (2) does not change the output characteristics.

INTERNAL VOLTAGE REGULATOR at $T_A = -40$ to 85°C , $DVSS = AVSS1 = AVSS2 = XVSS = 0\text{ V}$

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|----------------|--------|-----------------------------------|------|------|------|------|
| Output Voltage | DVDD12 | $V_{DD1} = 3.0$ to 3.6 V | 1.08 | 1.20 | 1.32 | V |
| Load current | lope | $V_{DD1} = 3.3\text{ V}$ | | | 200 | mA |

NOTE: The specification of "load current" above is sum of the load current of two internal voltage regulator.

Example of 1.2 V Regulator Circuit



* Same circuit needs to be mounted both for two regulator pins.

(No.44 and No.87)

* C1 is for capacitor to stop oscillation.

There is a possibility of oscillation due to temperature change and etc., so C1 must be greater than $50\mu\text{F}$ and low ESR at the operational temperature.

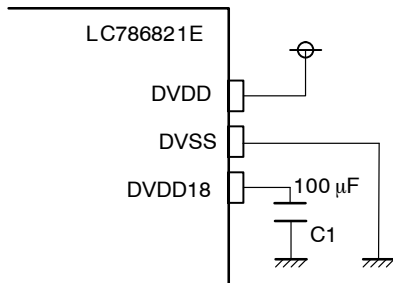
(The recommended value is $100\mu\text{F}$)

Figure 18.

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| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|----------------|--------|-------------------------------------------|------|------|------|------|
| Output Voltage | DVDD18 | $V_{DD1} = 3.0 \text{ to } 3.6 \text{ V}$ | 1.65 | 1.80 | 1.95 | V |
| Load current | lope | $V_{DD1} = 3.3 \text{ V}$ | | | 50 | mA |

Example of 1.8V Regulator Circuit



- * Build a circuit shown at left for the regulator pin No. 90.
- * C1 is for capacitor to stop oscillation.
There is a possibility of oscillation due to temperature change and etc., so C1 must be greater than 50 µF and low ESR at the operational temperature. (The recommended value is 100 µF)

Figure 19.

Oscillator

Example Circuit for Oscillator

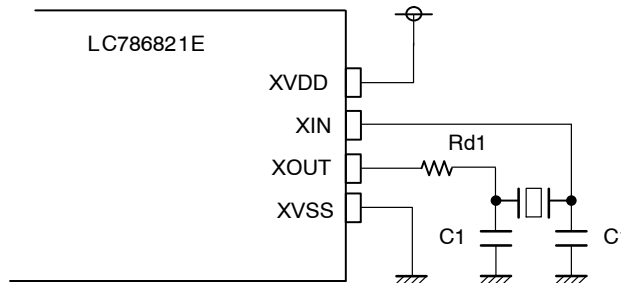


Figure 20.

XIN/XOUT: 12.0000 MHz

- ◆ For System Main clock and USB control
- ◆ Recommended Oscillator
Nihon Dempa Kogyo Co., Ltd.

| Type | Frequency | Recommended Constants |
|----------|-----------|--------------------------------------------------|
| NX3225GA | 12 MHz | $Rd1 = 1 \text{ k}\Omega$, $C1 = 12 \text{ pF}$ |

<Notes>

- ◆ Because the characteristics of oscillator could be changed according to the circuit board, ask evaluation with the individual original circuit board to the oscillator maker.
- ◆ The precision of oscillator used in XIN/ XOUT should meet the USB standard.
- ◆ If oscillation clock is disturbed by noise or by the other factors, it may lead to operation failure. Hence, make sure to connect resistor and capacitor for oscillation circuit as close as XIN/ XOUT and the wire should be as short as possible. Also needs to select parts with caution so as to obtain stable external constant value within the guaranteed operating temperature range because the variation of external constant due to temperature change could affect the oscillation precision
- ◆ About internal circuit for XIN/XOUT, refer to the “Analog Pin Internal Equivalent Circuits” section

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PLL Circuit

Example of PLL Circuit

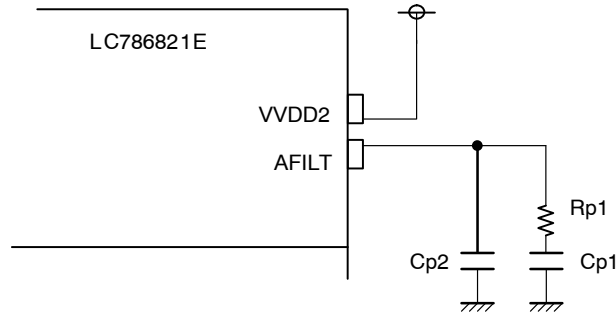


Figure 21.

- About PLL
LC786821E includes PLL1 and PLL2.
PLL1 is for generating system clock and PLL2 is for generating Audio clock.
- External filter constant for PLL2

| |
|-------------------------------------------------------------------------------------|
| PLL2 constant |
| $R_{p1} = 3.3 \text{ k}\Omega / C_{p1} = 3300 \text{ pF} / C_{p2} = 220 \text{ pF}$ |

<Notes>

- ◆ This PLL filter circuit of resistor (R_{p1}) and capacitance (C_{p1} , C_{p2}), are for audio generation/system clock generation connected to AFILT. If oscillation clock is disturbed by noise or by the other factors, it may lead to operation failure. Hence, make sure to connect resistor and capacitor that constitute filter circuit as close as AFILT and the wire should be as short as possible. Also if filter constant changes due to temperature change, oscillation of PLL may become unstable and the following problem may occur:
- ◆ See section on "Analog Pin Internal Equivalent Circuits" for the internal configuration of AFILT

ANALOG PINS INTERNAL EQUIVALENT CIRCUIT

| Pin Name () shows pin # | Internal Equivalent Circuit |
|------------------------------------------------------------------|-----------------------------|
| LFOUT (97) LR0UT (98) RR0UT (7) RF0UT (8) SW0UT (11) | |
| LVRIN (99) RVRIN (6) SWIN (10) | |

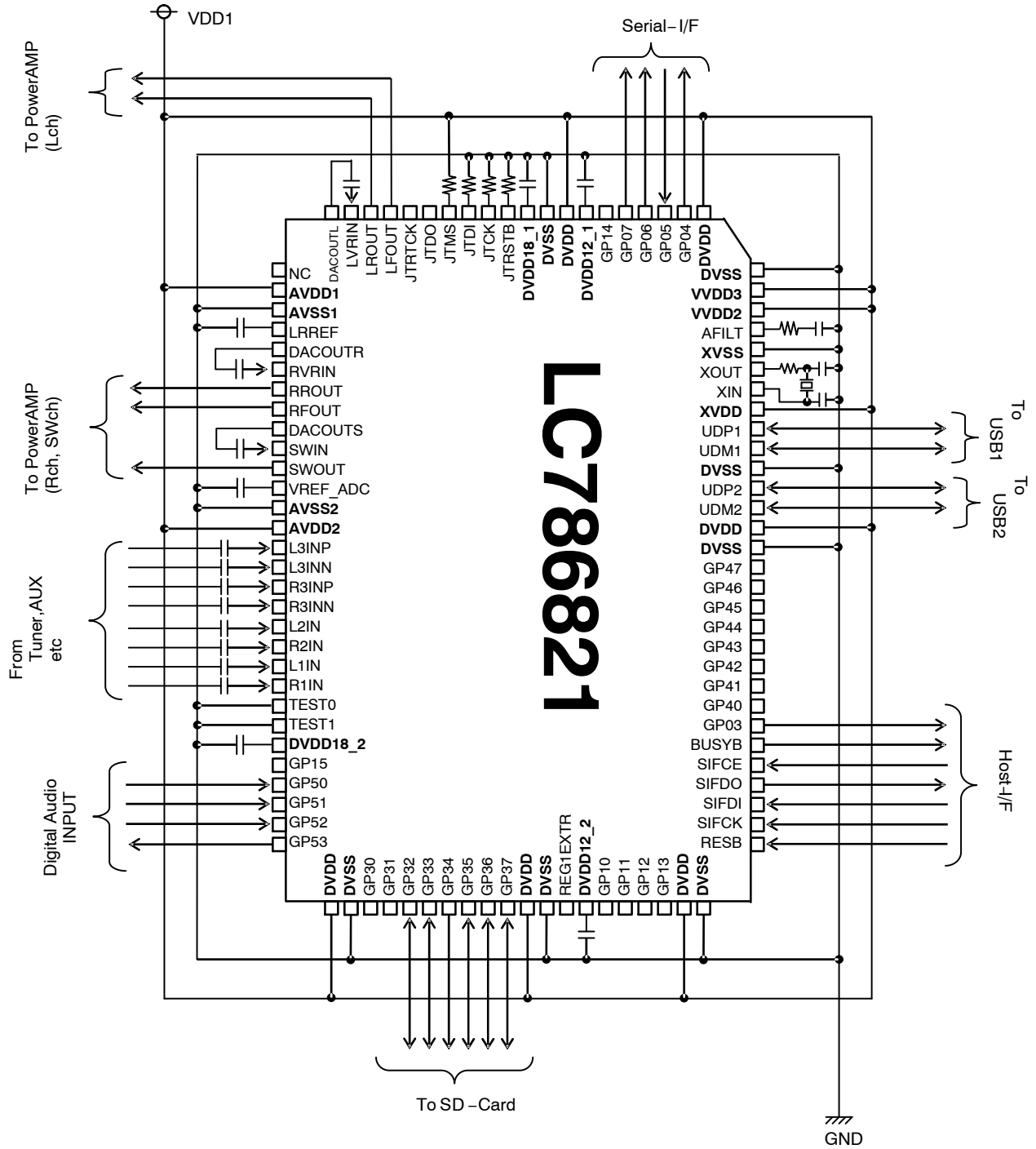
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ANALOG PINS INTERNAL EQUIVALENT CIRCUIT (continued)

| Pin Name () shows pin # | Internal Equivalent Circuit |
|----------------------------------------------------------------------------------------------------------|-----------------------------|
| DACOUTL (100) DACOUTR (5) DACOUTS (9) | |
| L1IN (21) R1IN (22) L2IN (19) R2IN (20) L3INP (15) L3INN (16) R3INP (17) R3INN (18) | |
| VREF_ADC (12) | |
| XIN (74) XOUT (75) | |
| AFILT (77) | |
| LRREF (4) | |

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Reference Circuit



- For analog audio input, it is necessary to consider the input level.
- Please refer to [USB Specification](#) table, [Internal Voltage Regulator](#) table and [PLL Circuit](#) for the detail of USB/Regulator/oscillator reference circuit.

Figure 22.

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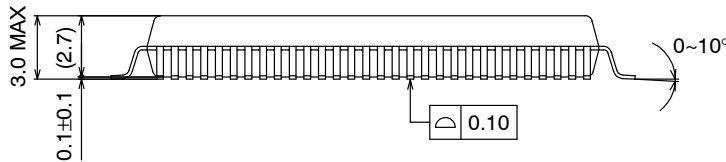
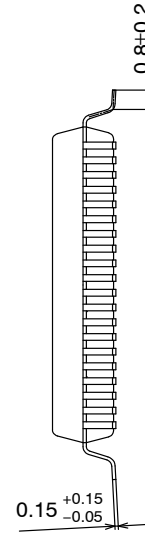
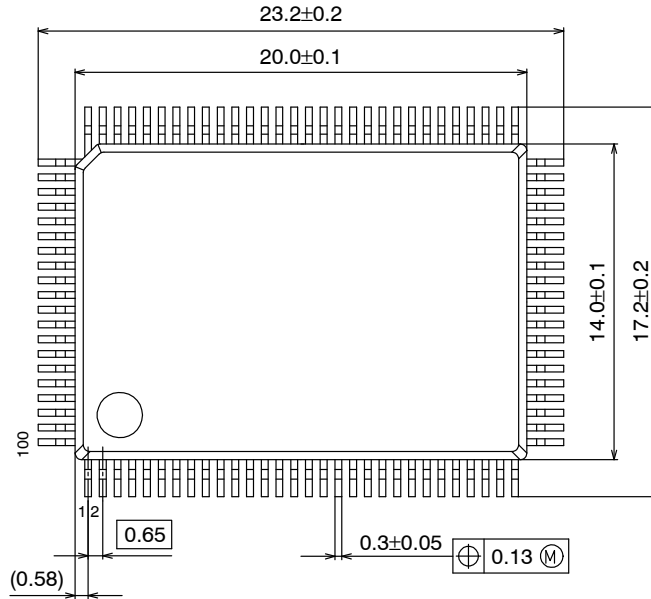
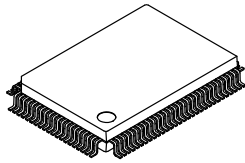
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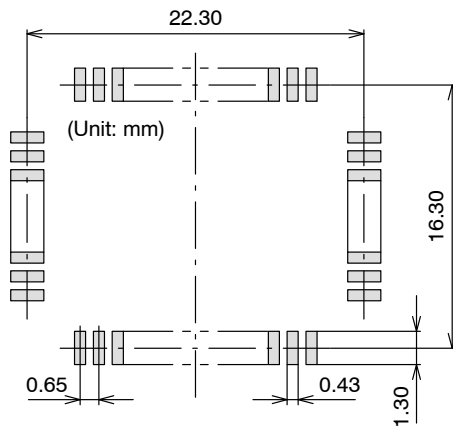


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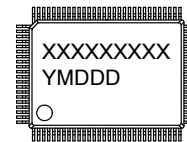
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SOLDERING FOOTPRINT*



GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

NOTE: The measurements are not to guarantee but for reference only.

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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