

## USB Type-C Ultra-Low-THD Audio and Data Switch Array

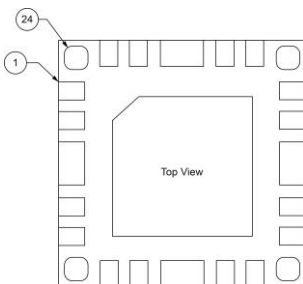
### Features

- Support USB High Speed (480Mbps) and Full Speed (12Mbps) Signaling Capability per USB 2.0
- USB switches: High bandwidth (1 GHz) & Low On-Resistance (5 ohm).
- Audio switches: Low On-Resistance (1 ohm).
- Support USB Type-C Audio Accessory Mode per USB Type-C Cable and Connector Specification 1.1
- Low Distortion (THD: -110dB from 20Hz to 20kHz, 2.0VRMS, 32ohm load)
- Negative Signal (+/-3V) Handling Capability
- Programmable soft-start and soft-stop time to eliminate click/pop sounds of DC-coupled audio signals
- High Off Isolation: -85dB @ 30kHz
- High Crosstalk Rejection: -85dB @ 30kHz
- Autonomous microphone and ground lines Switching
- Separate Ground switches for microphone and audio to minimize crosstalk
- Sideband switches
- I2C control
- Wide VDD Range: 1.7V to 5.5V
- ESD: 4kV for HBM mode, 1kV for CDM mode
- Extended Industrial Temperature Range: -40°C to 85°C
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- Packaging (Pb-free & Green): TQFN-24 (3mm x 3mm)

### Applications

- Notebook, PC
- Cell Phones, PDAs, MP3 Players
- Portable Instrumentation

### Pin Assignment



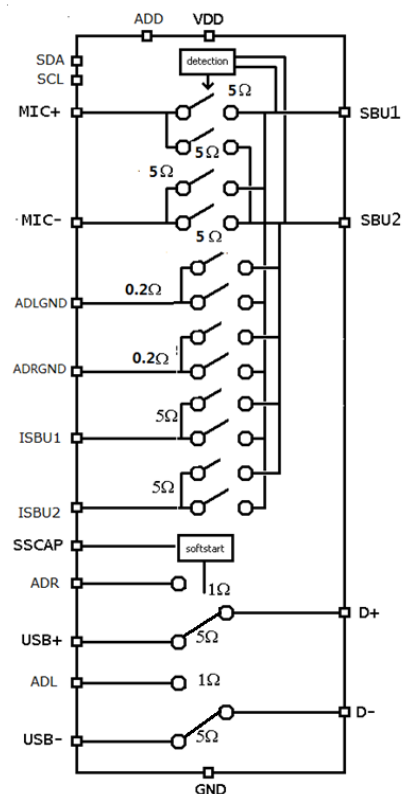
### Description

PI3A6386 includes a dual, single-pole double throw (SPDT) switch for high speed USB signal and high quality audio signal. It can be used in USB Type-C D+/D- switching for USB signal in data mode and analog audio signal in audio accessory mode.

The audio path with negative signal handling capability has a very low THD of -110dB for high quality audio requirement. It also has a programmable soft-start/soft-stop feature to eliminate the click/pop sounds of DC-coupled audio signals. The data path has a high USB bandwidth of 1 GHz for USB High Speed signals.

PI3A6386 can also detect the microphone signals in SBU1 and SBU2, and automatically route them to the correct inputs of microphone amplifier. Separate switches for microphone negative input and audio signal ground can minimize the crosstalk & echo between audio output signals and microphone input signals. Sideband switches can be configured to route SBU1 and SBU2 for sideband usage.

### Functional Block Diagram

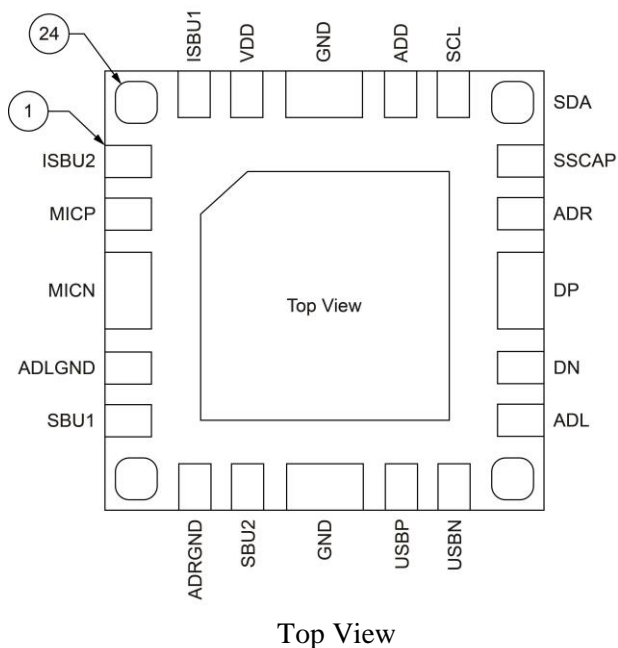


#### Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

### Pin Description

Pin#	Name	Description
1	ISBU2	Sideband 2
2	MIC+	Microphone +
3	MIC-	Microphone -
4	ADLGND	Ground for Audio Signal L
5	SBU1	SBU1 of USB receptacle
7	ADRGND	Ground for Audio Signal R
8	SBU2	SBU2 of USB receptacle
10	USB+	USB Signal +
11	USB-	USB Signal -
13	ADL	Audio Signal L
14	D-	D- pin of USB receptacle
15	D+	D+ pin of USB receptacle
16	ADR	Audio Signal R
17	SSCAP	Slew Rate Control
18	SDA	I2C Data Input /Output
19	SCL	I2C Clock Input
20	ADD	I2C Slave Address Select
22	VDD	Power Supply
23	ISBU1	Sideband 1
9, 21, Thermal Pad	GND	Ground
6, 12, 24	NC	No Connection



## Maximum Ratings

Storage Temperature.....	-65°C to +150°C
Ambient Temperature with Power Applied.....	-40°C to +85°C
Supply Voltage $V_{DD}$ .....	-0.5V to +6V
Input Voltage of All I/O Pins (Except Audio Path).....	-0.5V to +6V
Input Voltage of Audio Path (D+/D-).....	-3.5V to +6V
Input Voltage of Audio Path (ADR/ADL).....	-3.5V to +3.5V
Continuous Current of Audio Switches.....	±150mA
Continuous Current of All Switches.....	±20mA
Peak Current of Audio Switches (pulsed at 50% duty cycle) ...	±200mA
Peak Current of All Switches (pulsed at 50% duty cycle) .....	±30mA
ESD HBM mode.....	4kV
CDM mode.....	1kV

### Note:

Stresses greater than those listed under **MAXIMUM RATINGS** may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Control input must be held HIGH or LOW; it must not float.

## Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{DD}$	Supply Voltage	1.7	-	5.5	V
$V_{IO}$	Input Voltage of All I/O Pins (Except ADR/ADL/D+/D-)	-0.3	-	5.5	V
$V_{AUDIO}$	Input Voltage of Audio Path (ADR/ADL)	-3	-	3	V
$V_{D+/-}$	Input Voltage of D+/D-	-3	-	5.5	V
$T_A$	Operating Temperature	-40	25	85	°C

## Electrical Characteristics

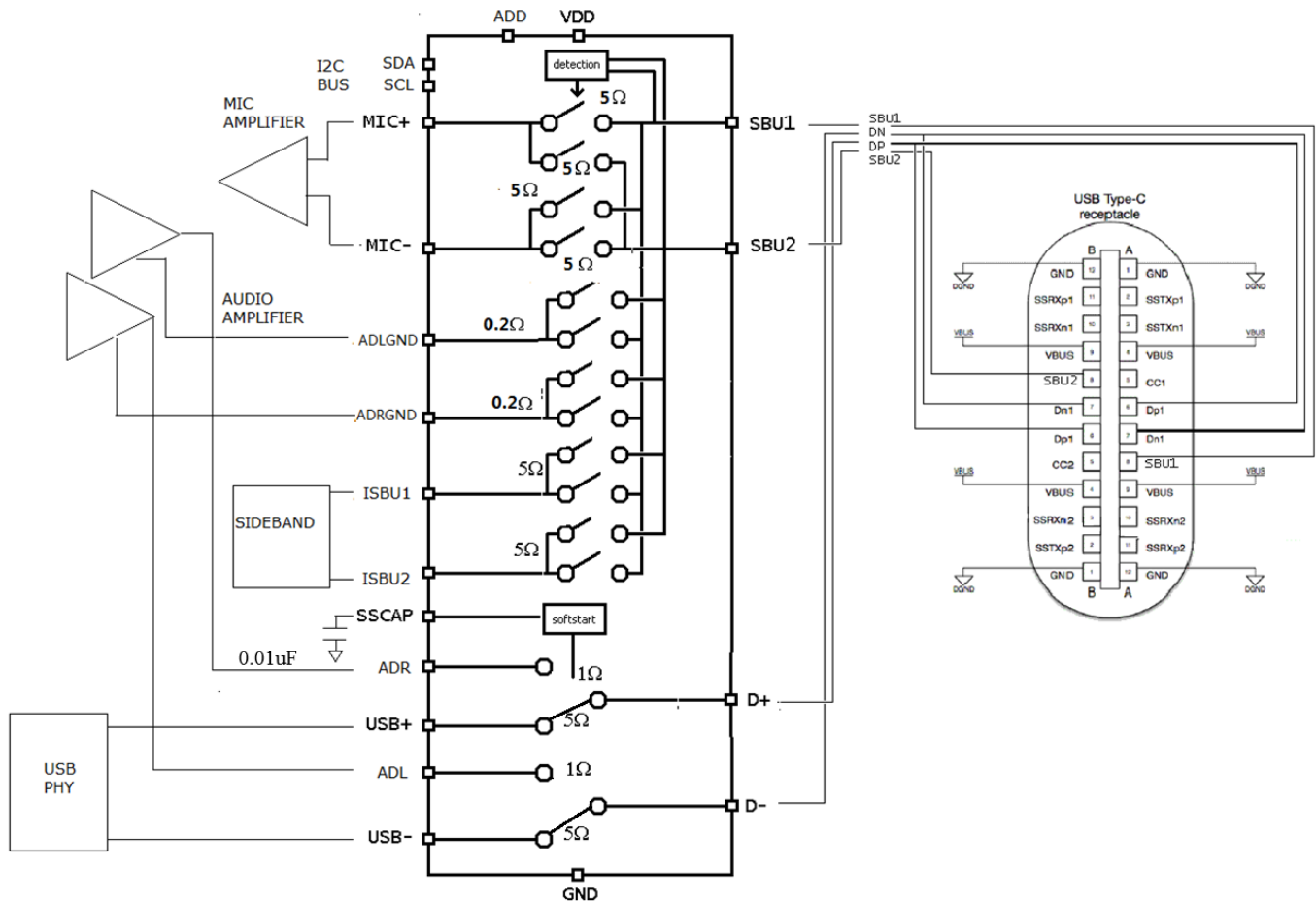
( $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ , unless otherwise noted. Typical values are at 3.3V  $V_{DD}$  and  $+25^\circ\text{C}$ .)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit	
<b>ANALOG SWITCH (ADR, ADL)</b>							
Analog Signal Range	$V_{ADR/ADL+/-}$ $V_{D+/D-}$		-3	-	3	V	
On-Resistance	$R_{ON}$	$V_{ADR/ADL} = -3\text{V to } +3\text{V}$ , $I_{Load} = -100\text{mA}$	-	1	-	$\Omega$	
On-Resistance Match Between Channels	$\Delta R_{ON}$		-	0.05	0.2	$\Omega$	
On-Resistance Flatness	$R_{ONF}$	$V_{ADR/ADL} = -3\text{V to } +3\text{V}$		0.005	0.025	$\Omega$	
<b>ANALOG GROUND SWITCH (ADRGND, ADLGND)</b>							
On-Resistance	$R_{ON}$	$V_{ADRGND/ADLGND} = 0\text{V}$ , $I_{Load} = -100\text{mA}$	-	0.2	-	$\Omega$	
<b>AUDIO SWITCH DYNAMIC CHARACTERISTICS</b>							
Turn-Off Time	$t_{OFF}$	$V_{AUDIO+/-} = 3\text{V}$ , $R_L = 32\Omega$ SSCAP=float		30		$\mu\text{s}$	
Turn-On Time	$t_{ON}$	$V_{AUDIO+/-} = 3\text{V}$ , $R_L = 32\Omega$ SSCAP=float		30		$\mu\text{s}$	
Soft-Start Time	$t_{START}$	SSCAP=0.01 $\mu\text{F}$ $V_{NC} = 0.1\text{V}$ , 10% to 90%		5		ms	
Soft-Stop Time	$t_{STOP}$	SSCAP=0.01 $\mu\text{F}$ $V_{NC} = 0.1\text{V}$ , 90% to 10%		5		ms	
Off-Isolation (AUDIO+/- to D+/D-)	$O_{ISO}$	$V_{BIAS} = 0\text{V}$ , $V_{IN} = 0\text{dBm}$ (NOTE1)	30kHz	-	-85	-	dB
Channel-to-Channel Crosstalk (AUDIO+ to AUDIO-)	$X_{TALKD}$	$V_{BIAS} = 0\text{V}$ , $V_{IN} = 0\text{dBm}$ (NOTE1)	30kHz	-	-85	-	dB

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
-3dB Bandwidth	$f_{3dB}$	$V_{BIAS}=0V, V_{IN}=0dBm$ (NOTE1)	-	1000	-	MHz
Total Harmonic Distortion	THD+N	$f=20Hz$ to $20kHz, R_L=32\Omega, V_{IN}=2.0V_{RMS}, V_{BIAS}=0V$ (NOTE1)	-	-110	-	dB
<b>DATA SWITCH (USB+, USB-)</b>						
Data Signal Range	$V_{USB+/-}, V_{D+/-}$		-0.3	-	5.5	V
On-Resistance	$R_{ON}$	$V_{USB+/-}=0V, 0.4V, I_{load}=-8mA$	-	5	-	$\Omega$
On-Resistance Match Between Channels	$\Delta R_{ON}$	$V_{USB+/-}=0V\sim 1V, I_{load}=-8mA$	-	0.025	0.25	$\Omega$
<b>DATA SWITCH DYNAMIC CHARACTERISTICS</b>						
Turn-Off Time	$t_{OFF}$	$V_{USB+/-} = 3V, R_L = 50\Omega$		1		$\mu s$
Turn-On Time	$t_{ON}$	$V_{USB+/-} = 3V, R_L = 50\Omega$		30		$\mu s$
Off-Isolation (USB+/- to D+/D-)	$O_{ISO}$	$V_{BIAS}=0V, V_{IN}=0dBm$ (NOTE1) 240MHz	-	-25	-	dB
Channel-to-Channel Crosstalk (USB+ to USB-)	$X_{TALKD}$	$V_{BIAS}=0V, V_{IN}=0dBm$ (NOTE1) 240MHz	-	-25	-	dB
-3dB Bandwidth	$f_{3dB}$	$V_{BIAS}=0V, V_{IN}=0dBm$ (NOTE1)	-	1	-	GHz
Switch on capacitance	$C_{on}$	$V_{cc}=3.3V, frequency :240MHz$		6		pF
<b>MICROPHONE SWITCHES (MIC+, MIC-)</b>						
Microphone Signal Range	$V_{MIC+/-}$		-0.3	-	3.6	V
MIC+, MIC- On-Resistance	$R_{ON}$	$V_{MIC+} = 0V$ to $+2.6V, I_{Load}=-8mA$	-	5	-	$\Omega$
MIC+ On-Resistance Flatness	$R_{ONF}$	$V_{MIC+} = 0V$ to $+2.6V, V_{DD}>2.5V$		0.01	0.1	$\Omega$
		$V_{MIC+} = 0V$ to $+2.6V, V_{DD}<2.5V$		0.01	0.25	$\Omega$
Off-Isolation (MIC+, MIC- to SBU1/SBU2)	$O_{ISO}$	$V_{BIAS}=0V, V_{IN}=0dBm$ (NOTE1) 30kHz	-	-85	-	dB
Channel-to-Channel Crosstalk (MIC+ to MIC-)	$X_{TALKD}$	$V_{BIAS}=0V, V_{IN}=0dBm$ (NOTE1) 30kHz	-	-85	-	dB
Total Harmonic Distortion	THD+N	$f=20Hz$ to $20kHz, R_L=600\Omega, V_{IN}=0.1V_{RMS}, V_{BIAS}=2V$ (NOTE1)	-	-90	-	dB
<b>SIDEBAND SWITCH (ISBU1, ISBU2)</b>						
On-Resistance	$R_{ON}$	$V_{ISBU1/2}=0V, 3.6V, I_{Load}=-8mA$	-	5	-	$\Omega$
-3dB Bandwidth	$f_{3dB}$	$V_{BIAS}=0V, V_{IN}=0dBm$ (NOTE1)	-	100	-	MHz
<b>I2C INPUT (SCL, SDA)</b>						
Input Logic High	$V_{IH}$		0.7V D			
Input Logic Low	$V_{IL}$				0.25V DD	
SCL Frequency	$f_{SCL}$		0		1	MHz
SCL Input capacitance	$C_i$	$V_I = GND$	-	5	10	pF
SDA Low level Output Current	$I_{OL}$	$V_{OL}=0.4V$	20	-	-	mA
<b>CURRENT CONSUMPTION</b>						
Operating Current	$I_{CC}$		-	100	250	$\mu A$
Shutdown Current	$I_{SD}$				1	$\mu A$
<b>MICROPHONE DETECTION</b>						
Valid Headphone Impedance	$R_{LR}$	TRRS connector	16	-	64-	$\Omega$
	$R_{LR}$	TRS connector	16	-	-	$\Omega$
Valid Microphone Impedance	$R_{MIC}$	TRRS connector	600	-	-	$\Omega$

Note 1: These parameters are measured on TA=25°C

## Typical Application Circuit



## Function Description

The PI3A6386 is a completed switch array to route the USB/AUDIO/Sideband signals between a Type-C receptacle and internal USB PHY/audio amplifier/microphone amplifier and other sideband circuits. It also includes the automatic microphone detection to detect the various configurations/orientations. It operates from a 1.8V to 5.5V supply and is controlled through I2C.

During Audio Accessory Mode, the PI3A6386 includes a pair of ultra-low THD, low on-resistance audio switches for high-performance audio applications to route the D+/D- to audio amplifier. The Beyond-the-Rails signal capability allows signals below ground and above Vdd to pass without distortion. Soft start/stop feature can minimize the click-and-pop sound due to the offset voltage of the audio amplifier. An automatic microphone detection can detect the configurations of the microphone and route SBU1/2 to the microphone amplifier and ground correspondingly. Separate grounds for microphone, audio L and audio R signals are provided to minimize the crosstalk/echo between them.

During DFP/UEP mode, the PI3A6386 has a pair of high bandwidth data switches to route D+/D- to USB PHY for USB 2.0 (High Speed and Full Speed) applications. Sideband crossbar switch is also provided to swap SBU1/2 based on the orientation of the Type-C plug.

When a device is attached to the USB Type-C port, the Type-C port controller can determine whether it is a DFP/UEP device or an audio accessory. In case of an audio accessory, the system controller will tell PI3A6386 to initialize the detection of the microphone connections through Bit 3 of the control register. After the detection is completed and the results are reported in Bit 2-0 of the

information register. The system controller can then enable the switch array and route the audio signals to the audio accessory with Bit 6,5,2,1 of the control register. In case of a DFP/UFPP device, the system controller can directly enable the switch array and route the USB signals to the USB PHY, and route the Sideband signal to the internal circuits with Bit 6, 5, 4, 2, 1 of the control register.

## I2C Control

The PI3A6386 provides the I2C interface to control the connections of Audio/Data mux, Sideband/Microphone mux, Sideband crossbar switch and report how Mic+/Mic- connected to SBU1/SBU2. Max 2 I2C slave addresses can be configured by connecting ADD to VDD/GND.

### a. Device address

Table 1: Device address

	b7(MSB)	b6	b5	b4	b3	b2	b1	b0
Address Byte (ADDR = 0)	1	0	0	0	0	0	1	R/W
Address Byte (ADDR = 1)	1	0	0	1	0	0	1	R/W

Note: Read "1", Write "0"

### b. Registers

#### Command byte

The command byte is the first byte to follow the address byte during a write transmission. It is used as a pointer to determine which of the following registers will be written or read.

Table 2: Command byte

Command	Register
0	Information register
1	Control register

#### Register 0: Information register

Table 3: Information register

	b7(MSB)-b3	b2	b1	b0
Name	Reserved	Mic detection Success	Mic present	Mic+/Mic- Connection
Description		1 : detection not successful 0 : detection successful ( only valid if Register 1 b1=1 )	1 : Mic not present 0 : Mic present ( only valid if Register 1 b1=1 )	1 : Mic+/Mic- connected to SBU1/SBU2 0 : Mic+/Mic- connected to SBU2/SBU1 ( only valid if Register 1 b1=1)
Type	R	R	R	R
Default	1	1	1	1

### Register 1: Control register

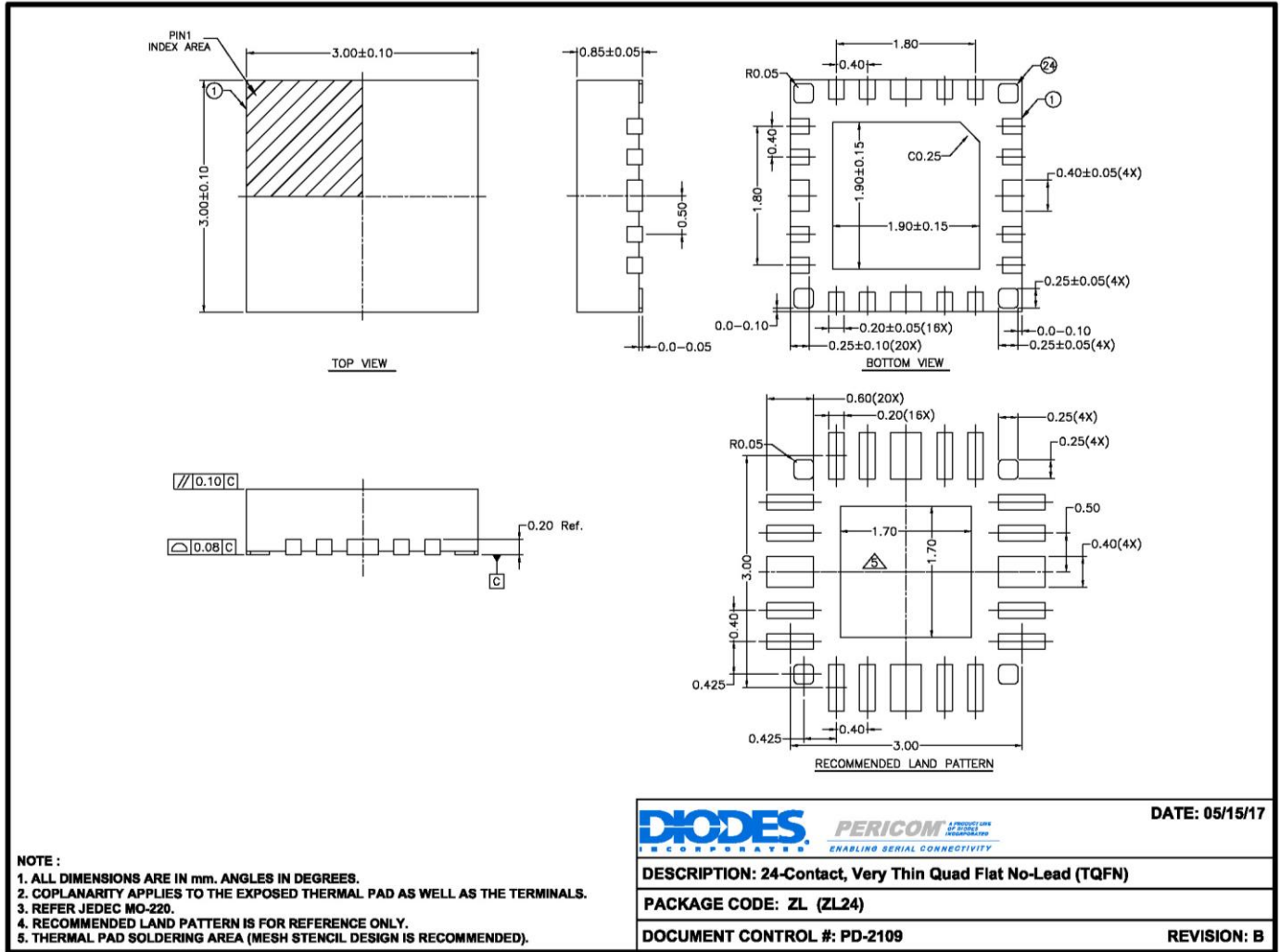
Table 4: Control register

	b7(MSB)	b6	b5	b4	b3	b2	b1	b0
Name	Enable	USB/ AUDIO Mux	Mic/Sideband Mux	Sideband Mux	Detection	USB/ AUDIO Mux Connect ion	Mic/Sideb and Mux Connectio n	Reser ved
Description	0 : IC disabled and all switches disconnected 1: IC enabled	0 : D+/D- connected to ADR/ARL 1: D+/D- connected to USB+/USB- (only valid if Register 1 b2 = 0)	0: SBU1/SBU2 connected to Mic+/Mic-, ADLGND, ADRGND or Mic-, ADLGND, ADRGND /Mic+ 1: SBU1/SBU2 connected to ISBU1/ISBU2 (only valid if Register 1 b1 = 0)	0 : SBU1/SBU2 connected to ISBU2/ISBU1 1: SBU1/SBU2 connected to ISBU1/ISBU2 (only valid if Register 1 b1=0 & b5 = 1)	0 : Start Mic detection (After the mic detection cycle, b3 will be reset to 1.) 1 : Stop Mic detection/Detection stop (During mic detection cycle, writing 1 to b3 can force mic detection stop)	0: Closed 1: Opened	0: Closed 1: Opened	
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Default	1	1	1	1	1	0	1	1

### Part Marking

Top mark not available at this time. To obtain advance information regarding the top mark, please contact your local sales representative.

**Packaging Mechanical:**  
TQFN-24 (ZL)



17-0353

For latest package info.

please check: <http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/>

**Ordering Information**

Part Number	Package Code	Package
PI3A6386ZLEX	ZL	24-Contact, Very Thin Quad Flat No-Lead (TQFN)

**Notes:**

- No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
- See <http://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
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