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### LM746

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#### LM746 Bluetooth<sup>®</sup> Dual Mode Audio Module Standalono (With Embedded Bluetooth® E. Compliant Ctor

Standalone (With Embedded Bluetooth® 5 Compliant Stack)

Revised Datasheet Version Ordering Options 19/FEB/2021 1.3 See last page

🚯 Bluetooth

2.3mm





- Bluetooth<sup>®</sup> 5 Compliant
- Low Power Consumption
- IC Antenna Onboard
- Partial SPP & GATT-Based Profiles
- HSP, HFP, A2DP and AVRCP Audio Profiles
- Application Firmware Support
- Integrated 16-bit Stereo Audio CODEC
- SBC, MP3 and AAC decoder
- aptX<sup>®</sup> codec (including support for SCMS-T) and Faststream codec
- CSR's cVc noise-cancellation technology
- I2S, PCM and SPDIF Audio Interfaces
- UART and USB 2.0 Serial Interfaces
- 6 Capacitive touch sensor input interfaces
- Individual PWM blocks (3 on dedicated LED pads)

• 8 digital and 2 analogue I/O

16<sub>mm</sub>

- Microphone input and Speaker output interfaces
- 23.9mm x 16mm x 2.3mm
- SMT Side and Bottom Pads for easy production
- See our website for this products certifications.
- RoHS, REACH and WEEE

# **Typical Applications**

- Wireless Headphones and Speakers
- Hand-free Headsets
- Automotive Infotainment systems
- Home Entertainment Devices
- Audio Adapters.

### **Overview**

The LM746 Bluetooth<sup>®</sup> Dual Mode audio module is an extremely versatile and cost effective solution. Enabling audio data to be wirelessly communicated between audio devices using a Bluetooth<sup>®</sup> v2.0, v2.1 and Bluetooth<sup>®</sup> v4.0, v4.1, (or 5 compliant) connection. It's sound enhancement features, makes it a perfect fit within your premium audio device. The sound enhancement features includes CSR's aptX<sup>®</sup> audio technology. Providing CD-like quality over a Bluetooth<sup>®</sup> connection. And CSR's cVc audio technology for noise cancellation. Perfectly suited to wireless headphones, speakers and hand-free headsets.

This standalone module allows the developer to connect a microphone, speakers, capacitive touch sensors and other I/O devices. Running the user application without using an external MCU. LM offer application support to the developer and can create new user applications for the module.

Your developed user application and settings can be preloaded to the LM746, simplifying the manufacturing and testing process. It's SMT side and bottom pads allows for easy integrations into your embedded system.



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# LM746 Bluetooth<sup>®</sup> Dual Mode Audio Module Standalone (With Embedded Bluetooth<sup>®</sup> 5 Compliant Stack)

# **General Specification**

Wireless	
Bluetooth® Standard	5 Compliant (Dual Mode)
Module Type	Standalone (Configurable with AT Commands)
Profiles	HSP, HFP, A2DP, AVRCP, Partial-SPP and GATT-Based

#### Hardware

Chipset	Qualcomm
Antenna	IC Antenna Onboard
Microcontroller (MCU)	16-bit RISC 80 MHz MCU
Flash Memory	16 Mbit
RAM	56 KB
Program Interface	SPI
Interfaces	UART, PWM, USB 2.0, PIO and AIO
Audio Interfaces	I2S, PCM and SPDIF
Power Supply	3V3 (VBAT) or 5V (VCHG)
Crystal Oscillators	26 MHz
Development Kit	LM558

#### **RF** Characteristics

Tx Output Power	2 dBm (Bluetooth® v2.0, v.2.1)
Rx Sensitivity	-90 dBm (Bluetooth® v2.0, v.2.1)
Data Rate	Up to 3Mbps
Frequency	2.4 GHz to 2.485 GHz

#### **Physical Characteristics**

Operating Temperature	-20°C to +75°C
Storage Temperature	-40°C to +85°C
Dimensions (L x W x H)	23.9mm x 16mm x 2.3mm
Weight	1.38g +/- 0.25g tolerance
Certifications	See our website for this products certifications.
Compliance	RoHS, REACH and WEEE



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# LM746 Bluetooth® Dual Mode Audio Module

Standalone (With Embedded Bluetooth® 5 Compliant Stack)

### **Pin Outs**



### **Pin Assignments**

Pin	Name	Туре	Supply Domain	Description
1	GND	Ground	0V	Common Ground
2	AIO1	Bi-directional	VDD_AUX (1.35V)	Analogue input/output
3	AIOO	Bi-directional	VDD_AUX (1.35V)	Analogue input/output
4	CAP_SENSE_0	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Capacitive touch sensor input
5	CAP_SENSE_1	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Capacitive touch sensor input
6	CAP_SENSE_2	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Capacitive touch sensor input
7	CAP_SENSE_3	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Capacitive touch sensor input
8	CAP_SENSE_4	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Capacitive touch sensor input
9	CAP_SENSE_5	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Capacitive touch sensor input
10	SD_IN & SPDIF_IN	Bi-directional with weak pull-down	PIO_POWER	I2S Interface & SPDIF Interface
				Sync data output. Alt PIO_17
11	SD_OUT & SPDIF_OUT	Bi-directional with weak pull-down	PIO_POWER	I2S Interface & SPDIF Interface
				Sync data output. Alt PIO_18
12	WS	Bi-directional with weak pull-down	PIO_POWER	I2S Interface & SPDIF Interface
				Sync data output. Alt PIO_19
13	SCK	Bi-directional with weak pull-down	PIO_POWER	I2S Interface & SPDIF Interface
				Sync data output. Alt PIO_20
14	SPI_CLK	Input with strong pull-down	PIO_POWER	SPI clock
15	SPI_MOSI	Input with weak pull-down	PIO_POWER	Master out slave in (SPI)
16	SPI_MISO	Output with strong pull-up	PIO_POWER	Master in slave out (SPI)
17	SPI_CS#	Input with weak pull-down	PIO_POWER	Chip select for SPI, active low
18	RESET	Input with strong pull-up	PIO_POWER	Reset if low. Pull low for minimum 5ms for reset.
19	UART_RX	Bi-directional strong pull-up	PIO_POWER	UART data input
20	GND	Ground	OV	Common Ground
21	UART_TX	Bi-directional weak pull-up	PIO_POWER	UART data output
22	LED0	Open drain output	PIO_POWER	LED Driver



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# LM746 Bluetooth® Dual Mode Audio Module

Standalone (With Embedded Bluetooth® 5 Compliant Stack)

### **Pin Assignments Continued**

Pin	Name	Туре	Supply Domain	Description
23	LED1	Open drain output	PIO_POWER	LED Driver
24	LED2	Open drain output	PIO_POWER	LED Driver
25	PIO0	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
26	PIO1	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
27	PIO2	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
28	PIO3	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
29	PIO4	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
30	PIO5	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
31	PIO6	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
32	PIO7	Bi-directional with weak pull-down	PIO_POWER	Programmable input / output line
33	USB_DP	Bi-directional	3V3_USB	USB data +
34	USB_DN	Bi-directional	3V3_USB	USB data -
35	PIO_POWER	VDD		Positive supply for PIO
36	GND	Ground	0V	Common Ground
37	1V8_SMPS	VDD		1V8 Output
38	VBAT	Battery terminal +ve		Lithium ion/polymer battery positive terminal.
				Battery charger output and input to switch mode
				regulator.
39	VBAT_SENSE			Battery charger sense input
40	VCHG	Charger input		Lithium ion/polymer battery charger input
41	CHG_EXT			External charger control
				Otherwise leave unconnected
42	VREG_ENABLE	Analogue		Regulator enable input
43	UART_CTS	Bi-directional weak pull-down	PIO_POWER	UART clear to send, active low.
44	UART_RTS	Bi-directional weak pull-up	PIO_POWER	UART request to send, active low. Alt PIO16.
45	MIC_LN	Analogue	VDD_AUDIO (1.35V)	Microphone input negative, left.
46	MIC_LP	Analogue	VDD_AUDIO (1.35V)	Microphone input positive, left.
47	MIC_BIAS_A	Analogue	VBAT/3V3_USB	Microphone bias A
48	MIC_RN	Analogue	VDD_AUDIO (1.35V)	Microphone input negative, right
49	MIC_RP	Analogue	VDD_AUDIO (1.35V)	Microphone input positive, right
50	MIC_BIAS_B	Analogue	VBAT/3V3_USB	Microphone bias B
51	SPKR_RN	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Speaker output negative, right
52	SPKR_RP	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Speaker output positive, right
53	SPKR_LN	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Speaker output negative, left
54	SPKR_LP	Analogue	VDD_AUDIO_DRV (1V8_SMPS)	Speaker output positive, left



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# LM746 Bluetooth® Dual Mode Audio Module

Standalone (With Embedded Bluetooth® 5 Compliant Stack)

#### **General Electrical Specification**

Absolute Maximum Ratings	Min	Max	Recommended Operating Condition	Min	Max
Storage Temperature	-40° C	+85° C	Operating Temperature Range	-20° C	+75° C
Supply Voltage (VCHG)	-0.4V	5.75V	Supply Voltage (VCHG)	4.75V / 3.10V	5.75V
Supply Voltage (VBAT)	-0.4V	4.4V	Supply Voltage (VBAT)	2.5V	4.25V
Supply Voltage (VBAT_SENSE)	-0.4V	5.75V	Supply Voltage (VBAT_SENSE)	0V	4.25V
Supply Voltage (VREG_ENABLE)	-0.4V	4.4V	Supply Voltage (VREG_ENABLE)	OV	4.25V
Supply Voltage (LED [2:0] )	-0.4V	4.4V	Supply Voltage (LED [2:0])	1.10V	4.25V
Supply Voltage (PIO_POWER)	-0.4V	3.6V	Supply Voltage (PIO_POWER)	1.7V	3.6V

#### 1.8V Switch-mode Regulator

1.8V Switch-mode Regulator	Min	Тур	Max	Unit
Input Voltage (VBAT)	2.80	3.70	4.25	V
Output Voltage (1V8_SMPS)	1.70	1.80	1.90	V
Normal Operation				
Transient setting time	-	30	-	μs
Load current	-	-	185	mA
Current available for external use, stereo audio with 16 $\Omega$ load (a)	-	-	25	mA
Peak conversion efficiency	-	90	-	%
Switching frequency	3.63	4.00	4.00	MHz
Low Power Mode, automatically entered in Deep Sleep				
Transient setting time	-	200	-	μs
Load current	0.005	-	5	mA
Current available for external use	-	-	5	mA
Peak conversion efficiency	-	85	-	%
Switching frequency	100	-	200	kHz

#### **Regulator Enable**

VREG_ENABLE, Switching Threshhold	Min	Тур	Max	Unit
Rising Threshold	1.0	-	-	V

(a) = More current available for audio loads above  $16 \Omega$ 



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### **Battery Charger**

Battery Charger		Min	Тур	Max	Unit
Input Voltage, VCHG (a)		4.75 / 3.10	5.00	5.75	V
(a) = Reduced specification from 3.1 to	9 4.75. Full specification > 4.75V				
Trickle Charge Mode		Min	Тур	Max	Unit
Charge current Itrickle as per	centage of fast charge current	8	10	12	%
Vfast rising threshold		-	2.9	-	V
Vfast rising threshold trim st	ep size	-	0.1	-	V
Vfast falling threshold		-	2.8	-	V
Fast Charge Mode		Min	Тур	Max	Unit
Charge current during const	ant Max headroom > 0.55V	194	200	206	mA
Current mode, Ifast	Min headroom > 0.55V		10		mA
Reduced headroom charge	current,				
as a percentage of Ifast	Mid headroom = 0.15V	50	-	100	%
I-CTRL charge current step	size	-	10	-	mA
Vfloat threshold, calibrated		4.16	4.20	4.24	V
Standby Mode		Min	Тур	Max	Unit
Voltage hysteresis on VBAT,	Vhyst	100	-	150	mV
Error Charge Mode		Min	Тур	Max	Unit
Headroom (a) error rising th	reshold	30	-	50	mV
Headroom (a) error threshold hysteresis (a) = Headroom = VCHG-VBAT		20	-	30	mV
External Charge Mode		Min	Тур	Max	Unit
Fast charge current Ifast		200	-	500	mA
Control current into CHG_EXT		0	-	20	mA
Voltage on CHG_EXT		0		5.75	V
External pass device hfe		-	50	-	-
Sense voltage, between VB	AT_SENSE and VBAT at max current	195	200	205	mV

(a) = In the external mode, the battery charger meets all the previous charger electrical characteristics and the additional or superceeded elecectrical characteristics are listed in this table

### Stereo Codec: Analogue to Digital Converter

Parameter	Conditions		Min	Тур	Max	Unit
Resolution	-		-	-	16	Bits
Input Sample Rate Fsample	-		8	-	48	kHz
SNR	fin = 1kHz	Fsample				
	B/W = 20HzFsample/2	8kHz	-	93	-	dB
	(20kHz max)	16kHz	-	92	-	dB
	A-Weighted	32kHz	-	92	-	dB
	THD+N < 1%	44.1kHz	-	92	-	dB
	1.6Vpk-pk input	48kHz	-	92	-	dB



Standalone (With Embedded Bluetooth® 5 Compliant Stack)

### Stereo Codec: Analogue to Digital Converter Continued...

Parameter	Conditions		Min	Тур	Max	Unit
THD+N	fin = 1kHz	Fsample				
	B/W = 20HzFsample/2					
	(20kHz max)	8kHz	-	0.004	-	%
	1.6Vpk-pk input	48kHz	-	0.008	-	%
Digital gain	Digital gain resolution = 1 / 32		-24	-	21.5	dB
Analogue gain	Pre-amplifier setting		-3	-	42	dB
	= 0dB, 9dB, 21dB or 30dB					
	Analogue setting					
	= -3dB to 12dB in 3dB steps					
Stereo seperation (crosstalk)			-	-89	-	dB

### Stereo Codec: Digital to Analogue Converter

Parameter	Conditions			Min	Тур	Max	Unit
Resolution	-			-	-	16	Bits
Output Sample Rate Fsample	-			8	-	96	kHz
SNR	fin = 1kHz	Fsample	Load				
	B/W = 20Hz20kHz						
	A-Weighted	48kHz	100Ω	-	96	-	dB
	THD+N < 0.1%	48kHz	32Ω	-	96	-	dB
	OdBFS input	48kHz	16Ω	-	96	-	dB

Parameter	Conditions			Min	Тур	Max	Unit
THD+N	fin = 1kHz	Fsample	Load				
	B/W = 20Hz20kHz						
	OdBFS input	8kHz	100kΩ	-	0.002	-	%
		8kHz	32Ω	-	0.002	-	%
		8kHz	16Ω	-	0.003	-	%
		48kHz	100kΩ	-	0.003	-	%
		48kHz	32Ω	-	0.003	-	%
		48kHz	16Ω	-	0.004	-	%
Digital Gain	Digital Gain Resolution = 1	/32		-24	-	21.5	dB
Analogue Gain	Analogue Gain Resolution	= 3dB		-21	-	0	dB
Stereo seperation (crosstalk)				-	-88	-	dB



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#### Digital

Digital Terminals		Min		Тур	Max	Unit
Input Voltage						
VIL input logic level low		-0.4		-	0.4	V
VIH input logic level high		0.7xPIO_POW	/ER	-	PIO_POWER+0.4	V
Tr/Tf		-		-	25	ns
Output Voltage						
VOL output logic level low, IOL	= 4.0mA	-		-	0.4	V
VIH output logic level high, IOH	l = -0.4mA	.75xPIO_POW	/ER	-	-	V
Tr/Tf		-		-	5	ns
Input and Tristate Currents						
Strong pull-up		-150		-40	-10	uA
Strong pull-down		10		40	150	uA
Weak pull-up		-5		-1.0	-0.33	uA
Weak pull-down		0.33		1.0	5.0	uA
CI input Capacitance		1.0			5.0	pF
LED Driver Pads						
LED Driver Pads			Min	Тур	Max	Unit
Current, IPAD	High impedance	state	-	-	5	μΑ
	Current sink stat	e	-	-	10	mA
LED pad voltage, VPAD	IPAD = 10mA		-	-	0.55	V
LED pad resistance	VPAD < 0.5V		-	-	40	Ω
VOL output logic level low(a)			-	0	-	V
VOH output logic level high(a)			-	0.8	-	V
VIL input logic level low			-	0	-	V
VIH input logic level high			-	0.8	-	V

(a) LED output port is open-drain and requires a pull-up

#### **Auxiliary ADC**

Auxiliary ADC		Min	Тур	Max	Unit
Resolution		-	-	10	Bits
Input voltage range(a)		0	-	1.35	V
Accuracy	INL	-1	-	1	LSB
(Guaranteed monotonic)	DNL	0	-	1	LSB
Offset		-1	-	1	LSB
Gain error		-0.8	-	0.8	%
Input bandwidth		-	100	-	kHz
Conversion time		1.38	1.69	2.75	μs
Sample rate(b)		-	-	700	Samples/s

(a) LSB size = VDD\_AUX/1023

(b) The auxiliary ADC is accessed through a VM function. The sample rate given is achieved as part of this function.



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# **Auxiliary DAC**

Auxiliary DAC	Min	Тур	Max	Unit
Resolution	-	-	10	Bits
Supply voltage, VDD_DAC	1.30	1.35	1.40	V
Output voltage range	0	-	1.35	V
Full-scale output voltage	1.30	1.35	1.40	V
LSB size	0	1.32	2.64	mV
Offset	-1.32	0	1.32	mV
Integral non-linearity	-1	0	1	LSB
Settling time(a)	-	-	250	ns

(a) The settling time does not include any capacitive load

### **RF Specification: Temperature = +20° C**

Transmitter	Min	Тур	Max	Bluetooth <sup>®</sup> Specification	Unit
Maximum RF transmit power	-6	2	-	-6 to +4	dBm
RF power variation over temperature range with compensation enabled	-	±0.5	-	-	dB
RF power variation over temperature range with compensation disabled	-	±1.5	-	-	dB
20dB bandwidth for modulated carrier	-	925	1000	≤1000	kHz
Adjacent channel transmit power F = F0 $\pm$ 2MHz	-	-23	-20	≤-20	dBm
Adjacent channel transmit power F = F0 $\pm$ 3MHz	-	-32	-28	≤-40	dBm
Adjacent channel transmit power F = F0 $\pm$ > 3MHz	-	-65	-40	≤-40	dBm
Δflavg Maximum Modulation	140	165	175	140 <f1avg<175< td=""><td>kHz</td></f1avg<175<>	kHz
Δf2max Minimum Modulation	115	137	-	≥115	kHz
Δf2avg/Δf1avg	0.8	0.9	-	≥0.80	-
Initial carrier frequency tolerance	-75	15	75	±75	kHz
Drift Rate	-	5	20	≤20	kHz/50 $\mu$
Drift (single slot packet)	-	15	25	≤25	kHz
Drift (five slot packet)	-	15	40	≤40	kHz
2nd Harmonic Content	-	-40	-	≤-30	dBm
3rd Harmonic Content	-	-55	-	≤-30	dBm

### **RF Specification: Temperature = +20° C**

Receiver		Min	Тур	Max	Bluetooth <sup>®</sup> Specification	Unit
Sensitivity at 0.1% BER for all packet types	2.402	-	-87	-83	≦-70	dBm
	2.441	-	-90	-86		
	2.480	-	-90	-86		
Maximum received signal at 0.1% BER		-20	>-10	-	≥-20	dBm
C/I co-channel		-	5	11	≤11	dB
Adjacent channel selectivity C/I F = F0 + 1MHz		-	-5	0	≤0	dB
Adjacent channel selectivity C/I F = F0 - 1MHz		-	-3	0	≤0	dB
Adjacent channel selectivity C/I		-	-35	-30	≤-30	dB



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A Better Connection

# LM746 Bluetooth® Dual Mode Audio Module

Standalone (With Embedded Bluetooth® 5 Compliant Stack)

# **RF Specification: Temperature = +20° C Continued...**

Receiver	Min	Тур	Max	Bluetooth® Specification	Unit
F = FO + 2MHz					
Adjacent channel selectivity C/I F = F0 - 2MHz	-	-25	-20	≤-20	dB
Adjacent channel selectivity C/I F = F0 + 3MHz	-	-45	-40	≤-40	dB
Adjacent channel selectivity C/I F = F0 - 5MHz		-45	-40	≤-40	dB
Adjacent channel selectivity C/I F = FImage	-	-20	-9	≤-9	dB
Maximum level of intermodulation interferers	-39	-23	-	≥-39	dBm
Spurious output level	-	-155	-		dBm/Hz

#### **1. Serial Interface**

#### 1.1 USB Interface

LM746 has a full-speed (12Mbps) USB interface for communicating with other compatible digital devices.

The USB interface on LM746 acts as a USB peripheral, responding to requests from a master host controller. LM746 contains internal USB termination resistors and requires no external resistor matching.

LM746 supports the Universal Serial Bus Specification, Revision v2.0 (USB v2.0 Specification), supports

USB standard charger detection and fully supports the USB Battery Charging Specification, available from http://www.usb.org. For more information on

how to integrate the USB interface on LM746 see the Bluetooth® and USB Design Considerations Application Note.

As well as describing USB basics and architecture, the application note describes:

- Power distribution for high and low bus-powered configurations
- Power distribution for self-powered configuration, which includes USB VBUS monitoring
- USB enumeration
- Electrical design guidelines for the power supply and data lines, as well as PCB tracks and the effects of ferrite beads
- USB suspend modes and Bluetooth<sup>®</sup> low-power modes:
  - Global suspend
  - Selective suspend, includes remote wake
  - Wake on Bluetooth®, includes permitted devices and set-up prior to selective suspend Suspend mode current draw
  - PIO status in suspend mode
  - Resume, detach and wake PIOs
- Battery charging from USB, which describes dead battery provision, charge currents, charging in suspend modes and USB VBUS voltage consideration
- USB termination when interface is not in use
- Internal modules, certification and non-specification compliant operation



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#### **1. Serial Interface**

#### 1.2 Programming and Debug Interface

LM746 provides a debug SPI interface for programming, configuring (PS Keys) and debugging the LM746. Access to this interface is required in production. Ensure the 4 SPI signals and the SPI line are brought out to either test points or a header. To use the SPI interface, the SPI line requires the option of being pulled high externally.

#### 2. Interfaces

#### 2.1 Analogue I/O Ports, AIO

LM746 has 2 general-purpose analogue interface pin, AIO[0] & AIO[1]. Typically, this connects to a thermistor for battery pack temperature measurements during charge control.

#### 2.2 LED Drivers

LM746 includes a 3-pad synchronised PWM LED driver for driving RGB LEDs for producing a wide range of colours. All LEDs are controlled by firmware.

The terminals are open-drain outputs, so the LED must be connected from a positive supply rail to the pad in series with a current-limiting resistor.



#### Figure 2.1: LED Equivalent Circuit

From Figure 2.1 it is possible to derive Equation 2.1 to calculate ILED. If a known value of current is required through the LED to give a specific luminous

intensity, then the value of RLED is calculated.

$$I_{LED} = \frac{VDD - V_{F}}{R_{LED} + R_{ON}}$$

#### Equation 2.1: LED Current

For the LED pads to act as resistance, the external series resistor, RLED, needs to be such that the voltage drop across it, VR, keeps VPAD below 0.5V.

Equation 2.2 also applies.

$$VDD = VF + VR + VPAD$$

#### Equation 2.2: LED PAD Voltage

Note: The LED current adds to the overall current. Conservative LED selection extends battery life.



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#### 3. Power Control and Regulation

#### 3.1 Voltage Regulator Enable

When using the integrated regulators the voltage regulator enable pin, VREG\_ENABLE, enables the LM746 and the following regulators:

-1.8V switch-mode regulator

-1.35V switch-mode regulator

-Low-voltage VDD\_DIG linear regulator

-Low-voltage VDD\_AUX linear regulator

The VREG\_ENABLE pin is active high.

LM746 boots-up when the voltage regulator enable pin is pulled high, enabling the regulators. The firmware then latches the regulators on, it is then

permitted to release the voltage regulator enable pin.

The status of the VREGENABLE pin is available to firmware through an internal connection. VREGENABLE also works as an input line.

#### 3.2 Reset, RST#

LM746 is reset from several sources:

-RST# pin

-Power-on reset

-USB charger attach reset

-Software configured watchdog timer

The RST# pin is an active low reset and is internally filtered using the internal low frequency clock oscillator. LM Developes recommends applying RST# for a period >5ms. At reset the digital I/O pins are set to inputs for bidirectional pins and outputs are set to tristate.

#### 4. Battery Charger

#### 4.1 Battery Charger hardware Operating Modes

The battery charger hardware is controlled by the VM. The battery charger has 5 modes:

#### -Disabled

-Trickle charge

-Fast charge

-Standby: fully charged or float charge

-Error: charging input voltage, VCHG, is too low

The battery charger operating mode is determined by the battery voltage and current.

The internal charger circuit can provide up to 200mA of charge current, for currents higher than this the LM746 can control an external pass transistor

#### 4.2 External Mode

The external mode is for charging higher capacity batteries using an external pass device. The current is controlled by sinking a varying current into the CHG\_EXT pin, and the current is determined by measuring the voltage drop across a resistor, Rsense, connected in series with the external pass device, see Figure 4.2.1. The voltage drop is determined by looking at the difference between the VBAT\_SENSE and VBAT pins. The voltage drop across Rsense is typically 200mV. The value of the external series resistor determines the charger current. This current can be trimmed with a PS Key. In Figure 4.2.1, R1 (220mQ) and C1 (4.7 $\mu$ F) form a RC snubber that is required to maintain stability across all battery ESRs. The battery ESR must be <1.0 $\Omega$ 



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# 4. Battery Charger Continued...

#### Figure 4.2.1: Battery Charger External Mode Typical Configuration





In Figure 4.2.2, Optional fast charge,400m $\Omega$  = 500m. Connect VBAT\_SENSE to VBAT if not using this circuit.



#### 5. Flash Memory

#### 5.1 eFlash Memory

The internal flash memory provides 16Mb of internal code and data storage. For improved performance, the internal flash memory has 45ns access time and is organised as 64-bit wide.

#### 5.2 Serial Quad I/O Flash (Optional)

LM746 supports serial flash. This enables additional data storage areas for device specific data. LM746 use the Serial Quad I/O Flash 4Mb Flash.

#### 6. Capacitive Touch Sensor

#### LM746 capacitive touch sensor interface features:

-Support for up to 6 capacitive touch sensing electrodes

-Printed on the PCB

-Made from flex PCB

-Configuration for individual buttons

-Configuration for a wipe-type arrangement where 2 or more pads sense taps at each end or a wipe from one side to the other

-Operates in deep sleep and is a programmable source for wake-up



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Figure 6.1 shows the system block diagram for the capacitive touch sensor interface. The interface depends on the capacitive touch sensor type.

Therefore the overall control of the capacitive touch sensor interface resides in the VM, so it is easily modified in each end-user application.



The overall system-level specification for the capacitive touch sensor interface on the LM746 Module is:

- 6 inputs multiplexed in to 1 touch sensor on the front-end
- Capacitances of 0pF to 50pF measured with a resolution of 4fF, where a touch is assumed to be between ±50fF and ±1pF
- Each reading takes 172µs
- 6 pads read every 1.03ms
- System auto-calibrates to remove parasitic and environmental effects including
- PCB construction
- Temperature
- Humidity
- Works in normal and deep sleep modes
- System current is approximately 50µA from the battery
- The touch sensor also functions like a PIO

The system block diagram in Figure 6.1 highlights the top-level architecture for the capacitive touch sensor interface, it consists of:

- Capacitive range control
- Sets the rough capacitance of the touch sensor pad, which is product dependent
- Splits into 4 integrated capacitors
- The VM selects which capacitors are enabled, i.e. the range capacitance
- Sampling front end
- An internal capacitance is trimmed by the digital state machine ensuring
- Touch Capacitance = Range Capacitance + Internal Capacitance
- When the internal capacitance is correctly trimmed: The sense voltage is OV
- A touch changes the touch capacitance, which then changes the sense voltage
- ADC: Uses a successive approximation, charge redistribution ADC Clocked at 64kHz
- 9-bit resolution, where LSB is ±2fF and full range is ±1pF
- The internal capacitance is a 7-bit variable capacitor with 114fF steps and 14.5pF range



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The internal capacitance is trimmed, putting it in the mid range of the ADC. This enables measurements from OpF to 50pF, where a capacitive touch is

between ±50fF and ±1pF.

Digital signal conditioning:

Only the enabled inputs are scanned

Enabling fewer inputs increases readings per second

Averaging of ADC readings reduces noise, this is software programmable from 1 to 64 readings in intervals to the power of 2

The internal capacitance updates using a rolling average of the ADC readings, software programmable from 1 to 215 readings in intervals to the power

of 2. For example, 32768 readings take approximately:

5.6s if polling one pad (no averaging)

33.8s if polling 6 pads (no averaging)

Pulse skipping mode is possible, reducing the current consumption. Here the system waits a programmable number of 64kHz clock cycles (maximum

29) before the next read, i.e. an 8ms maximum pause.

ADC trigger level is software programmable. If the threshold is crossed the firmware gets an interrupt.

6 hardware event registers store the pad number and trigger time, which enables the system to sense swipes.

Programmable hysteresis, with one value for all pads

Software signal conditioning (firmware):

The firmware reads ADC and Cint values after an interrupt as the hardware only stores the pad number and trigger time

Digital state machine scans pads and calibrates the internal capacitance

If a swipe happens in deep sleep the firmware reads the trigger order and event time when it wakes

up. It then reads the last ADC reading for each input, not the reading that triggered the interrupt.

VM:

Configures the hardware and gets an interrupt when a programmable threshold is crossed

Selects the range capacitance

Decides whether an event is a valid touch



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# **Physical Dimensions**



# **Front View**



# Side View





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# Tray Dimensions



#### Quantitites

1 Tray = 30 modules 10 Trays = 300 modules 20 Trays = 600 modules

The trays/reels are stacked and inserted into an anti-static vacuum bag with a Humidity Indicator Card. On the outside of the bag are labels for Anti-Static, Model Name and Moisture Sensitivity Levels.



The vacuum bag is placed inside the box and a Model Name Label stuck on the front-side of each box.





Each carton contains 4 boxes.



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### **Datasheet Version Notes**

v1.0	18 APR 2018	Added version notes to datasheet.
		Added Bluetooth <sup>®</sup> 5 Complaint.
v1.1	04 JUL 2018	Packing information addition.
v1.2	14 AUG 2018	Changed part number.
v1.3	19 FEB 2021	Datasheet branding update.



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# **Ordering Options**

ET T	746-0419	LM746 Module MOD SMT PROG BT4.1 D/Mode Fw.ATSNK_0202_Headset IC ANT CSP
E	746-0420	LM746 Module MOD SMT PROG BT4.1 D/Mode Fw.ATSNK_0202_Headset IC ANT TRAY
E	746-0421	LM746 Module MOD SMT PROG BT4.1 D/Mode Fw.ATCom_0102 IC ANT TRAY
E	746-0422	LM746 Module MOD SMT PROG BT4.1 D/Mode Fw.ATCom_0102 IC ANT CSP



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