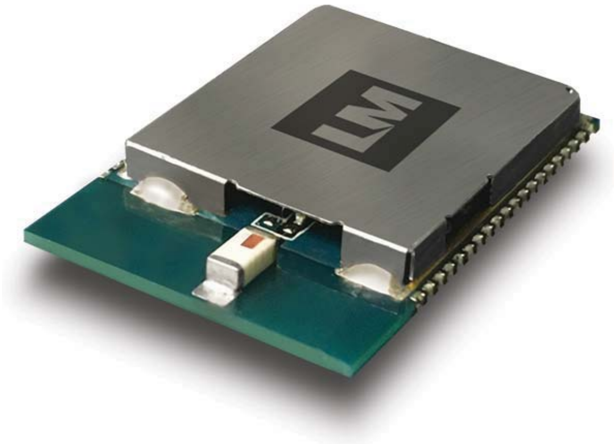
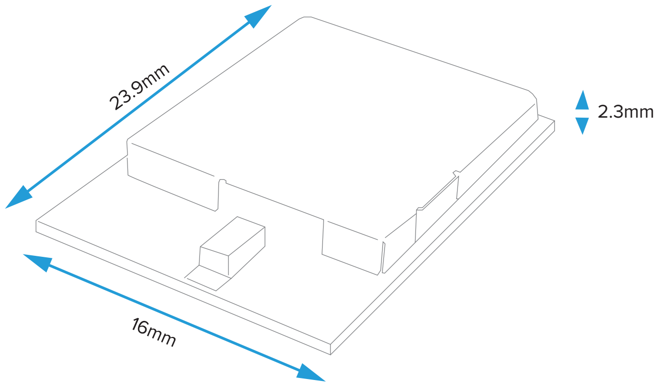
LM746 Bluetooth® Dual Mode Audio Module
Standalone (With Embedded Bluetooth® 5 Compliant Stack)

Product	LM746
Part No	See Last Page
Revised	18/APR/2018





Features

- Bluetooth® 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® 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 (Full Speed) Serial Interfaces
- 6 Capacitive touch sensor input interfaces
- Individual PWM blocks (3 on dedicated LED pads)
- 8 digital and 2 analogue I/O
- 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® 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® v2.0, v2.1 and Bluetooth® v4.0, v4.1, 5 connection. It's sound enhancement features, makes it a perfect fit within your premium audio device. The sound enhancement features includes CSR's aptX® audio technology. Providing CD-like quality over a Bluetooth® 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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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 (Full Speed), 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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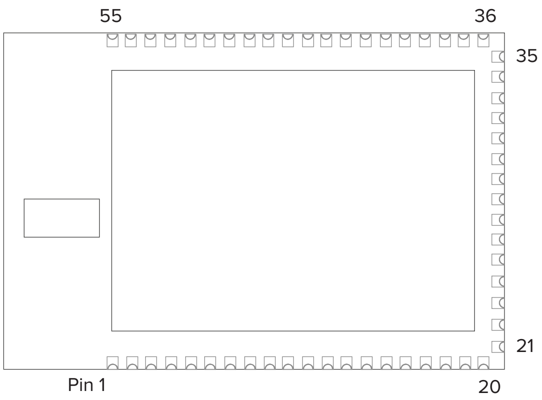
Pin Outs



Pin Assignments

Pin	Name	Type	Supply Domain	Description
1	GND	Ground	0V	Common Ground
2	AIO1	Bi-directional	VDD_AUX (1.35V)	Analogue input/output
3	AIO0	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	0V	Common Ground
21	UART_TX	Bi-directional weak pull-up	PIO_POWER	UART data output
22	LED0	Open drain output	PIO_POWER	LED Driver

Pin Assignments Continued

Pin	Name	Type	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
55	GND	Ground	0V	Common Ground

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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)	0V	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	Typ	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 16Ω 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	Typ	Max	Unit
Rising Threshold	1.0	-	-	V

(a) = More current available for audio loads above 16Ω

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Battery Charger

Battery Charger	Min	Typ	Max	Unit
Input Voltage, VCHG (a)	4.75 / 3.10	5.00	5.75	V

(a) = Reduced specification from 3.1 to 4.75. Full specification > 4.75V

Trickle Charge Mode		Min	Typ	Max	Unit
Charge current $I_{trickle}$ as percentage of fast charge current		8	10	12	%
Vfast rising threshold		-	2.9	-	V
Vfast rising threshold trim step size		-	0.1	-	V
Vfast falling threshold		-	2.8	-	V
Fast Charge Mode		**Min**	**Typ**	**Max**	**Unit**
Charge current during constant	Max headroom > 0.55V	194	200	206	mA
Current mode, I_{fast}	Min headroom > 0.55V		10		mA
Reduced headroom charge current, as a percentage of I_{fast}	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**	**Typ**	**Max**	**Unit**
Voltage hysteresis on VBAT, V_{hyst}		100	-	150	mV
Error Charge Mode		**Min**	**Typ**	**Max**	**Unit**
Headroom (a) error rising threshold		30	-	50	mV
Headroom (a) error threshold hysteresis		20	-	30	mV

(a) = Headroom = VCHG-VBAT

External Charge Mode	Min	Typ	Max	Unit
Fast charge current I_{fast}	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 VBAT_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	Typ	Max	Unit
Resolution	-		-	-	16	Bits
Input Sample Rate Fsample	-		8	-	48	kHz
SNR	fin = 1kHz	Fsample				
	B/W = 20Hz--Fsample/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

Stereo Codec: Analogue to Digital Converter Continued...

Parameter	Conditions		Min	Typ	Max	Unit
THD+N	fin = 1kHz	Fsample				
	B/W = 20Hz--Fsample/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	Typ	Max	Unit
Resolution	-			-	-	16	Bits
Output Sample Rate Fsample	-			8	-	96	kHz
SNR	fin = 1kHz	Fsample	Load				
	B/W = 20Hz--20kHz						
	A-Weighted	48kHz	100Ω	-	96	-	dB
	THD+N < 0.1%	48kHz	32Ω	-	96	-	dB
	0dBFS input	48kHz	16Ω	-	96	-	dB

Parameter	Conditions			Min	Typ	Max	Unit
THD+N	fin = 1kHz	Fsample	Load				
	B/W = 20Hz--20kHz						
	0dBFS 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	Typ	Max	Unit
Input Voltage				
VIL input logic level low	-0.4	-	0.4	V
VIH input logic level high	0.7xPIO_POWER	-	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 = -0.4mA	.75xPIO_POWER	-	-	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	Typ	Max	Unit
Current, IPAD	High impedance state	-	-	5	µA
	Current sink state	-	-	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	Typ	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	Typ	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	Typ	Max	Bluetooth® 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 ± 2MHz	-	-23	-20	≤-20	dBm
Adjacent channel transmit power F = F0 ± 3MHz	-	-32	-28	≤-40	dBm
Adjacent channel transmit power F = F0 ± > 3MHz	-	-65	-40	≤-40	dBm
Δf1avg Maximum Modulation	140	165	175	140<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/50µ
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	Typ	Max	Bluetooth® 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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RF Specification: Temperature = +20° C Continued...

Receiver	Min	Typ	Max	Bluetooth® Specification	Unit
F = F0 + 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® 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 considera- tion
- 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.

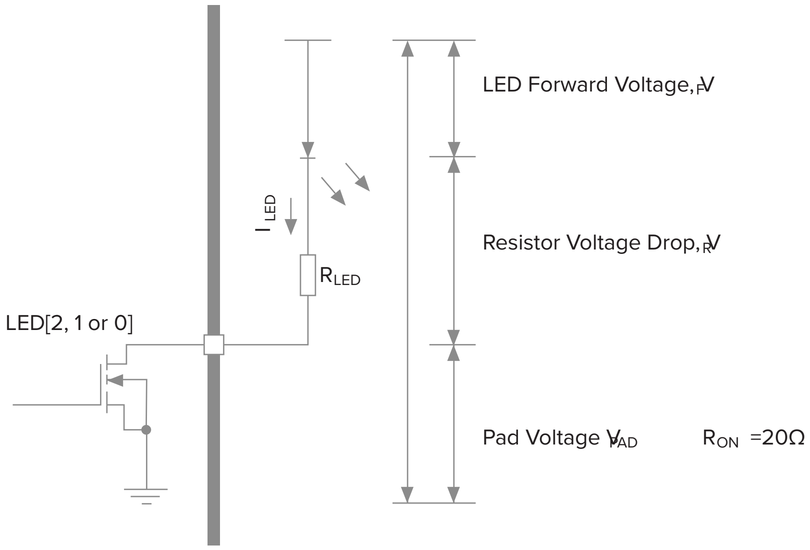


Figure 2.1: LED Equivalent Circuit

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.

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 (220mΩ) and C1 (4.7µF) form a RC snubber that is required to maintain stability across all battery ESRs. The battery ESR must be <1.0Ω

4. Battery Charger Continued...

Figure 4.2.1: Battery Charger External Mode Typical Configuration

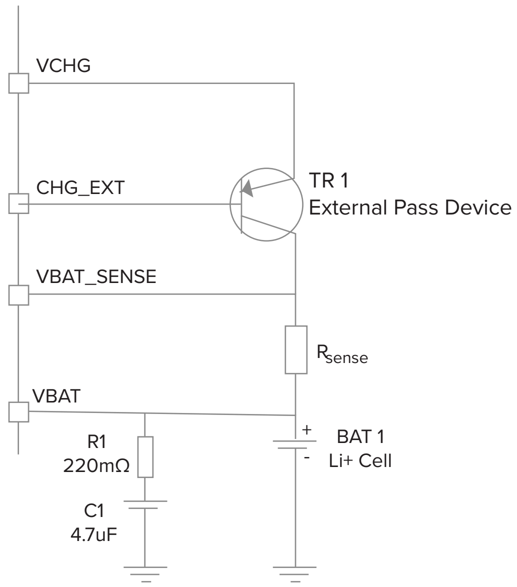
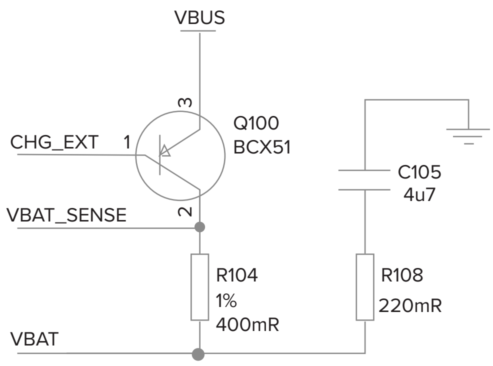


Figure 4.2.2: Optional Ancilliary Circuits

In Figure 4.2.2, Optional fast charge,400mΩ = 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

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.

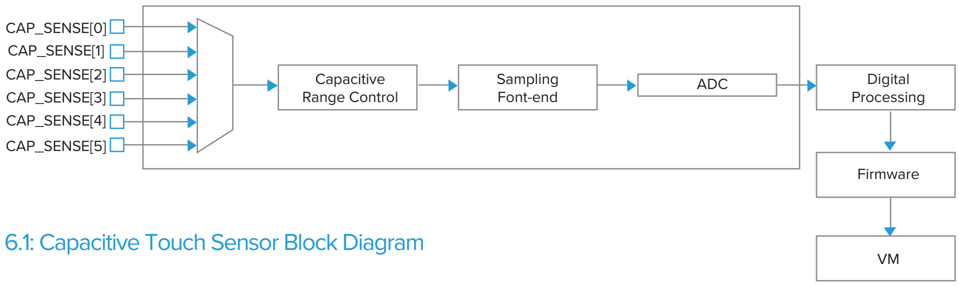


Figure 6.1: Capacitive Touch Sensor Block Diagram

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 0V
- 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

The internal capacitance is trimmed, putting it in the mid range of the ADC. This enables measurements from 0pF 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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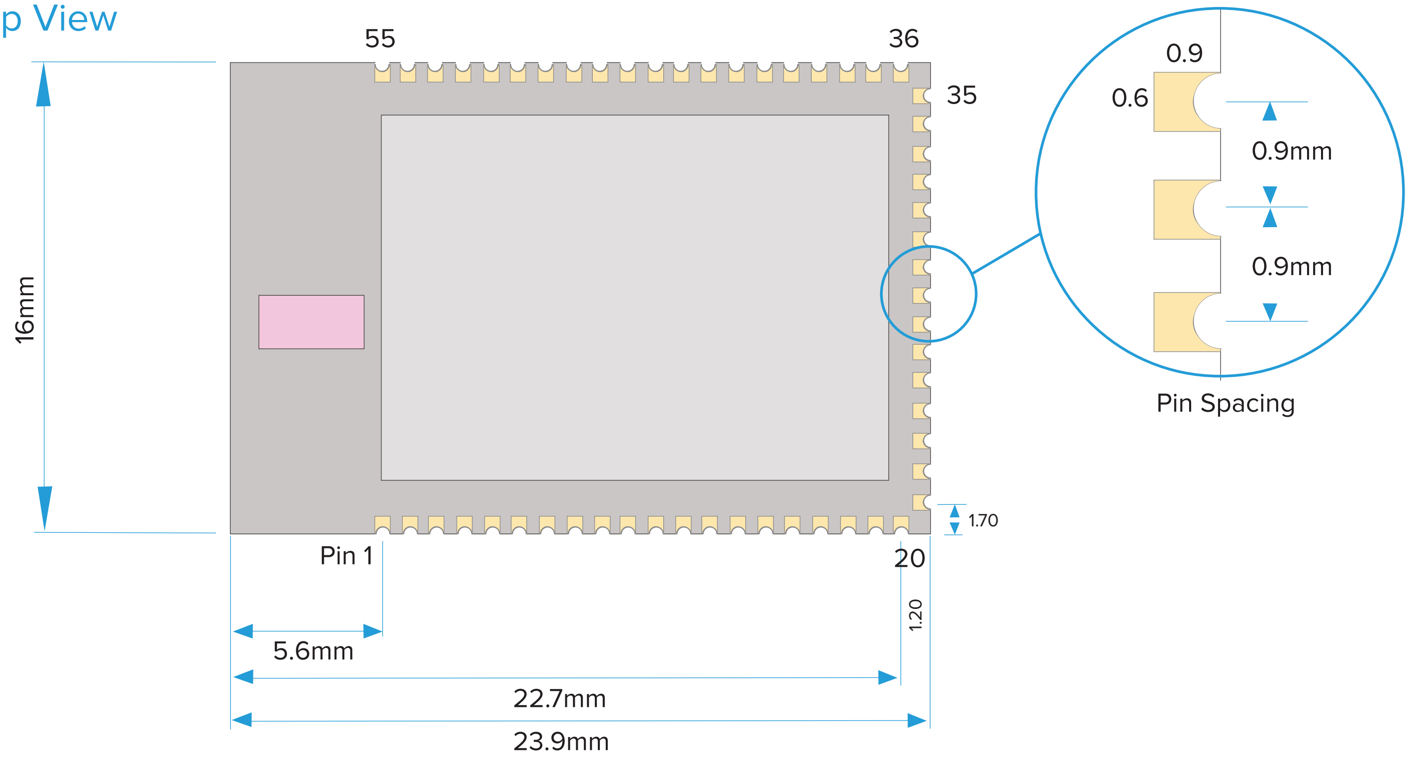
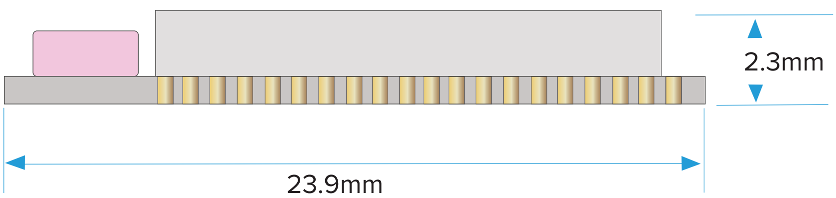
Physical Dimensions

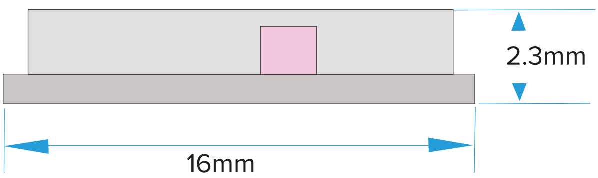
Top View



Front View



Side View



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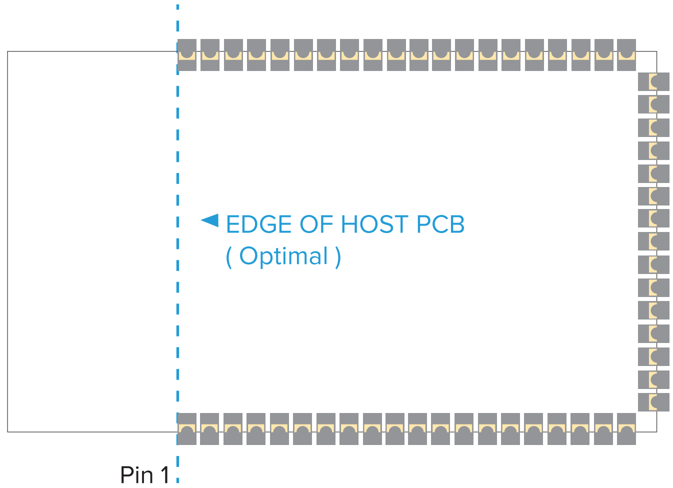
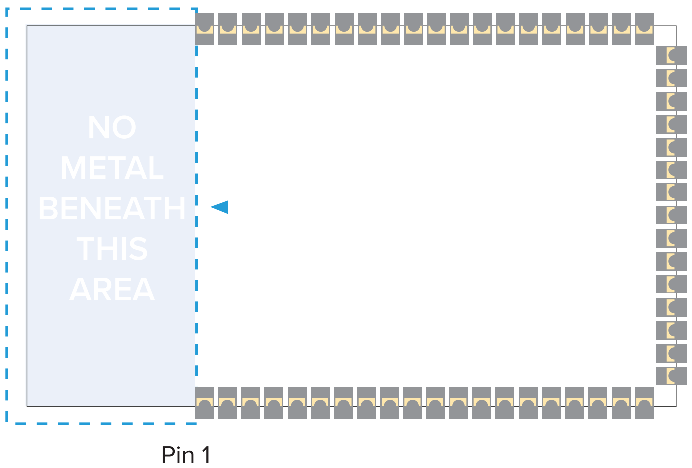
PCB Footprint

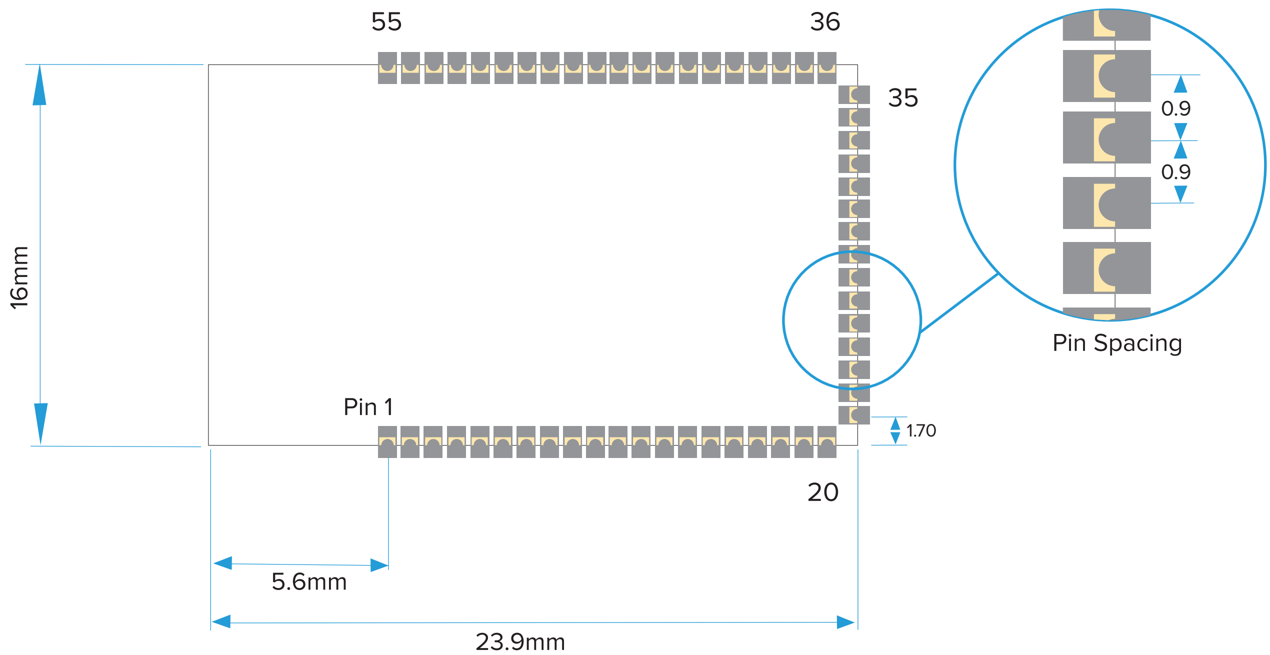
Optimal Placement Position



Placement Note
If the optimal placement position cannot be achieved, ensure there is no metal beneath the highlighted part of module.

NB
Aim to place the module away from interference. (i.e: place the module at the edge of the board.)





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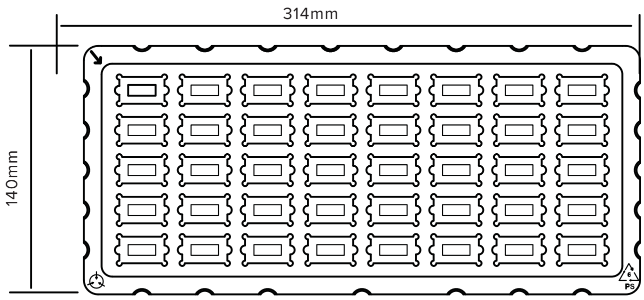
Tray Dimensions



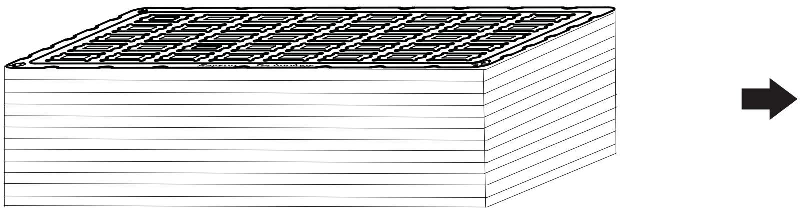
Quantitites

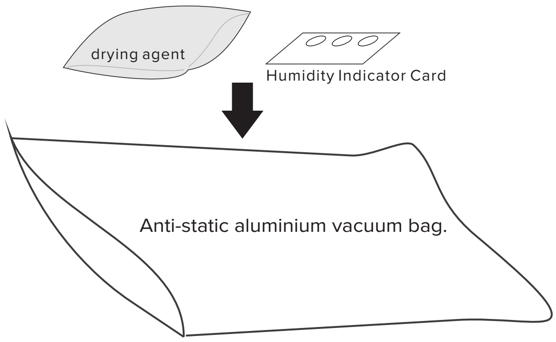
1 Tray = 30 modules

10 Trays = 300 modules

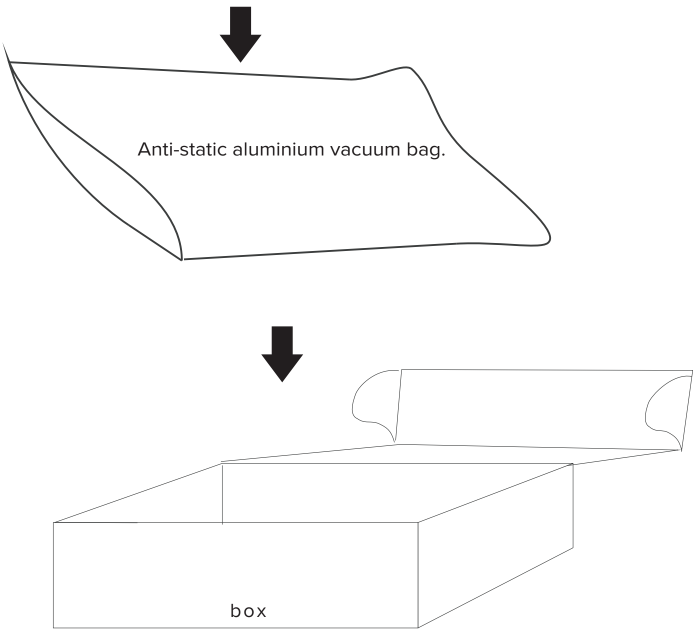
20 Trays = 600 modules

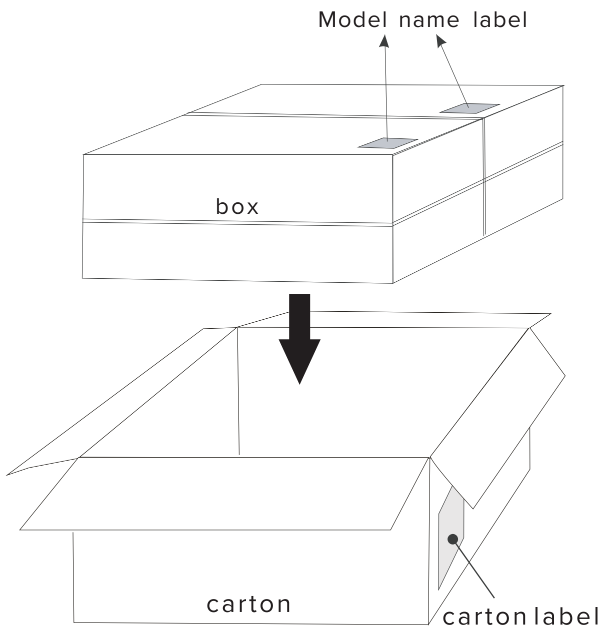
The trays are stacked and inserted into an anti-static vacuum bag and the Anti-Static Label, Model Name Label and Moisture Sensitive Labels stuck on.





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® 5 Complaint.

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LM746 Packaging Options

746-0420

LM746 Module
MOD SMT PROG BT4.1 D/Mode FwA20Rx IC ANT TRAY

746-0421

LM746 Module
MOD SMT PROG BT4.1 D/Mode FwA20HIC IC ANT TRAY

FCC Warning

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE 1: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

NOTE 2: Any changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC ID: VVXLM746" any similar wording that expresses the same meaning may be used.
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
The module is limited to OEM installation ONLY.
The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.
A separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and difference antenna configurations.
There is requirement that the grantee provide guidance to the host manufacturer for compliance with Part 15B requirements.