HT MICRON

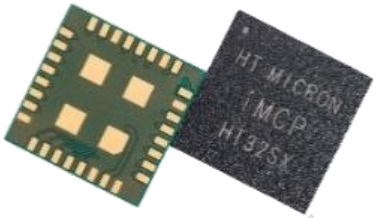
iMCP HT32SX V2.2 – SiP Sigfox

Sigfox® Monarch RF Transceiver System-in-Package

FO440 - rev.01 Data: 12/08/2020 Doc. Ref.: PR001

OVERVIEW

The iMCP – HT32SX is a Multicomponent Integrated Circuit (MCO) designed to provide a ready-to-use connectivity solution for Internet of Things (IoT) applications. It provides both uplink (transmit) and downlink (receive) communications, and it is the first HT Micron product in a new family of non-memory components. Its small dimensions, high performance and low power consumption targets the best experience for IoT developers. It features an ARM Cortex M0+ 32bit (STM32L052x8) and the S2-LP low power transceiver from ST Microelectronics combined with the SKY66420 from Skyworks Solutions which provide all the performance advantages, integration and convenience of advanced semiconductor packaging technology into a single chip.



FEATURES

- Key features
  - Enables operations in the SIGFOX™ network
  - Multizone worldwide operation – MONARCH feature
  - ARM Cortex M0+ 32bit STM32L052x8 MCU
  - Integrated 50 MHz crystal
  - 64 KB flash - Other options will be available on demand
  - 8 KB RAM
  - TX output power up to +24 dBm
  - RX sensitivity: **-128 dBm***
- Power consumption
  - 18 mA RX
  - 160 mA TX @22.4 dBm, 902.2MHz
- RF
  - S2-LP Transceiver STMicroelectronics
  - SKY66420-11 Front-End Module
  - Frequency bands:
    - 413-479 MHz
    - 452-527 MHz
    - 826-958 MHz
    - 904-1055 MHz
  - Modulation schemes:
    - DBPSK, 2(G)FSK, OOK, ASK
  - Data Rate:
    - Up to region: 100bps or 600bps

INTERFACES

- Up 21 General-Purpose Input/Output (GPIO) pins, with configurable pull-up/pull-down resistors
- 12-bit ADC
- 12-bit 1 channel DAC
- 2 USART, LPUART, USB 2.0, I2C

- Single power supply: 2.7 V to 3.6 V
- Operating temperature range: **-20°C to +75°C***
- External antenna
- 13x13x1.35mm LGA – 32 pads package
- Part number: HT32SX

APPLICATIONS

- Smart home
- Wireless alarm systems
- Manufacturing
- Agriculture
- Building automation
- Smart metering
- Smart lighting systems
- Smart grid monitoring

*Expected performance

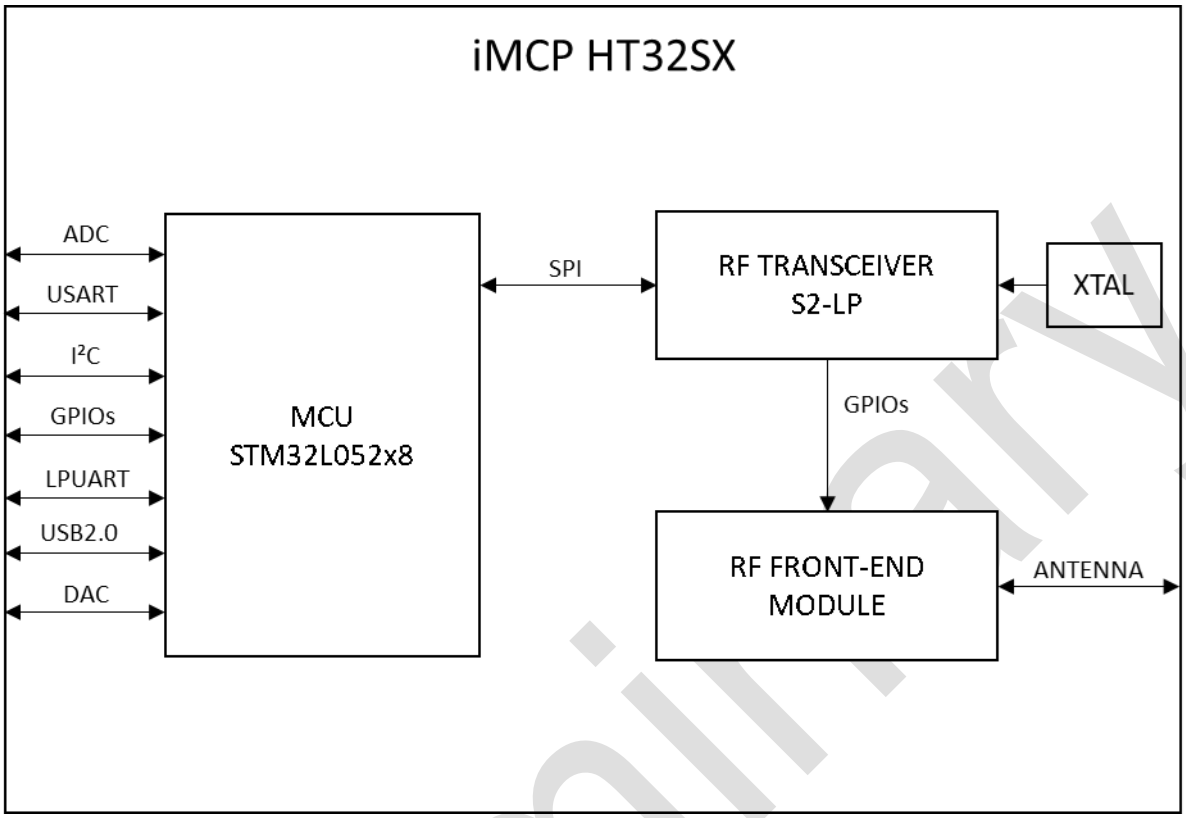
SUMMARY

DOCUMENT INFO

This document provides information about iMCP HT32SX – Sigfox® Monarch RF Transceiver System-in-Package.

1 BLOCK DIAGRAM

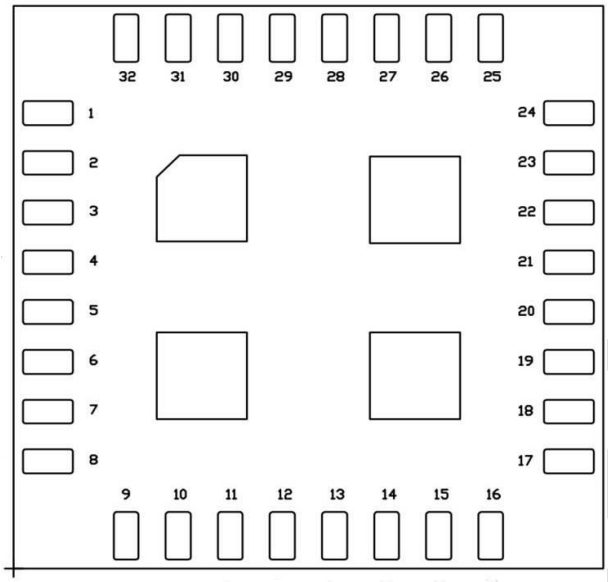
FIGURE 1: BLOCK DIAGRAM



2 PINOUT INFORMATION

2.1 Pin Diagram

FIGURE 2: PIN DIAGRAM



2.2 Pin description

TABLE 1: LEGEND/ABBREVIATIONS USED IN PIN DESCRIPTION TABLE

Name	Abbreviation	Definition
I/O Structure	FT	5V tolerant I/O
	FTf	5V tolerant I/O, FM+ capable
	TC	Standard 3.3V I/O
	B	Dedicated BOOT0 pin
	RST	Bidirectional reset pin with embedded weak pull-up resistor

TABLE 2: PIN DESCRIPTION

Number	Symbol	Pin name	Pin Type	I/O Structure	Description
1	ANTENNA	ANTENNA	RF I/O	-	RF input and output signal
2	GND	GND	Ground	-	Exposed pad connected to the ground of the application board
3	MCU-PA11	USART1_CTS	Digital I/O	FT	USART interface
		USB_DM	Digital I/O		USB
		COMP1_OUT	Analog O		Comparator output
		EVENT_OUT	Digital I/O		
4	MCU-PA9	USART1_TX	Digital I/O	FT	Serial wire
5	MCU-PA10	USART1_RX	Digital I/O	FT	
6	MCU-PB11	LPUART1_RX	Digital I/O	FT	Low-power USART interface
		TIM2_CH4	Digital I/O		General-purpose timer
		EVENTOUT	Digital I/O		
7	MCU-PB0	ADC_IN0	Analog I	FT	ADC external input 0
		VREF_OUT	Analog I/O		Output reference voltage

8	VDD_3.3V	VDD_3.3V	Power	-	3.3 V power supply
9	MCU-PA8	USART1_CK	Digital I/O	FT	USART interface
		USB_CSR_SYNC	Digital I/O		USB
		EVENT_OUT	Digital I/O		
10	MCU-PA5	ADC_IN5	Analog I	TC	ADC external input 5
		TIM2_CH1	Digital I/O		General-purpose timer
		TIM2_ETR	Digital I/O		General-purpose timer
		COMP1_INM5	Analog I		Comparator input
11	MCU-PA3	USART2_RX	Digital I/O	FT	USART interface
		ADC_IN3	Analog I		ADC external input 3
		TIM2_CH4	Digital I/O		General-purpose timer
		TIM21_CH2	Digital I/O		General-purpose timer
12	MCU-PA1	USART2_RTS_DE	Digital I/O	FT	USART interface
		ADC_IN1	Analog I		ADC external input 1
		COMP1_INP	Analog I		Comparator input
		TIM21_ETR	Digital I/O		General-purpose timer
		EVENT_OUT	Digital I/O		
13	MCU-PB10	LPUART1_TX	Digital I/O	FT	USART interface
		TIM2_CH3	Digital I/O		General-purpose timer
14	MCU-PA6	LPUART1_CTS	Digital I/O	FT	USART interface
		ADC_IN6	Analog I		ADC external input 6
		TIM22_CH1	Digital I/O		General-purpose timer
		COMP1_OUT	Analog O		Comparator output
		EVENT_OUT	Digital I/O		
15	MCU-PA4	USART2_CK	Digital I/O	TC	USART interface
		ADC_IN4	Analog I		ADC external input 4
		DAC_OUT	Analog O		DAC analog output
		TIM22_ETR	Digital I/O		General-purpose timer
		COMP1_INM4	Analog I		Comparator input
16	GND	GND	Ground	-	Exposed pad connected to the ground of the application board
17	MCU-PA2	USART2_TX	Digital I/O	FT	USART interface
		ADC_IN2	Analog I		ADC external input 2
		TIM21_CH1	Digital I/O		General-purpose timer
		TIM2_CH3	Digital I/O		General-purpose timer
18	MCU-PA0	WKUP1	Digital I	TC	MCU external wakeup input
		ADC_IN0	Analog I		ADC external input 0
		USART2_CTS	Digital I/O		USART interface
		TIM2_CH1	Digital I/O		General-purpose timer
19	MCU-BOOT0	BOOT0	Digital I	B	Boot selection
20	MCU-PB5	I2C1_SMBA	Digital I/O	FT	I2C interface
		LPTIM1_IN1	Digital I/O		Low-power timer
		TIM22_CH2	Digital I/O		General-purpose timer
21	GND	GND	Ground	-	Exposed pad connected to the ground of the application board
22	NRESET	NRESET	I/O	RST	Bidirectional reset pin with embedded weak pull-up resistor
23	MCU-PA14	SWCLK	Digital O	FT	Serial wire clock output
		USART2_TX	Digital I/O		USART interface
24	MCU-PA13	SWDIO	Digital I/O	FT	Serial wire
		USB_NOE	Digital I/O		USB

25	MCU-PC15	OSC32OUT	Ext. clock	TC	External clock source pins
		GPIO	Digital I/O		General purpose I/O
26	MCU-PC14	OSC32IN	Ext. clock	FT	External clock source pins
		GPIO	Digital I/O		General purpose I/O
27	GND	GND	Ground	-	Exposed pad connected to the ground of the application board
28	MCU-PB1	LPUART1_RTS_DE	Digital I/O	FT	Low-power USART interface
		ADC_IN9	Analog I		ADC external input 9
		VREF_OUT	Analog O		1.2 V VCO-LDO band-gap reference voltage decoupling
29	MCU-PB7	USART1_RX	Digital I/O	FTf	USART interface
		I2C1_SDA	Digital I/O		I2C interface
		LPTIM1_IN2	Digital I/O		Low-power timer
30	MCU-PB6	USART1_TX	Digital I/O	FTf	USART interface
		I2C1_SCL	Digital I/O		I2C interface
		LPTIM1_ETR	Digital I/O		Low-power timer
31	MCU-PA12	USART1_RTS_DE	Digital I/O	FT	USART interface
		USB_DP	Digital I/O		USB
		EVENT_OUT	Digital I/O		
32	GND	GND	Ground	-	Exposed pad connected to the ground of the application board

3 ELECTRICAL CHARACTERISTICS

3.1 General operating range

TABLE 3: GENERAL OPERATING RANGE

Parameter	Conditions	Min	Typ.	Max	Unit
Internal XTAL frequency	-	-	50	-	MHz
Supply voltage	-	2.7	3.3	3.6	V
Operating temperature	-	**-20***	**25***	**75***	°C
Storage temperature	-	-	-	-	°C

*Expected performance

3.2 MCU I/O port characteristics

TABLE 4: MCU I/O PORT CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ.	Max	Unit
$\mathbf{V_{IL}}$	Input low level voltage	TCFT, FTf, RST I/Os	-	-	$0.3\mathbf{V_{DD}}$	V
		BOOT0 pin	-	-	$0.14\mathbf{V_{DD}}$	
$\mathbf{V_{IH}}$	Input high level voltage	All I/Os	$0.7V_{DD}$	-	-	
$\mathbf{V_{hys}}$	I/O Schmitt trigger voltage hysteresis	Standard I/Os	-	10% $\mathbf{V_{DD}}$	-	
		BOOT0 pin	-	0.01	-	
$\mathbf{I_{lkg}}$	Input leakage current	$V_{SS} < V_{IN} < V_{DD}$ All I/Os except PA11, PA12, BOOT0, FTf I/Os	-	-	+-50	nA

		$V_{SS} < V_{IN} < V_{DD}$ PA11 and PA12 I/Os	-	-	-50/+250	
		$V_{SS} < V_{IN} < V_{DD}$ FTf I/Os	-	-	+-100	
		$V_{VDD} < V_{IN} < 5V$ All I/Os except PA11, PA12, BOOT0, FTf I/Os	-	-	200	
		$V_{SS} < V_{IN} < 5V$ FTf I/Os	-	-	500	nA
		$V_{SS} < V_{IN} < 5V$ PA11, PA12, BOOT0	-	-	10	uA
R_{PU}	Weak pull-up equivalent resistor	$V_{IN} = V_{SS}$	25	45	65	kΩ
R_{PD}	Weak pull-down equivalent resistor	$V_{IN} = V_{DD}$	25	45	65	kΩ
C_{IO}	I/O pin capacitance	-	-	5	-	pF

TABLE 5: OUTPUT VOLTAGE CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Max	Unit
V_{OL}	Output low level voltage for an I/O pin	CMOS port I_{IO}=+8mA 2.7V <V_{DD}< 3.6V	-	0.4	V
V_{OH}	Output high level voltage for an I/O pin		V_{DD}-0.4	-	
V_{OL}	Output low level voltage for an I/O pin	TTL port I_{IO}=+8mA 2.7V <V_{DD}< 3.6V	-	0.4	
V_{OH}	Output high level voltage for an I/O pin	TTL port I_{IO}= -6mA 2.7V <V_{DD}< 3.6V	2.4	-	
V_{OL}	Output low level voltage for an I/O pin	I_{IO}=+15mA 2.7V <V_{DD}< 3.6V	-	1.3	
V_{OH}	Output high level voltage for an I/O pin	I_{IO}= -15mA 2.7V <V_{DD}< 3.6V	V_{DD}-1.3	-	
V_{OL}	Output low level voltage for an I/O pin	I_{IO}=+4mA 2.7V <V_{DD}< 3.6V	-	0.45	
V_{OH}	Output high level voltage for an I/O pin	I_{IO}= -4mA 2.7V <V_{DD}< 3.6V	V_{DD}-0.45	-	
V_{OLFM+}	Output low level voltage for an FTf I/O pin in FM+ mode	I_{IO}=+20mA 2.7V <V_{DD}< 3.6V	-	0.4	
		I_{IO}= 10mA 2.7V <V_{DD}< 3.6V	-	0.4	

3.3 Power consumption

Characteristics measured over recommended operating conditions unless otherwise specified. Typical values are referred to 25 °C temperature, VDD = 3.3 V.

TABLE 6: LOW-POWER STATE POWER CONSUMPTION TA = 25 °C, VDD = 3.3 V, 50 MHZ CRYSTAL OSCILLATOR.

Parameter	Conditions	Min	Typ.	Max	Unit
Supply current	Shutdown	-	-	-	nA
	Standby	3.8	4.5	5	mA
	Sleep	-	-	-	uA
	Deep sleep	-	4	8	uA

TABLE 7: POWER CONSUMPTION IN RECEPTION TA = 25 °C, VDD = 3.3 V, FC = 905 MHZ

Parameter	Conditions	Min	Typ.	Max	Unit
Supply current	RX @ -102 sensitivity level	-	18	-	mA

TABLE 8: POWER CONSUMPTION IN TRANSMISSION TA = 25 °C, VDD = 3.3 V, FC = 902.2 MHZ

Parameter	Conditions	PA	Min	Typ.	Max	Unit
Supply current	TX @22.4 dBm on packet transmission	ON	-	-	160	mA
	TX @13 dBm on packet transmission	OFF	-	-	30	

3.4 Clock source

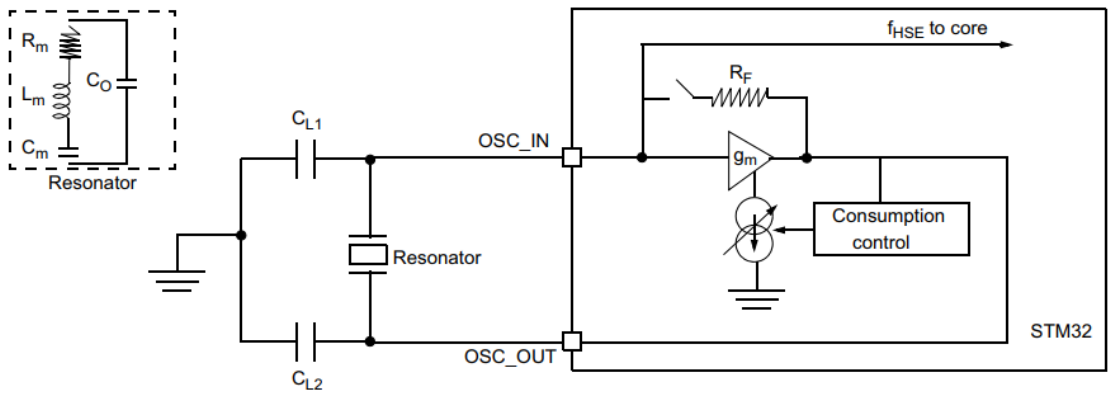
TABLE 9: 50 MHZ INTERNAL XTAL CLOCK SOURCE CHARACTERISTICS

Parameter	Conditions	Min	Typ.	Max	Unit
Nominal frequency	-	-	50	-	MHz
Frequency tolerance	-20°C to 75 °C	-10	-	+10	ppm
Load capacitance	-	-	7	-	pF
Motional resistance (ESR)	-	-	-	60	Ω

3.5 External clock resonator

The external clock resonator can be of high speed (1-25MHz) or low speed (32.768kHz), which can be connected to pins 25 and 26 of the iMCP HT32SX V2.2. The connection diagram is shown below. For CL1 and CL2, it is recommended to use high quality ceramic capacitors in the 5pF to 25 pF range (typ.), designed for high frequency applications, and selected to match the requirements of the crystal or resonator. These capacitors are usually of equal value with a rough estimate of 10 pF each. CL1 and CL2 includes PCB and the MCU pin capacitances.

FIGURE 3: EXTERNAL OSCILLATOR CIRCUIT DIAGRAM.



4 RF CHARACTERISTICS

TABLE 10: TRANSCEIVER AND RECEIVER CHARACTERISTICS. TA = 25°C BASED ON CHARACTERIZATION; NOT TESTED IN PRODUCTION. VDD = 3.3V; ALL RX MEASUREMENTS MADE AT THE ANTENNA CONNECTOR, TO A BIT ERROR RATE (BER) LIMIT OF 1%. LOWER FREQUENCIES UPDATE SOON.

Parameter		Min	Typ.	Max	Unit
RF Frequency	TX	865	-	924	MHz
	RX	869	-	923	MHz
Tx max. output power		-	24	-	dBm
Tx power variation vs. temperature	-40°C to +85°C	-	-	-	dB
Emission 2nd Harmonics (conducted)		-40.4	-47.3	-39.9	dBc
Emission 3rd Harmonics (conducted)		-50.5	-76.2	-55.0	
Emission 4th harmonic		-78.9	-78.6	-70.0	
Data Rate (for Sigfox Regions)	TX (RC1, RC3, RC5, RC6, RC7)	-	100	-	bps
	TX (RC2, RC4)	-	600	-	bps
	RX (All RCs)	-	600	-	bps
Antenna Load Impedance			50		Ohm
Rx Sensitivity (@600bps, GFSK)			-128*		dBm
Rx Spurious Emission (30MHZ~12.75GHZ)		-	-	-	dBm
Rx Blocking at 10MHz offset		-	-	-	dB
RSSI Resolution		-	-	-	dB

*Expected performance

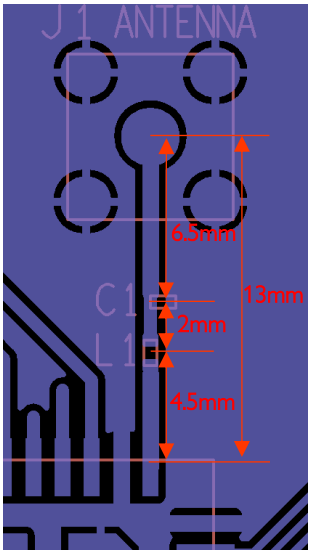
4.1 External impedance matching network

An external LC matching network is recommended to improve the output power level of the output signal in pin 1 (series inductor and shunt capacitor). The reference specifications for a reference FR4 1.6 mm 1 Oz copper printed circuit board (PCB) are shown below.

- SMD ceramic inductor: 5.6 nH, +-5% tolerance, 0402 size, PN L-07C5N6SV6, Johanson Technologies
- SMD ceramic capacitor: 4.7 pF, +-0.1pF tolerance, 0201 size, PN 250R05L4R7BV4S, Johanson Technologies

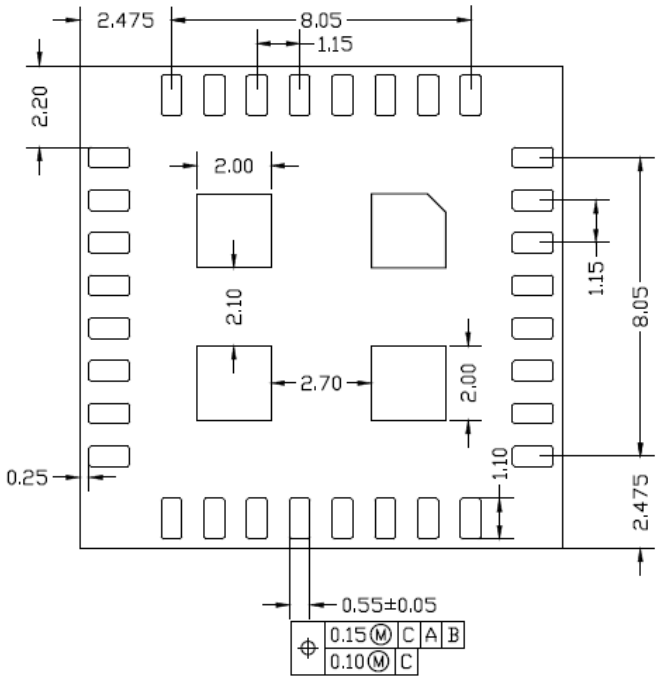
The reference PCB traces are shown in Figure 4 for an example of an output using an SMA connector. The trace width are the same as the pad width in the recommended footprint in section 6.

FIGURE 4: RECOMMENDED EXTERNAL LC MATCHING NETWORK LAYOUT.



5 PACKAGE OUTLINE

FIGURE 5: PACKAGE OUTLINE

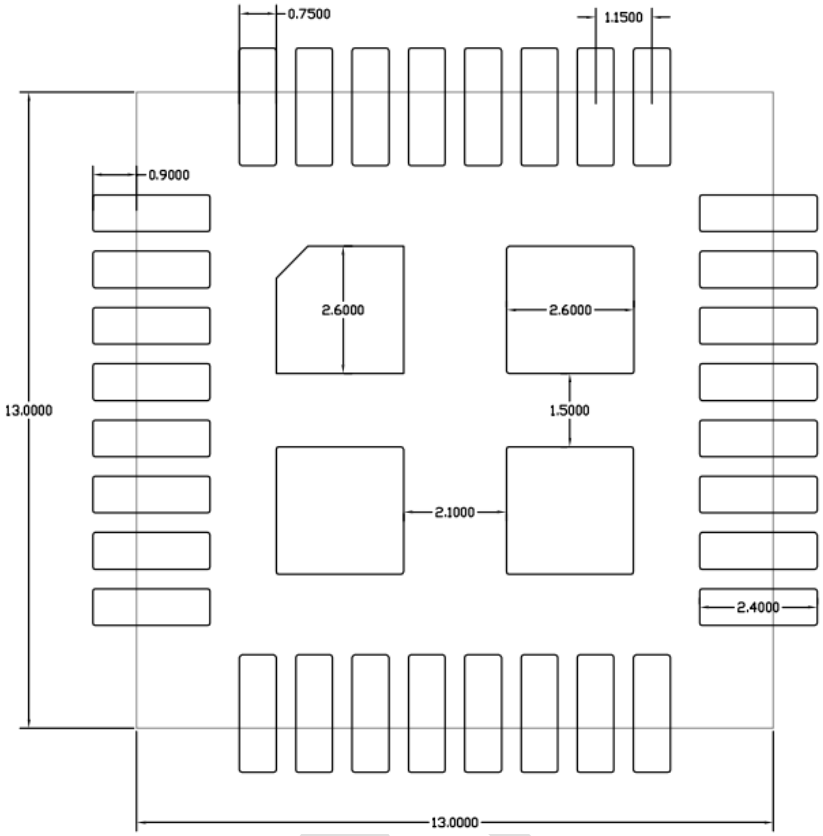


BOTTOM VIEW

SIDE VIEW

6 RECOMMENDED PCB FOOTPRINT

FIGURE 6: RECOMMENDED PCB FOOTPRINT



7 PART NUMBER

HTSXMO32L-22

HT XX XX ## X - ##

HT Micron

Family
SX: SigFox

Technology
MO: Monarc
LP: Low Power

Leads
32:32
36:36
40:40

Package
L: LGA
F: FBGA
B: BGA

Version
22: version 2.2

8 ORDERING INFORMATION

TABLE 11: ORDERING INFORMATION

Type number	Package		
	Name	Description	Version
HTSXMO32L	iMCP HT32SX	SiP module in LGA package; body 13mm x 13mm	2.2

ABBREVIATIONS

TABLE 12: ABBREVIATIONS

Acronym	Description
ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
API	Application Program Interface
CLK	Clock
EEPROM	Electrically-Erasable Programmable Read Only Memory
FIFO	First in First Out
GPIO	General Purpose Input Output
ID	Identification
IF	Intermediate frequency
IO	Input Output
MSL	Moisture sensitivity level
PCB	Printed-Circuit Board
PHY	Physical
SPI-bus	Serial Peripheral Interface -bus
PWM	Pulse Width Modulation
RAM	Random Access Memory
RC	Remote Control
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RSSI	Receive Signal Strength Indication
RX	Receiver
SCL	Serial Clock
SDA	Serial Data
TX	Transmitter

LIST OF FIGURES

LIST OF TABLES

REVISION HISTORY

Date	Version	Changes	Authors
13/04/2020	00	- Initial draft	HT Micron
05/08/2020	01	- Preliminary	HT Micron
20/11/2020	02	- Preliminary - fixed power consumption information	HT Micron

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