

15W Wireless Power Transmitter SOC

Description

The CCX1033 is a highly integrated, magnetic induction, wireless power transmitter supporting the WPC1.3 specifications. The product is designed to operate with a wide input supply voltage range of 4.5V to 20V. The system-on-chip device is comprised of a step-down switching regulator, linear regulators, a microcontroller, Q factor detector, voltage and current ASK decoders, Two-Half bridge power stages drivers and 4-power MOSFETs.

The CCX1033 support PD 3.0 protocol for PD adapter, which can be adjusted the input supply voltage. And support Qualcomm Quick Charge technology when using a QC2.0 or QC3.0 power adaptor.

The CCX1033 includes an industry-leading 32-bit MCU processor offering a high level of programmability while consuming extremely low standby power less than 10uA. It can provide Automatic wake up function with the ability which can calculate Q factor under battery voltage. CCX1033 has excellent thermal performance due to high efficiency driver and integrated MOSFET low Rdson. In addition, the microcontroller empowers the user to customize features such as LED patterns, buzzer, and FOD threshold settings. The SWD or I²C serial communication allows the user to read information such as voltage, current, frequency, and fault conditions.

The CCX1033 includes an under-voltage lockout and thermal management circuit to safeguard the device under fault conditions. Together with the Crechip CCX1121A/B, the CCX1033 offers a complete wireless power system solution.

The CCX1033 is available in a lead-free, space-saving QFN40-5x5x0.75mm package. The product is rated for a -40°C to +85°C operating temperature range.

Features

- WPC1.3 compliant, flexible coil configuration
- Wide input voltage range: 4.5V to 20V
- Efficient 5W/7.5W/10W/15W/30W power transfer with typical 85% efficiency at 10W output
- Supports quick charging power adaptors of USB PD3.0, QC 2.0/3.0 etc.
- Integrated step-down switching regulator, linear regulator, 2-half bridge drivers and 4-power MOSFETs
- Low standby power consumption (<10uA)
- Dedicated remote temperature sensing(NTC)
- Supports 127.7KHz fixed frequency and voltage tuning by PD3.0 protocols or off-chip DCDC
- Supports WPC EPP Q detection or advanced proprietary Q detection with programmable FOD sensitivity
- Embedded 32bit core microprocessor
- Supports over-voltage, over-current, over-temperature detection and protection
- Supports I²C interface for program/debug/control
- User-programmable power transfer LED indicators
- 5mm x 5mm x0.75mm, pitch 0.4mm, QFN 40pin package

Typical Applications

- BPP and EPP Wireless Charging Pads
- Up to 7.5W/15W/30W charging for iPhones
- After-Market Automotive Wireless Charging
- Portable Instruments/ Electronic Equipment
- Charging Cradles

Description for Implementation

1. Overview and function

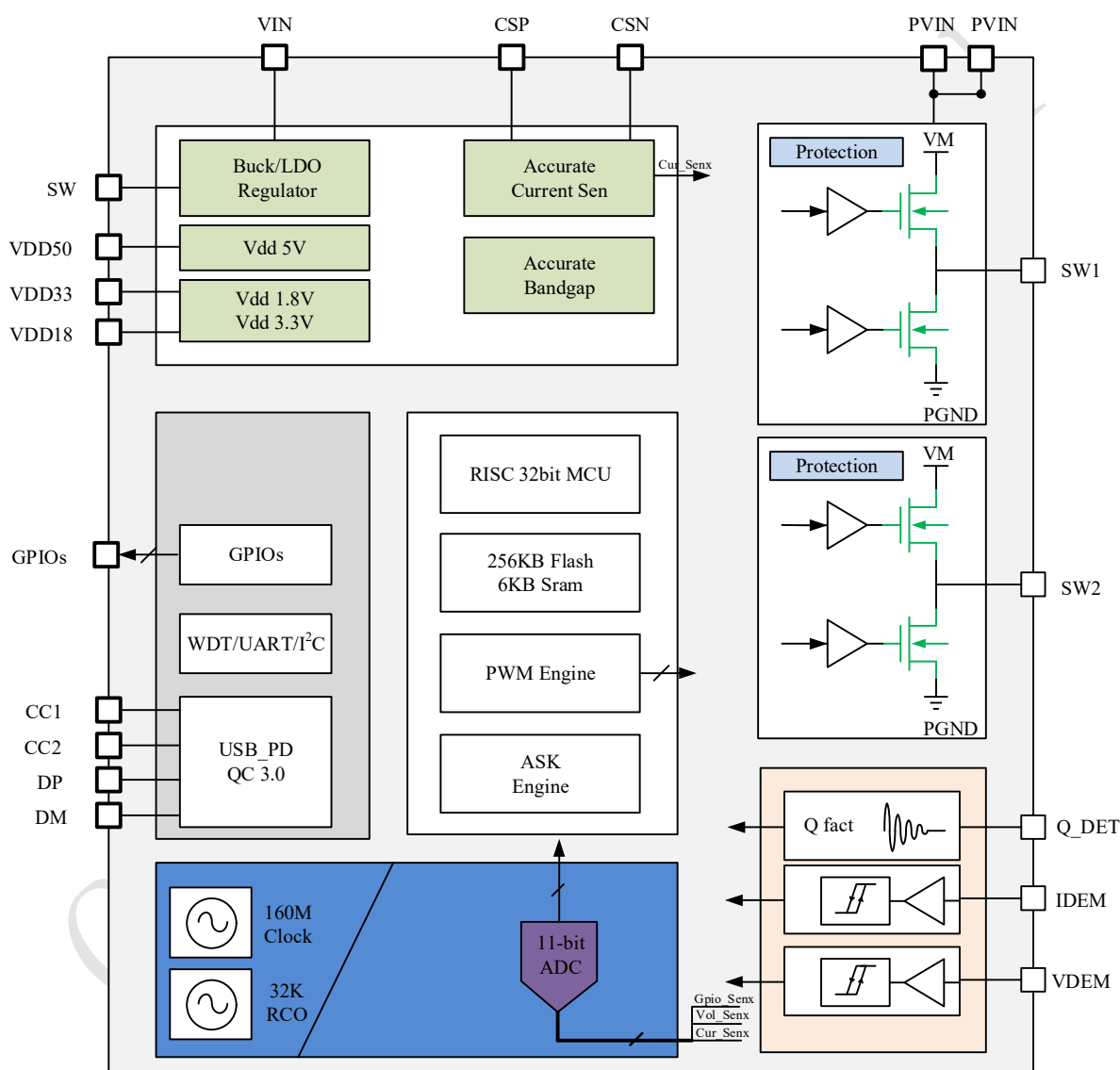


Figure 1 CCX1033 function block diagram

Figure 1 is the function block diagram of CCX1033 which is compliant with Qi 1.3 and supports 5W/7.5W/10W/15W/30W transmission power. The efficient buck can work stably with input voltage from 4.5V to 20V and be bypassed when it is below the working voltage. It can automatically change the PFM and PWM modulation according to the load condition which can get best efficiency in different conditions.

The CCX1033 high voltage drivers change DC power to AC power with integrated MOSFETs. Each PWM's frequency and duty cycle can be configured independently from 110KHz to 200KHz frequency output. High resolution PLL can realize 1Hz frequency step and 0.1% duty PWM resolution. Q factor detector is the key feature which can realize the object detection, FOD detection and low standby power operation.

The Chip realizes the communication with the receiver through ASK and FSK modulation. It supports voltage and current ASK demodulation without any external active device. The patented demodulation algorithm can ensure the charging stability under various interferences and different positions. The high speed PWM clock guarantees that the difference between FSK reference frequency and modulation frequency conforms to Qi EPP standard.

The CCX1033 supports internal voltage, current, temperature detection and abnormal protection. External NTC protection can be used to ensure chip charging safety. Two LED outputs are used to indicate charging status and abnormal protection. FOD sensitivity can be programmed according to user's requirement.

2. Pin Definition and Descriptions

2.1 Pin Definition

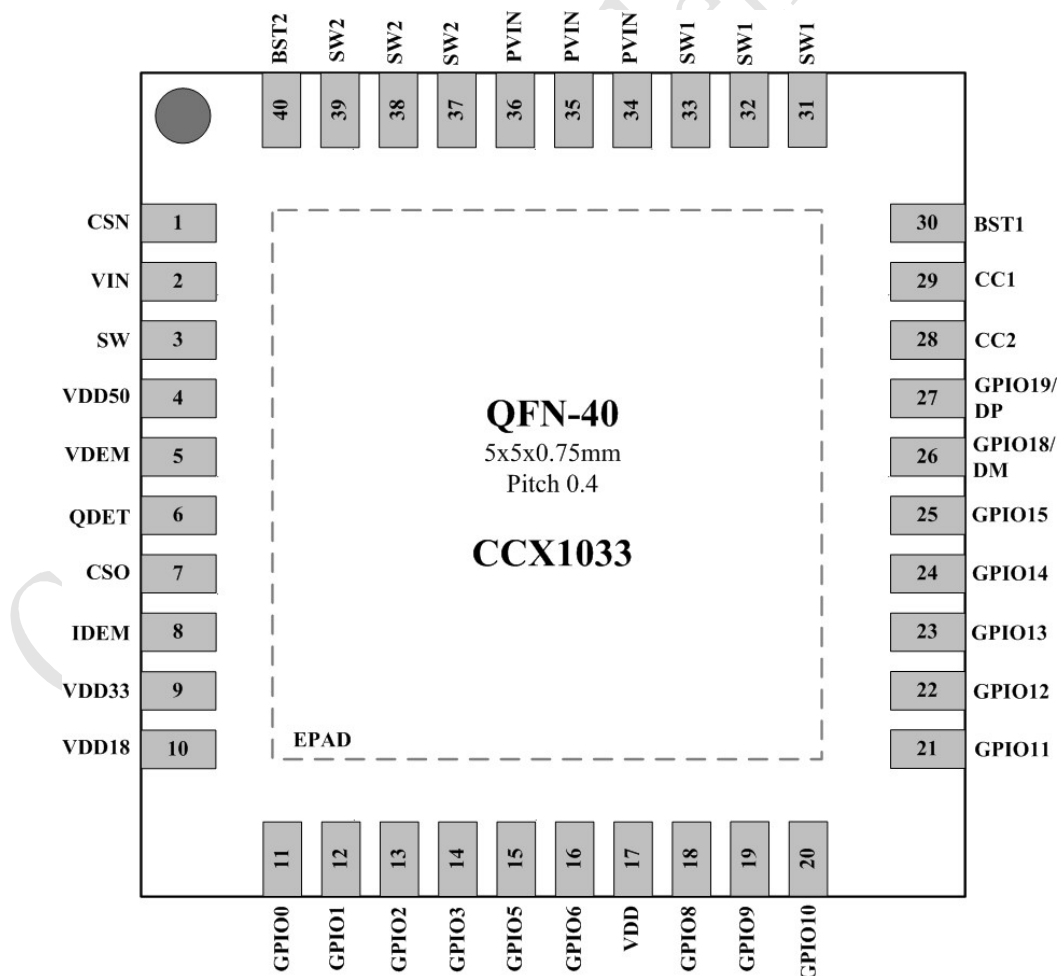


Figure 2 CCX1033 Pin Definition (QFN40-5x5x0.75mm, pitch 0.4mm)

2.2 Pin Description

ORDER	NAME	I/O TYPE	DESCRIPTION
1	CSN	AI(HV)	Current Sense Negative terminal connect
2	VIN	PI(HV)	Input voltage for HV analog. Bypass with a 1 μ F ceramic capacitor to GND
3	SW	AIO(HV)	Internal step-down regulator's switch node. Connect an external 4.7 μ H inductor to this pin.
4	VDD50	PI(5.0V)	5V supply input power supply. Connect this pin to the 5V output of the step-down regulator. (*This pin MUST NOT be externally loaded)
5	VDEM	AI	Voltage demodulation pin for data packets based on coil voltage variation
6	QDET	AI	Coil quality factor Detection input
7	CSO	AO	Current sense amplifier output
8	IDEM	AI	Current demodulation pin for data packets based on input current variation
9	VDD33	PO(3.3V)	Regulated 3.3V output used for internal device biasing. Bypass with a 1 μ F ceramic capacitor to GND
10	VDD18	PO(1.8V)	Regulated 1.8V output used for internal device biasing. Bypass with a 1 μ F ceramic capacitor to GND
11~16	GPIO0~3,5~6	DIO	General purpose I/O; ADC input pin;
17	VDD	PI(1.8V)	Regulated 1.8V input used for digital core supply. Connect a 1 μ F capacitor from this pin to GND
18~25	GPIO8~15	DIO	General purpose I/O
26	GPIO18/DM	AIO	General purpose I/O. USB2.0 D+ & D- interface for QC protocol
27	GPIO19/DP	AIO	General purpose I/O. USB2.0 D+ & D- interface for QC protocol
28	CC2	AIO (HV)	Type-c Configuration channel CC1 for PD protocol
29	CC1	AIO(HV)	Type-c Configuration channel CC1 for PD protocol
30	BST1	AI(HV)	Connect a 0.1 μ F capacitor between BST1 and SW1 to Bootstrap a voltage to provide the bias for high side MOSFET driver.
31~33	SW1	AO(HV)	Switch node of the half-bridge MOSFET
34~36	PVIN	PI(HV)	Input voltage for half-bridge MOSFET. Bypass with 22 μ F ceramic capacitor to GND

37~39	SW2	AO(HV)	Switch node of the half-bridge MOSFET
40	BST2	AI(HV)	Connect a 0.1μF capacitor between BST2 and SW2 to Bootstrap a voltage to provide the bias for high side MOSFET driver.
41	EPAD	--	The exposed thermal pad should be connected to ground(PGND&GND)

Electrical Characteristic

2.3 Absolute Maximum Ratings

ITEM(V/I)	PIN NAME	MIN	MAX	UNIT
Input Voltage	VIN, PVIN, SW, SW1, SW2	-0.3	24	V
	BST1,	-0.3	SW1+6	V
	BST2	-0.3	SW2+6	V
	CC1, CC2	-0.3	24	V
	TS, CSO, VDEM, IDEM, DP, DM, VDD50, VDD33 GPIO0~ GPIO19	-0.3	6	V
	VDD18	-0.3	2	V
Source Current	EPAD / GND	-0.3	0.3	V
Source /Sink Current	GPIO0~GPIO19	-20	20	mA

2.4 ESD Ratings

TEST MODEL	MIN	MAX	UNIT	NOTE
Human Body Model (HBM)		2	KV	All pins
Charged Device Model (CDM)		500	V	All pins
Machine Model (MM)		200	V	All pins

2.5 Recommended Operating Conditions

RATING	MIN	TYP	MAX	UNIT
Input Operating Range, V_{IN}	4.5	9/12	20	V
Analog voltage Range V_{DD33}	3.0	3.3	3.6	V
Input Voltage Range for GPIO, V_{DD33}	1.8	3.3	3.6	V
Digital voltage range, V_{DD18}	1.62	1.8	1.98	V
Ambient Temperature, T_A	0		85	°C
Junction Temperature, T_J	-20		125	°C

2.6 Electrical Characteristic

Note: $V_{IN} = V_{PVIN} = 9V$, $T_A = 25^\circ C$, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT
System Efficiency (Coupling with RX)					
20W WPT	$V_{IN} = 15V$, $I_{LOAD} = 1.56A$		86		%
15W WPT	$V_{IN} = 12V$, $I_{LOAD} = 1.3A$		85		%
10W WPT	$V_{IN} = 9V$, $I_{LOAD} = 1.1A$		84		%
5W WPT	$V_{IN} = 5V$, $I_{LOAD} = 1.0A$		82		%
Input Supply (V_{IN})					
Input Operating Rang, V_{IN}	$V_{IN} = V_{PVIN}$	4.5	9/ 12	20	V
Operating Mode Current, I_{IN}	Power Transfer phase, No Load		30		mA
Standby Mode Current, $I_{STANDBY}$	Periodic Ping, No Load		2		mA
Deep sleep Mode Current, I_{DSLEEP}	No active, No Load		10		uA
Buck Regulator (V_{DD50})					
Buck Output Voltage, V_{OUT}	$C_{OUT} = 10\mu F$, $L = 4.7\mu H$ FT Trimming	4.75	5.0	5.25	V
Buck Output Current, I_{OUT}			50	100	mA
Buck Efficiency, η_{BUCK}	$I_{OUT} = 30mA @ 9V$		85		%
1.8V LDO (V_{DD18})					
LDO18 Output, V_{DD18}	FT Trimming	1.75	1.8	1.85	V
LDO18 Current, I_{DD18}			30		mA
3.3V LDO (V_{DD33})					
LDO33 Output, V_{DD33}	FT Trimming	3.15	3.3	3.45	V
LDO33 Current, I_{DD33}			30		mA
Power MOSFET					
NMOS Turn-On Resistance, R_{DS_ON}	$V_{GS} = 5V$		30		mΩ
MOSFET driver slew rate	Programmable, Step=0.25	0.5	1.0	1.25	V/ns

Dead Time, T_{DEAD}	Programmable, Step=10ns	15	45	85	ns
Analog Digital Converter (ADC)					
Resolution, N			11		bit
Sampling Rate, F_s		62.5	250	500	KSPS
Number of Channels, N_{MUX}	Mux with GPIO0~7		8		
Full-Scale Range, V_{FS}	FT Trimming		1.8		V
HF RC Oscillator (HRC)					
HRC Frequency, F_{HRC}	Target frequency		32		MHz
HRC Frequency Accuracy	FT Trimming	-1		+1	%
LF RC Oscillator (LRC)					
LRC Frequency, F_{LRC}	Target frequency		32		KHz
LRC Frequency Accuracy	FT Trimming	-1		+1	%
HF Crystal Oscillator (HXT)					
HXT Frequency, F_{HXT}	Optional for high accuracy application, Mux GPIO1/2		16/32		MHz
HXT Frequency Accuracy			20	40	ppm
LF Crystal Oscillator (LXT)					
LXT Frequency, F_{LXT}	Optional for RTC application Mux GPIO3/4		32.768		KHz
LXT Frequency Accuracy			50	100	ppm
High Frequency PLL					
PLL Refer Frequency, F_{REF}	from HRC or HXT		16		MHz
PLL Frequency Range, F_{PLL}		80	128	160	MHz
Jitter (Phase Noise)			300		ps
Current Sense (ISEN)					
Input Current Range, I_{SEN}	$R_{SENSE}=20mohm$	0		2.5	A
ISEN Gain, I_{SEN_GAIN}	$R_{SENSE}=20mohm$		0.5		V/A
ISEN Gain Error, I_{SEN_GE}	$I_{SENSE} > 100mA$	-1%		1%	
Output offset voltage, V_{SENO_OFST}	After calibration		50		mV
ASK Demodulator					
VDEM input hysteresis voltage, V_{DEM_HYS}	Programmable, Step=10 mV	10	64	80	mV
IDEM input hysteresis voltage, I_{DEM_HYS}	Programmable, Step=10 mV	10	64	80	mV
Q-factor Detector (QDET)					
QDET Detect Voltage, V_{Q_DET}		1.8	3.3	5.0	V
QDET High Threshold, $V_{Q_TH_HIGH}$	Programmable, Step=50 mV	50	200	400	mV
QDET Low Threshold, $V_{Q_TH_LOW}$	Programmable, Step=50 mV	25	50	200	mV
Over Current Protection (OCP)					
Over Current Protection,HB- I_{OCP}	Programmable, Step=1A	7	10	14	A
Over Current Protection,CS- I_{OCP}	Programmable, Step=0.2A	1.6	2.8	3.2	A
VIN Under-Voltage Protection (UVLO)					
Under-Voltage Lockout, V_{IN_UVLO}	V_{IN} rising Programmable, Step=0.2V	3.6	4.0	4.2	V

Under-Voltage Hysteresis, V_{IN_UVHYS}	V_{IN} falling		0.2/ 0.4		V
VIN Over Voltage Protection (OVP)					
Over Voltage Protection, V_{OVP}	V_{IN} Rising Programmable, Step=2V	15	20	25	V
Junction Thermal Protection (OTP)					
Thermal Warning, T_{J_WAR}	Temp Rising		120		°C
Thermal Shutdown, T_{J_SD}	Temp Rising		140		°C
Hysteresis, T_{J_HYS}	Temp Falling		20		°C
DP/DM (QC, AFC)					
DP/DM pull down resistance, R_{DM_DWN}			20		kΩ
DP pin leakage resistance, R_{DP_LKG}			500		kΩ
DP/DM OVP threshold, V_{DPM_OVP}		4.6	4.7	4.8	V
CC1/CC2 (PD)					
CC1/2 pull down resistor, R_{PD_CC}	$V_{CC1/2} = 0V$ to 2.5V	4.59	5.1	5.61	kΩ
CC1/2 open impedance, R_{CC_OPEN}	CC1/2 in disable status	126			kΩ
CC1/2 OVP threshold, V_{CC_OVP}		5.8	6.1	6.4	V
Digital General-Purpose Input/ Output (GPIO)					
Input Voltage HIGH Level, V_{IH}	$> 0.7 * V_{DDIO}$ ($V_{DDIO} = V_{DD33}$)	70			%
Input Voltage LOW Level, V_{IL}	$< 0.3 * V_{DDIO}$			30	%
Leakage Current, I_{LKG}			1		uA
Output Logic HIGH, V_{OH}	$> 0.9 * V_{DDIO}$	90			%
Output Logic LOW, V_{OL}	$< 0.1 * V_{DDIO}$			10	%
Source Current, I_{SRC}	$V_{GS}=3.3V$, $R_{ON}=100\Omega$		4/12		mA
Sink Current, I_{SINK}	$V_{GS}=3.3V$, $R_{ON}=80\Omega$		4/12		mA

3. Package information

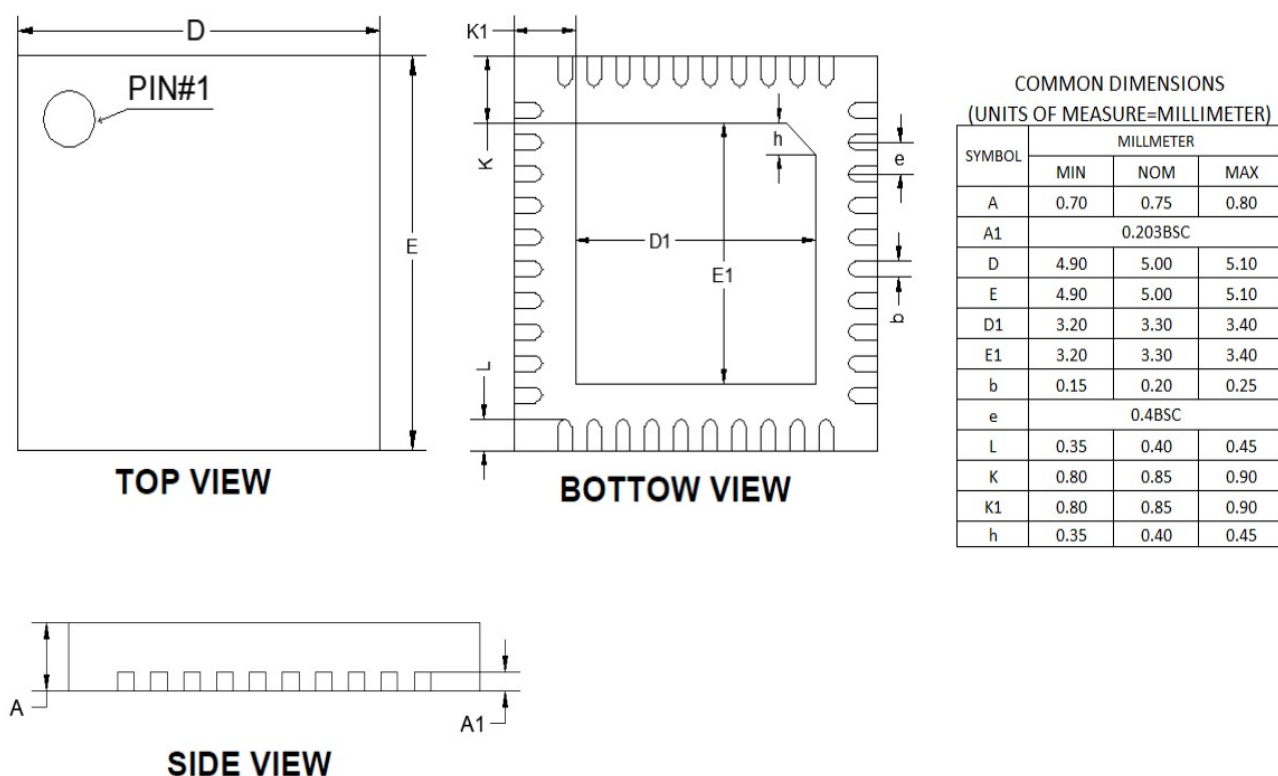


Figure 3 CCX1033 Package information

4. Revision History

Date	Version	Description	Owner
April-8,2022	V0.1	datasheet of CCX1033	T.L.
November-8,2022	V0.2	datasheet of CCX1033	