



偉詮電子股份有限公司
Weltrend Semiconductor, Inc.

WT6630P
USB Power Delivery Controller

Data Sheet

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REVISION HISTORY

Date	Version	Description
2015/02/06	0.80	Preliminary Data Sheet
2015/03/20	0.81	1. Add QFN16pin package and update pin description. 2. Add section 2.2 "Ordering information" 3. Update "shunt regulator" description.

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1. General Description

The WT6630P is an USB Power Delivery (PD) controller designed for USB Type-C adapter or charger. It integrates USB PD baseband PHY, Type-C detection, shunt regulator, voltage and current monitor, 8-bit MCU and control circuit of blocking MOSFET. An One-Time-Programmable (OTP) ROM is provided for program code and user configuration data.

To minimize external components, on-chip regulator provides 1.8V for MCU and can operate at single power supply from 4 to 30V.

Features:

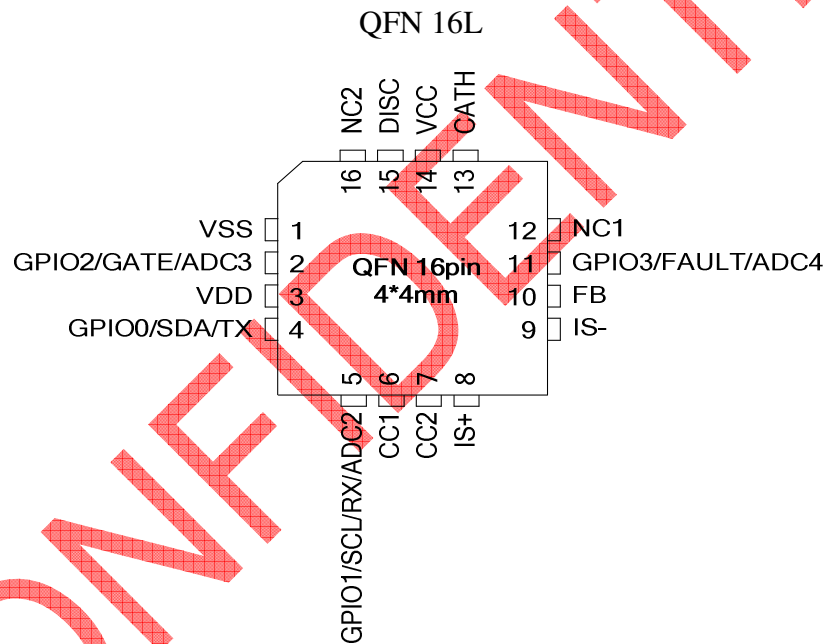
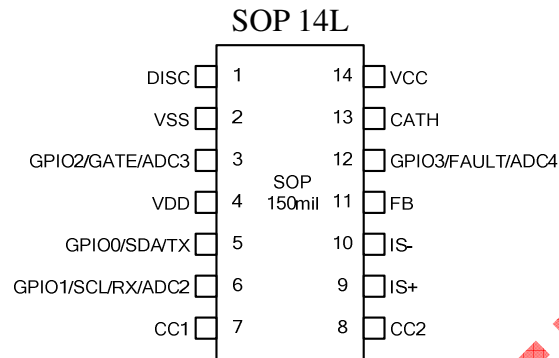
- USB Type-C charge-only Downstream Facing Port (DFP)
- USB Power Delivery Rev.2.0 baseband communication
- Built-in shunt regulator and support 5V to 20V VBUS output
- Programmable Over Voltage Protection (OVP)
- Low side voltage output current shunt monitor
- 10-bit ADC for voltage and current monitoring
- 8-bit MCU
 - implements Power Delivery message protocol and device policy
 - VBUS output control
 - power supply protection
- 8k bytes One-Time-Programmable (OTP) ROM
- 512 bytes RAM
- Timers : Timer0, Timer2
- External blocking MOSFET control
- Internal RC oscillator
- Internal VDD regulator
- General purpose I/O
- Serial interface : I²C and UART
- Watchdog timer
- Support power saving mode
- Operating voltage range : 4V ~ 30V
- Operating temperature range : -20 ~ +105°C
- Package : 14-pin SOP

Application :

- USB Type-C AC adapters and chargers

2. Pin Assignment

2.1. Package



2.2. Ordering Information

Package Type	Package Outline	Part Number
16-pin QFN	4mm x 4mm	WT6630P-UG160WT
14-pin SOP	150 mil	WT6630P-SG140WT

2.3. Pin Description

Pin No.		Name	Function	I/O Voltage	Type		Description
SOP 14	QFN 16				Input	Output	
1	16	DISC	DISC	HV	-	OD	Discharge
2	1	VSS	VSS	-			Ground
3	2	GPIO2/GATE/ ADC3	GPIO2	HV	TTL	PP	General purpose I/O.
			GATE		-	PP	Blocking MOS Control
			ADC3		AN	-	ADC input
4	3	VDD	VDD	LV	-	AN	1.8V regulator
5	4	GPIO0/SDA/ TX/T2EX	GPIO0	HV	TTL	OD	General purpose I/O.
			SDA		TTL	OD	I ² C data
			TX		-	OD	UART transmitter
			T2EX		TTL	-	Timer2 capture mode input
6	5	GPIO1/SCL/ RX/ADC2	GPIO1	LV	TTL	OD	General purpose I/O.
			SCL		TTL	OD	I ² C clock
			RX		TTL	-	UART receiver
			ADC2		AN	-	ADC input
7	6	CC1	CC1	HV	CC	PP	USB Type-C Configuration Channel
8	7	CC2	CC2	HV	CC	PP	USB Type-C Configuration Channel
9	8	IS+	IS+	LV	AN	-	Positive input of current sensing amplifier.
10	9	IS-	IS-	LV	AN	-	Negative input of current sensing amplifier.
11	10	FB	FB	LV	AN	-	Feedback of shunt regulator
12	11	GPIO3/FAULT / ADC4	GPIO3	HV	TTL	OD	General purpose I/O. Open drain output.
			FAULT		-	OD	Fault indication. Outputs low when OVP/OCP.
			ADC4		AN	-	ADC input
13	13	CATH	CATH	HV	-	AN	Cathode of shunt regulator
14	14	VCC	VCC	HV	-	-	Positive power supply

Legend : HV=High Voltage(max. 30V), LV=Low voltage(max. 5V), OD=Open Drain, PP=Push Pull, AN=analog, TTL= TTL compatible input, CC= USB PD baseband input

3. Block Diagram

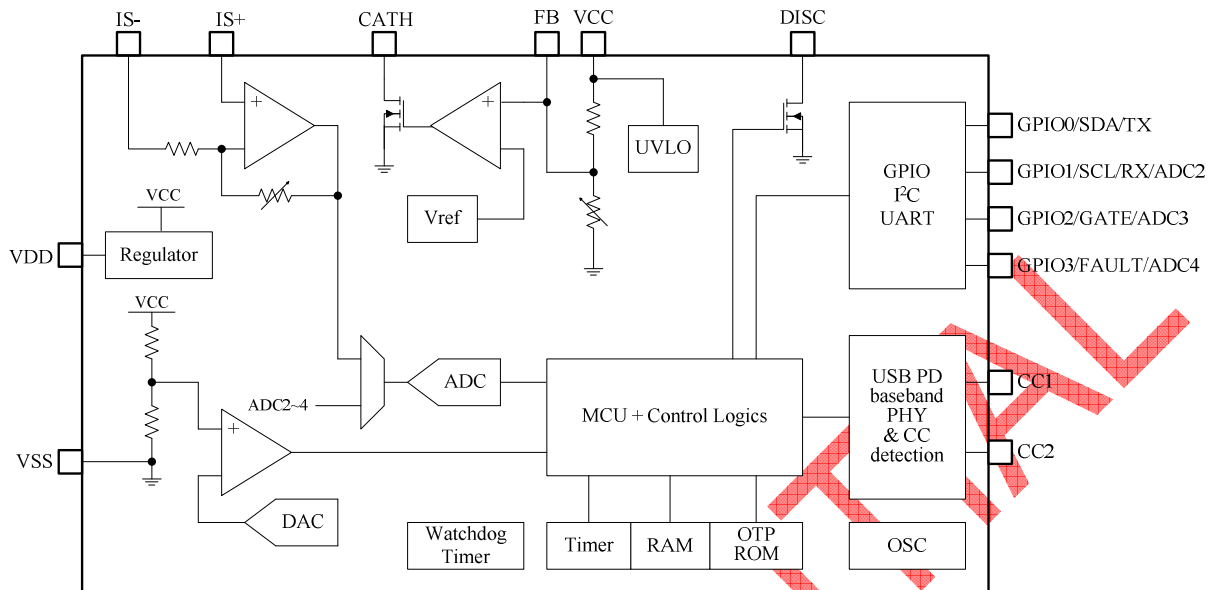


Fig. 3.1 Block diagram

4. Functional Description

4.1. Shunt Regulator

VBUS output voltage can be selected by setting the resistor ratio of shunt regulator and is illustrated in Fig.4.1. MCU controls the resistor value and supports 5V, 9V, 12V, 15V, 16V, 17V, 19.5V and 20V VBUS output. Default is 5V after power on.

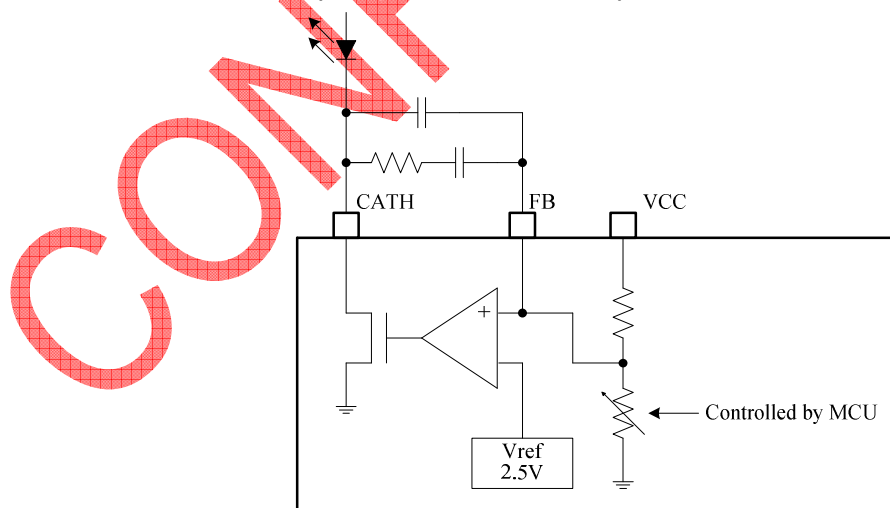


Fig. 4.1 VBUS voltage control

4.2. Over Voltage Protection (OVP)

Over voltage protection is implemented by a comparator, Digital to Analog Converter and debounce circuit.

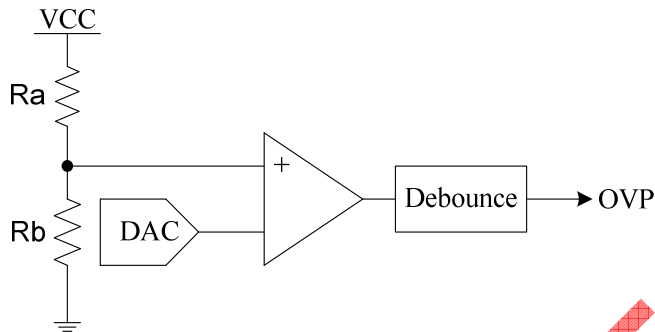


Fig. 4.2 OVP circuit

4.3. Low Side Current Shunt Monitor

Load current is sensed by the programmable gain amplifier which amplifies the voltage drop across shunt resistor.

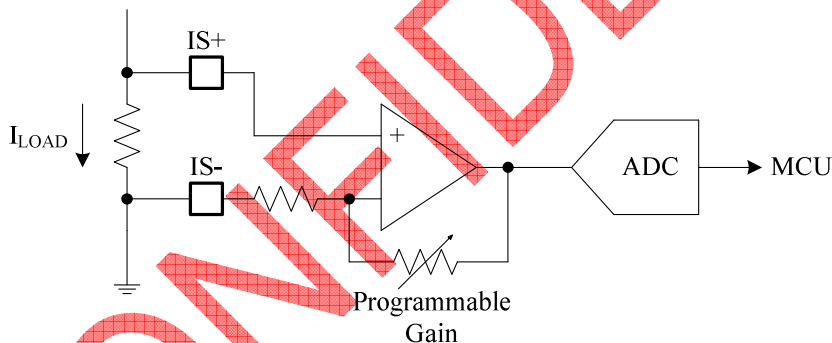


Fig. 4.3 Load current monitor

4.4. USB Type-C and Power Delivery

4.4.1 CC termination and connection detect

The termination is implemented by a selectable current source, I_{RP_CC} , which is 80, 180, or 330 μ A. By monitoring the CC1 and CC2 voltage, it can detect a UFP is attached or not.

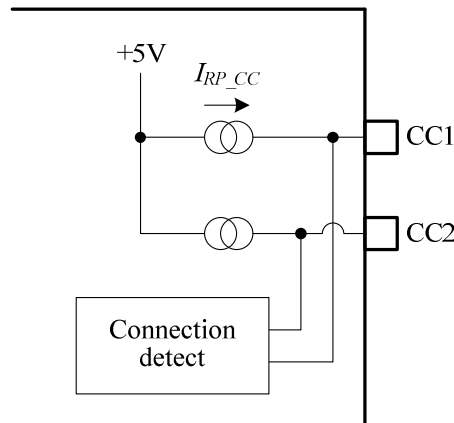


Fig. 4.5 CC1 and CC2 pull-up and detection

When UPF is attached, GATE pin goes to low and turn on blocking MOSFET.

When UPF is detached, GATE pin goes to high level and turn off blocking MOSFET.

4.4.2 USB PD PHY

USB PD PHY consists of a pair of transmitter and receiver that communicate across CC wire using Biphase Marking Coding (BMC).

The transmitter performs :

- Receive packet data from the protocol layer
- Calculate and append a CRC
- Encode the packet data including the CRC
- Transmit the Packet (Preamble, SOP, payload, CRC and EOP) across the CC channel using BMC

The receiver performs :

- Recover the clock and lock onto the Packet from the Preamble
- Detect the SOP
- Decode the received data including the CRC
- Detect the EOP and validate the CRC
- If the CRC is valid, deliver the packet data to the protocol layer.
- If the CRC is not valid, flush the received data

4.5. Discharge

When VBUS is changed from a higher voltage level to a lower voltage level, a programmable current sink can be enabled to discharge the VBUS. There are four discharge transistors can be enabled independently to control discharge time. Care must be taken when discharging with large current at high voltage level.

4.6. MCU

Embedded turbo 8051 compatible CPU with 16-bit address bus and 8-bit data bus.

Maximum operating frequency is 10MHz.

Internal RAM: 256 bytes
 External RAM : 256 bytes

4.7. Timer/Counter

The WT6630P contains two 16-bit Timer/Counters (Timer0 and Timer2). All two Time/Counter can be configured as Timer or Counter.

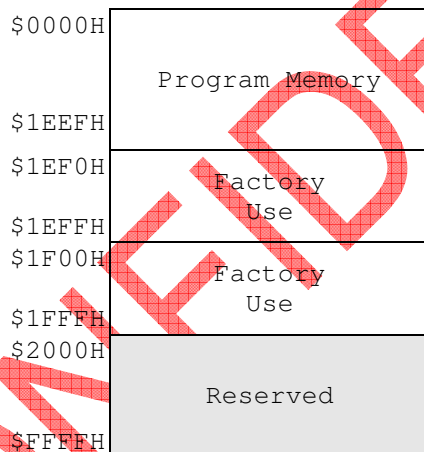
4.8. Serial interface

Two serial interfaces are provided:

- UART: standard 8052 UART
- I²C: slave mode only

4.9. OTP Memory

One-Time-Programmable Memory is 8k bytes. A 256 bytes space is reserved for user data and can be programmed through CC pin.



4.10. GPIO

General purpose I/O pin is controlled by MCU. When set as an output, it is an open drain output.

4.11. Watchdog Timer

The watchdog timer is a programmable timer that generates a RESET if the MCU does not clear it before time out. The clock source of watchdog timer is from a independent low frequency oscillator.

5. Electrical Characteristics

5.1. Absolute Maximum Ratings

Parameter		Min.	Max.	Unit
Supply voltage VCC pin		-0.3	30	V
Input voltage	CATH, CC1, CC2	-0.3	VCC + 0.3 (max. 30V)	V
	FB, IS+, IS-	-0.3	5	V
Output voltage	DISC, GPIO0, GATE/GPIO2, FAULT/GPIO3	-0.3	VCC + 0.3 (max. 30V)	V
	GPIO1	-0.3	5	V
	VDD	-0.3	3	V
Operating temperature		-40	125	°C
Storage temperature		-55	150	°C

NOTE: Maximum ratings applied to the device are individual stress limit value. Stresses above those listed may cause permanent damage and reliability may be affected.

5.2. Thermal Characteristics

5.2.1. 16-Pin QFN

Parameter		Condition	Min.	Typ.	Max.	Unit
θ_{JA}	Thermal Resistance (Junction to Air)			2.6		°C /W
θ_{JC}	Thermal Resistance (Junction to Case)			37		°C /W
T_{JMAX}	Maximum Junction Temperature			125		°C

5.2.2. 14-Pin SOP

Parameter		Condition	Min.	Typ.	Max.	Unit
θ_{JA}	Thermal Resistance (Junction to Air)			90		°C /W
θ_{JC}	Thermal Resistance (Junction to Case)			37		°C /W
T_{JMAX}	Maximum Junction Temperature			125		°C

5.3. Recommended Operating Conditions

Parameter		Condition	Min.	Typ.	Max.	Unit
V_{CC_OPR}	Operating voltage		4		30	V
T_{OPR}	Operating Temperature		-20		105	°C

5.4. DC Characteristics (VCC=20V, Ta= -20 ~ +105°C, unless specified)

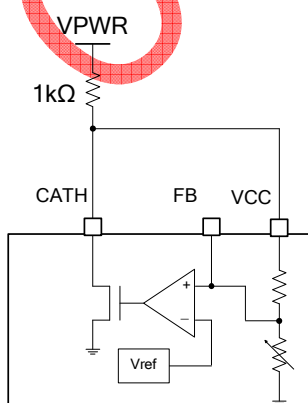
5.4.1. VCC and VDD

Parameter	Condition	Min.	Typ.	Max.	Unit	
V _{CC}	VCC Operating Voltage	4		30	V	
I _{CC_OPR}	VCC Current, normal operating		1.5	3	mA	
I _{CC_SLEEP}	VCC Current, sleep mode		0.8	1.0	mA	
	CC1 pin 5.1KΩ pull low			1.3	mA	
V _{UVLO}	VCC Under Voltage Lockout			3.8	V	
	VCC falling	3.2			V	
I _{DISC}	VCC discharge current	VCC=8V, DISC_CTL=0001	65	100	145	mA
		DISC_CTL=0010	79	120	171	mA
		DISC_CTL=0100	92	135	202	mA
		DISC_CTL=1000	105	150	229	mA
V _{DD}	VDD regulator output voltage	I _{DDO} = 0 ~ 5mA	1.75	1.85	1.95	V

5.4.2. Shunt regulator

Parameter	Condition	Min.	Typ.	Max.	Unit
V _{REF}	V _{CATH} =V _{FB} and I _{CATH} = 1mA Ta= 25°C	2.49	2.5	2.51	V
	V _{CATH} =V _{FB} and I _{CATH} = 1mA Ta= -20°C ~ +105°C	2.48	2.5	2.52	V
V _{OUT}	Regulator output voltage				
	VPWR=8V, 5V output	4.9	5	5.1	V
	VPWR=15V, 12V output	11.64	12	12.36	V
	VPWR=23V, 20V output	19.4	20	20.6	V

* Regulator output voltage test circuit



5.4.3. Over Voltage Protection (OVP)

Parameter		Condition	Min.	Typ.	Max.	Unit
E_{OVP}	OVP trip point error	$V_{CC} > 5V$, $V_{REF_OVP} = 1.8V$			± 150	mV
V_{REF_OVP}	Reference voltage of DAC		1.78	1.8	1.82	V

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5.4.4. ADC

Parameter		Condition	Min.	Typ.	Max.	Unit
N _{ADC}	ADC resolution			10		bit
INL _{ADC}	ADC INL	V _{REF_ADC} = 1.8V			±5	LSB
DNL _{ADC}	ADC DNL	V _{REF_ADC} = 1.8V			±5	LSB
V _{REF_ADC}	Reference voltage of ADC		1.78	1.8	1.82	V

5.4.5. CC1 and CC2

Parameter		Condition	Min.	Typ.	Max.	Unit
V _{OH_CC}	Output high voltage of BMC transmitter		1.05	1.125	1.2	V
V _{OL_CC}	Output low voltage of BMC transmitter		0		0.075	V
V _{IH_CC}	Input high voltage of BMC receiver		0.67		1.45	V
V _{IL_CC}	Input low voltage of BMC receiver		-0.25		0.43	V
Z _{DRIVER_C}	BMC Transmitter output impedance		33		75	Ω
I _{RP_CC}	CC1 and CC2 pull-up current	Capability 0.5A @5V	64	80	96	μA
		Capability 1.5A @5V	166	180	194	μA
		Capability 3.0A @5V	304	330	356	μA
V _{Rd_CC}	CC1 and CC2 attachment detection threshold	Capability 0.5A @5V	1.5	1.6	1.65	V
		Capability 1.5A @5V	1.5	1.6	1.65	V
		Capability 3.0A @5V	2.45	2.6	2.75	V

5.4.6. GPIO pin

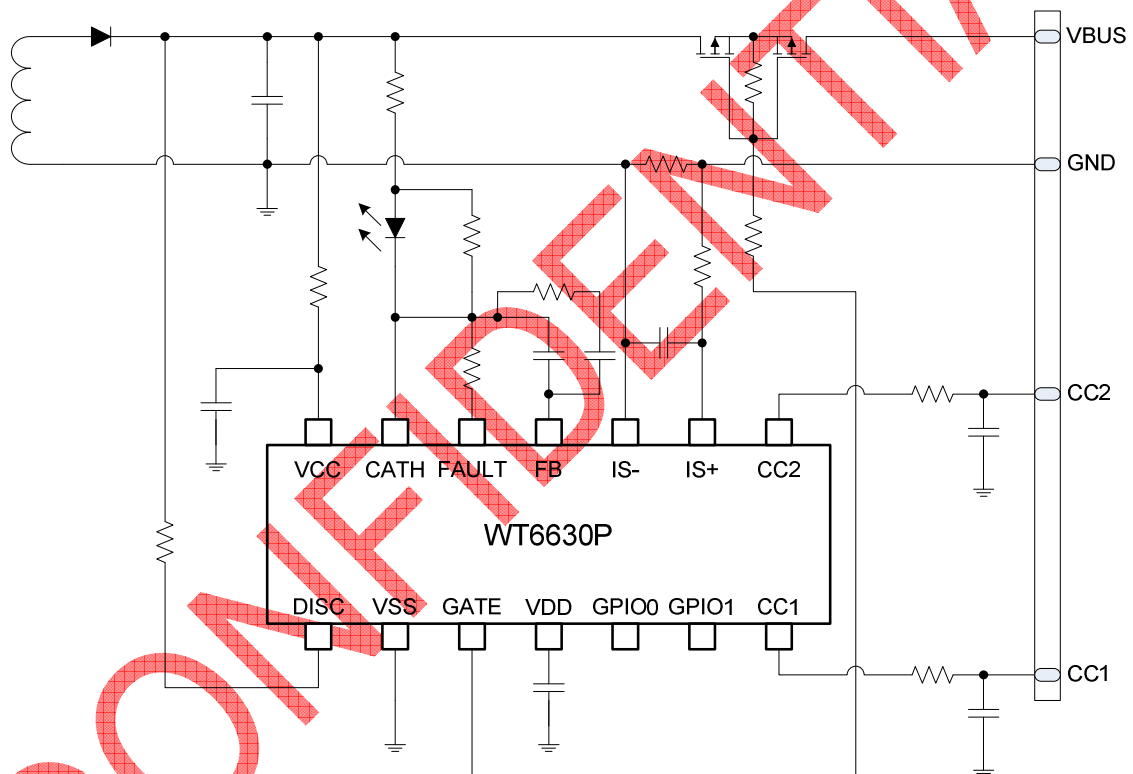
Parameter		Condition	Min.	Typ.	Max.	Unit
V _{OL_GPIO1}	Output Low Voltage of GPIO1	I _{OL} = 4mA			0.4	V
V _{OL_GPIOx}	Output Low Voltage of GPIO0, GPIO2 and GPIO3	I _{OL} = 10mA			0.4	V
V _{OH_GPIO2}	Output High Voltage of GPIO2	I _{OH} = 10mA	V _{CC} - 0.4			V
I _{Z_GPIO}	Leakage current of GPIO in Hi-Z				10	μA
V _{IH}	Input high voltage	GPIO1	1.4		4.5	V
		GPIO0, GPIO2, GPIO3	1.4		V _{CC}	V
V _{IL}	Input low voltage		0		0.8	V

5.5. AC Characteristics (VCC=20V, Ta= -20 ~ +105°C, unless specified)

5.5.1. Internal Oscillator

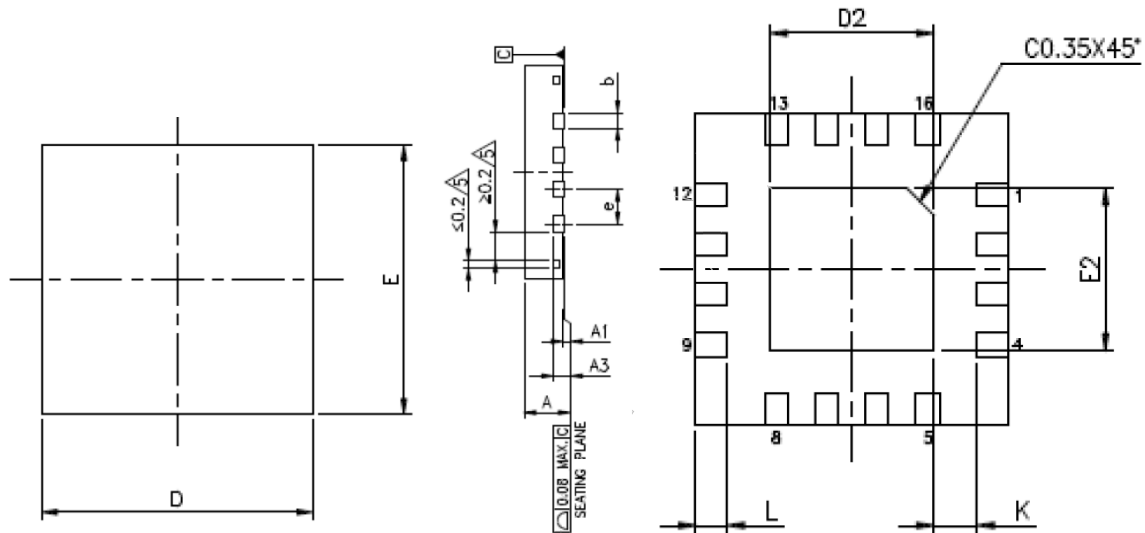
Parameter	Condition	Min.	Typ.	Max.	Unit
f _{OSC}	Main oscillator frequency	9.5	10	10.5	MHz
f _{LFOSC}	Low frequency oscillator frequency	50	60	70	KHz

6. Example of Application



7. Package Dimension

7.1. 16-pin QFN



(All dimensions shown in mm)

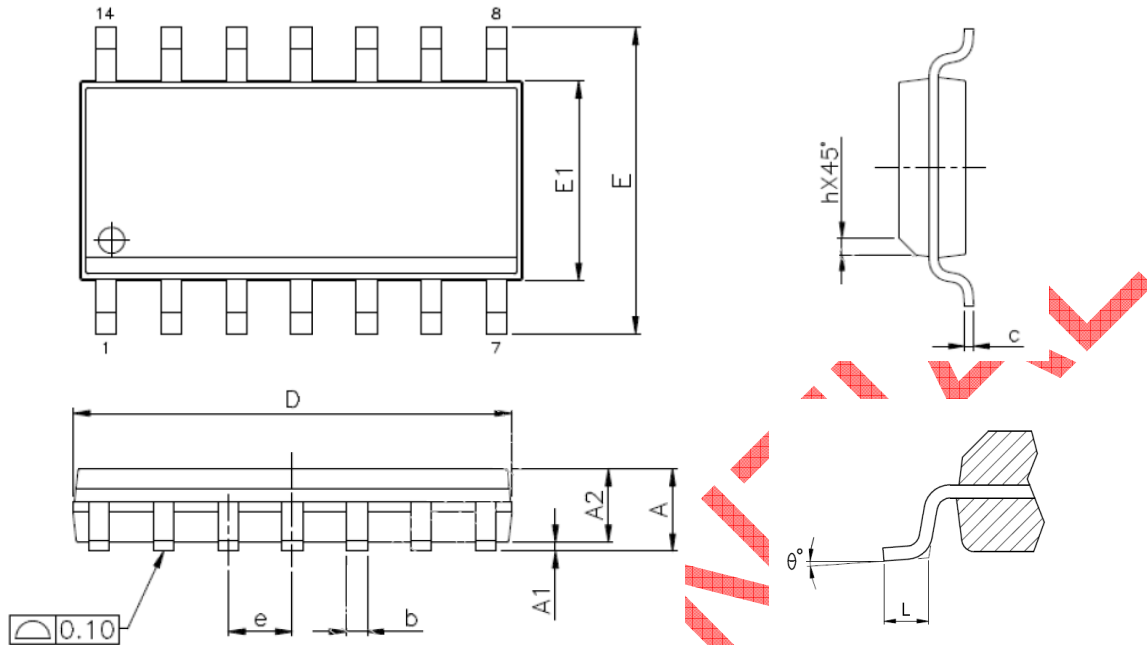
All dimensions shown in mm

SYMBOL	MIN	NOR	MAX.
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.20	
b	0.25	0.30	0.35
D		4.00	
E		4.00	
e		0.65	
K	0.20	-	-
L	0.35	0.40	0.45
D2	2.00	2.10	2.15
E2	2.00	2.10	2.15

NOTES :

1. Dimension "b" applies to metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip. If the terminal has the optional radius on the other end of the terminal, the dimension "b" should not be measured in that radius area.

7.2. 14-pin SOP



(All dimensions shown in mm)

All dimensions shown in mm

SYMBOL	MIN.	MAX.
A	-	1.75
A1	0.10	0.25
A2	1.25	-
b	0.31	0.51
c	0.10	0.25
D	8.53	8.74
E	6.00 BSC	
E1	3.81	3.99
e	1.27 BSC	
L	0.40	1.27
h	0.25	0.50
θ°	0	8

NOTES :

2. Dimensions "D" does not include mold flash, protrusions or gate burrs mold flash. Protrusions or gate burrs shall not exceed 0.15mm.
3. Dimensions "E1" does not include inter-lead flash, or protrusions. Inter-lead flash and protrusions shall not exceed 0.25mm per side.