PT8A2713S

及其组成的带预放电的Ni-Cd充电器

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PT8A2713S是一款国产的充电器专用IC，专门设计用于控制Ni-MH、Ni-Cd电池的充放电。与大部分具有类似功能的MCU控制的充电器相比，它具有功能完善、性能稳定、易于生产调试以及整体价格便宜等优点。

该IC采用DIP20或SOP20封装，也可提供裸片，其引脚排列见图1，内部功能框图见图2。

按照顺序排列，1脚是V_{cc}供电脚，2脚是报警BUZOUT输出脚，3脚是电池低电压指示，4脚是充电状态指示，5脚是内部稳压器的输出，为一个非常稳定的2.0V ±0.05V的电压输出，为外部OSC时钟振荡器和NTC温度检测电路提供稳定的电源电压，6脚和11脚、13脚为内部功能引脚，主要供IC生产测试使用，7脚为地，8脚VB在充电过程中用于检测电池电压以判断电池是否充满，9脚VB2用于在放电过程中判断电池电压是否低过限定值。因为在充电状态和放电状态内部由许多不同的电路模块分别工作，而且两种状态下电池电压差别较大，因此为了提高检测效率和精度，分别用两个通道（VB和VB2）来检测电池电压。详细应用请参考推荐应用电路（图3）。

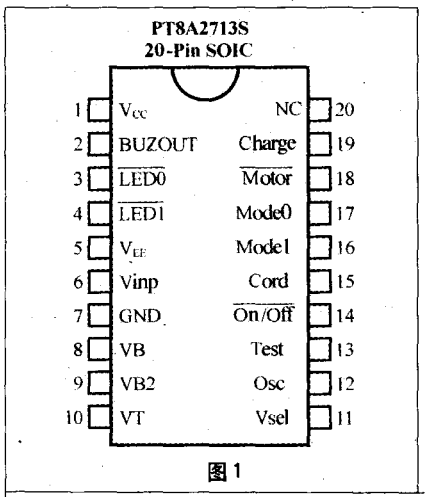


图1

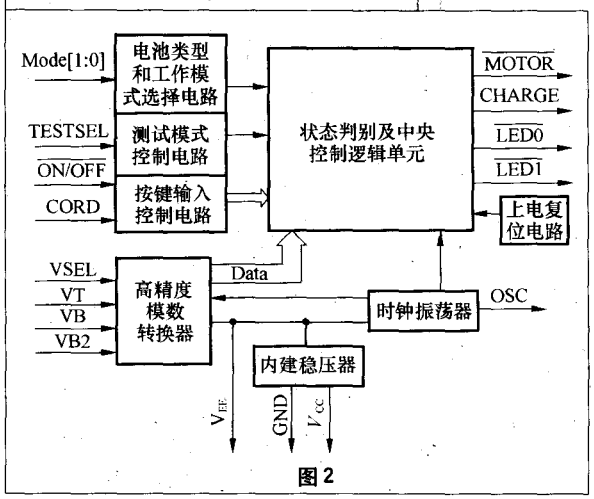


图2

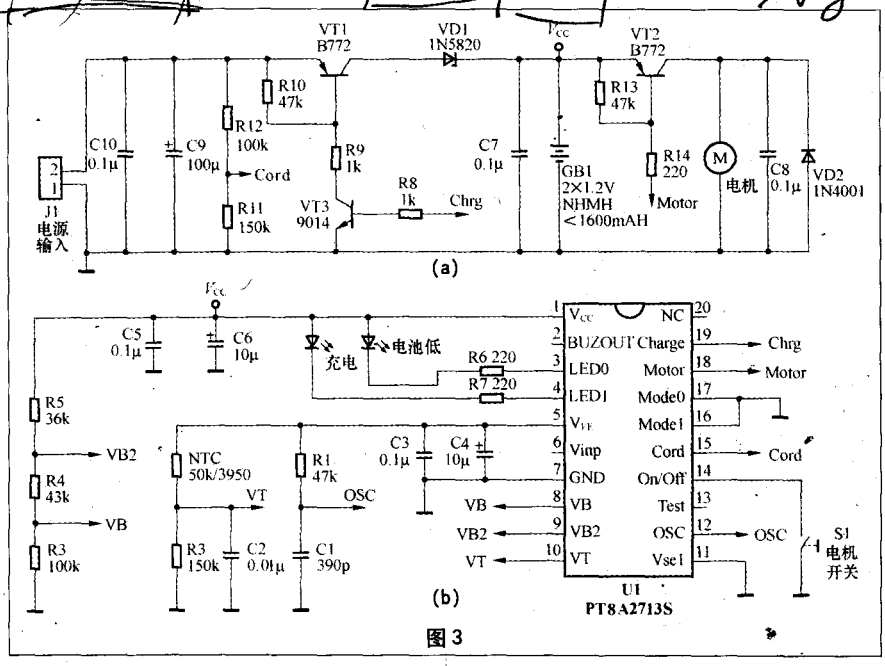


图3

图3中10脚用于读取外部NTC上的电压值以判断其温度，通常将NTC紧贴被充电电池表面，这样，通过NTC读取的温度就是电池体的温度，14脚就是开关键，用于控制负载（电机）的开（放电）或关，如果14脚由外部按键拉低，并且IC内部由逻辑电路判别电池有足够电能推动电机的话，则IC将18脚输出拉低，从而控制VT2管导通，接通电机和电池，使电机得电运转。运转过程中IC通过VB2脚不断判断电池电压，如果电池电压降低到通过R5、R4、R3的分压使VB2引脚上的电压低过1.65V（与V_{EE}有关，设定值是$0.825 \times V_{EE}$），则点亮7s低电压指示LED（3脚），并在每次关闭电机时同样点亮7s。而如果继续使用使得电池电压下降到$0.80 \times V_{EE}$时，IC

会自动控制18脚关闭电机，以保护电池不至于被过放电损坏。

15脚Cord是用来判断外接充电电源的状况，如果接上外接电源，则通过R12、R11的分压使得Cord引脚拉高，这样IC就会自动进入充电模式，使图3(b)中的19脚Charg输出高电平从而使图3(a)的VT3导通，VT3导通使外接电源通过VT1和VD1给电池提供快速恒流充电，同时使充电指示灯LED1闪亮，充电过程中通过VB引脚不断判断电池的电压，如果继续充电使得电池电压上升到顶点然后微微下降，即表现出所谓的－ΔV特性时，IC就认为电池已经充满，IC内部控制电路就会关闭快速恒流充电而转为1/10倍率的脉冲补充充电。

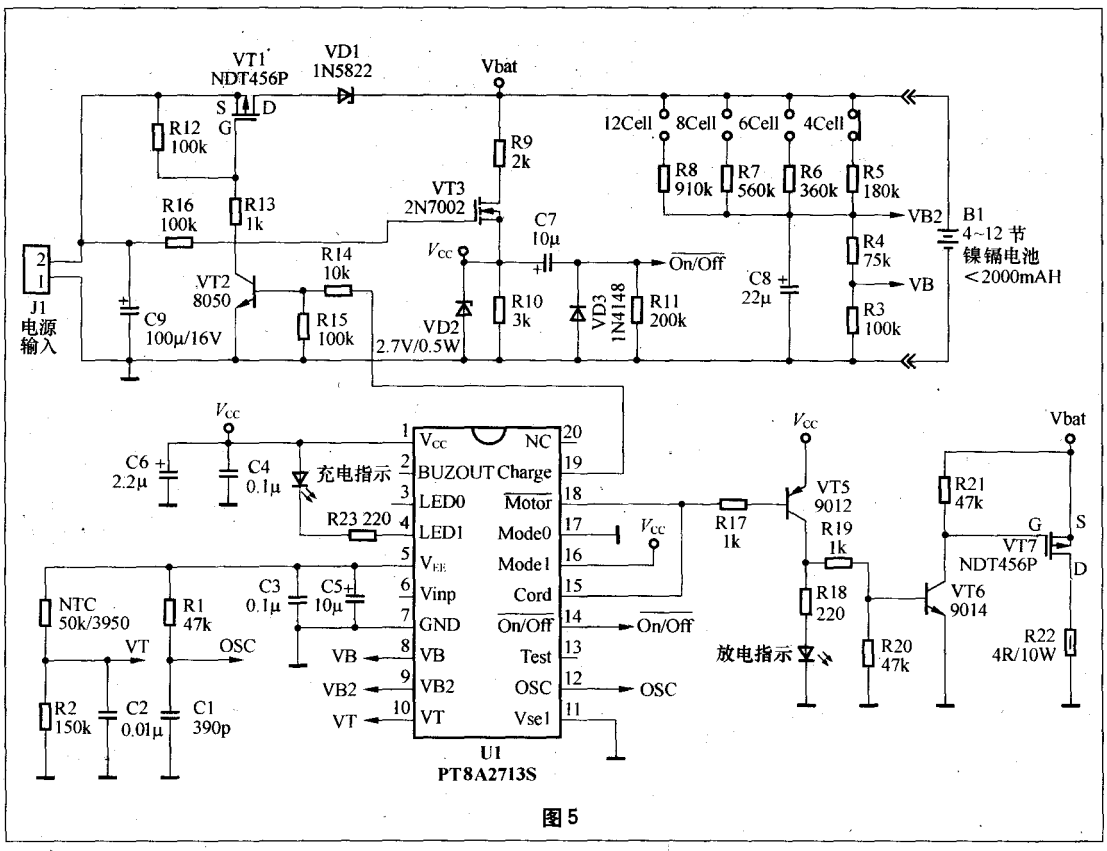


图5

在充电过程中除了判断－ΔV特性之外，IC还同时检测电池的其他状态，实现最大充电电压保护、最大充电时间保护和电池体温度超限保护等完善的保护措施，具体保护过程与本刊较早介绍的PT8A2704一样，请读者参考该篇文章说明。

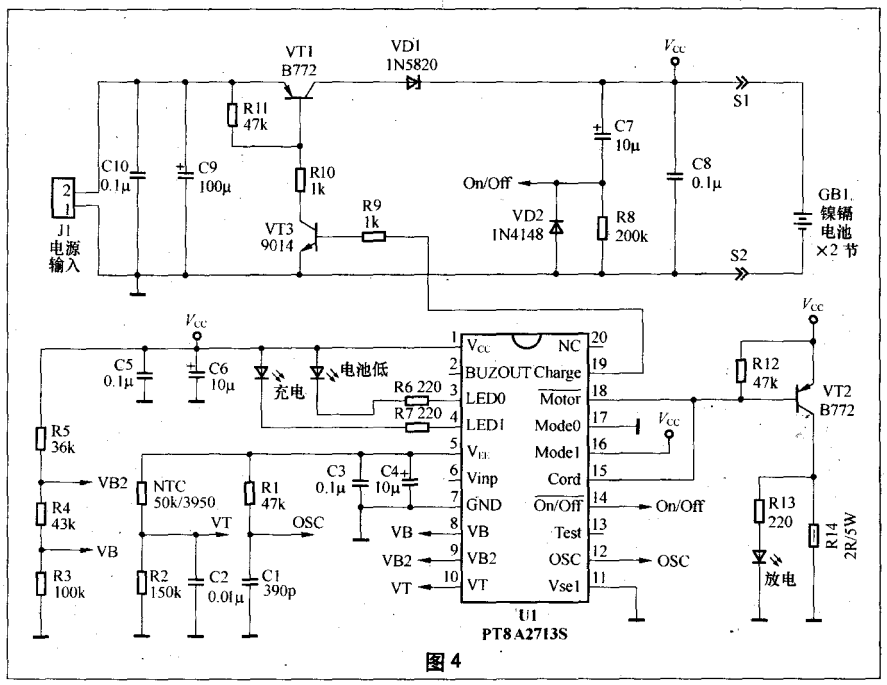


图4

上面介绍的电路具有完善的过放电保护，但是对于Ni-Cd电池来讲，不光是需要可靠的充电保护和放电保护，另外还因为存在比较明显的记忆效应，如果充电前电池未完全放电，久而久之电池容量就会越来越小，因此人们希望在每次充电前充电器能自动将Ni-Cd电池内的残余电量放完后再充电，在此笔者介绍一款采用PT8A2713组成的电路（图4）。

图4是适用于2～3节Ni-Cd电池串联的充电电路（需要微调R3～R5的数值），其工作过程大致是：电池一旦接上，则通过C7、R8适当延时后产生一个低有效的脉冲信号，给IC的$\overline{\text{On/Off}}$引脚一个触发信号，触发IC拉低$\overline{\text{Motor}}$引脚（IC已经开启负载放电），而$\overline{\text{Motor}}$引脚拉低VT2管导通，使电池通过VT2、R14放电，同时将连在一起的Cord引脚拉低，这样IC就认为外接电源输入已经被断开，从而进入纯粹的放电状态，IC通过VB2引脚不断检测电池的端电压，当持续放电

使得每节电池的端电压低于0.8V时，IC的VB2引脚电压低于1.6V（也可通过改变外部R5、R4、R3电阻的比值来调整），这时可以认为电池已经放完了残余电量，而IC则判断为放电过程中电池电压低过极限，从而自动拉高$\overline{\text{Motor}}$引脚，关闭负载（在这里也就是关闭放电回路），$\overline{\text{Motor}}$引脚同时将Cord引脚拉高，这样IC认为外接充电电源已经接上，从而控制Charg引脚自动开启充电回路，转换为给电池充电，这样就实现了在充电之前自动给被充电电池放电的目的。

上图仅能适用2～3节镍镉电池，而且IC的电源供应直接接在充电输出端，变化较大，如果像遥控玩具或者电动工具这些使用8节、12节甚至更多节数镍镉电池的应用，其电池组的充电可否使用呢？当然可以，请看下面修改后的电路（图5）。

图5是一个已经大量生产的通用充电器电路，可通过一个单刀多掷开关选择不同的电池节数（实际是选择R5～R8不同的电阻接入），从而可以设置VB、VB2在相同的检测范围，另外，因为IC的供电电压V_{cc}和电池电压Vbat相差太多，因此在放电回路要增加VT5、VT6来作为电压隔离，而IC的供电也采用了R9、VD2来降压提供并由外接供电电源通过VT3来控制，这样只有在电池和外部供电同时都接上时才会给IC供电，避免了图4电路的供电弊端，另外充放电开关管选用了性能优良的P-MOS管，大大增加了其电流负载能力并有效降低了充放电过程中PCB组件的温升，性能非常完美。已经大批量配套应用于某高端遥控航模中。

PT8A2713S控制功能精确而完善，避免了市面其他MCU的方案需要定制软件的问题。加之性能非常稳定，价格适中，具有比MCU更先进的性能优势。

Product Features

- On-chip analog functions for rechargeable battery charge/discharge management.
- Constant and pulse current charging operations
- Fast charge detection by: -ΔV, 0ΔV,
- Charge protection with safety timer 90 minutes, maximum voltage, maximum temperature.
- On-chip voltage reference and regulator.
- On-chip high precision 5-bits ADC.
- Cord existence detection and indicator
- Low Battery detection and indicator
- Few external components needed

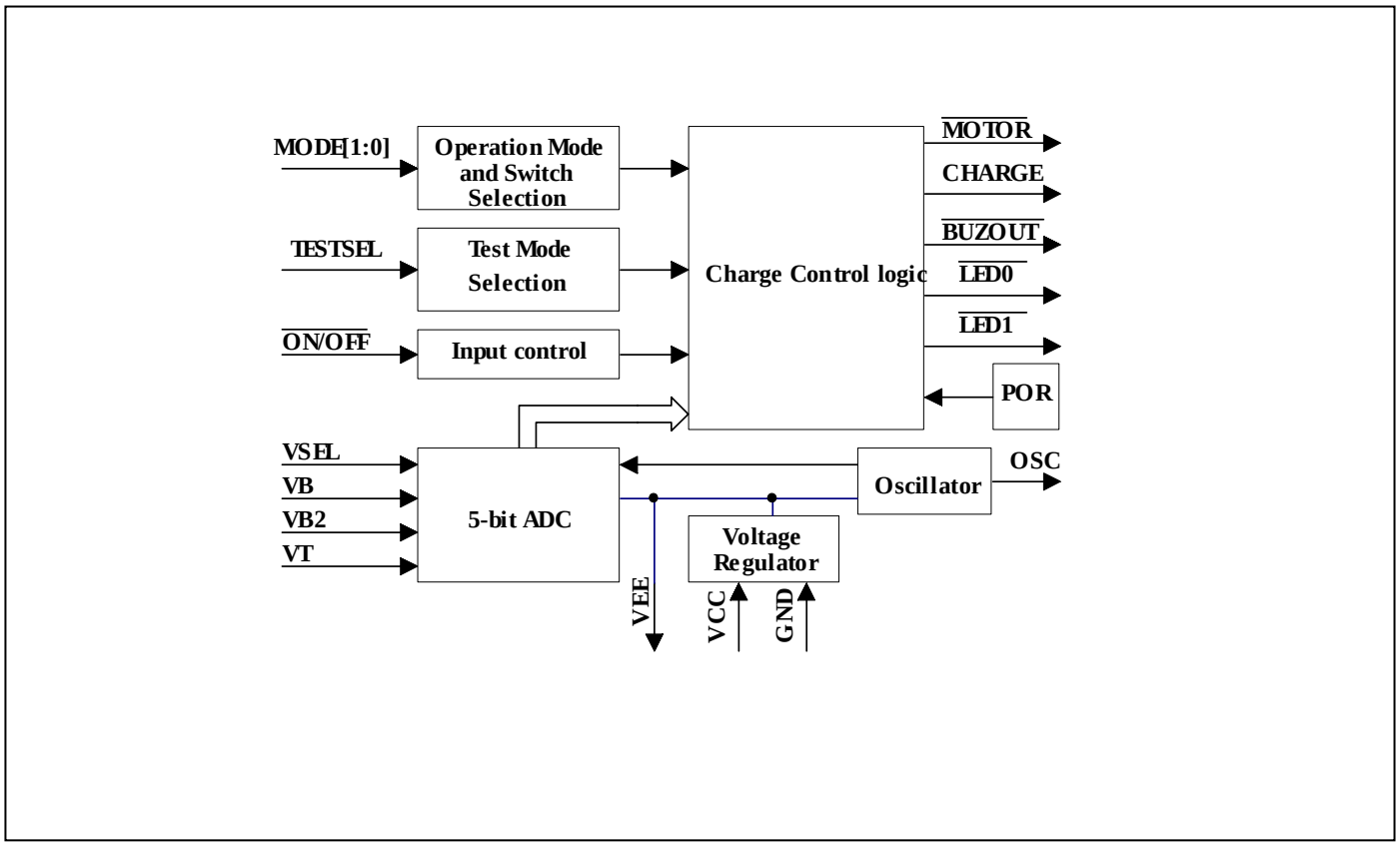
Product Description

PT8A2703 is designed as a mixed signal device to provide a single chip solution for rechargeable battery powered smart controllers using only a few external components such as transistors, passive components and LED. The chip handles charging with fast constant or pulse current charging modes and discharging. It contains enough logic circuits on chip to implement custom applications such as clipper, hair remover, high-end toy/aeromodelling and other portable devices.

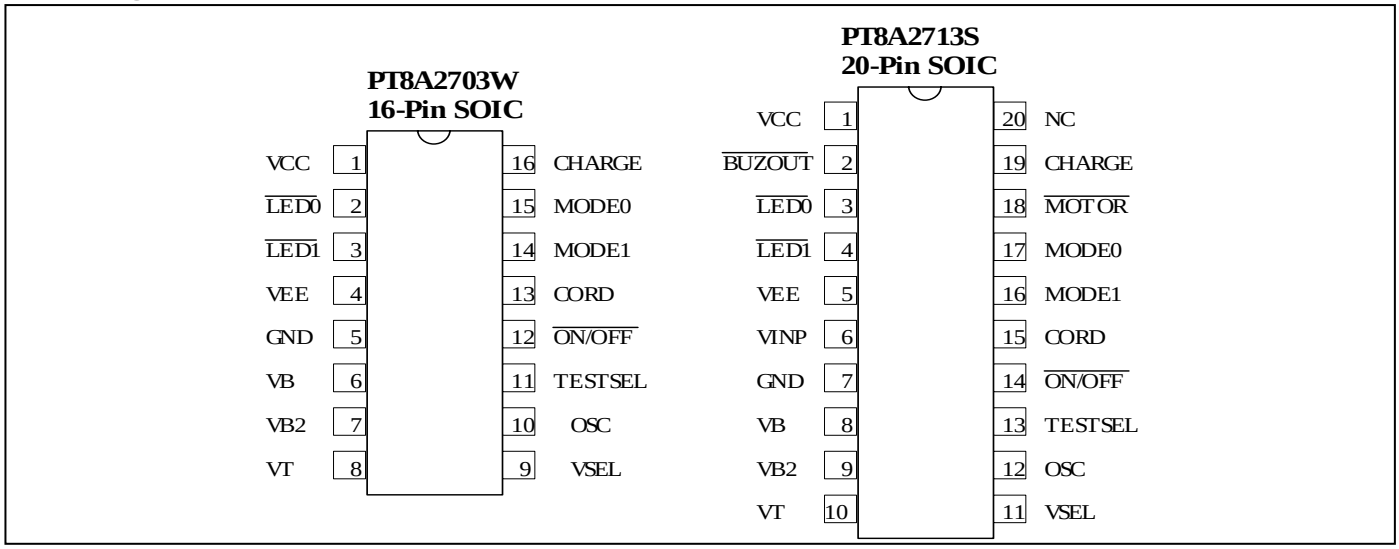
Ordering Information

Part Number	Package
PT8A2703DE	Die Form
PT8A2703W	16-Pin SOIC
PT8A2703WE	16-Pin SOIC
PT8A2713S	20-Pin SOIC

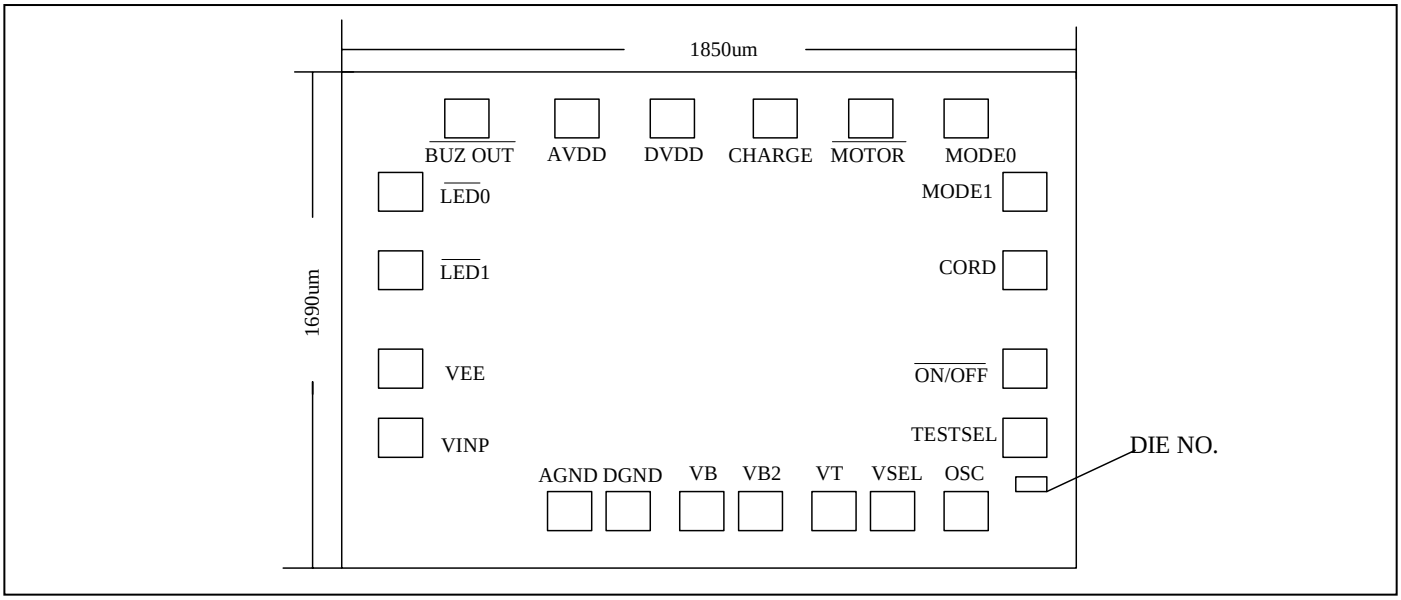
Block Diagram



Pin assignment



Pad Location



Pad Coordinates

Pad Name	X Coordinate	Y Coordinate	Pad Name	X Coordinate	Y Coordinate
DVDD	808.5	1534.45	**VT**	1081.85	166.05
AVDD	520.1	1534.45	**VSEL**	1185.75	166.05
BUZOUT	264.7	1534.45	**OSC**	1351.15	166.05
LED0	155.4	1298.3	**TESTSEL**	1688.05	478.35
LED1	155.4	1038.7	**ON/OFF**	1688.05	733.75
VEE	155.4	750.3	**CORD**	1688.05	1022.15
VINP	155.35	395.1	**MODE1**	1688.05	1277.55
AGND	560.05	166.05	**MODE0**	1607.7	1534.45
DGND	663.95	166.05	**MOTOR**	1352.3	1534.45
VB	820.95	166.05	**CHARGE**	1063.9	1534.45
VB2	924.85	166.05			
Note: Substrate is connected to GND					

Pad/Pin Description

Pin #		Pin/Pad Name	I/O	Pad/Pin Descriptions
2703W	2713S			
1	1	VCC(DVDD,AVDD)	-	Positive supply voltage from battery
-	2	$\overline{\text{BUZOUT}}$	O	Buzzer output, active low.
2	3	$\overline{\text{LED0}}$	O	Low battery indicator LED output, active low.
3	4	$\overline{\text{LED1}}$	O	Corded Mode/Charging indicator LED output, active low.
4	5	VEE	O	Internal regulator output (about 2.0V)
-	6	VINP	I	Positive input terminal of regulator opamp
5	7	GND (AGND,DGND)	-	Power ground
6	8	VB	I	Divided input of Battery voltage (range from 1.6V to 1.8V)
7	9	VB2	I	Low battery voltage detection channel (range from 1.6V to 1.8V)
8	10	VT	I	Battery temperature NTC voltage (range from 1.6V to 1.8V)
9	11	VSEL	I	Zero/negative delta voltage duration selection <0.825VEE : 3min (NiCd)/ 10min (NiMH) <0.850VEE and >0.825VEE: 1min (NiCd)/ 6min (NiMH) <0.875VEE and >0.850VEE: 2min (NiCd)/ 8min (NiMH) >0.875VEE: 4min (NiCd)/ 12min (NiMH)
10	12	OSC	I	Connected to an RC network for the internal system clock, 64kHz
11	13	TESTSEL	I	Test mode select, internal pull up.
12	14	$\overline{\text{ON/OFF}}$	I	Motor On/Off key
13	15	CORD	I	External cord detection (digital level), , active high
14	16	MODE1	I	0 : zero delta voltage detection; 1 : negative delta voltage detection
15	17	MODE0	I	0 : Tact switch; 1 : Slide switch mode
-	18	$\overline{\text{MOTOR}}$	O	Drive motor switch enable (active low)
16	19	CHARGE	O	Battery charge control signal to drive NPN switch for charging
-	20	NC	-	No connection

Notes : All LED signals are active low with negative pulse trains

Functional Description

5-bit ADC: On-chip high precision 5-bit ADC to sample the data of Battery voltage and temperature.

Voltage Regulator (2.0V Regulator): Build-in voltage regulator used to power supply RC oscillator and 5-bit ADC.

Oscillator: Internal RC oscillator to generate a 64KHz system oscillator.

POR: Power on reset to reset all internal logic

Operation Mode and Switch selection

Operation Mode selection to select different fast charging detection methods by setting MODE1, including 0ΔV detection and -ΔV detection approach. Switch selection to select the usage of tact or slide switch by setting MODE0. Table 2 is the relationship between operation mode and fast charging detection method as well as relationship between MODE0 and switch type

Table 2

MODE1	Fast charging detection method		MODE0	Switch type
0	0ΔV detection		0	Tact switch
1	-ΔV detection		1	slide switch

Switch operation with $\overline{\text{ON/OFF}}$

$\overline{\text{ON/OFF}}$ is a Tact Switch or Slide Switch input. $\overline{\text{ON/OFF}}$ acts as active high input for slide switch and active low for tact switch. For 2703, only slide switch mode is supported.

LED display

The $\overline{\text{LED1}}$ indicates corded mode/charging . The $\overline{\text{LED0}}$ indicates low battery voltage.

Charging and Motor control

Cord Mode and Motor off

Constant Current Charging and Motor off

Before full charged, battery will be fast charged with 1C constant current, The $\overline{\text{LED1}}$ always lights during this period.

Pulse Current Charging and Motor off

Once battery voltage experiences zero delta V or negative delta V according to the selection of fast charging detection approach, The $\overline{\text{LED1}}$ indicator flashes at the frequency of 1Hz (0.5s ON, 0.5s OFF). At the same time, Charging operation transfers to pulse Current Charging.

Battery charge operation will drop to pulse current charging if the temperature of battery exceeds preset temperature by VT pin. The $\overline{\text{LED1}}$ indicator flashes at a frequency of 1Hz (0.5 s ON, 0.5 s OFF).

During pulse current charging, charge pulses output at charge pin run about at the rate of 12.5Hz with duty cycle of 10%.

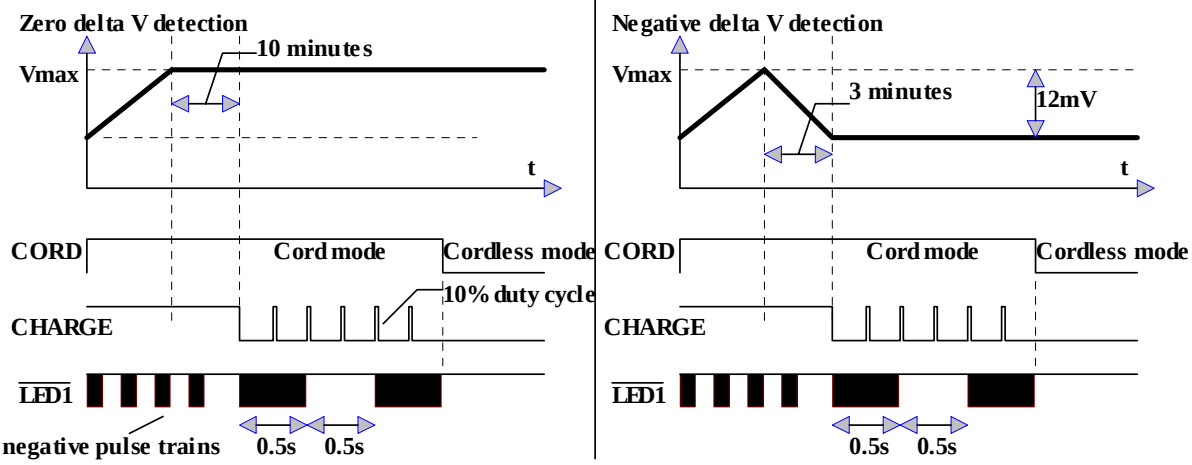


Fig 4 Two approaches for fast charging termination

Temperature to terminate charging: Charging stops immediately if temperature of Battery exceeds maximum preset temperature value. Pulse charge continues when temperature drops below a lower preset temperature value. Once over-temperature condition, the two led indicators turn off right away.

Corded Mode and Motor on

When $\overline{\text{ON/OFF}}$ is triggered to turn on the Motor during Cord Mode, $\overline{\text{MOTOR}}$ output low to drive Motor.

When $\overline{\text{ON/OFF}}$ is triggered to turn off the Motor during Cord Mode, Shaver switches immediately to “Charging operation”.

When CORD removed during Corded Mode, Shaver switches to “Cordless Mode” operation.

The $\overline{\text{LED1}}$ indicator is always on during Cord Mode. The $\overline{\text{LED0}}$ indicator is on if Battery voltage is lower than a preset voltage value at VB2 pin. In contrary, the $\overline{\text{LED0}}$ indicator is off if Battery voltage is normal.

Cordless Mode and Motor on or off

When CORD is removed (Cordless Mode) and Motor off, the $\overline{\text{LED1}}$indicator is off immediately. The $\overline{\text{LED0}}$ indicator is on for 7 seconds if Battery voltage is over low. In contrary, the $\overline{\text{LED0}}$ indicator is off if Battery voltage is normal.

Once motor on during Cordless Mode, the $\overline{\text{LED1}}$ indicator is off.

If motor off during Cordless Mode, the $\overline{\text{LED0}}$ indicator is on for 7 seconds if Battery voltage is over low. In contrary, the $\overline{\text{LED0}}$ indicator is off if Battery voltage is normal.

Low Battery

If Battery voltage is below or equal a preset voltage value at the VB2, the $\overline{\text{LED0}}$ indicator is on to show low battery, the Motor will turn off. In contrary, the $\overline{\text{LED0}}$ indicator is off if Battery voltage is normal.

Maximum Ratings

Storage Temperature	-25°C to +85°C
Ambient Temperature with Power Applied	0°C ~70°C
Supply Voltage to Ground Potential (Inputs & V_{CC} Only)	-0.5V to V_{CC}+0.5V
DC Input Voltage	-0.5V to V_{CC}+0.5V
DC Output Current	20mA
Power Dissipation	500mW

Note:
Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Die Handling Recommendation

1. Aassembly process under 10k class cleanroom, environmental control is important.
2. Rregular cleaning of pick & place vacuum cups to prevent die scratch.
3. Sselect the most suitable encapsulant for die coverage. Encapsulant can affect the device performance. Characterization and pilot production are highly recommended.
4. ESD environment control and esd-safe materials in all equipment, especially die bonder and wire bonder. For example, esd-safe vacuum cups used in die bonder.
5. failure analysis cannot be performed for die sale material and very limited investigation on process tracability.

Recommendation operation condition.

Parameters	Description	Min.	Typ.	Max.	Unit
V_{CC}	Operating Voltage	2.2	2.4	3.0	V
Vin	Input voltage range (VT,VB,VB2,VSEL)	0.8	-	0.9	VEE
Fosc	Frequency of oscillator (C=390pf, R=47kohm)	58.88	64	69.12	kHz
T_A	Operation Temperature	0	25	70	˚C

DC Electrical Characteristics (T_A= 0~70°C, V_{CC}= 2.4V unless otherwise claims)

Regulator

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{CC}	Condition				
VEE	Regulator Output Voltage	2.4V	No load	1.90	2.0	2.1	V
ΔV_O	Line regulation	-	2.2≤V_{CC}≤3.0V, No load	-	-	50	mV
ΔV_{LDR}	Load regulation	2.4V	0mA ≤ I_L≤3mA	-	-	50	mV

5-bit ADC

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{CC}	Condition				
Average rslt	A/D resolution	2.4V	No load	5.5	6.25	7.0	mV
DNL	Differential Nonlinearity	2.4V	No load	-	1	-	LSB
INL	Integral Nonlinearity	2.4V	No load	-	1	-	LSB

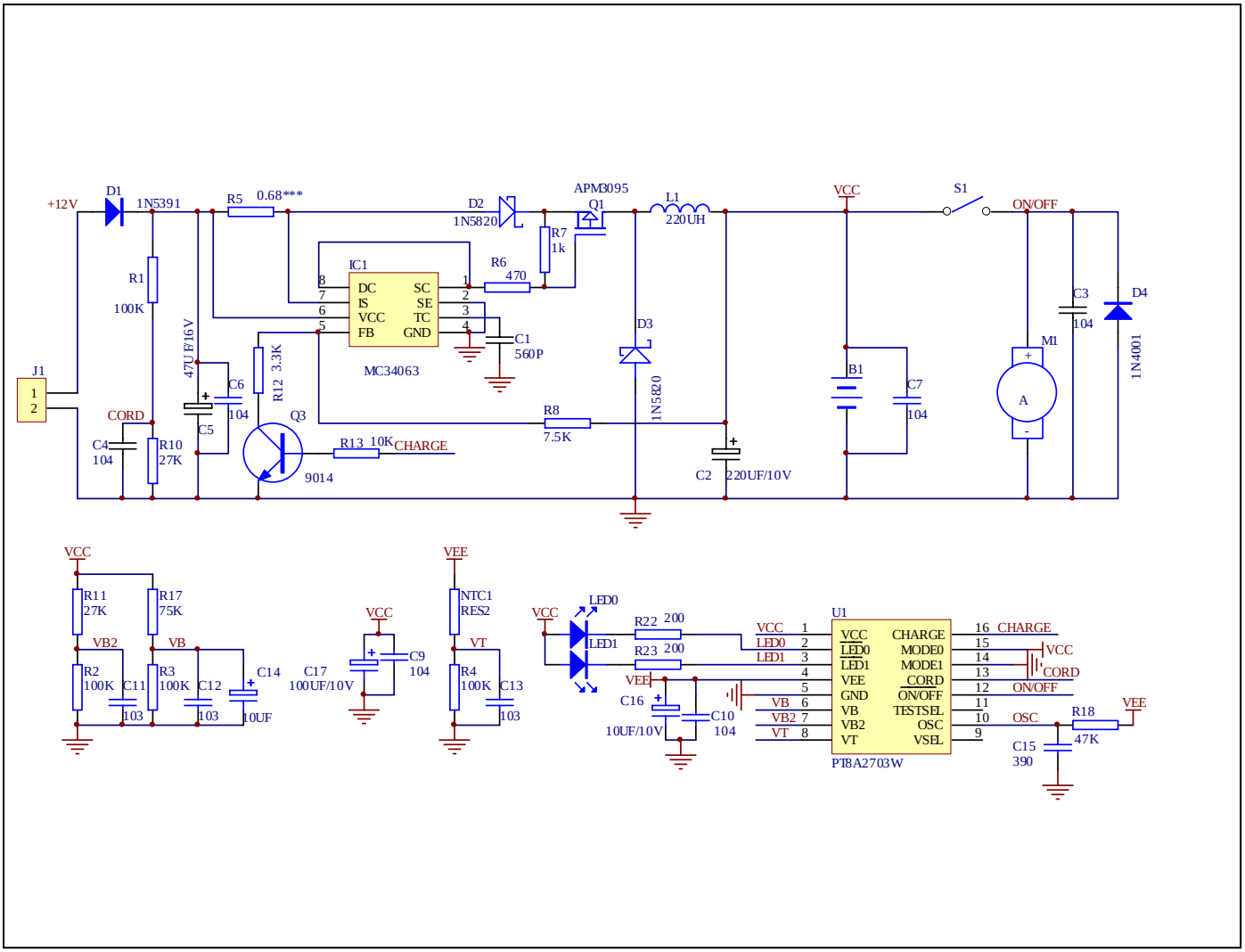
Symbol	Description	Test Conditions		Min.	Typ.	Max.	Unit
I_{CC}	Supply Current	V_{CC}=2.4V,R=47K,C=390pf, no load		-	-	1	mA
I_{IL}	Input Low leakage Current	V_{CC}=2.4V,V_{IL}=0.2V, (CORD, MODE[1..0], $\overline{ON/OFF}$)		-1	-	1	uA
I_{IH}	Input High leakage Current	V_{CC}=2.4V,V_{IL}=2.2V (CORD, MODE[1..0] , $\overline{ON/OFF}$)		-1	-	1	uA
I_{OH}	Output High Current	$\overline{LED[1:0]}$	V_{CC}=2.4V, V_{OH}=2.2V	-30	-	-	uA
		CHARGE		-2	-	-	mA
		$\overline{MOTOR}$		-0.5	-	-	mA
I_{OL}	Output Low Current	$\overline{LED[1:0]}$	V_{CC}=2.4V, V_{OL}=0.2V	5	-	-	mA
		CHARGE		2	-	-	mA
		$\overline{MOTOR}$		10	-	-	mA

AC Eletrical Characteristics (T_A= 0~70°C, V_{CC}= 2.2V~3.0V)

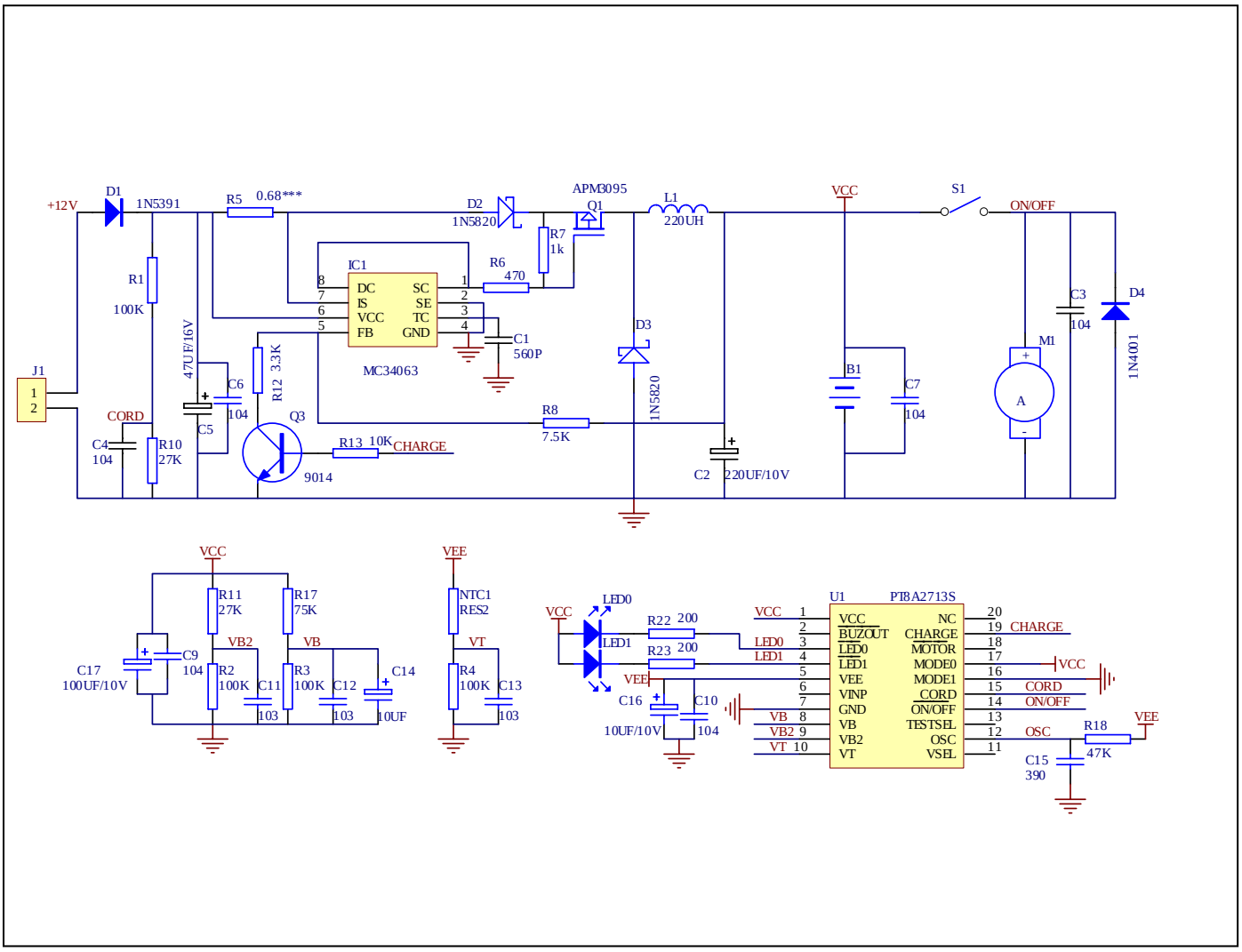
Symbol	Description	Test Conditions	Min.	Typ.	Max.	Unit
F_{OSC}	Oscillator Frequency	C=390pf, R=47kohm	58.88	64	69.12	KHz

Typical Application Circuit

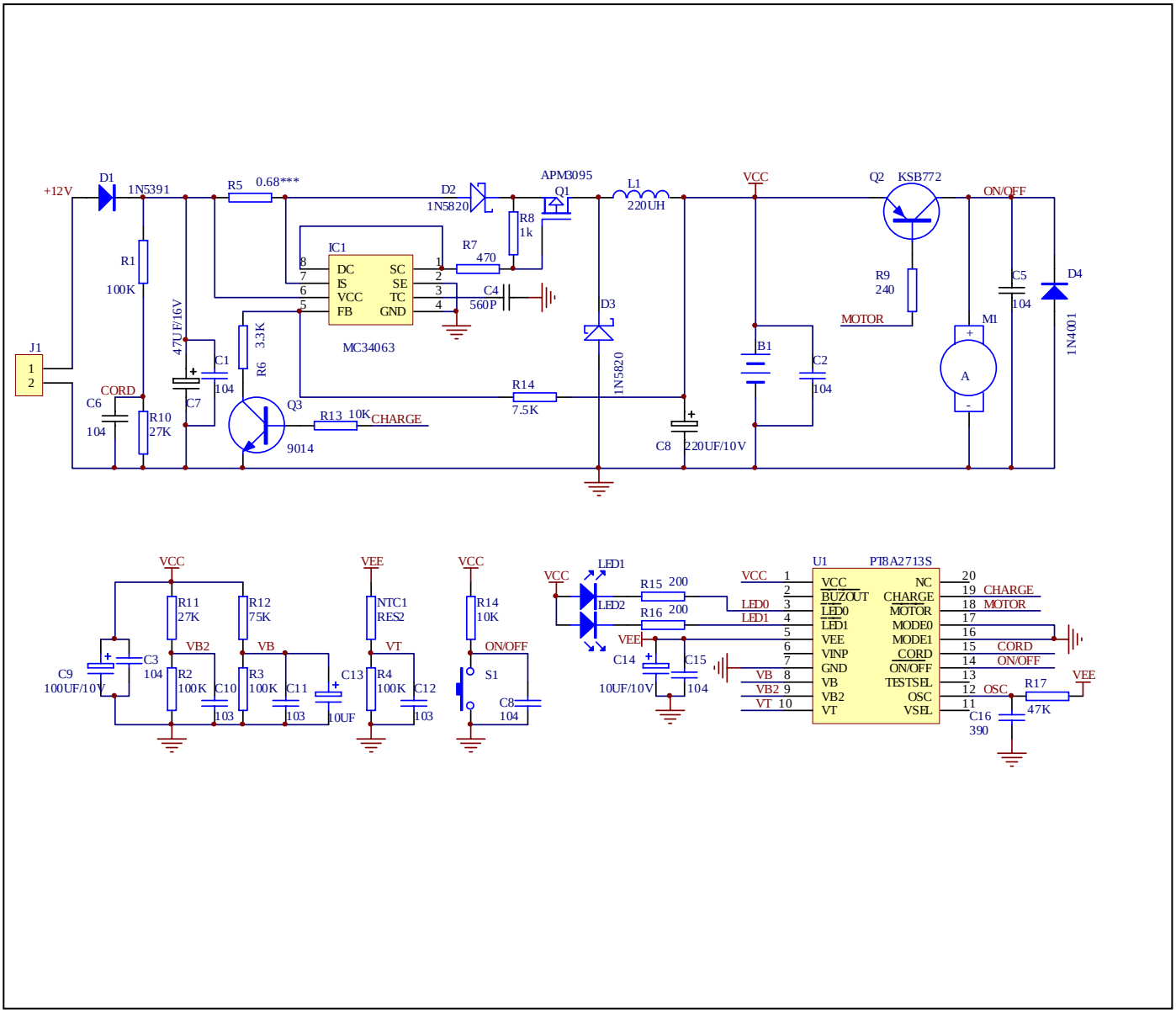
Slide Switch Mode(Zero Delta Voltage Detection) of 2703



Slide Switch Mode(Zero Delta Voltage Detection) of 2713



Tact Switch Mode(Zero Delta Voltage Detection) of 2713

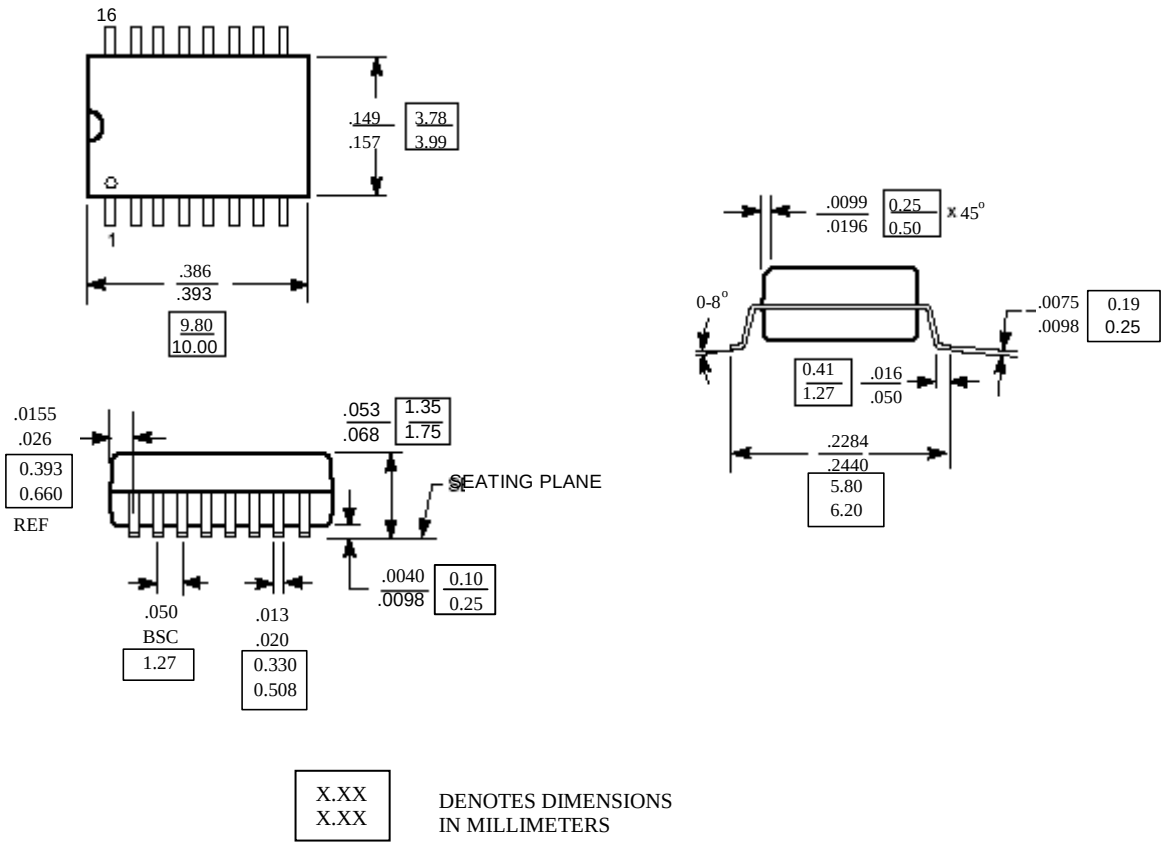


PCB Layout constraint.

1. Cross angle between two Tracks should be larger than 90 degree.
2. Track should be short and wide enough to reduce voltage drop, especially Power supply and Ground as well as some tracks flowing with large current, such as MC34063, switch Q1.
3. Some components need be far from MC34063, such as RC related to oscillator, electrolytic capacitance, NTC, because MC34063 may be very hot during charging mode.
4. A ceramic cap C6 about 104 need to add between VCC and Ground of MC34063 in order to prevent Charge control circuit from switch noise.
5. A ceramic cap C7 about 104 need to add between two poles of Battery.

Mechanical Information

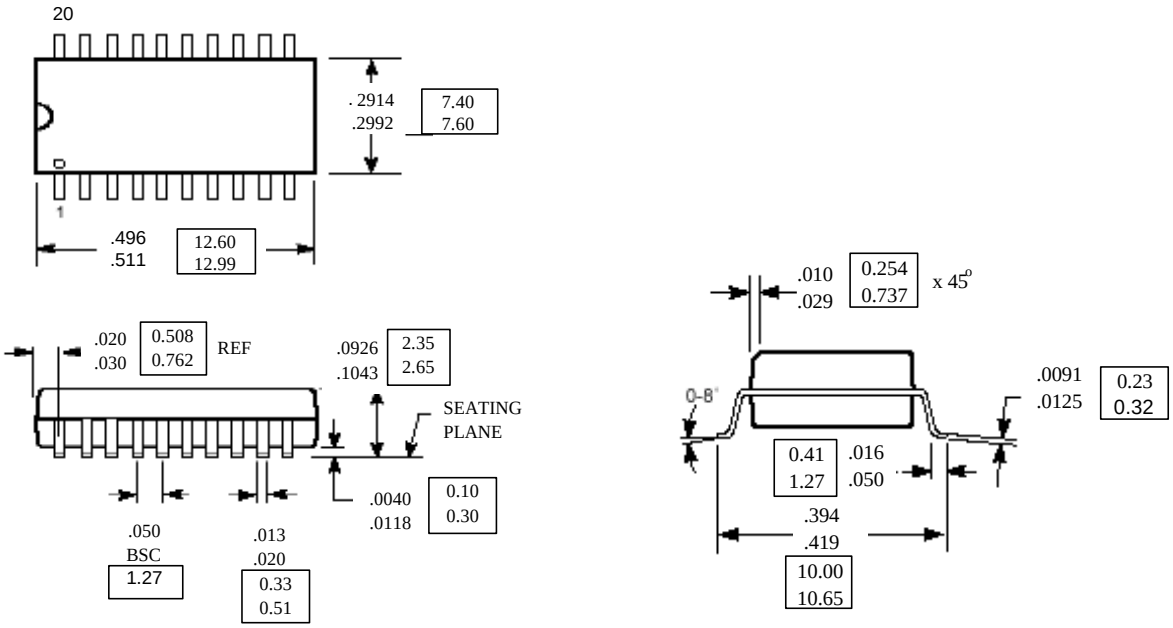
16-Pin SOIC



Notes:

1) Controlling dimensions in millimeters.
2) Ref: JDDEC MS-012 AC

20-Pin SOIC



X.XX
X.XX
DENOTES DIMENSIONS
IN MILLIMETERS

Note:

1) Controlling dimensions in millimeters.
2) Ref: JDDEC MS-013 AC

Notes

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