

## Industrial Application Battery Monitoring IC

# KA49701A Product Standards

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Regarding the specifications of this product, it is considered that you have agreed to the quality level and disclaimer described below.

**Support for industry standards and quality standards**

<b>Functional safety standards for automobiles ISO26262</b>	<b>No</b>
<b>AECQ-100</b>	<b>No</b>
<b>Market failure rate</b>	<b>50Fit</b>

**Disclaimer**

1. When the application system is designed using this IC, please design the system at your own risk. Please read, consider, and apply appropriate usage notes and description in this standard.
2. When designing your application system, please take into the consideration of break down and failure mode occurrence and possibility in semiconductor products. Measures on the systems such as, but not limited to, redundant design, mitigating the spread of fire, or preventing glitch, are recommended in order to prevent physical injury, fire, social damages, etc. in using the Nuvoton Technology Japan Corporation (hereinafter referred to as NTCJ) products.
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4. Please use this IC in compliance with all applicable laws, regulations and safety-related requirements that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. NTCJ shall not be held responsible for any damage incurred as a result of this IC being used not in compliance with the applicable laws, regulations and safety-related requirements.
5. This IC does not have any security functions using cryptographic algorithms, such as authentication, encryption, tampering detection.
6. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular industry standard (e.g., ISO 9001, IATF 16949, ISO 26262, etc.), this IC is neither designed nor intended for use in such environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular industry standard.
7. Using IC that have been indicated as compliant with industry functional safety standards does not warrant that the application meets the requirements of industry functional safety standards. NTCJ shall not be held responsible for the application compliance with requirements of the particular industry functional safety standard.
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9. In case of damages, costs, losses, and/or liabilities incurred by NTCJ arising from customer's non-compliance with above from 1 to 8, customer will indemnify NTCJ against every damages, costs, losses and responsibility.

### Characteristics

- Maximum support 17 battery cells in series
- 3mV measurement accuracy with 14 bits voltage ADC for cell voltage, and 5 channels analog input measurement for Thermistor
- Built-in 16 bits Low speed Current measurement ADC (Coulomb Counter)
- Low-side Sense resistor Current measurement and monitoring
- Operation mode - Active, Standby/Low power; Sleep and Shutdown
- SPI serial communication interface up to 1MHz clock with CRC code correction and watchdog timer
- Built-in ALARM pins for overvoltage, undervoltage, overcurrent and short circuit detection and protection feature
- Support external cell balance MOSFET operation as well
- 4 channels General GPIO Interrupt signal provision for MCU to notify state of operation as well as measurement cycle indication at the available GPIO pins
- Low-side N-MOSFET control: Charge (CHG) & Discharge (DIS) and FETOFF control pin
- Built in controllable Fuse driver for cells Over-voltage, Over-current and Over-temperature monitoring algorithm to serve as secondary protection system
- Regulator (REGEXT) for external circuit power provision with selectable output setting 3.3V/Hi-z, and 50mA drive ability
- Package : HQFP 48L (7x7x1mm<sup>3</sup>, Lead Pitch 0.5mm)

### Overview

**KA49701A** is a battery monitoring IC with protection function. With high resolution ADC built-in, **this IC** is capable to measure battery cell voltage and current level accurately.

Through SPI serial interface, microcontroller unit (MCU) is able to read the status and measured result by **this IC**.

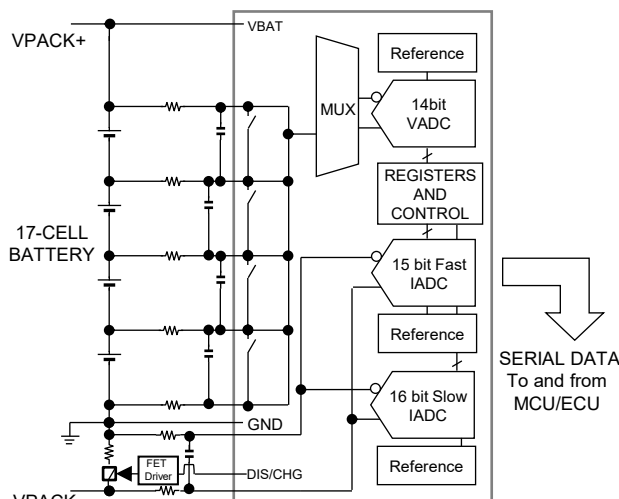
The ALARM pins alert the MCU with the abnormal condition such as over voltage (OV), under voltage (UV), over temperature (OT), under temperature (UT), over current (OC) and short circuit (SC).

**KA49701A** can support an application with up to 17 batteries cells in series or a maximum voltage of 85V, it is suitable for application with high input voltage such as E-bike, UPS etc.

### Applications

- Pedelec, e-Bike, UPS, Server Backup System, Power Tool, Energy Storage Systems etc

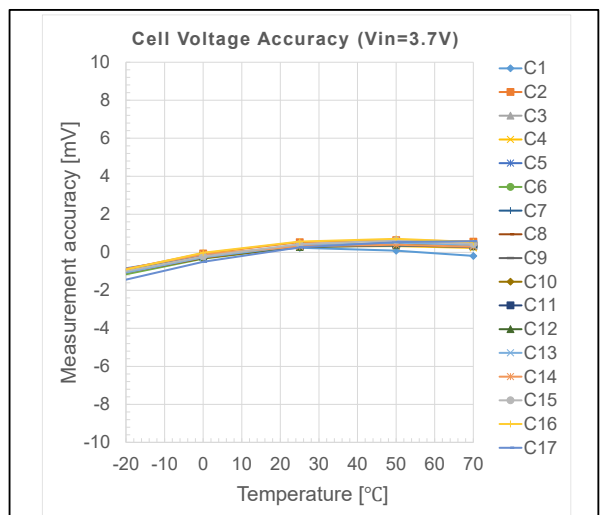
### System Block Diagram



Notes: This is just an example of a circuit set: it is not guaranteed to function identically to the final production version. When designing a set for production, make sure to carefully evaluate and verify the circuitry.

### Representation Characteristics

#### Measurement accuracy



Application circuit example (17cells connection), VBAT=62.9V, cell voltage ΔCn (Cn-Cn-1) = 3.7V, with averaging filter activated (ADV\_AVE=10)

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**Absolute Maximum Ratings**

Parameter	Symbol *1	Rating	Unit	Notes
Supply voltage	$V_{VBAT}$ to GND	-0.3 to 90	V	*5
	$V_{VDD50}$ to GND	-0.3 to 5.8	V	*2
	$V_{VDD15}$ to GND	-0.3 to 2.0	V	*2
	$V_{REGEXT}$ to GND	-0.3 to $\min(V_{VDD50} + 0.3, 5.8)$	V	*2
Input Voltage Range	$C_n$ (n=7 ~17)	-0.3 to $(V_{VBAT} + 0.3)$	V	
	$C_n$ (n=1 ~6)	-0.3 to $(6 + 15*(n))$	V	
	$C_0$	-0.3 to + 6	V	
	SEN, SCL, SDI, FETOFF, GPIO <sub>n</sub> (n=1~4)	-0.3 to $V_{REGEXT}+0.3$	V	
	TMON <sub>In</sub> (n=1~5)	-0.3 to $V_{VDD50}+0.3$	V	*3
	SRP.SRN	-0.5 to 2.0	V	
	CHG,DIS	-0.3 to 5.8	V	
	SHDN	-0.3 to 6.0	V	
Output Voltage Range	ALARM1,SDO	-0.3 to $V_{REGEXT}+0.3$	V	
	REGB	-0.3 to (12)	V	
Output Current Range	ALARM1,SDO, GPIO <sub>n</sub> (n=1~4)	-6.0 to +6.0 (-12.0 to +12.0)	mA	*4
	REGB	-3.5 to 3.5	mA	
	REGEXT	-50.0 to 0	mA	*6
Allowable Voltage Between Pins	$C_n - C_{n-1}$ (n=1~17)	-0.3 to 15	V	
Operating junction temperature	$T_j$	-40 to 125	°C	
Storage temperature	$T_{stg}$	-55 to 125	°C	

Notes: Stresses that exceed the absolute maximum ratings may cause fatal damage to the product.

This specifies the maximum rating for stress.

It is NOT a guaranteed operating region because it exceeds the recommended operating conditions.

The reliability of the IC may be affected if it is kept under absolute maximum rating conditions for long periods.

Applied external current and voltage to pins should also not exceed the absolute maximum ratings listed here.

\*1: GND is the voltage of pins GND and AVSS which are connected inside the device.

Connect these pins on the board and apply the same voltage.

\*2: The maximum ratings are allowable unless the power consumption exceeds the power dissipation ratings.

\*3:  $V_{VDD50}$  is the voltage of VDD50. It should not exceed the rated 5.8 V.

\*4: + Polarity is the direction in which current flows into the IC pins.

– Polarity is the direction in which current flows out from the IC pins.

\*5:  $V_{VBAT}$  is the voltage of VBAT. It should not exceed the rated 90V.

\*6: The output circuit consists of both external components and internal circuitry. Refer to the application circuit diagram.

## Power Dissipation Ratings

Package	$\theta_{j-a}$	$\theta_{j-c}$	$P_D$ (Ta = 25°C)	$P_D$ (Ta=105°C)	Note
TQFP 48 (7x7x1mm <sup>3</sup> , Lead Pitch 0.5mm)	74.6 °C/W	8.2 °C/W	1.34 W	0.268 W	*1

Notes: These characteristics are the reference values for design.

Refer to the PD-Ta characteristics diagram in the package specifications. Thermal design with a sufficient margin is recommended based on the conditions of supply voltage, load, and ambient temperature.

\*1: Mounting board: Glass epoxy 4-layer board without soldered heat spreader measuring 50 mm x 50 mm x 0.8 mm

Wiring layer thickness: all layers 0.035 mm, proportion of copper foil: 5% / 80% / 80% / 5%

## Recommended Operating Conditions

Below items must be within the range of Recommended Operating Conditions.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Supply voltage range	$V_{VBAT}$	12.5	62.9	85	V	*1
	$V_{REGEXT}$	2.3	5.0	5.5	V	*2
Input Voltage Range	$C_n - C_{n-1}$ (n=1~17)	1.0	—	4.8	V	*3
	SEN, SCL, SDI	0	—	$V_{REGEXT}$	V	
	TMONIn (n=1~5)	0	—	$V_{VDD50}$	V	
	GPIO <sub>n</sub> (n=1~4)	0	—	$V_{REGEXT}$	V	
	SRP,SRN	-0.18	—	0.18	V	
	VPC	0	—	85	V	
Operating Ambient Temperature	$T_{a_{opr}}$	0	—	$V_{VDD50}$	V	
		-40	25	105	°C	

\*1 : The recommended operating supply range varies due to the characteristics of the external Nch BJT connected to VDD50. Use the parts described in the recommended circuit.

\*2: The  $V_{REGEXT}$  is used in common with the digital IO power supply.

\*3: The  $C_n - C_{n-1}$  voltage measurement accuracy is not guaranteed if input is less than 2.0 V or more than 4.3 V. Moreover, the measurement accuracy is not guaranteed unless the following conditions are fulfilled.

$C2 > 2.0 V$ ,  $C17 > 12 V$ ,  $VBAT - C17 > -2 V$ ,  $VBAT - C16 > 1 V$

\*  $C_n$  (n = 1 to 17) and VBAT voltage in this conditions are in reference to GND.

\* Similarly for the monitoring system, replace the above condition  $C_n$  (n = 1 to 17) with  $CB_n$  (n = 1 to 17).

### Electrical Characteristics (continued)

Unless otherwise noted, the characteristics are specified under the recommended operating condition:

VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>SUPPLY CURRENT*1</b>							
VBAT Active Mode	I <sub>BAT1</sub>	250ms intermittent mode ADV_AVE=00	—	160	—	μA	
VBAT Low power Mode	I <sub>BAT2</sub>	4s intermittent mode REGEXT=off Coulomb Counter=off FDRV=off Communication=off	—	60	—	μA	
VBAT Sleep Mode	I <sub>BAT3</sub>	REGEXT=off, Communication=off	—	13	—	μA	
VBAT Shutdown Mode	I <sub>BAT4</sub>		—	0	1	μA	
<b>VDD50</b>							
VDD50 Output Voltage	V <sub>VDD50</sub>		4.75	5.0	5.25	V	
VDD50 Base Current1	I <sub>BVDD501</sub>	High Power mode; Temp=25°C; VBAT=62.9V	2.6	3.3	4.0	mA	
<b>REGEXT</b>							
REGEXT Output Voltage1	V <sub>EXT1</sub>		VDD50 input			V	
REGEXT Output Voltage2	V <sub>EXT2</sub>	0mA ~ 50mA	3.05	3.3	3.55	V	
REGEXT Output Current1	I <sub>EXT1</sub>	Normal mode	0	—	50	mA	
<b>VDD15</b>							
VDD15 output Voltage1	V <sub>VDD15_V1</sub>	Active mode No load condition	1.45	1.50	1.55	V	
VDD15 output Voltage2	V <sub>VDD15_V2</sub>	Sleep mode No load condition	1.40	1.50	1.60	V	

\*1 : Current consumption is based on the following settings.

- Consumption current is measured based total current from VBAT pin and VDD50 pin .
- All pins no load ;SEN, SCL, and SDI = Low
- Unless otherwise specified, all registers are in the default setting.

If VDD50 and REGEXT are supplying an external load, this extra current should be included additionally .

\*2 : Design reference value not tested during final production inspection.

**Electrical Characteristics (continued)**

Unless otherwise noted, the characteristics are specified under the recommended operating condition:  
 VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>CELL VOLTAGE MONITOR</b>							
Input Voltage Range	V <sub>IN1</sub>	C <sub>n</sub> - C <sub>n-1</sub> (n=1~17)	0	—	5	V	*3
Voltage Resolution	V <sub>RES1</sub>	14bits V <sub>RES1</sub> = 5 / 2 <sup>14</sup>	—	0.3	—	mV	*3
Voltage Accuracy1	V <sub>ACC_VC1</sub>	ΔCn = 2.0V ~ 4.3 V ADV_AVE=10	-3	—	3	mV	*1 to *2
Voltage Accuracy2	V <sub>ACC_VC2</sub>	ΔCn = 2.0V ~ 4.3 V Ta = -20°C ~ 65°C ADV_AVE=10	-5	—	5	mV	*3
Voltage Accuracy3	V <sub>ACC_VC3</sub>	ΔCn = 2.0V ~ 4.3 V Ta = -30°C ~ 85°C ADV_AVE=10	-8	—	8	mV	*3
Cell Measurement Input Current	I <sub>IN</sub>	Active mode	-5	—	5	μA	
Input Leakage Current	I <sub>LK</sub>	Shutdown mode	-1	—	1	μA	
<b>OVER / UNDER VOLTAGE DETECTOR (OV / UV)</b>							
OV detection threshold step	V <sub>ACC_OV</sub>	2.0~4.5V@6bit	—	50	—	mV	*3
UV detection threshold step	V <sub>ACC_UV</sub>	0.5~3.0V@6bit	—	50	—	mV	*3
<b>C17- GND STACK VOLTAGE MONITOR</b>							
Input Voltage Range	V <sub>IN2</sub>		0	—	85	V	*3
Voltage Resolution	V <sub>RES2</sub>	14bits	—	7.63	—	mV	*3
Voltage Accuracy1	V <sub>ACC_C17S</sub>	V <sub>C17</sub> = 12.5V ~ 76.5V	-0.2	—	0.2	V	*3
Voltage Accuracy2	V <sub>ACC_C17S1</sub>	V <sub>C17</sub> = 12.5V ~ 76.5V Ta = -30°C ~ 85°C	-0.5	—	0.5	V	*3

\*1 : The C<sub>n</sub> - C<sub>n-1</sub> voltage measurement accuracy is not guaranteed if input is less than 2.0 V or more than 4.3 V. Moreover, the measurement accuracy is not guaranteed unless the following conditions are fulfilled.

C2 > 2.0 V, C17 > 12 V, VBAT - C17 > -2 V, VBAT - C16 > 1 V

\* Cn (n = 1 to 17) and VBAT voltage in this conditions are in reference to GND.

\*2 : Measurement accuracy value including consideration of input average current and input leakage current.

\*3 : Design reference value not tested during final production inspection.

\*4 : Voltage resolution Typ. value is an approximate value derived from the Input voltage range Max. value and the number of bits.

Cell (Monitoring) voltage resolution, V<sub>RES1</sub> = V<sub>IN1</sub> / 2<sup>14</sup> = 5 / 2<sup>14</sup> = 0.3mV approx.



**Electrical Characteristics (continued)**

Unless otherwise noted, the characteristics are specified under the recommended operating condition:  
 VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>TMONI1-5 VOLTAGE MONITOR</b>							
Input Voltage Range	V <sub>IN3</sub>		0	—	5	V	*1
Voltage Resolution	V <sub>RES3</sub>	14bits	—	0.3	—	mV	*1
Voltage Accuracy1	V <sub>ACC_</sub> TMONI1	VIN = 0.4V~4.7V Not use Pull-up Resistance T <sub>a</sub> = 25°C	-10	—	10	mV	*2 to *3
Voltage Accuracy2	V <sub>ACC_</sub> TMONI2	VIN = 0.4V~4.7V Not use Pull-up Resistance T <sub>a</sub> = -30°C ~ 75°C	-10	—	10	mV	*1
Voltage Accuracy3	V <sub>ACC_</sub> TMONI3	VIN = 0.4V~4.7V Not use Pull-up Resistance T <sub>a</sub> = -40°C ~ 85°C	-15	—	15	mV	*1
Input Pull-up Resistance	R <sub>PU</sub>		7	10	13	kΩ	
Input Pull-up Resistance Temperature coefficient	RT <sub>PU</sub>	T <sub>a</sub> = -30°C ~ 75°C (with reference to 25°C)	-1.0	—	1.0	%	*1
<b>GPIO1-2 VOLTAGE MONITOR</b>							
Input Voltage Range	V <sub>IN4</sub>		0	—	5	V	*1
Voltage Resolution	V <sub>RES4</sub>	14bits	—	0.3	—	mV	*1
Voltage Accuracy1	V <sub>ACC_</sub> GPIO1	VIN = 0.4V~4.7V T <sub>a</sub> = 25°C	-10	—	10	mV	*2 to *3
Voltage Accuracy2	V <sub>ACC_</sub> GPIO2	VIN = 0.4V~4.7V T <sub>a</sub> = -30°C ~ 75°C	-15	—	15	mV	*1
Voltage Accuracy3	V <sub>ACC_</sub> GPIO3	VIN = 0.4V~4.7V T <sub>a</sub> = -40°C ~ 85°C	-20	—	20	mV	*1

\*1 : Design reference value not tested during final production inspection.  
 Voltage resolution Typ. value is an approximate value derived from the Input voltage range Max. value and the number of bits.

TMONI voltage resolution,  $V_{RES3} = V_{IN3}(Max.) / 2^{14} = 5 / 2^{14} = 0.3mV$  approx.

GPIO voltage resolution,  $V_{RES4} = V_{IN4}(Max.) / 2^{14} = 5 / 2^{14} = 0.3mV$  approx.

\*2 : This is the final inspection value before shipping out. The value does not include variations caused by stress applied during board mounting or after board mounting.

\*3 : Measurement accuracy value including consideration of input average current and input leakage current.

**Electrical Characteristics (continued)**

Unless otherwise noted, the characteristics are specified under the recommended operating condition:  
 VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>VDD50 VOLTAGE MONITOR</b>							
Input Voltage Range	V <sub>IN5</sub>		0	—	7.5	V	*1
Voltage Resolution	V <sub>RES5</sub>	14bits	—	0.5	—	mV	*1
Voltage Accuracy1	V <sub>ACC_VDD501</sub>	VIN = 5.0V T <sub>a</sub> = 25°C	-10	—	10	mV	*2 to *3
Voltage Accuracy2	V <sub>ACC_VDD502</sub>	VIN = 5.0V T <sub>a</sub> = -30°C ~ 75°C	-15	—	15	mV	*1
Voltage Accuracy3	V <sub>ACC_VDD503</sub>	VIN = 5.0V T <sub>a</sub> = -40°C ~ 85°C	-20	—	20	mV	*1
<b>REGEXT VOLTAGE MONITOR</b>							
Input Voltage Range	V <sub>IN6</sub>		0	—	7.5	V	*1
Voltage Resolution	V <sub>RES6</sub>	14bits	—	0.5	—	mV	*1
Voltage Accuracy1	V <sub>ACC_REGEXT1</sub>	VIN = 5.0V T <sub>a</sub> = 25°C	-10	—	10	mV	*2 to *3
Voltage Accuracy2	V <sub>ACC_REGEXT2</sub>	VIN = 5.0V T <sub>a</sub> = -30°C ~ 75°C	-15	—	15	mV	*1
Voltage Accuracy3	V <sub>ACC_REGEXT3</sub>	VIN = 5.0V T <sub>a</sub> = -40°C ~ 85°C	-20	—	20	mV	*1

\*1 : Design reference value not tested during final production inspection.  
 Voltage resolution Typ. value is an approximate value derived from the Input voltage range Max. value and the number of bits.

VDD50 voltage resolution,  $V_{RES5} = V_{IN5}(Max.) / 2^{14} = 7.5 / 2^{14} = 0.5mV$  approx.

REGEXT voltage resolution,  $V_{RES6} = V_{IN6}(Max.) / 2^{14} = 7.5 / 2^{14} = 0.5mV$  approx.

\*2 : This is the final inspection value before shipping out. The value does not include variations caused by stress applied during board mounting or after board mounting.

\*3 : Measurement accuracy value including consideration of input average current and input leakage current.

### Electrical Characteristics (continued)

Unless otherwise noted, the characteristics are specified under the recommended operating condition:  
 VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>VDD15 VOLTAGE MONITOR</b>							
Input Voltage Range	V <sub>IN7</sub>		0	—	5	V	*1
Voltage Resolution	V <sub>RES7</sub>	14bits	—	0.3	—	mV	*1
Voltage Accuracy1	V <sub>ACC_VDD151</sub>	V <sub>IN</sub> = 1.50V T <sub>a</sub> = 25°C	-10	—	10	mV	*2 to *3
Voltage Accuracy2	V <sub>ACC_VDD152</sub>	V <sub>IN</sub> = 1.50V T <sub>a</sub> = -30°C ~ 75°C	-15	—	15	mV	*1
Voltage Accuracy3	V <sub>ACC_VDD153</sub>	V <sub>IN</sub> = 1.50V T <sub>a</sub> = -40°C ~ 85°C	-20	—	20	mV	*1
<b>CELL BALANCING CONTROL OUTPUT (CBn)</b>							
Output Impedance	Z <sub>CB</sub>	ΔCn = 3.0V ~ 5.0V	—	10	20	Ω	
<b>THERMAL SHUTDOWN</b>							
Shutdown Threshold	T <sub>SD2</sub>	T <sub>j</sub>	130	155	180	°C	*1

- \*1 : Design reference value not tested during final production inspection.  
 Voltage resolution Typ. value is an approximate value derived from the Input voltage range Max. value and the number of bits.  
 VDD18 voltage resolution,  $V_{RES7} = V_{IN7}(\text{Max.}) / 2^{14} = 5 / 2^{14} = 0.3\text{mV}$  approx.
- \*2 : This is the final inspection value before shipping out. The value does not include variations caused by stress applied during board mounting or after board mounting.
- \*3 : Measurement accuracy value including consideration of input average current and input leakage current.

**Electrical Characteristics (continued)**

Unless otherwise noted, the characteristics are specified under the recommended operating condition:  
VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>CURRENT MONITOR (SRP,SRN)</b>							
Input Voltage Range	V <sub>IN4</sub>		-180	—	180	mV	*1
Voltage Resolution	V <sub>RES4</sub>	16bits	—	5.493	—	μV	
Voltage Accuracy1	V <sub>ACC_IMONI1</sub>	VIN = 100mV ADIL_SEL=00	-1000	—	1000	μV	*2
Voltage Accuracy2	V <sub>ACC_IMONI2</sub>	VIN = 10mV ADIL_SEL=00	-150	—	150	μV	*1
Voltage Accuracy3	V <sub>ACC_IMONI3</sub>	VIN = 1mV ADIL_SEL=00	-25	—	25	μV	
<b>Wake-up/CHG/DIS CURRENT MONITOR (SRP,SRN)</b>							
Voltage Accuracy1	V <sub>ACC_IWCD1</sub>	VIN < ± 10 mV.	-300	—	300	μV	*3
Voltage Accuracy2	V <sub>ACC_IWCD2</sub>	VIN ≥ ± 10 mV.	-3	—	3	%	
<b>CURRENT PROTECTION (SRP,SRN)</b>							
Over Current in Charge Detection Accuracy1	V <sub>CP_OCC1</sub>	Detection Threshold 5mV & 10mV	-4	—	4	mV	*1
Over Current in Charge Detection Accuracy2	V <sub>CP_OCC2</sub>	Detection Threshold from 15mV to 120mV	-10	—	10	mV	
Over Current in Discharge Detection Accuracy1	V <sub>CP_OCD1</sub>	Detection Threshold from 10mV to 100mV	-10	—	10	mV	
Over Current in Discharge Detection Accuracy2	V <sub>CP_OCD2</sub>	Detection Threshold from 100mV to 320mV	-10	—	10	%	
Short Circuit in Discharge Detection Accuracy1	V <sub>CP_SCD1</sub>	Detection Threshold from 20mV to 100mV	-10	—	10	mV	
Short Circuit in Discharge Detection Accuracy2	V <sub>CP_SCD2</sub>	Detection Threshold from 100mV to 500mV	-10	—	10	%	

\*1 : Design reference value not tested during final production inspection.  
Voltage resolution Typ. value is an approximate value derived from the Input voltage range Max. value and the number of bits.  
V<sub>RES8</sub> = V<sub>IN8</sub>(max.) / 2<sup>16</sup> = 360mV / 2<sup>16</sup> = 5.493μV approx. ; V<sub>RES9</sub> = V<sub>IN9</sub>(max.) / 2<sup>15</sup> = 360mV / 2<sup>15</sup> = 10.99μV approx.  
\*2 : This is the final inspection value before shipping out. The value does not include variations caused by stress applied during board mounting or after board mounting.  
\*3 : T<sub>a</sub> = 25°C, VIN = VSRP – VSRN. ADIL\_SEL=2'bx1 (Coulomb counter conversion period 31.25ms)  
INTM\_TIM3=2'b01(WAKEUP measurement cycle 31.25ms)

### Electrical Characteristics (continued)

Unless otherwise noted, the characteristics are specified under the recommended operating condition:  
 VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>GENERAL PURPOSE INPUT/OUTPUT (GPIO)</b>							
Input Voltage "H"	$V_{IH1}$		$V_{REGEXT} \times 0.8$	—	$V_{REGEXT}$	V	
Input Voltage "L"	$V_{IL1}$		0	—	$V_{REGEXT} \times 0.2$	V	
Output Voltage "H"	$V_{OH1}$	$I_{OH} = -1mA$	$V_{REGEXT} - 0.6$	—	$V_{REGEXT} + 0.3$	V	
Output Voltage "L"	$V_{OL1}$	$I_{OL} = +1mA$	-0.3	—	0.4	V	
<b>DIGITAL INPUT(1) VPC</b>							
Input Voltage "H"	$V_{IH2}$		2.0	—	—	V	
Input Voltage "L"	$V_{IL2}$		—	—	0.5	V	
Pull-down resistance	$R_{IL2}$		20	40	80	MΩ	
<b>DIGITAL INPUT(3) SHDN</b>							
Input Voltage "H"	$V_{IH4}$		2.0	—	—	V	
Input Voltage "L"	$V_{IL4}$		—	—	0.1	V	
Pull-down resistance	$R_{IL4}$		200	820	1500	kΩ	
<b>DIGITAL INPUT(4) SDI,SCL,SEN,FETOFF</b>							
Input Voltage "H"	$V_{IH5}$		$V_{REGEXT} \times 0.8$	—	$V_{REGEXT}$	V	
Input Voltage "L"	$V_{IL5}$		0	—	$V_{REGEXT} \times 0.2$	V	
Input Leakage Current	$I_{LK5}$		-1	0	1	μA	
<b>DIGITAL OUTPUT ALARM1,SDO,DIS,CHG</b>							
Output Voltage "H"	$V_{OH7}$	$I_{OH} = -1mA$	$V_{REGEXT} - 0.6$	—	$V_{REGEXT} + 0.3$	V	
Output Voltage "L"	$V_{OL7}$	$I_{OL} = +1mA$	-0.3	—	0.4	V	

### Electrical Characteristics (continued)

Unless otherwise noted, the characteristics are specified under the recommended operating condition:

V<sub>BAT</sub> = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>REGEXT UVLO</b>							
UV detection voltage	V <sub>IL_UV1</sub>		—	2.65	—	V	*1
UV release voltage	V <sub>IH_UV1</sub>		—	2.80	—	V	*1
<b>VDD50 UVLO</b>							
UVLO detection voltage	V <sub>IL_UV2</sub>		—	4.0	—	V	*1
UVLO release voltage	V <sub>IH_UV2</sub>		—	4.2	—	V	*1

\*1 :Design reference value not tested during final production inspection.

**Electrical Characteristics (continued)**

Unless otherwise noted, the characteristics are specified under the recommended operating condition:  
 VBAT = 62.9 V, REGEXT = 5.0V, ambient temperature and test circuit reference.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
<b>SPI Interface Timing (SEN, SDI, SCL, SDO)</b>							
SCL Frequency	$f_{SCL}$	—	—	—	1	MHz	
SCL Duty Cycle	$t_{DUTY}$	—	45	50	55	%	
SEN Rising to SCL Rising	$t_{SEN\_LD}$	—	100	—	—	ns	
SCL Falling to SEN Falling	$t_{SEN\_LG}$	—	100	—	—	ns	
SEN "L" Width	$t_{SEN\_LO}$	—	500	—	—	ns	
SDI Setup Time	$t_{SDI\_SU}$	SDI valid to SCL falling	100	—	—	ns	
SDI Hold Time	$t_{SDI\_HD}$	SCL falling to SDI valid	100	—	—	ns	
SDO Valid Time	$t_{SDO\_VD}$	SCL rising to SDO valid $C_L \leq 50$ pF	—	—	400	ns	
SDO Disable Time	$t_{SDO\_DIS}$	SEN falling to SDO disable	—	—	400	ns	

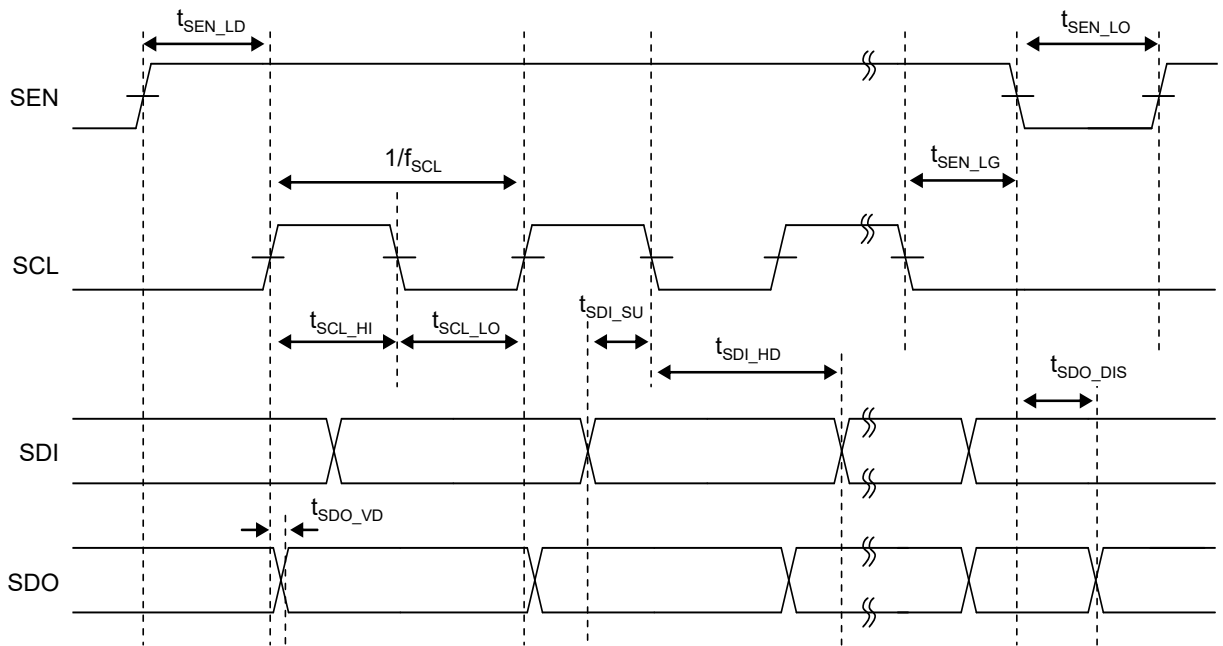
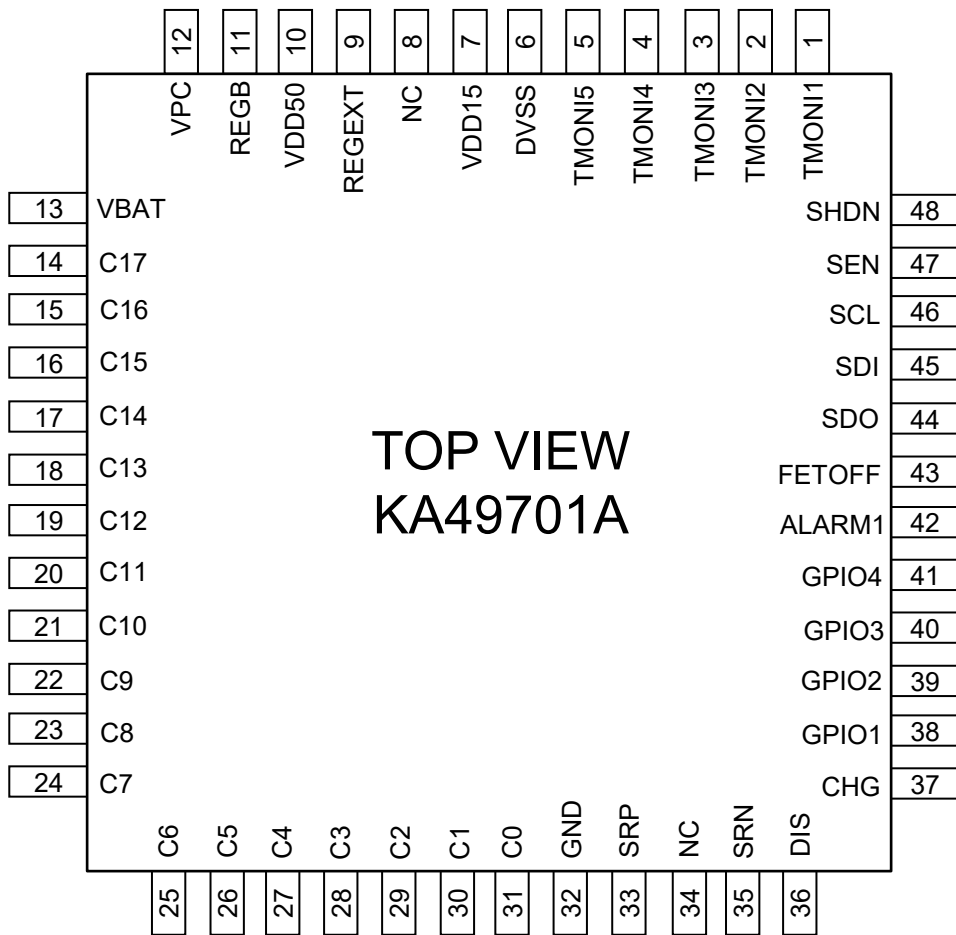


Fig.2.4.1 SPI Timing

Pin Assignment



KA49701A Product Standards



**Pin Description**

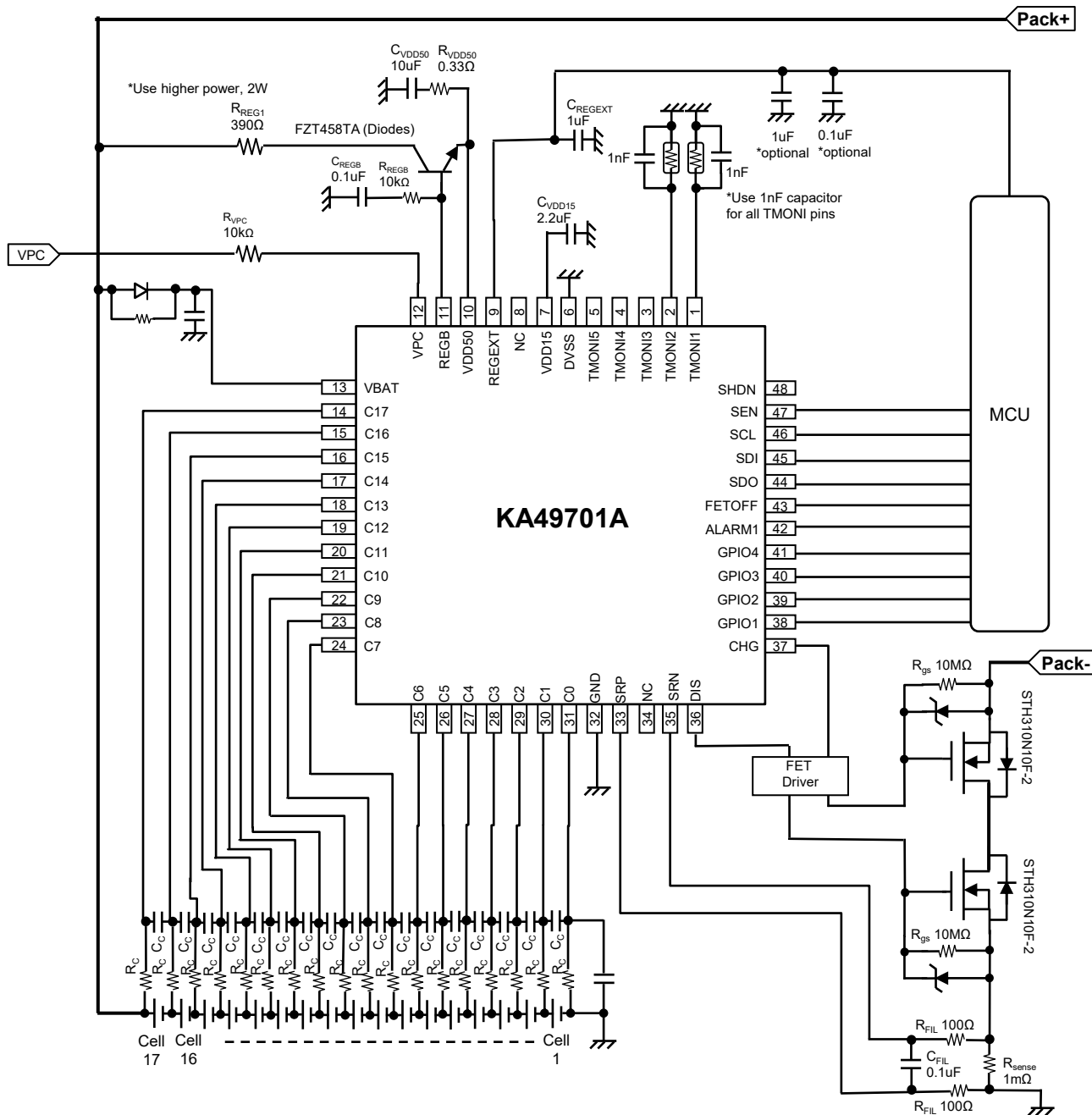
Pin	Pin name	Type	Description
1	TMONI1	I	Analog Input Pin
2	TMONI2	I	Analog Input Pin
3	TMONI3	I	Analog Input Pin
4	TMONI4	I	Analog Input Pin
5	TMONI5	I	Analog Input Pin
6	DVSS	GND	Digital Ground
7	VDD15	O	1.5V LDO Output Pin for Internal Use
8	NC	-	-
9	REGEXT	O	External 5V/3.3V LDO Output Pin
10	VDD50	I	External 5V Regulator Input Pin
11	REGB	O	Base Pin for 5V Pre-regulator
12	VPC	I	Wake Up Signal Pin - "L" Active / "H" Wake Up. Also for Charger Detect.
13	VBAT	I (Supply)	Stacked Cells Highest Voltage Pin
14	C17	I	Cell 17 Input Pin (+ve)
15	C16	I	Cell 16 Input Pin (+ve) / Cell 17 Input Pin (-ve)
16	C15	I	Cell 15 Input Pin (+ve) / Cell 16 Input Pin (-ve)
17	C14	I	Cell 14 Input Pin (+ve) / Cell 15 Input Pin (-ve)
18	C13	I	Cell 13 Input Pin (+ve) / Cell 14 Input Pin (-ve)
19	C12	I	Cell 12 Input Pin (+ve) / Cell 13 Input Pin (-ve)
20	C11	I	Cell 11 Input Pin (+ve) / Cell 12 Input Pin (-ve)
21	C10	I	Cell 10 Input Pin (+ve) / Cell 11 Input Pin (-ve)
22	C9	I	Cell 9 Input Pin (+ve) / Cell 10 Input Pin (-ve)
23	C8	I	Cell 8 Input Pin (+ve) / Cell 9 Input Pin (-ve)
24	C7	I	Cell 7 Input Pin (+ve) / Cell 8 Input Pin (-ve)

Pin Description (continued)

Pin	Pin name	Type	Description
25	C6	I	Cell 6 Input Pin (+ve) / Cell 7 Input Pin (-ve)
26	C5	I	Cell 5 Input Pin (+ve) / Cell 6 Input Pin (-ve)
27	C4	I	Cell 4 Input Pin (+ve) / Cell 5 Input Pin (-ve)
28	C3	I	Cell 3 Input Pin (+ve) / Cell 4 Input Pin (-ve)
29	C2	I	Cell 2 Input Pin (+ve) / Cell 3 Input Pin (-ve)
30	C1	I	Cell 1 Input Pin (+ve) / Cell 2 Input Pin (-ve)
31	C0	I	Cell 1 Input Pin (-ve)
32	GND	GND	Analog Ground
33	SRP	I	Shunt Resistor Positive Pin
34	NC	-	-
35	SRN	I	Shunt Resistor Negative Pin
36	DIS	O	Discharge NMOSFET Gate Drive Pin
37	CHG	O	Charge NMOSFET Gate Drive Pin
38	GPIO1	I/O	General Purpose I/O Pin 1
39	GPIO2	I/O	General Purpose I/O Pin 2
40	GPIO3	I/O	General Purpose I/O Pin 3
41	GPIO4	I/O	General Purpose I/O Pin 4
42	ALARM1	O	ALARM1 Pin
43	FETOFF	I	CHG/DIS FET Control Pin - "L" Normal / "H" FET Forced OFF
44	SDO	O	SPI Interface Pin – Data Out *1
45	SDI	I	SPI Interface Pin – Data In *1
46	SCL	I	SPI Interface Pin – Clock *1
47	SEN	I	SPI Interface Pin – Enable *1
48	SHDN	I	Shutdown Control "L": Active / "H": Shutdown

\*1: An external capacitor may be required near the unused open pin to increase noise immunity.

Application Circuit Example



\*1: There is a requirement for the usage of REGEXT total capacitor value.  
Please refer to page 24 bottom note (\*3) for more detail.

KA49701A Product Standards

### Recommended Constant of External Component

Item	Symbol	Constant				Note
		Min.	Typ.	Max.	Unit	
Constant of components connected to pins	$C_{REGB}$	—	22	—	nF	*1, *2
	$R_{REGB}$	—	18	—	k $\Omega$	*2
	$C_{VDD50}$	—	10	—	$\mu$ F	*1, *2
	$R_{VDD50}$	—	0.33	—	$\Omega$	*2
	$R_{REG1}$	—	390	—	$\Omega$	*2
	$C_{VDD15}$	—	2.2	—	$\mu$ F	*1
	$C_{REGEXT}$	—	1	—	$\mu$ F	*1, *3
	$R_{GS}$	—	10	—	M $\Omega$	*2
	$C_{F1}$	—	0.68	—	$\mu$ F	*1
	$C_{F2}$	—	0.68	—	$\mu$ F	*1
	$R_C$	—	1	—	k $\Omega$	*5
	$C_C$	—	1	—	$\mu$ F	*1, *4
	$R_{sense}$	—	100	—	m $\Omega$	*6
	$R_{VPC}$	—	10	—	k $\Omega$	
	$R_{FIL}$	—	100	—	$\Omega$	
	$C_{FIL}$	—	0.1	—	$\mu$ F	*1

\*1: Use of a ceramic capacitor is recommended.

\*2: The parameters are applicable for system using an external NPN BJT (Diodes Inc FZT458TA), as shown in the recommended circuit.

\*3: REGEXT can be used for as power supply for external circuit. 1uF capacitor ( $C_{REGEXT}$ ) is necessary at REGEXT output. It is recommended to connect a maximum of 1uF capacitor for external circuit, which is compatible with default  $C_{VDD50}$  and VDD50 NPN device (Diodes Inc FZT458TA)

If it is necessary to increase these total capacitor value, the capacitor  $C_{VDD50}$  must be increased proportionally with about 5 times ratio to ensure stability. Please note start-up time of VDD50 and REGEXT would increase proportionally by doing this.

\*4: Usage of  $C_n$  pin input filter Capacitor or Resistor of different value other than the recommended values, or, RC filter connection other than the 17 cells testing circuitry indicated in the Electrical Characteristics, will cause a shift in voltage accuracy.

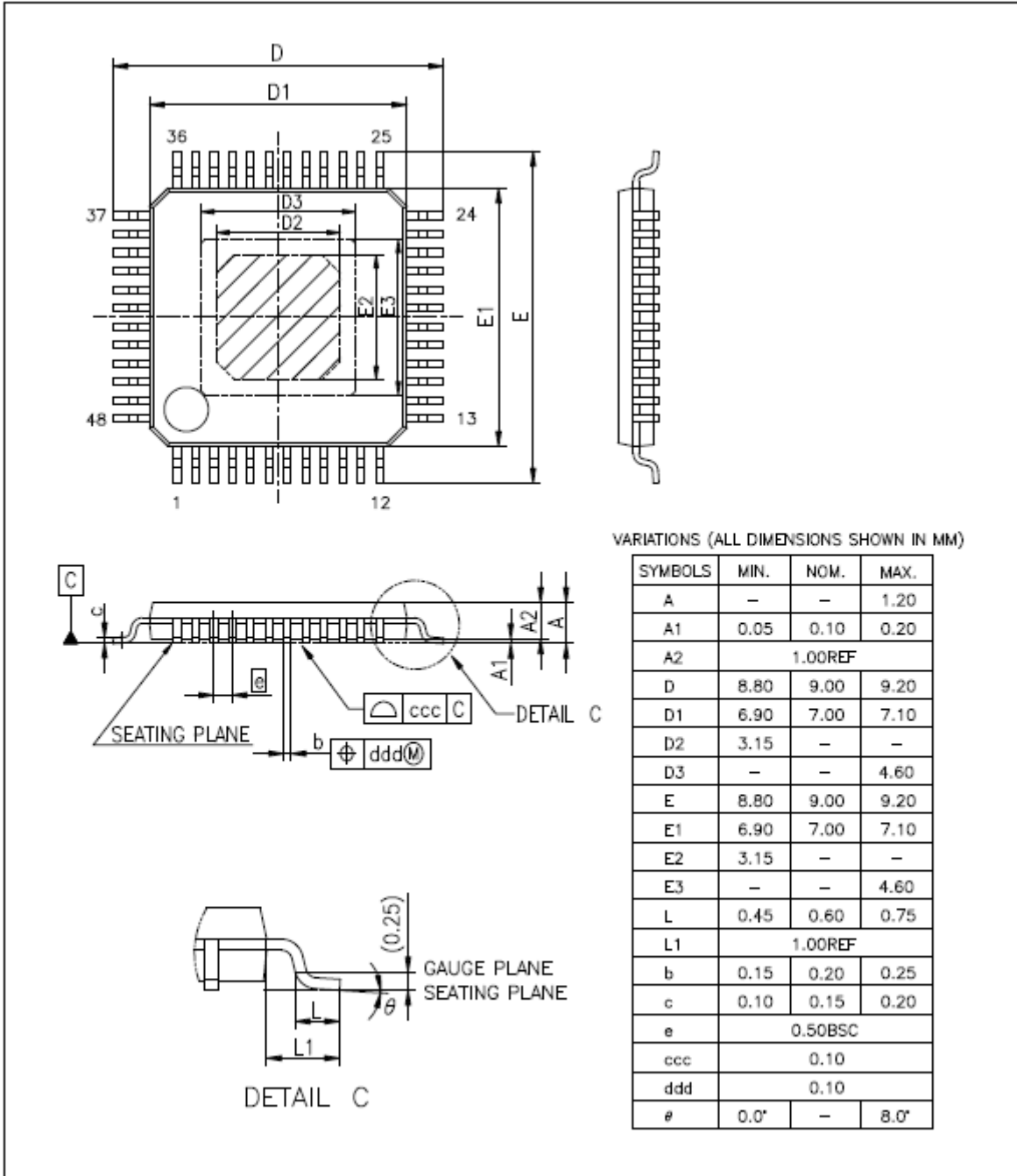
\*5:  $R_C$  can be selected based on the required internal MOS Cell Balance function. It is important to maintain the current below its rated value.

\*6:  $R_{sense}$  resistor design is based on actual load current needed. This value should not cause SRP and SRN pin to generate voltage out of the sensing range which will affect measurement accuracy.

**Dimensions**

TQFP48L 7x7mm<sup>2</sup>, Thickness 1.00mm, Lead Pitch 0.50mm,  
Lead\_Length 1.00mm, EP Size 3.15x3.15mm<sup>2</sup>

Unit: mm



Rev 1.00

**IMPORTANT NOTICE**

1. When using the IC for new models, verify the safety including the long-term reliability for each product.
2. When the application system is designed by using this IC, please confirm the notes in this book. Please read the notes to descriptions and the usage notes in the book.
3. This IC is intended to be used for measuring battery cell voltage in automotive application. Consult our sales staff in advance for information on the following applications: Special applications in which exceptional quality and reliability are required, or if the failure or malfunction of this IC may directly jeopardize life or harm the human body.  
Any applications other than the standard applications intended.
  - (1) Space appliance (such as artificial satellite, and rocket)
  - (2) Traffic control equipment (such as for automotive, airplane, train, and ship)
  - (3) Medical equipment for life support
  - (4) Submarine transponder
  - (5) Control equipment for power plant
  - (6) Disaster prevention and security device
  - (7) Weapon
  - (8) Others : Applications of which reliability equivalent to (1) to (7) is required

Our company shall not be held responsible for any damage incurred as a result of or in connection with the IC being used for any special application, unless our company agrees to the use of such special application.  
However, for the IC which we designate as products for automotive use, it is possible to be used for automotive.
4. This IC is neither designed nor intended for use in automotive applications or environments unless the IC is designated by our company to be used in automotive applications.  
Our company shall not be held responsible for any damage incurred by customers or any third party as a result of or in connection with the IC being used in automotive application, unless our company agrees to such application in this book.
5. Please use this IC in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Our company shall not be held responsible for any damage incurred as a result of our IC being used by our customers, not complying with the applicable laws and regulations.
6. Pay attention to the direction of the IC. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might be damaged.
7. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
8. Perform visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as solder-bridge between the pins of the IC. Also, perform full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the IC during transportation.
9. Take notice in the use of this IC that it might be damaged when an abnormal state occurs such as output pin - VBAT short, output pin - CVDD fault (Power supply fault), output pin-GND short (Ground fault), output-to-output-pin short (load short), or leakage current between pins. Safety measures such as installation of fuses are recommended because the extent of the above-mentioned damage will depend on the current capability of the power supply.
10. The protection circuit is for maintaining safety against abnormal operation. Therefore, the protection circuit should not work during normal operation.  
Especially for the thermal protection circuit, if the area of safe operation or the absolute maximum rating is momentarily exceeded due to output pin to VBAT short, output pin to CVDD short (Power supply fault), or output pin to GND short (Ground fault), the IC might be damaged before the thermal protection circuit could operate.
11. Verify the risks which might be caused by the malfunctions of external components.

## Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.

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