PRELIMINARY

White LED Driver with Automatic Luminance Control

■ GENERAL DESCRIPTION

The **NJU6052** is a White LED Driver with Automatic Luminance Control. It drives specially white color LEDs (Light Emitting Diodes) and automatically adjust the LEDs luminance by the ambient illuminance.

The **NJU6052** contains Output Driver, PWM (Plus Width Modulation) Luminance Control, A/D Converter for Illuminance Sensor, Step-Up DC/DC Converter, Serial Interface circuits and so on.

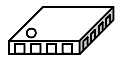
The Output Driver's current is 60mA, and permit to drive white LEDs of Max. 12 pcs (4 series, 3 parallel).

The PWM Luminance Control's registers are 8 which are selected in 64 levels, and the LEDs Luminance is automatically adjusted by A/D Converter and the external illuminance sensor.

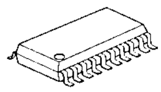
In addition, the Step-Up DC/DC Converter's frequency become high by the external capacitor, and it permit the use of small, low-profile inductors and capacitors to minimize the footprint in space-conscious portable applications.

NJU6052 is suitable for PDA, Camcorder, Car Navigation, LCD TV and so on.

■ PACKAGE OUTLINE



NJU6052KN1

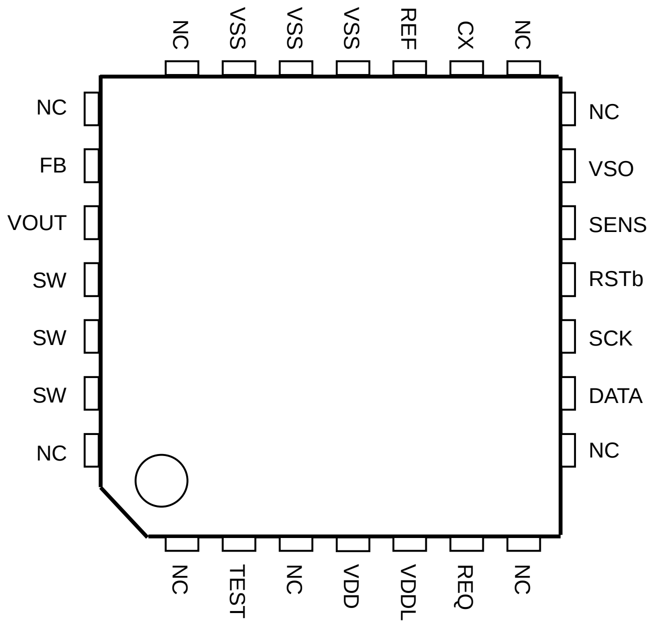


NJU6052V

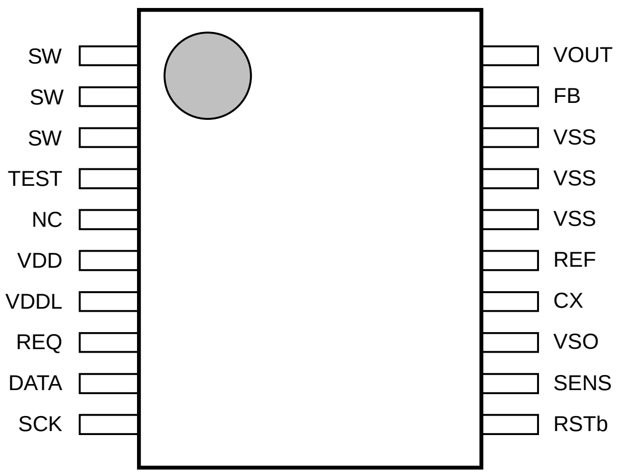
■ FEATURES

- Drives up to 12 white LEDs (4 series, 3 parallel)
  V_{SW} = 16.5V, I_{OUT} = 60mA
- Built-in PWM Luminance Control
  (Selected 8 levels in 64 levels)
- Built-in A/D Converter for Illuminance Sensor
  (No access to MPU after the initialize)
- Built-in Temperature Compensation Circuit for LED Characteristic
- 1.8V to 3.6V Operating Voltage for Logic Circuits (V_{DDL})
- Uses Small Inductor and Capacitors by High Frequency Switching
- 3.0V to 5.5V Operating Voltage for Step-up Circuits (V_{DD})
- CMOS Technology
- Package : QFN28 / SSOP20

■ QFN28 PIN CONNECTIONS (TOP VIEW)



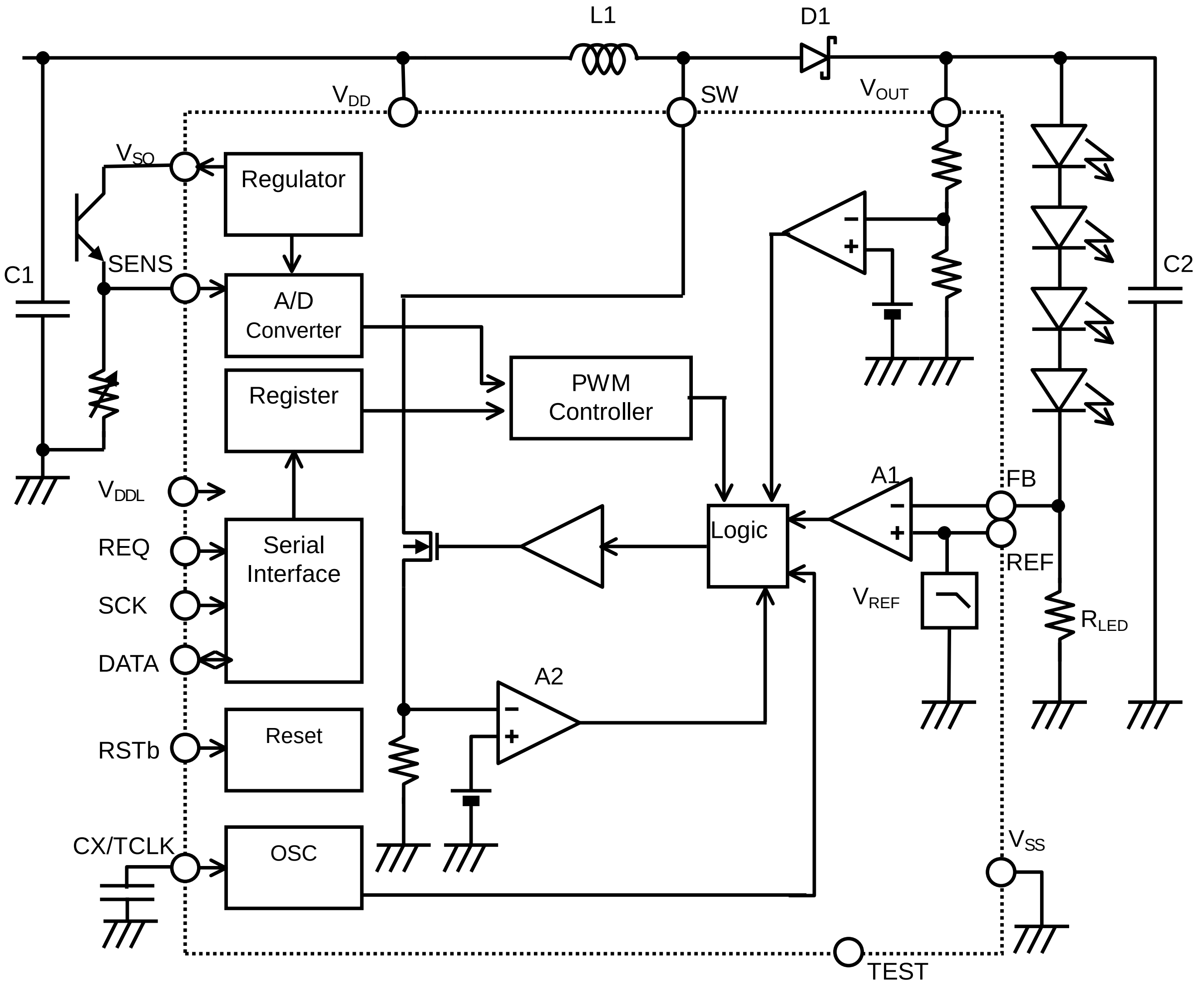
■ SSOP20 PIN CONNECTIONS (TOP VIEW)



■ PIN DESCRIPTIONS

No.		PIN NAME	TYPE	DESCRIPTIONS
QFN	SSOP			
4	6	V_{DD}	Power	V_{DD} Power Supply pin - This pin is the power supply for the step-up voltage.
5	7	V_{DDL}	Power	V_{DDL} Power Supply pin - This pin is the power supply for the logic voltage. The relation : $1.8V \leq V_{DDL} \leq V_{DD}$ must be maintained.
25 26 27	1 2 3	SW	Input	Switch pin This pin must be connected to all SW pins.
10	10	SCK	Input	Shift Clock pin - The serial data is fetched on the rising edge of SCK clock.
9	9	DATA	Input / Output	Serial Data pin
2	4	TEST	Output	Test pin - This pin must be open.
6	8	REQ	Input	Data Request pin "L" : Command Data Writing. "H" : Sensor Data Reading.
12	12	SENS	Input	illuminance Sensor Connection pin
11	11	RSTb	Input	Reset pin - Active "L".
24	20	V_{OUT}	Input	Output pin - This pin connects to the LED's anode.
23	19	FB	Input	Feedback pin
18 19 20	16 17 18	V_{SS}	Power	Ground pin This pin must be connected to all V_{SS} pins.
16	14	CX/TCLK	Input	Oscillator Capacitor pin / External Clock pin
13	13	V_{SO}	Output	V_{SO} Power Supply pin - This is used for the power supply of a luminance sensor, it is fixed to a typical 2.4V.
17	15	REF	Input	Reference Voltage pin - This pin must be open.
1 3 7 8 14 15 21 22 28	5	NC	-	Non Connection - This pin must be open.

BLOCK DIAGRAM



■ FUNCTIONAL DESCRIPTONS

(1) LED CURRENT CONTROL

(1-1) RESISTOR R_{LED} SELECTION

The **NJU6052** uses the LED current control circuits to regulate the LED current (I_{LED}), which is programmed by a feedback resistor (R_{LED}) connected between the FB and the VSS pins. The reference voltage V_{REF} is internally regulated to typically 0.6V and connected to the positive input of the comparator A1. Formula (1) is used to choose the value of the R_{LED}, as shown below.

$$R_{LED} = \frac{V_{REF}}{I_{LED}} \quad \text{--- Formula (1)}$$

VREF=0.6V (TYP.)

(1-2) CIRCUIT OPERATION

Referring to the block diagram of the **NJU6052** is recommended for understanding the LED current control operation.

I_{LED} is the programmable current regulated by R_{LED}. When the feedback voltage at the FB pin is above the reference voltage V_{REF} at the REF pin (i.e., I_{LED} is above the level programmed by R_{LED}), I_{LED} is provided by the output capacitor C2. Once the voltage at the FB pin drops below the voltage at the REF pin (i.e., I_{LED} drops below the level programmed by the R_{LED}), the comparator A1 detects and turns on the internal MOS switch, then the current in the inductor L1 begins increasing. Either when this switch current reaches 720mA and A2 generates a reset signal, or when the on-time specified in the oscillator (OSC) passes OFF, the MOS switch is turned off. L1 then delivers current to the output through the diode D1 as the inductor current drops. The MOS switch is turned on again and the switch current increases up to 720mA. This switching action continues until I_{LED} reaches the level programmed by R_{LED}, and ends up regulating the I_{LED}.

When the voltage at the FB pin is less than 1/2*V_{REF}, the switch current limit is reduced to around 500mA. This action reduces the average inductor current and minimizes the power dissipation and provides protection during start-up.
In addition, notice for total of the forward direction voltage of LED not to become smaller than power supply voltage. LED remains lighting up regardless of IC control.

(2) OSCILLATOR

The **NJU6052** incorporates an oscillator that uses the regulated voltage V_{REF} as a power supply, and therefore its frequency is not influenced by the fluctuation of V_{DD}. The frequency can be adjusted by the selection of external capacitor CX, as the attached DC Electrical Characteristics.

(3) BRIGHTNESS SENSOR CONTROL

The **NJU6052** incorporates a luminance sensor control, which senses the voltage on the SENS pin (SENS provided by an external sensor such as a photo diode), and results in reflecting to the PWM luminance control. In other words, the **NJU6052** can adjust the LED brightness according to the level of ambient light.

(4) PWM LUMINANCE CONTROL

The **NJU6052** incorporates eight PWM registers (PWM REGISTER 0 to 7). One out of the eight registers is selected according to the ambient illuminance and is sent to the PWM luminance control, which provides the PWM duty cycle.

The contents of the PWM registers (PWM REGISTER0 to 7) are selected from 64 levels corresponding to a PWM duty cycle between 0% and 100%, as shown in Tables 1 and 2.

Tables 1 PWM DUTY vs. PWM REGISTER

REGISTER	DUTY	REGISTER	DUTY	REGISTER	DUTY	REGISTER	DUTY
0,0,0,0,0,0	OFF	0,1,0,0,0,0	26.56%	1,0,0,0,0,0	51.56%	1,1,0,0,0,0	76.56%
0,0,0,0,0,1	3.13%	0,1,0,0,0,1	28.13%	1,0,0,0,0,1	53.13%	1,1,0,0,0,1	78.13%
0,0,0,0,1,0	4.69%	0,1,0,0,1,0	29.69%	1,0,0,0,1,0	54.69%	1,1,0,0,1,0	79.69%
0,0,0,0,1,1	6.25%	0,1,0,0,1,1	31.25%	1,0,0,0,1,1	56.25%	1,1,0,0,1,1	81.25%
0,0,0,1,0,0	7.81%	0,1,0,1,0,0	32.81%	1,0,0,1,0,0	57.81%	1,1,0,1,0,0	82.81%
0,0,0,1,0,1	9.38%	0,1,0,1,0,1	34.38%	1,0,0,1,0,1	59.38%	1,1,0,1,0,1	84.38%
0,0,0,1,1,0	10.94%	0,1,0,1,1,0	35.94%	1,0,0,1,1,0	60.94%	1,1,0,1,1,0	85.94%
0,0,0,1,1,1	12.50%	0,1,0,1,1,1	37.50%	1,0,0,1,1,1	62.50%	1,1,0,1,1,1	87.50%
0,0,1,0,0,0	14.06%	0,1,1,0,0,0	39.06%	1,0,1,0,0,0	64.06%	1,1,1,0,0,0	89.06%
0,0,1,0,0,1	15.63%	0,1,1,0,0,1	40.63%	1,0,1,0,0,1	65.63%	1,1,1,0,0,1	90.63%
0,0,1,0,1,0	17.19%	0,1,1,0,1,0	42.19%	1,0,1,0,1,0	67.19%	1,1,1,0,1,0	92.19%
0,0,1,0,1,1	18.75%	0,1,1,0,1,1	43.75%	1,0,1,0,1,1	68.75%	1,1,1,0,1,1	93.75%
0,0,1,1,0,0	20.31%	0,1,1,1,0,0	45.31%	1,0,1,1,0,0	70.31%	1,1,1,1,0,0	95.31%
0,0,1,1,0,1	21.88%	0,1,1,1,0,1	46.88%	1,0,1,1,0,1	71.88%	1,1,1,1,0,1	96.88%
0,0,1,1,1,0	23.44%	0,1,1,1,1,0	48.44%	1,0,1,1,1,0	73.44%	1,1,1,1,1,0	98.44%
0,0,1,1,1,1	25.00%	0,1,1,1,1,1	50.00%	1,0,1,1,1,1	75.00%	1,1,1,1,1,1	100.00%

Tables 2 REV vs. PWM REGISTER

REV	PWM REGISTER
0	PWM REGISTER0
	PWM REGISTER1
	PWM REGISTER2
	PWM REGISTER3
	PWM REGISTER4
	PWM REGISTER5
	PWM REGISTER6
	PWM REGISTER7
1	PWM REGISTER7
	PWM REGISTER6
	PWM REGISTER5
	PWM REGISTER4
	PWM REGISTER3
	PWM REGISTER2
	PWM REGISTER1
	PWM REGISTER0

Note)
Correspondence between the PWM registers and the sense voltage is reversed by setting the REV bit to “1”.
The voltage of SENS terminal vs. the number of PWM REGISTER is attached on the DC Electrical Characteristics.

SERIAL INTERFACE

SERIAL DATA WRITE

The **NJU6052** is controlled by serial data on the DATA pin. The serial data is fetched on the rising edge of the serial clock (SCK) and latched on the rising edge of the data request (REQ). The serial data format is with the MSB first.

For command data transmission, 2-byte data in which each byte has a "0" at B7 must be continuously transferred, and the order of the transmission is CMD1 first, then CMD2, as shown in example 1. If only 1-byte data is transferred, this byte is recognized as the CMD1. Do not transmit 3-byte or more data, the 3rd byte is only used for maker test. And if 4-byte or more data are transferred, only the 1st byte and the 2nd byte data are recognized as the CMD1 and the CMD2, and the data from the 4th byte are ighored.

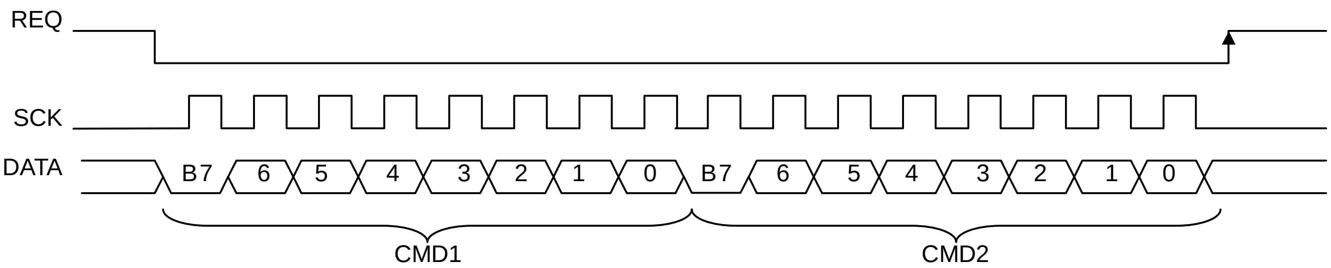
For DUTY data transmission, 8-byte data in which each has a "1" at B7 must be continuously transferred, and the order of the transmission is PWM REGISTER 0, 1, 2, 3, 4, 5, 6, and 7, as shown in example 2. Even if 7-byte or less data are transferred, all of the transferred data are valid. If 9-byte or more data are transferred, the data from the 1st to the 8th bytes are valid, but the data from 9th byte are ignored.

Transmitting the data other than in an 8*n-bit (n=integer number) format is prohibited, as this might cause an operating problem for the **NJU6052**.

TABLE 4 SERIAL DATA FORMAT

B7	B6	B5	B4	B3	B2	B1	B0	REGISTER	
0	SOFF	BRIGHT			STBY	HOLD	REV	CMD1	Command data 1
0	TEST					DIVIDE		CMD2	Command data 2
1	-	DUTY Data						PWM1 to 7	DUTY Data

EXAMPLE 1 COMMAND DATA TRANSMISSION



EXAMPLE 2 DUTY DATA TRANSMISSION

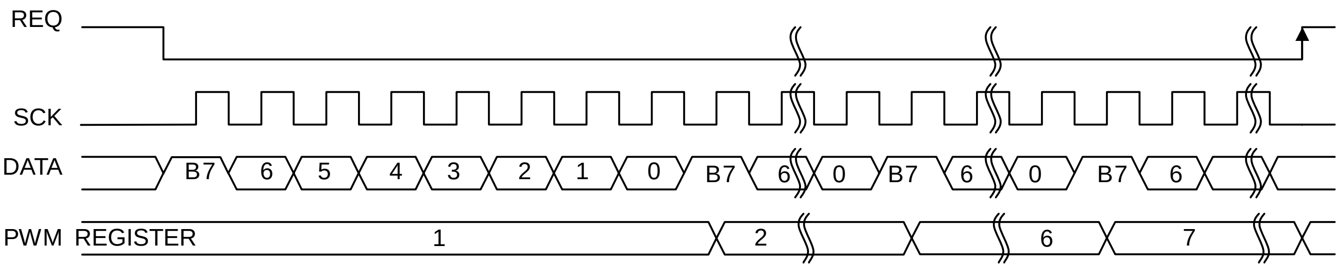


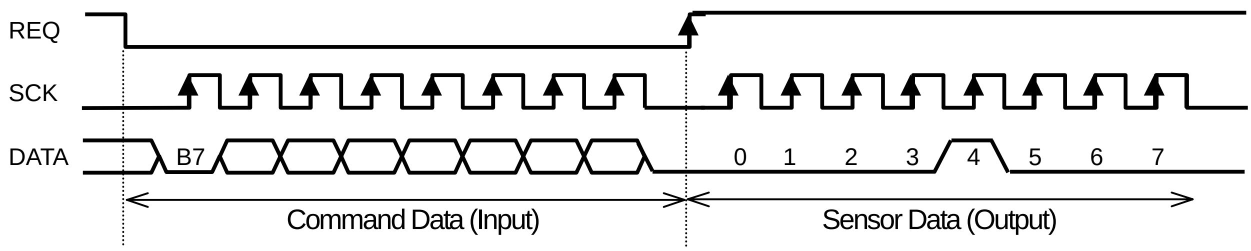
FIGURE 4 DATA TRANSMISSION

SENSOR DATA READ

The sensor data is read after the command data was transferred and the data request terminal was entered “H” and the data terminal became Output and the sift clock was transferred.

The sensor data is “1” if it had already selected by PMW REGISTER address, and the sensor data is “0” if it was the others.

EXAMPLE 1 : COMMAND DATA TRANSMISSION (REV=0, PWM REGISTER4 was selected)



(4-1) SOFF and BRIGHT

By setting the SOFF bit to “1”, the luminance sensor control is disabled, and the PWM duty cycle is controlled by the BRIGHT bits, as shown in Table 5.

TABLE 5 SOFF and BRIGHT

SOFF	BRIGHT	REV	PWM REGISTER
0	-	0	PWM REGISTER0
			PWM REGISTER1
			PWM REGISTER2
			PWM REGISTER3
			PWM REGISTER4
			PWM REGISTER5
			PWM REGISTER6
			PWM REGISTER7
1	000	-	PWM REGISTER0
	001		PWM REGISTER1
	010		PWM REGISTER2
	011		PWM REGISTER3
	100		PWM REGISTER4
	101		PWM REGISTER5
	110		PWM REGISTER6
	111		PWM REGISTER7

Note)

The voltage of SENS terminal vs. the number of PWM REGISTER is attached on the DC Electrical Characteristics.

(4-2) STBY

By setting the STBY bit to a “1”, the **NJU6052** goes into standby mode.

(4-3) HOLD

By setting the HOLD bit to a “1”, the luminance sensor control is disabled, and the PWM register selected before this setting is held. In other words, this setting works, so that the brightness of the LEDs doesn’t change, even if the VSENS changes. By initiating a RESET operation, all of settings are initialized, and the PWM REGISTER0 is selected as the default. Also, by coming out of the standby mode, this setting is initialized and the PWM REGISTER0 is selected at REV bit “0”, or the PWM REGISTER7 at REV bit “1”.

(4-4) REV

By setting the REV bit to a “1”, the correspondence between the PWM registers and VSENS is reversed.

TABLE 6 REV

REV	PWM REGISTER
0	PWM REGISTER0
	PWM REGISTER1
	PWM REGISTER2
	PWM REGISTER3
	PWM REGISTER4
	PWM REGISTER5
	PWM REGISTER6
	PWM REGISTER7
1	PWM REGISTER7
	PWM REGISTER6
	PWM REGISTER5
	PWM REGISTER4
	PWM REGISTER3
	PWM REGISTER2
	PWM REGISTER1
	PWM REGISTER0

Note)
The voltage of SENS terminal vs. the number of PWM REGISTER is attached on the DC Electrical Characteristics.

(4-5) DIVIDE

By setting the DIVIDE bits according to the oscillation frequency, the sensor sampling time (t_{SENS}) and PWM frequency (f_{PWM}) can be optimized.

The formula and table for the sensor sampling time are shown below.

$$t_{sens} = \frac{2^{(17+N)}}{f_{OSC}} \quad \text{(sec)} \qquad \text{--- Formula (2)}$$

TABLE 7 SENSOR SAMPLING TIME

DIVIDE	N	F_{OSC}			
		100kHz	200kHz	400kHz	800kHz
00	0	**1.311**	0.655	0.328	0.164
01	1	2.621	**1.311**	0.655	0.328
10	2	5.243	2.621	**1.311**	0.655
11	3	10.486	5.243	2.621	**1.311**

UNIT : sec

And, the formula and table for the PWM frequency are shown below.

$$f_{pwm} = \frac{1}{64} \cdot \frac{f_{osc}}{2^{(3+N)}} \quad (Hz) \qquad \text{--- Formula (3)}$$

TABLE 8 PWM FREQUENCY

DIVIDE	N	F_{OSC}			
		100kHz	200kHz	400kHz	800kHz
00	0	**195.3**	390.6	781.3	1562.5
01	1	97.7	**195.3**	390.6	781.3
10	2	48.8	97.7	**195.3**	390.6
11	3	24.4	48.8	97.7	**195.3**

UNIT : Hz

NOTE)
The PWM frequency written in bold or neighbor is recommended, otherwise it might cause flickering of the LEDs.

(5) LEVEL SHIFTER

The level shifter allows the **NJU6052** to interface to an MPU using V_{DDL}, which is lower than the V_{DD}.

(6) RESET

Setting the RSTB pin to "L" initializes the **NJU6052** into the following default status:

TABLE 9 RESET

REGISTER	DATA	Default status
REV	0	Refer to Table 6
HOLD	0	Sensor sampling is enabled
STBY	0	Standby Off
BRIGHT	000	
SOFF	0	Luminance sensor control is enabled
DIVIDE	00	
PWM REGISTER1-7	000000	PWM DUTY cycle 0%

(7) TEMPERATURE COMPENSATION

The reference voltage (V_{REF}) has temperature compensation, which suppresses the characteristic degradation of LEDs at high temperatures. V_{REF} vs. Temperature and I_{LED} vs. Temperature are attached on the DC Electrical Characteristics.

(8) PWM Duty Cycle and LED Current

The LED current is programmed with the single resistor R_{LED} and PWM duty cycle, as shown in Formula (4).

$$I_{LED(avg)} = I_{LED(max)} \cdot \frac{DUTY}{100} \qquad \text{--- Formula (4)}$$

$$I_{LED(max)} = \frac{V_{REF}}{R_{LED}}$$

(9) Inductor Selection

Formula (5) is used to choose the optimum inductor, as shown below:

$$L = \frac{2\left(\frac{V_{OUT}}{\eta} - V_{IN}\right) \cdot I_{LED}}{I_{LIMIT}^2 \cdot f_{OSC}} \qquad \text{--- Formula (5)}$$

η : Power conversion efficiency (= 0.7 to 0.8)

If the power supply voltage V_{IN} changes, as in battery-powered applications, the minimum voltage must be inserted as VIN in Formula (5).

The **NJU6052** has about 200ns of delay time (T_{DELAY}), which is defined by the time from the current limit of the 550mA to the switching off of the MOS switch. The T_{DELAY} will result in an overshoot current, which is called the peak current, $I_{L,PEAK}$, and is calculated by Formula (6). An inductor that has a rating twice of that of $I_{L,PEAK}$ and a low DSR (Copper Wire Resistance) for high efficiency should be used.

$$I_{L,PEAK} = I_{LIMIT} + \left(\frac{V_{IN(max)} - V_{DS}}{L}\right) \cdot T_{DELAY} \qquad \text{--- Formula (6)}$$

VDS : Drain-Source voltage of the MOS switch (=I_{LIMIT}*R_{ON})

(10) Diode Selection

A Schottky diode with a low forward voltage drop and a fast switching speed is ideal for the **NJU6052** application. The diode must have a rating greater than the output voltage and the output current.

(11) Capacitor Selection

A low ESR (Equivalent Series Resistance) capacitor should be used at the output to minimize output ripples. A multilayer ceramic capacitor is the best selection for the **NJU6052** application, because it has a low ESR and is available in a small package. A ceramic capacitor is also recommended for the input decoupling capacitor and should be placed as close as possible to the **NJU6052**.

■ ABSOLUTE MAXIMUMN RATINGS

Ta=25°C

PARAMETERS	SYMBOL	CONDITIONS	RATINGS	UNIT
VDD Power Supply	V_{DD}		-0.3 to +6	V
VDDL Power Supply	V_{DDL}		-0.3 to V_{DD}	V
Input Voltage	V_{IN1}	CX/TCLK, REF, FB, SENS terminals	-0.3 to V_{DD}+0.3	V
Input Voltage	V_{IN2}	REQ, DATA, SCK, RSTb Terminals	-0.3 to V_{DDL}+0.3	V
Switch Voltage	V_{SW}	SW terminal	+16.5	V
Power Dissipation	PD		T.B.D.	MW
Operating Temperature	T_{opr}		-40 to +85	°C
Storage Temperature	T_{stg}		-55 to +125	°C

Note1) V_{SS} = 0V to all conditions

Note2) If the LSI was used out of the absolute maximum ratings, LSI is damaged completely and the riliability become poor. The LSI is used on the electrical characteristics is recommended strongly for normal operation.

Note3) The maximum Volatge of **NJU6052** is Switch Voltage V_{SW} (=$V_{F(LED)}$x $N_{(LED)}$ +$V_{F(D1)}$ +V_{REF}). Don’t pass up the absolute maximum voltage.

$V_{F(LED)}$:Forward Direction Voltage of LED
$N_{(LED)}$:The Number of LED
$V_{F(D1)}$:Forward Direction Voltage of Diode D1

EXAMPLE)

In the case of $V_{F(LED)}$= 3.6V, $N_{(LED)}$= 4pcs, $V_{F(D1)}$ = 0.3V and V_{REF} = 0.6V(TYP.),
Switch Voltage is V_{SW} = 3.6V x 4 + 0.3V + 0.6V = 15.3V.

■ DC ELECTRICAL CHARACTERISTICS

V_{DD}=3.0 to 5.5V, Ta=-40 to 85°C

PARAMETERS	SYMBOL	CONDITIONS	RATINGS			Unit
			MIN.	TYP.	MAX.	
V_{DD} Power Supply	V_{DD}		3.0		5.5	V
V_{DDL} Power Supply	V_{DDL}		1.8		3.6	V
Output Current	I_{OUT}	RLED=22Ω		60		mA
Reference Voltage	V_{REF}	Ta=25°C	0.558	0.600	0.642	V
Operating Current	I_{OP}	fosc=350kHz		T.B.D.		uA
Standby Current	I_{STBY}			T.B.D.		uA
V_{SO} Power Supply	V_{SO}		2.23	2.40	2.57	V
PWM REGISTER0 Selected Voltage	V_{D0}	SENS terminal, REV=0	0		0.007V_{SO}	V
PWM REGISTER1 Selected Voltage	V_{D1}	SENS terminal, REV=0	0.015V_{SO}		0.020V_{SO}	V
PWM REGISTER2 Selected Voltage	V_{D2}	SENS terminal, REV=0	0.030V_{SO}		0.040V_{SO}	V
PWM REGISTER3 Selected Voltage	V_{D3}	SENS terminal, REV=0	0.060V_{SO}		0.090V_{SO}	V
PWM REGISTER4 Selected Voltage	V_{D4}	SENS terminal, REV=0	0.110V_{SO}		0.180V_{SO}	V
PWM REGISTER5 Selected Voltage	V_{D5}	SENS terminal, REV=0	0.440V_{SO}		0.360V_{SO}	V
PWM REGISTER6 Selected Voltage	V_{D6}	SENS terminal, REV=0	0.880V_{SO}		0.720V_{SO}	V
PWM REGISTER7 Selected Voltage	V_{D7}	SENS terminal, REV=0	V_{SO}		V_{SO}	V
Input "L" Level	V_{IL}	SCK, DATA, REQ, RSTB, TCLK terminals	0		0.2V_{DDL}	V
Input "H" Level	V_{IH}	SCK, DATA, REQ, RSTB, TCLK terminals	0.8V_{DDL}		V_{DDL}	V
Output "L" Level	V_{OL}	DATA terminals V_{DDL}=1.8V, I_{OL}=0.4mA			0.2V_{DDL}	V
Output "H" Level	V_{OH}	DATA terminals V_{DDL}=1.8V, I_{OH}= - 0.04mA	0.8V_{DDL}			V
Oscillation Frequency	f_{OSC}	V_{DD}=3V, CX=68pF	245	350	455	kHz
Oscillation Duty	DOSC	V_{DD}=3V, CX=68pF		75		%

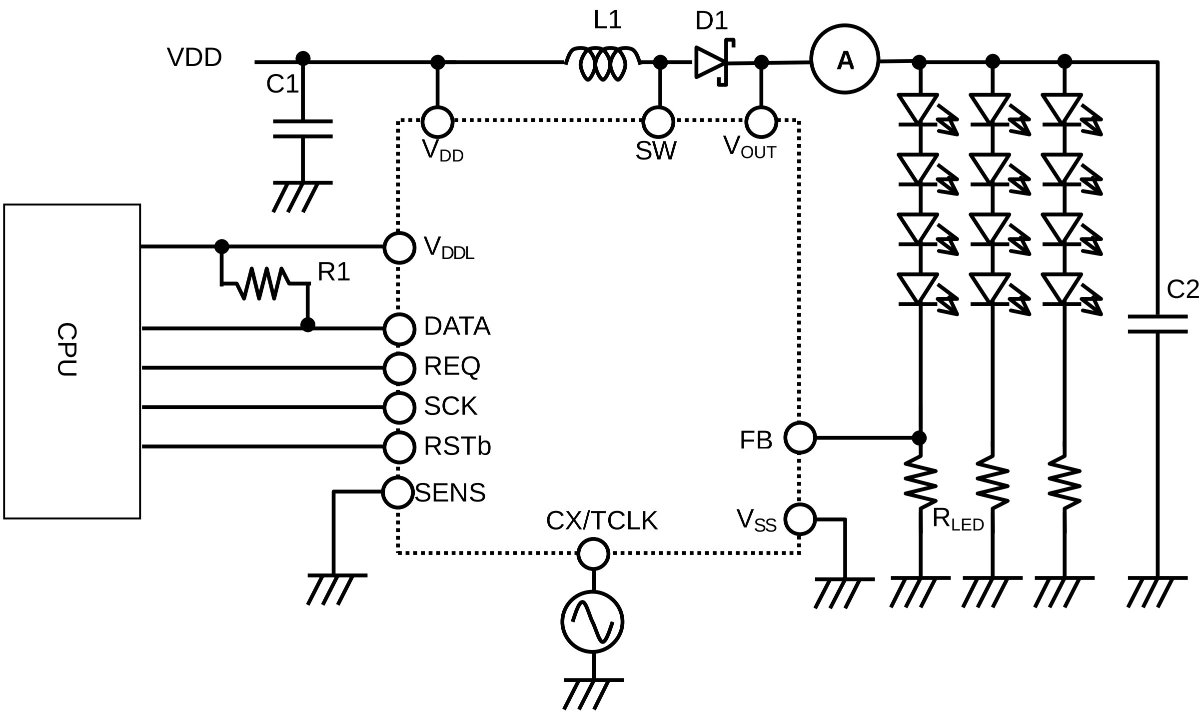
NOTE:1): Output Voltage Test Condition

TEST Command

B7	B6	B5	B4	B3	B2	B1	B0
0	1	1	1	1	0	0	0
0	1	0	0	0	0	0	0

TEST Circuit

LED : V_F=3.6V, ILED=**mA
VDD :5V
D1 :T.B.D.
L1 :10uH
C1 :4.7uF
C2 :1uF
R1 :100kΩ
RLED :22Ω
fOSC :350kHz



NOTE:2): TEMPERATURE COMPENSATION

The reference voltage (V_{REF}) has temperature compensation, which suppresses the characteristic degradation of LEDs at high temperatures. VREF is regulated to a typical 0.6V in the range of 45°C or lower, and it gradually decreases as the ambient temperature rises to higher than 45°C, as shown in Figure 5 and 6.

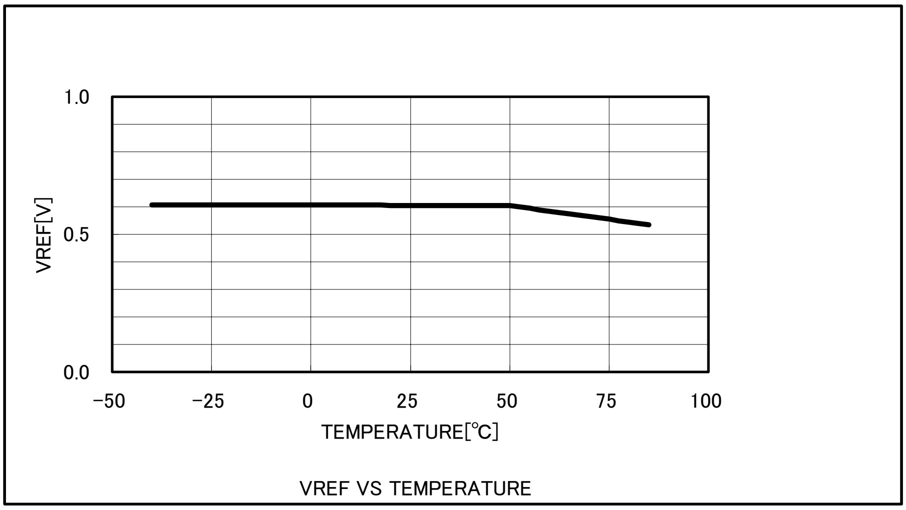


FIGURE 5 VREF vs. TEMPERATURE

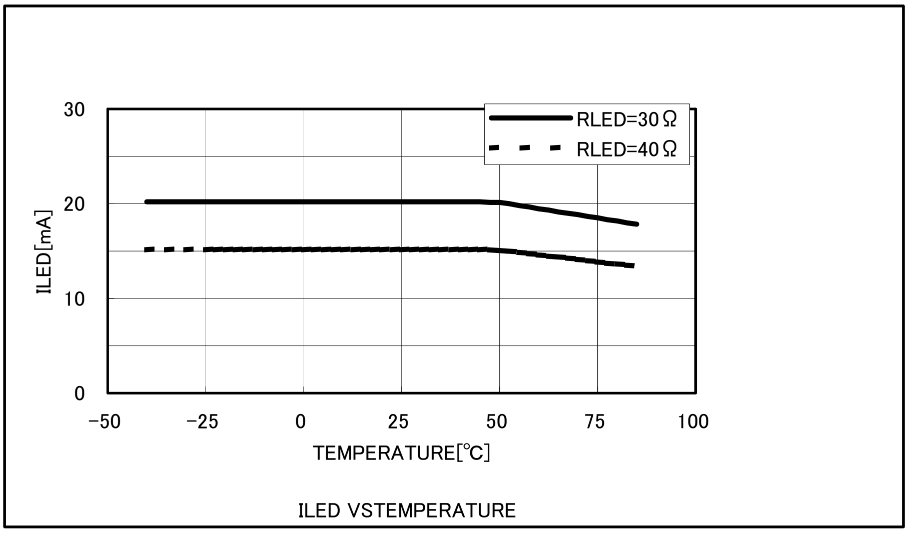


FIGURE 6 ILED vs. TEMPERATURE

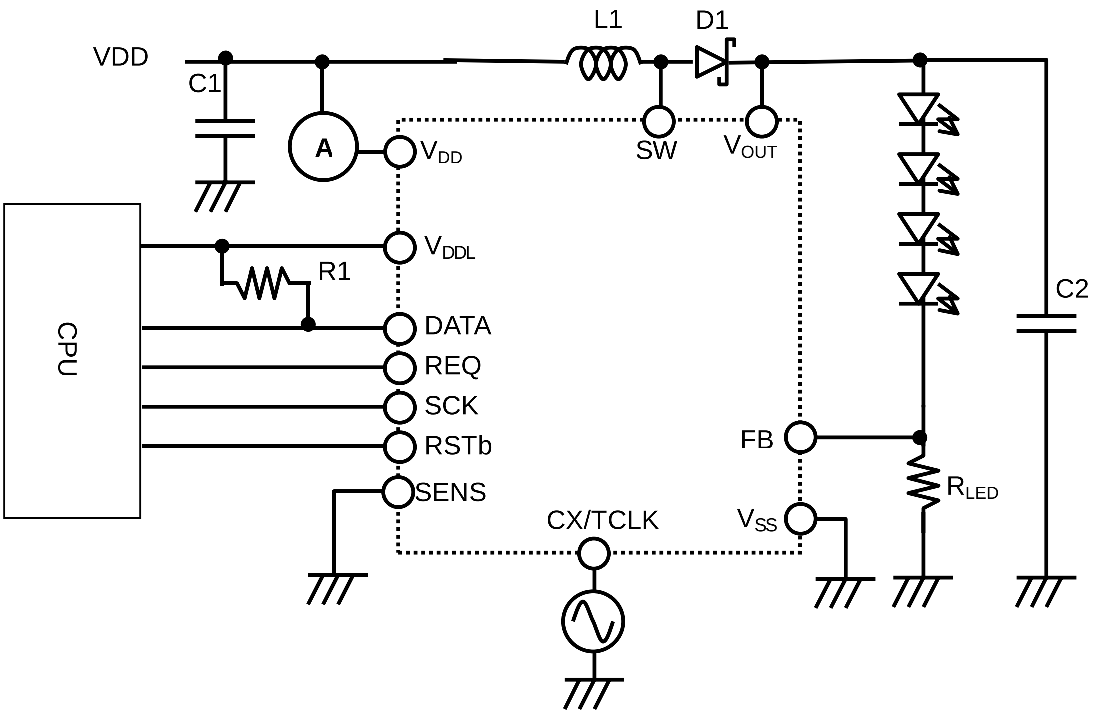
Note:3): Operating Current Test Condition

TEST Command

B7	B6	B5	B4	B3	B2	B1	B0
0	1	1	1	1	0	0	0
0	1	0	0	0	0	0	0

TEST Circuit

LED :V_F=3.6V, ILED=**mA
D1 :T.B.D.
L1 :10uH
C1 :4.7uF
C2 :1uF
R1 :100KΩ
RLED :15Ω
fOSC :350kHz



NOTE:4): Standby Current. Peripheral circuit is the same as the one shown in NOTE3

TEST Command

B7	B6	B5	B4	B3	B2	B1	B0
0	*	*	*	*	1	*	*
0	1	0	0	0	0	0	0

*: ”Don’t care”

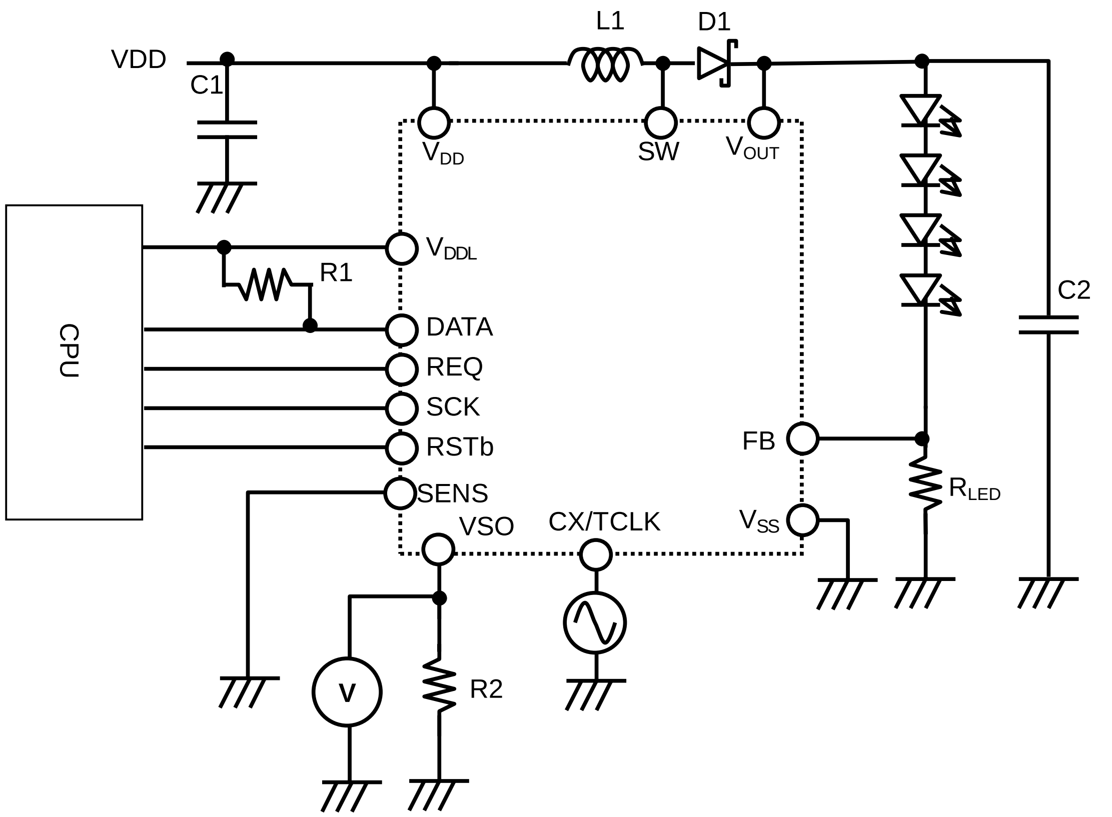
NOTE:5): V_{SO} Power Supply Test Condition

TEST Command

B7	B6	B5	B4	B3	B2	B1	B0
0	1	1	1	1	0	0	0
0	1	0	0	1	0	0	0

TEST Circuit

LED :V_F=3.6V, I_{LED}=**mA
D1 :T.B.D.
L1 :10uH
C1 :4.7uF
C2 :1uF
R1 :100KΩ
R2 :1KΩ
R_{LED} :15Ω
f_{OSC} :350kHz



Note:6): OSCILLATOR

The **NJU6052** incorporates an oscillator that uses the regulated voltage V_{REF} as a power supply, and therefore its frequency is not influenced by the fluctuation of V_{DD}. The frequency can be adjusted by the selection of external capacitor CX, as shown in Figure 8.

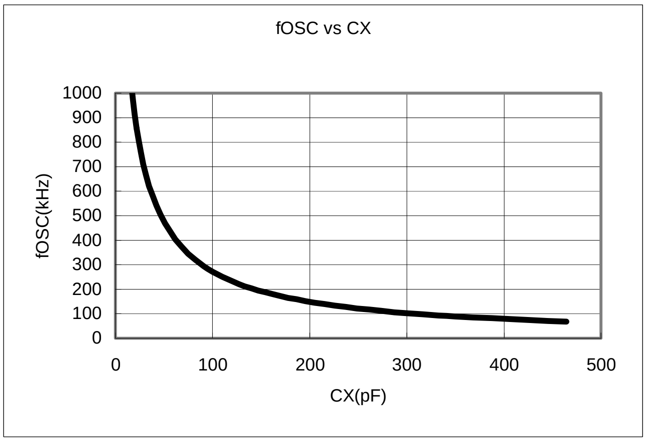


Figure 8: f_{OSC} vs. CX

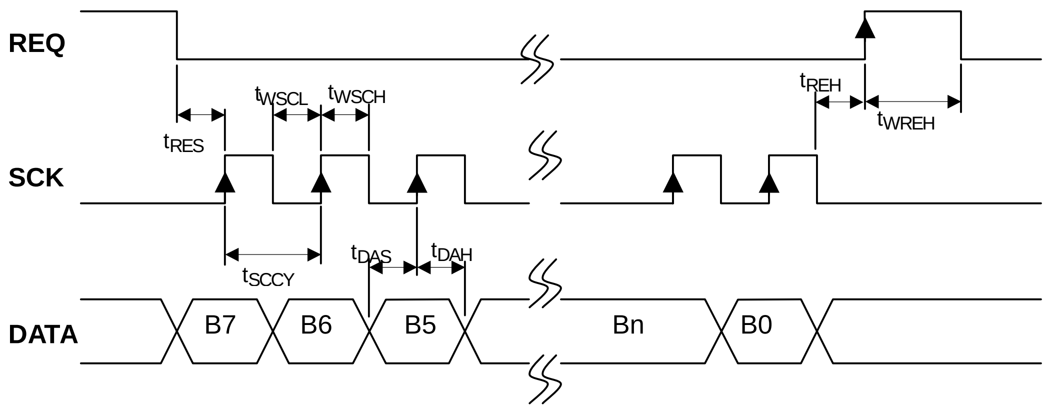
(Figure 8 is a reference characteristics and is not guaranteed.)

■ AC ELECTRICAL CHARACTERISTICS

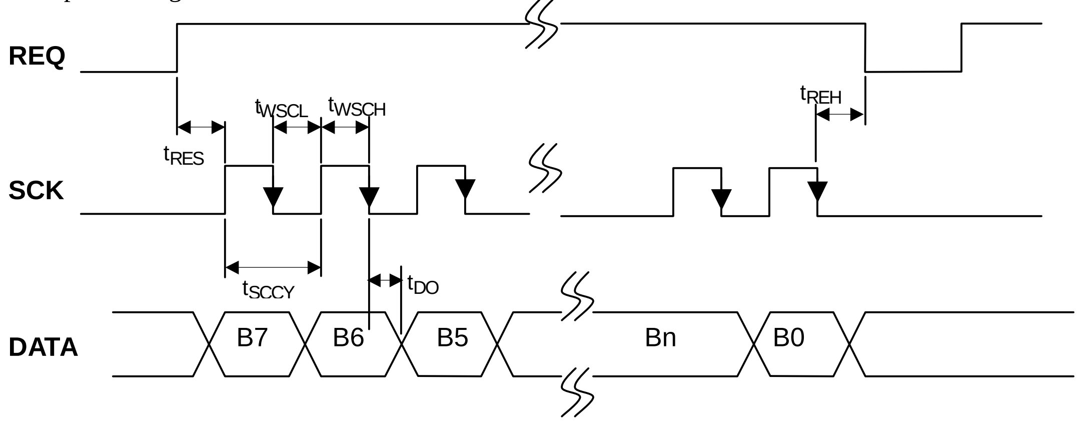
VDD=3.0 to 5.5V, Ta=-40 to 85°C

PARAMETERS		SYMBOL	RATINGS			UNIT
			MIN.	TYP.	MAX.	
SCK Clock Cycle		t_{CCY}	1.0	-	-	us
SCK Clock Width	"H" Level	t_{WSCH}	400	-	-	ns
	"L" Level	t_{WSCL}	400	-	-	ns
REQ Hold Time		t_{REH}	800	-	-	ns
Data Set-Up Time		t_{DAS}	400	-	-	ns
Data Hold Time		t_{DAH}	400	-	-	ns
Output Data Delay Time CL=20pF		t_{D0}	-	-	200	ns
REQ Set-Up Time		t_{RES}	400	-	-	ns
REQ High Level Width		t_{WREH}	800	-	-	ns
REQ,SCK,DATA Rising Time		t_r	-	-	100	ns
REQ,SCK,DATA Falling Time		t_f	-	-	100	ns
RSTB Pulse Width		t_{RSL}	1.0	-	-	us

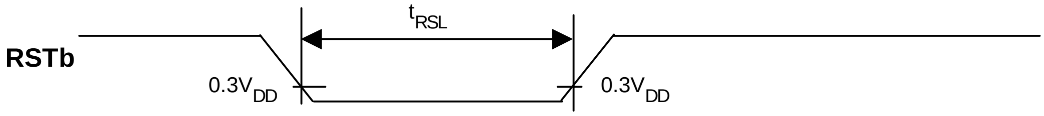
Serial Input Timing



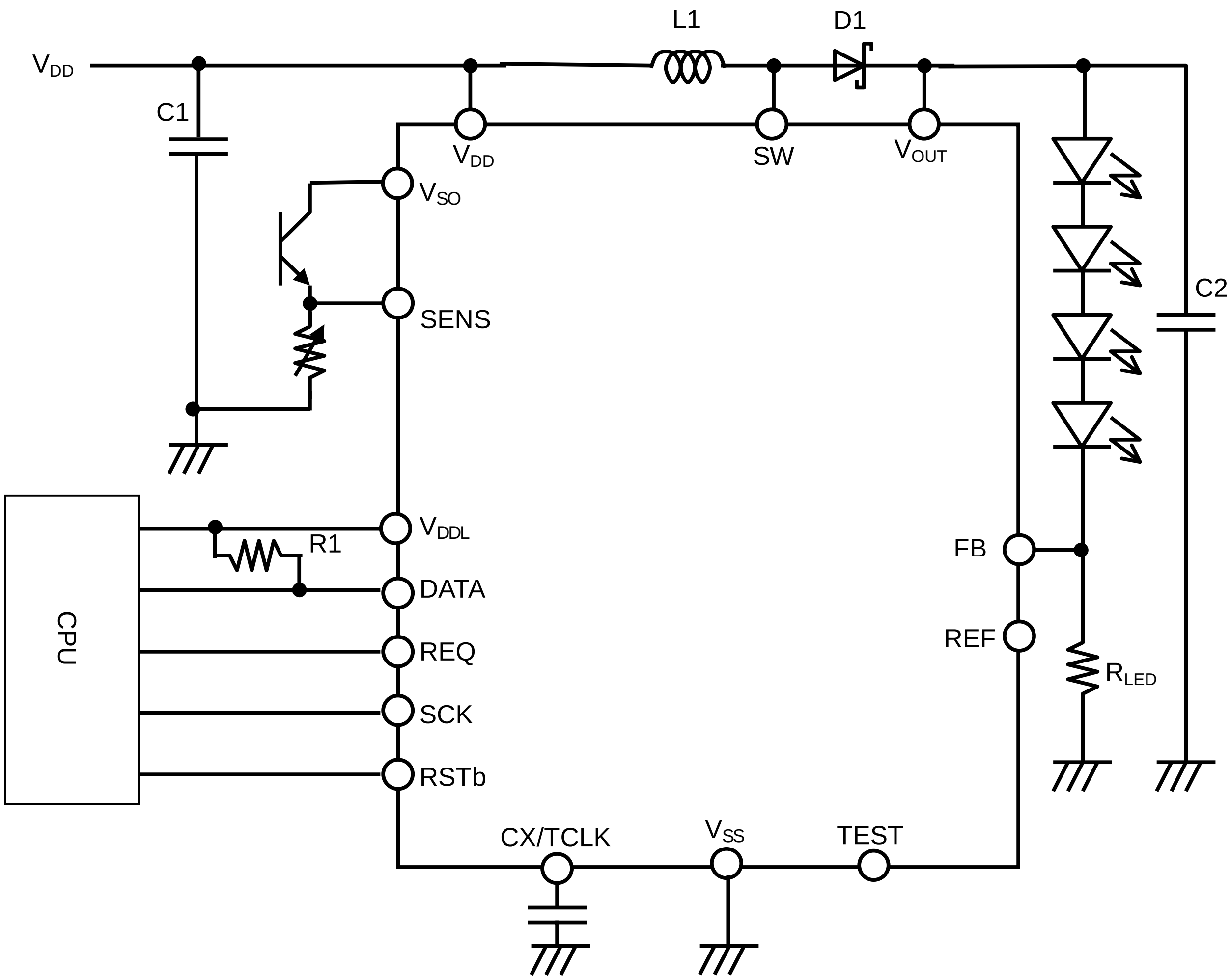
Serial Output Timing



Reset Input Timing



■ APPLICATION CIRCUIT



[CAUTION]
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