TU8FA0408AA

TERACHIPS, Inc.

General Description

The **TU8FA0408AA** is a single networking color LED driver designed for LED decorative lighting and LED sign. Three channel constant current circuitry with current value set by three external resistors and 7.3Mhz Internal RC oscillator, 16bit PWM and Power On Reset, built in buffers for data to next driver and device controller are integrated into the chip.

This LED driver include Voltage regulator and RC oscillation therefore only 3 lines (External High Voltage (H_VDD), Ground (VSS) and Serial Data (SDATI)) are needed to connect between cluster and network line (Asynchronous Mode). This feature can reduce network

This color LED drivers are connected cascade method via transmission line, which transmit data as like image or Text among cluster. So above feature can reduce network connection overhead and easy to make connection line.

In addition, this LED driver supports Synchronous Mode to enhance data transmission speed. In this Synchronous Mode, one more line is needed to receive synchronous clock (SCLKI). Therefore customer can choose Asynchronous or Synchronous Mode for their application by connection MOD pin to VSS or VDD levels.

The Key Features of TU8FA0408AA

- Analog Part

* 7.3Mhz Internal RC Oscillator
* Maximum Synchronous Clock : 25Mhz (only used for Synchronous Mode)
* Power On Reset and Low Voltage Detector
* 3.3V Internal Voltage Regulator (7V ~ 27V to 3.3V Regulation)
* Internal Bandgap Reference Circuit for High Voltage part and Low Voltage Part
* 60mA Constant Current Driver (REF = 18KΩ)
    * Current Fine Tuning can be executed by external resistors.
* Constant Current Accuracy
    * Between Channels : ± 1.5% (typ), ± 3% (max)
    * Between Chips : ± 6% (max)
* Support Up to 27V LED Power
* LED Open Detection to detect LED errors for each channel. (R,G,B)

- Control Part

* Device Controller
* 420 Kbps Enhanced Local Interconnect Network (ELIN ™, Asynchronous Mode)
    * Don't need external Sync clock
    * Only need 3 wires (H_VDD, VSS, SDATI) to form network
    * Maximum distance between two clusters is 1M
    * Support Total 65536 devices for one serial Network
* Max 25 Mbps Enhanced Local Interconnect Network (ELIN ™, Synchronous Mode)
    * Need 4 wires (H_VDD, VSS, SCLKI, SDATI) to form network
    * Support Total 65536 devices for one serial Network.
* 16bit Advanced Pulse Width Modulator (APWM ™) to improve refresh rate and reduce Flicker noise.
* Delayed LED output to reduce EMI noise and power fluctuation during data change
* Can Support 8bit ~ 16bit PWM mode (S/W selectable)
* Built in buffer for data to next driver

- Package

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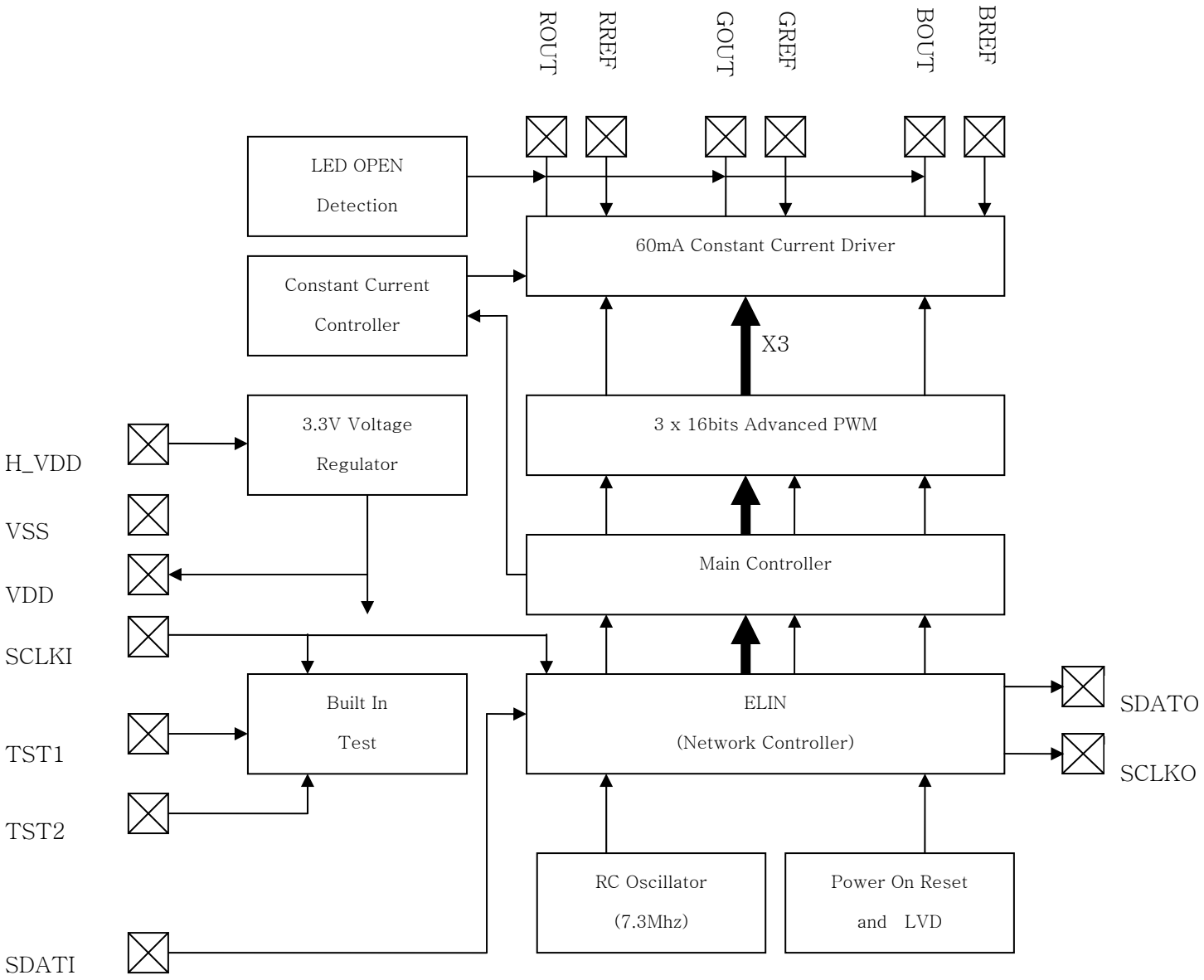
- Major Application

* LED Decorative Lighting
* Outdoor/Indoor LED Video
* Message Display

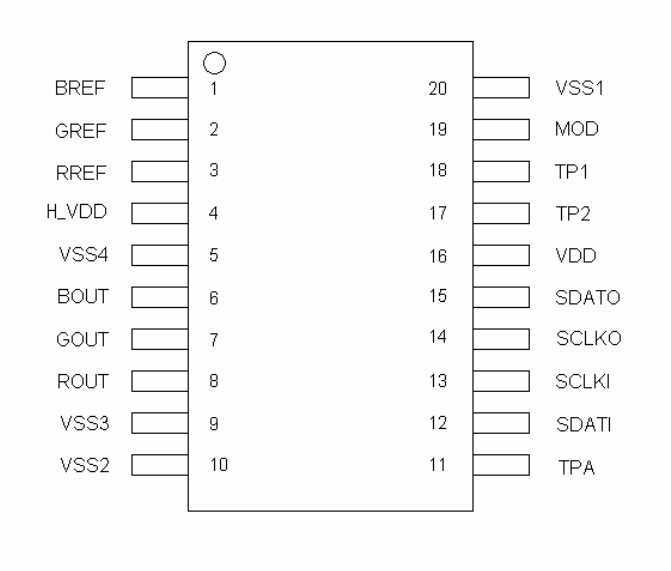
Block Diagram



Pin Descriptions

Pin Number (20 PIN)	Name	Type	Description
1	BREF	Analog	External Resister Terminal for Blue LED Current setting
2	GREF	Analog	External Resister Terminal for Green LED Current setting
3	RREF	Analog	External Resister Terminal for Red LED Current setting
4	H_VDD	Power	Supply Voltage
5	VSS4	Power	System Ground 4
6	BOUT	Analog	Constant Current Output for Blue LED
7	GOUT	Analog	Constant Current Output for Green LED
8	ROUT	Analog	Constant Current Output for Red LED
9	VSS3	Power	System Ground 3
10	VSS2	Power	System Ground 2
11	TPA	Analog	Test Point for Analog
12	SDATI	Input (PU)	Serial Data Input
13	SCLKI	Input (PU)	Serial Clock Input (SYNC Mode only)
14	SCLKO	Output	Serial Clock Output (SYNC Mode only)
15	SDATO	Output	Serial Data Output
16	VDD	Analog	Regulated Power
17	TP2	Input (PD)	Test Point 2
18	TP1	Input (PD)	Test Point 1
19	MOD	Input (PD)	Mode Selection (1/0=SYNC/ASYNC)
20	VSS1	Power	System Ground 1

Package Pin Drawing



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Constant Current Driver

TU8FA0408AA support 60mA constant current driver. This driver are made with very stable analog circuit so theirs are very low current variation between channel by channel (± 3%) and chip by chip (± 6%)

The current characteristics of output are flat so the output current can be constant regardless of variation LED forward voltage (V_F).

This can be guarantee stable LED brightness as user's application.

Below figure is constant current characteristics of this device and user can refer this figure.

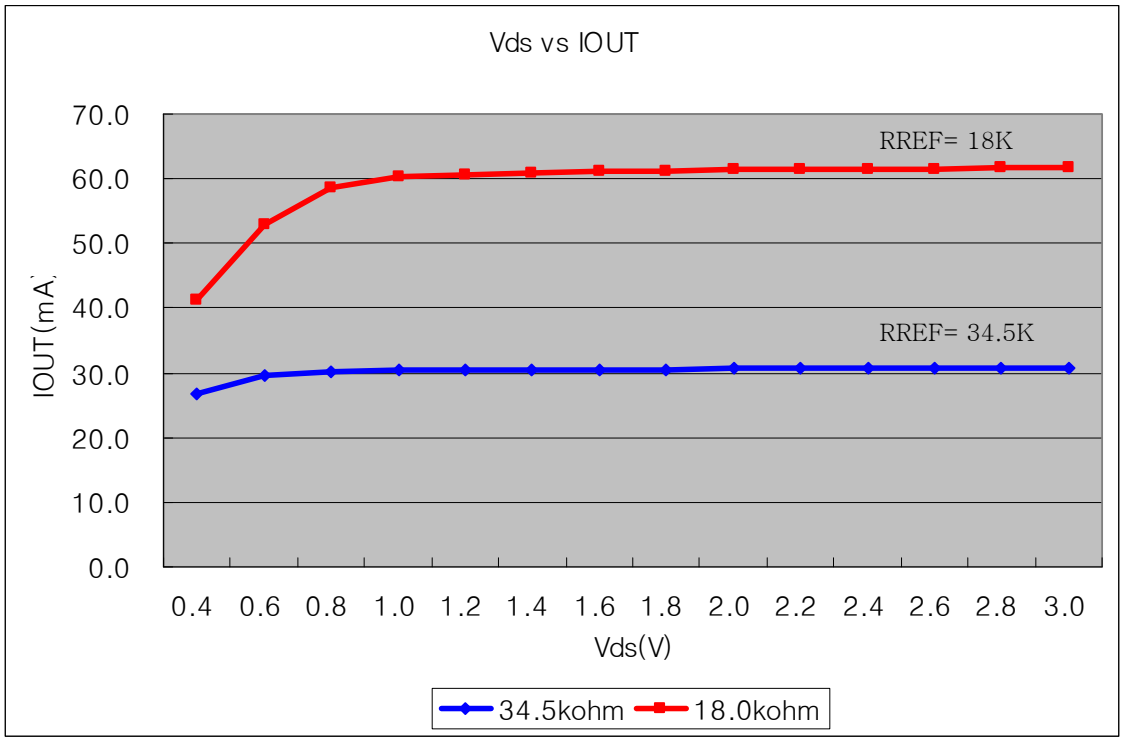


Fig 1) I_{OUT} vs V_{OUT} of TU8FA0408AA at various Reference resistor values

Setting Output Current

The Maximum current is set by external resistors (RREF, GREF, BREF) respectively. Once set, the maximum current remains constant regardless of the LED voltage variation, temperature or other parameter that could affect LED current.

The relationship between I_{OUT} and external resistor (R,G,B REF) is shown in the following figure

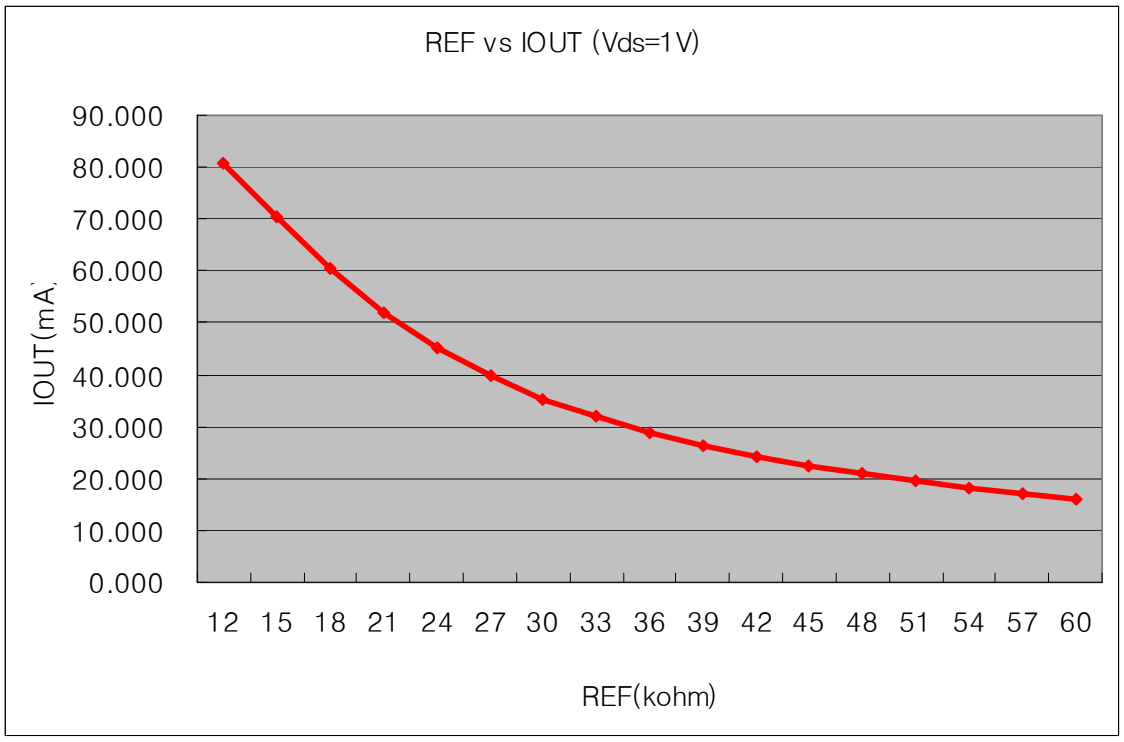


Fig 2) R,G,B REF vs I_{OUT}

Also the output current can be calculated from below equation.

- I_{OUT} = (V_{REF} x 900) / (R,G,B Ref)
- V_{REF} = 1.21V
- Where V_{REF} is internal Bandgap reference voltage and R,G,B Ref is external Resistor to set maximum constant current

Internal voltage regulator

TU8FA0408AA has internal Voltage regulator which can operate supply voltage (H_VDD) from 7V to 27V. It eliminates another power source to operate device and also make it possible to connect H_VDD power source directly to LED power. This simplifies board design by eliminating the need for a chip supply bus
TU8FA0408AA has VDD pin and the regulated power is out through this pin.
This VDD pin is for internal use only and is not intended as external power source. (Except level setting for MOD pin)
There should be above 1.0uF capacitor connected between this VDD pin and VSS.
The capacitor should be located as close to the VDD pin as possible.

LED Voltage (Load Voltage)

LED Voltage is a supply source for LED driver and this supply voltage is applied to constant current driver (LED Driving Port) as like below equation.

- V_{DS} = V_{LED} (Load Voltage) – V_F x N (number of serial LED) – V_{DROP}

The chip will be destroyed if V_{DS} is high to exceed Maximum Package Power Dissipation (P_D). Preventing chip destruction by power dissipation, it is recommended to use the lowest possible V_{DS} power is applied to chip.
TU8FA0408AA is designed to operate with adequate V_{DS} to achieve constant current around 0.7V ~ 1.2V range.
So user should to use voltage reducer as like Zener diode or resistor to reduce the V_{DS} voltage

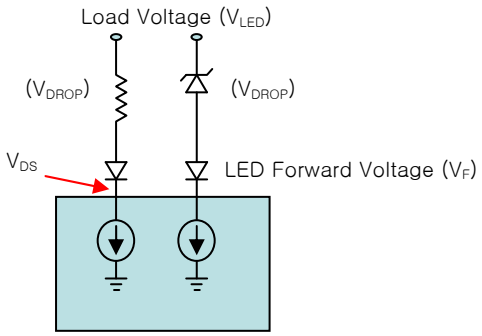


Fig 3) Load Voltage

OPEN CIRCUIT DETECTION

TU8FA0408AA has a LED Open Detection circuit and it can detect LED open when loading status are changed by LED open.

When one of the LED becomes open circuit, it can behave as either an infinite resistance or a gradually increasing finite resistance. The TU8FA0408AA monitors the current in each channel and if the Drain voltage (V_{DS}) down below the some level (0.3V typical), then it will set the LED Open detection status register "STATUS[2:0]".

This LED open detector are operated, when Open detection enable command "DC1" is applied.

If "DC1" command set dedicated LED channel to "1", then LED channel is connected and If "DC1" command reset LED channel, then the LED Open status is saved to status Register.

User can read this LED Open status register using "RDS" command.

Package Power Dissipation (P_D)

The maximum allowable package power dissipation is determined as :

- $P_D(max) = (T_J - T_A) / R_{JA}$.

  (where T_J max = 150) (R_{JA} : package thermal resistance)

The actual package power dissipation is:

- $P_D(act) =$ Duty R $\times$ V_{DSR} $\times$ I_{OUT-R}
  + Duty G $\times$ V_{DSG} $\times$ I_{OUT-G}
  + Duty B $\times$ V_{DSB} $\times$ I_{OUT-B} + V_{IN} $\times$ I_{IN} .

where Duty R,G, B is the PWM duty cycle for each R,G,B channel , and V_{DS} R,G,B is the LED output voltage for each R,G,B channel. And then, I_{OUT-R}, I_{OUT-G}, I_{OUT-B} are the LED output current which value is fixed by external resistor (RREF, GREG, BREF). When calculating power dissipation, the total number of available device outputs is usually used for the worst-case situation (displaying all 3 LEDs at 100% Duty Cycle).

Absolute Maximum Ratings

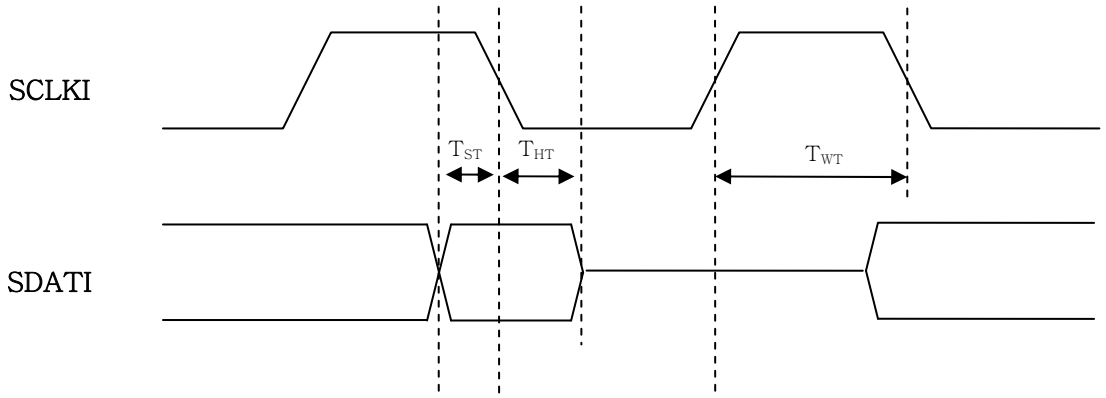
Parameter	Symbol	Ratings	Unit
Power Supply Voltage	H_VDD	30	V
Operating Temperature	T_A	-40 ~ 85	℃
Storage Temperature	T_S	-55 ~ 150	℃
Junction Temperature	T_J	150	℃
Input Pin Voltage	V_{IN}	-0.3 ~ VDD + 0.3	V
Output Voltage at LED pin	V_{DS}	-0.5 ~ 30	V
Output Current at LED pin	I_{OUT}	90	mA
Clock Frequency (SCLKI)	F_{SCLKI}	25	MHz

DC Electrical Characteristics at T_A=25°C Typical Application, VDD=3.3V)

Parameter	Sym	Test Condition	Limits			Unit
			Min	Typ	Max	
Supply Voltage	H_VDD	Operating	7	12	27	V
Regulation Voltage	VDD1	H_VDD=12V, 24V	3.0	3.3	3.6	V
Output Voltage	V_{OUT1}	LED Output			27	V
	V_{OUT2}	SDATO, SCLKO	VDD-0.3	VDD	VDD+0.3	V
Output Current	I_{OD}	LED output	5		60	mA
	I_{OH}	SDATO, SCLKO		24		mA
	I_{OL}	SDATO, SCLKO		-24		mA
Input Voltage	V_{IH}	Input Pins	2.4	VDD	VDD+0.3	V
	V_{IL}	Input Pins			1	V
Input Leakage	I_{IH}	Input Pins			0.5	uA
	I_{IL}	Input pins			0.5	uA
Output Leakage	I_{OLL1}	LED Output H_VDD=17V			0.5	uA
	I_{OLL2}	SDATO, SCLKO			0.5	uA
Supply Current	I_{DD1}	H_VDD=17V, REF=18K		10	TBD	mA
	I_{DD2}	H_VDD=12V, REF=18K		8	TBD	mA
Output Current Skew (Channel To Channel)	I_{OS1}	REF=18K V_{DS}=1.0V	-3		+3	%
Output Current Skew (Chip to Chip)	I_{OS2}	REF=18K V_{DS}=1.0V	-6		+6	%
Internal Oscillation Clock	F_{OSC}	H_VDD= 12V		7.3		Mhz

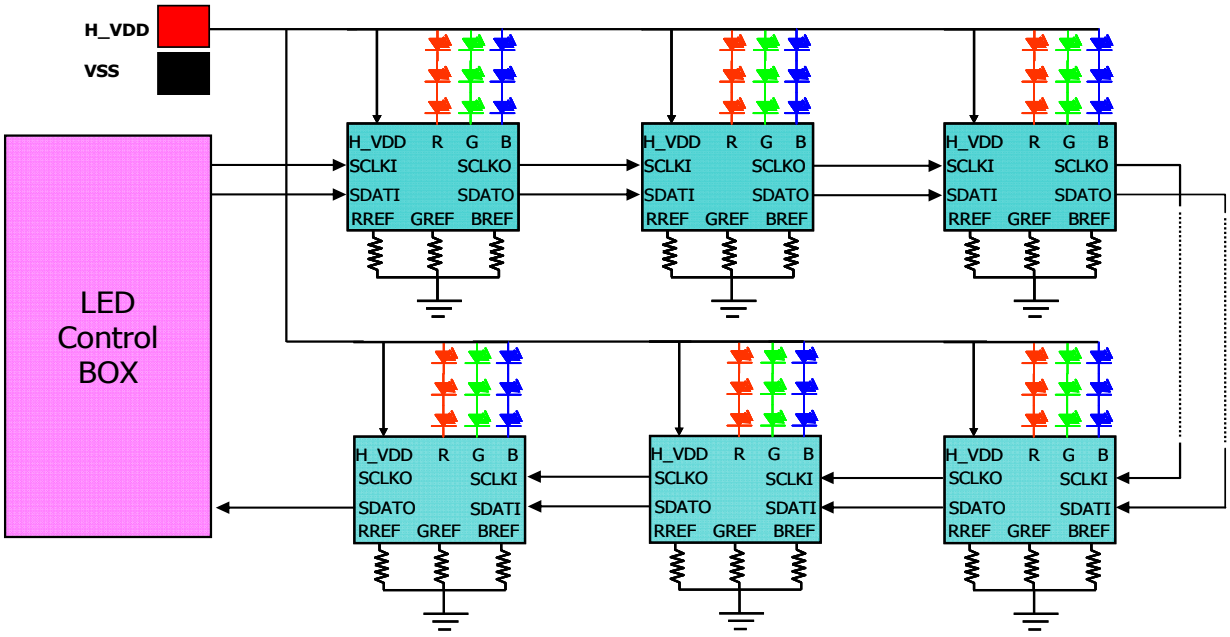
AC Electrical Characteristics at TA=25°C Typical Application, VDD=3.3V)

Parameter	Sym	Test Condition	Limits			Unit
			Min	Typ	Max	
Set Up Time	T_{ST}	VDD = 3.3V.	3			ns
Hold Time	T_{HT}	V_{IH} = VDD.	3			ns
Pulse Width	T_{WT}	V_{IL} = VSS	20			ns
		C_L=10pF				

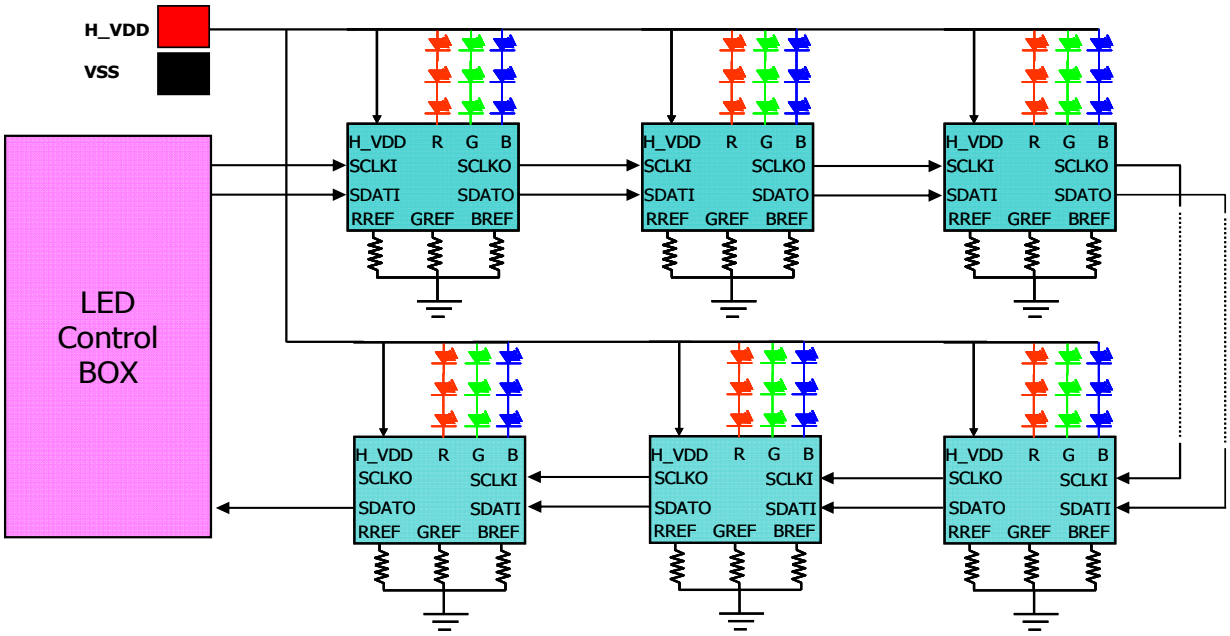


AC Timing Diagram

Typical Application Diagram

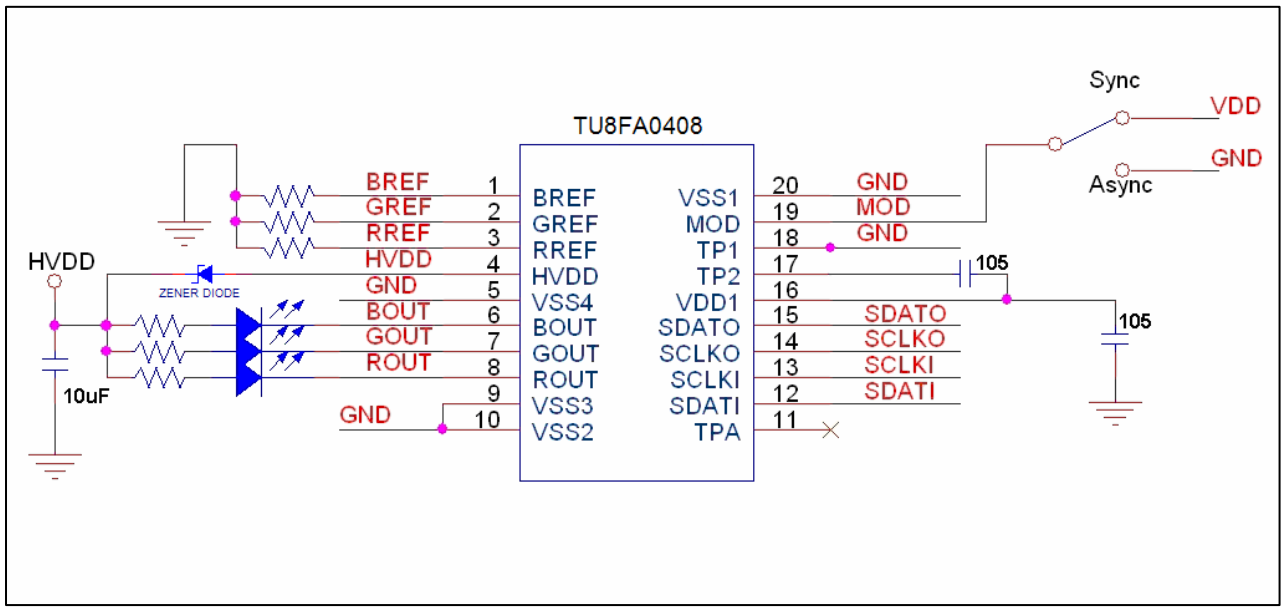


Application Example for Asynchronous mode



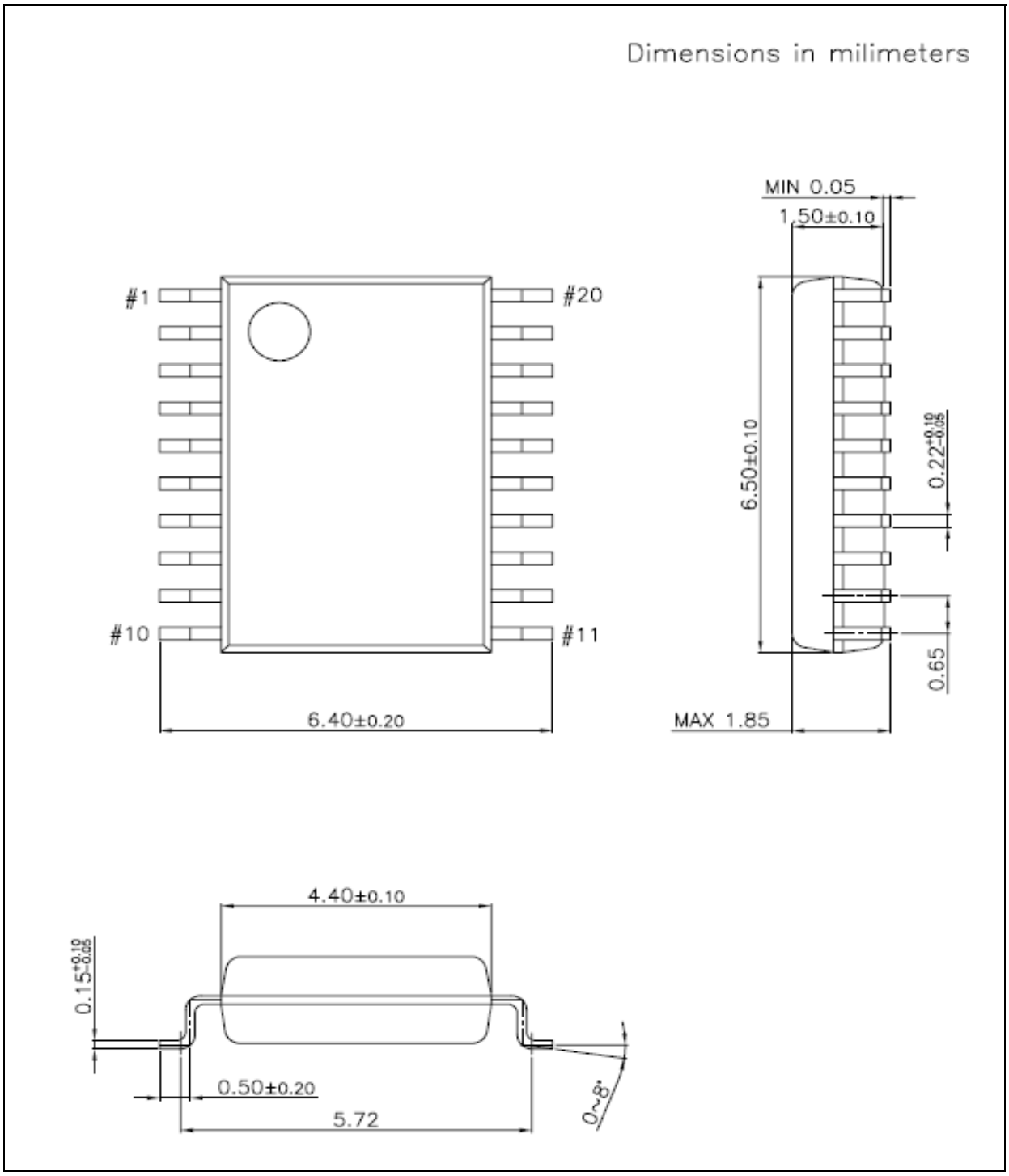
Application Example for Synchronous mode

Chip Application Note



Note1: Tie SCLKI pin to VDD Level when it use Asynchronous mode
Note2: Select the Zener Diode breakdown voltage to adjust the output voltage between 3.3 ~ 5V.

Package Dimension



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