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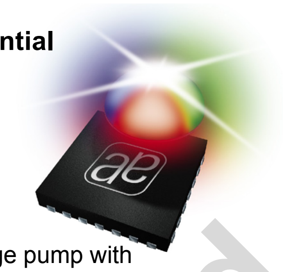
AS3665

Datasheet, Confidential

9 Channel Advanced Command Driven RGB/White LED Driver



1 General Description

The AS3665 is a capacitive low noise charge pump with 9 current sources. The charge pump automatically switches between 1:1 and 1:1.5 modes. The connected current sources have a very low voltage compliance to improve efficiency of the whole system. Three current sources have the possibility to operate either from VBAT or VCP (especially useful for red LEDs).

The internal control is done by command based pattern generators implemented by three sequencers. These commands are optimized for lighting applications (e.g. ramp up brightness logarithmically). It includes high level commands like conditionals jumps and variables. Any of the three sequencers can be dynamically mapped to any of the 9 PWM generators for the LEDs.

The AS3665 supports an audio input and sophisticated light patterns can be controlled by internal digital filters.

The AS3665 is controlled by I^2C mode. Synchronization over several AS3665 is possible by the TRIG pin.

The AS3665 is available in a space-saving WL-CSP-25 (2.610x2.675mm) 0.5mm pitch and operates over the -30ºC to +85ºC temperature range.

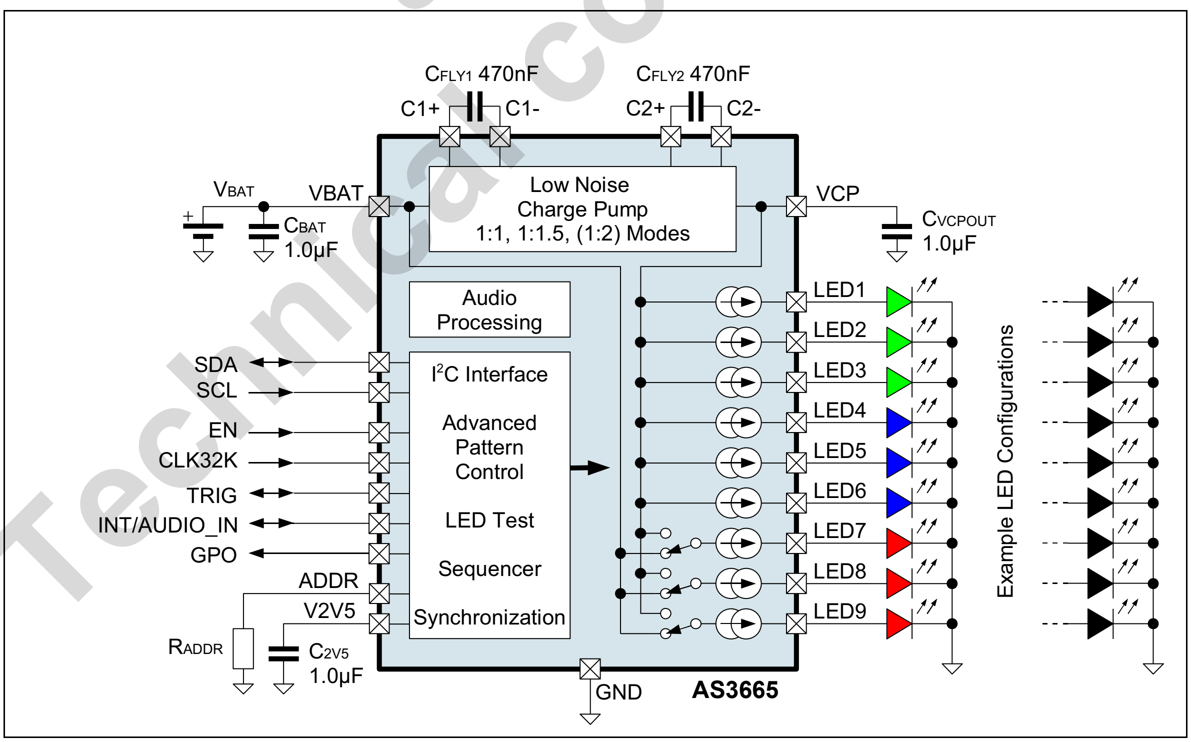
2 Key Features

- High efficiency capacitive 150mA charge pump with 1:1, 1:1.5 and 1:2 modes with automatic mode switching; 1:2 mode can be disabled
- 9 Channel High Side 20mA Current sources
  - Less than 50mV at 10mA dropout voltage
  - LED7,8,9 either powered by VBAT or VCP
- Advanced Command based Pattern Generator
  - 96 x 16 bits program memory
  - Dedicated lighting commands like logarithmic fade
  - Programming control and conditional jumps
- Audio Controlled Lighting with internal digital filters
- 3 Sequencers
  - Dynamically mapped to 9 PWM generators
  - Internal/External Synchronization
- 9 PWM generators (12 bit resolution)
  - Automatic RGB Color Correction by T_{AMB}
- I^2C interface with dedicated EN pin
- Available in WL-CSP-25 (2.610x2.675mm) 0.5mm pitch

3 Applications

RGB/White Fun or Event LED for mobile phones or portable devices; Lighting Management Unit

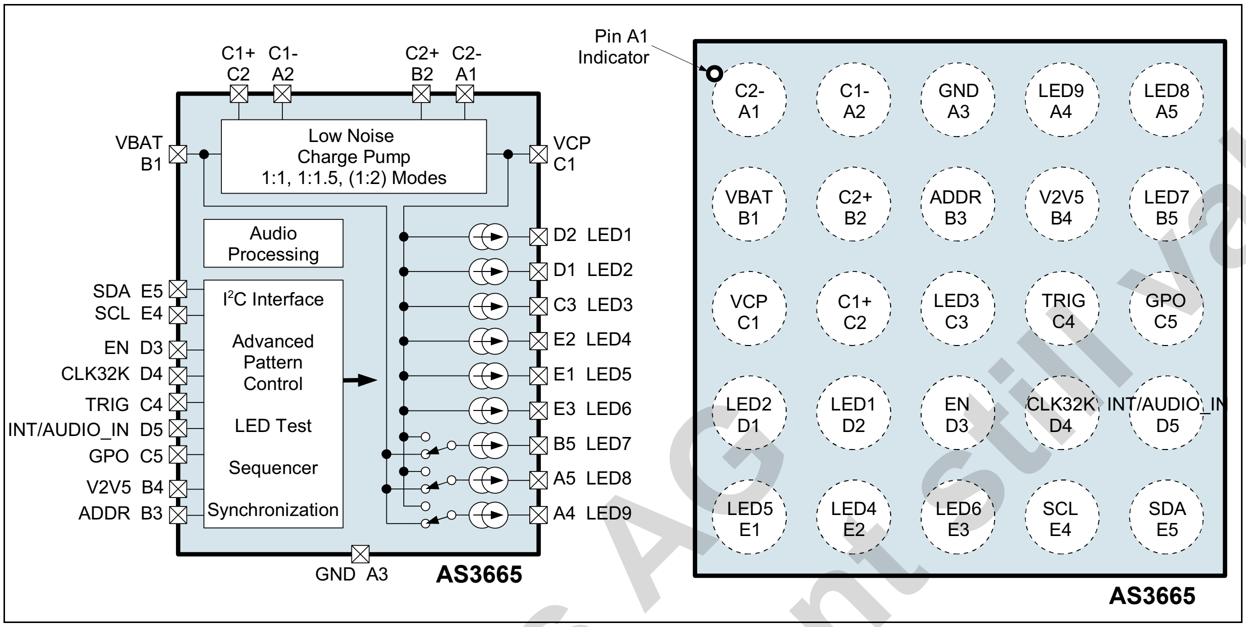
Figure 1. Typical Operating Circuit



4 Pinout

Pin Assignment

Figure 2. Pin Assignments WL-CSP-25 (2.610x2.675mm) 0.5mm pitch (Top View)



Pin Description

Table 1. Pin Description for AS3665

Pin Number	Pin Name	Description
A1	C2-	Charge Pump flying capacitor 2 - make a short connection to capacitor C_{FLY2}
A2	C1-	Charge Pump flying capacitor 1 - make a short connection to capacitor C_{FLY1}
A3	GND	Ground supply input pin
A4	LED9	LED9 output - current source from VCP or VBAT
A5	LED8	LED8 output - current source from VCP or VBAT
B1	VBAT	Positive supply input pin
B2	C2+	Charge Pump flying capacitor 2 - make a short connection to capacitor C_{FLY2}
B3	ADDR	Digital input - I^2C address select; the value of the resistor R_{ADDR} defines the actual I^2C address used
B4	C_{2V5}	Internal supply - connect a 1µF ceramic capacitor between C_{2V5} and GND
B5	LED7	LED7 output - current source from VCP or VBAT
C1	VCP	Charge Pump output - make a short connection to capacitor C_{VCPOUT}
C2	C1+	Charge Pump flying capacitor 1 - make a short connection to capacitor C_{FLY1}
C3	LED3	LED3 output - current source from VCP
C4	TRIG	Digital open drain input/output - used to synchronize across several AS3665
C5	GPO	Digital open drain input/output - General purpose output and ADC input
D1	LED2	LED2 output - current source from VCP
D2	LED1	LED1 output - current source from VCP

Table 1. Pin Description for AS3665 (Continued)

Pin Number	Pin Name	Description
D3	EN	Digital input - active high enable for AS3665
D4	CLK32K	Digital clock input - connect a 32.768kHz signal; if this signal is not available, connect this pin to GND
D5	INT/AUDIO_IN	Depending on the AS3665 configuration INT/AUDIO_IN is a 1. Open drain digital output - interrupt output pin 2. Analog input - audio or ADC signal input
E1	LED5	LED5 output - current source from VCP
E2	LED4	LED4 output - current source from VCP
E3	LED6	LED6 output - current source from VCP
E4	SCL	Digital input - clock input for I^2C communication
E5	SDA	Digital open drain input/output - data input/output for I^2C communication

5 Absolute Maximum Ratings

Stresses beyond those listed in Table 2 may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in Table 3, "Electrical Characteristics," on page 5 is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 2. Absolute Maximum Ratings

Parameter	Min	Max	Units	Comments
VBAT, VCP, C1+, C1-, C2+, C2- to GND	-0.3	+7.0	V	
VCP to VBAT	-0.3		V	**Note:** Diode between VCP and VBAT
LED1, LED2...LED9 to GND	-0.3	VCP + 0.3	V	
		7.0		
SDA, SCL, EN, CLK32K, TRIG, INT/AUDIO_IN, GPO, ADDR, C_{2V5} to GND	-0.3	VBAT + 0.3	V	
		7.0		
Input Pin Current without causing latchup	-100	+100 +I_{IN}	mA	Norm: EIA/JESD78
Continuous Power Dissipation (T_A = +70ºC)				
Continuous power dissipation		0.78	mW	P_T[1]
Continuous power dissipation derating factor		14.2	mW/ºC	P_{DERATE}[2]
Electrostatic Discharge				
ESD HBM		±1000	V	Norm: JEDEC JESD22-A114F
ESD CDM		±500	V	Norm: JEDEC JESD 22-C101C
ESD MM		±200	V	Norm: JEDEC JESD 22-A115-A level A
Temperature Ranges and Storage Conditions				
Junction Temperature		+150	ºC	Internally limited (overtemperature protection)
Storage Temperature Range	-55	+125	ºC	
Humidity	5	85	%	Non condensing
Body Temperature during Soldering		+260	ºC	according to IPC/JEDEC J-STD-020C

1. Depending on actual PCB layout and PCB used
2. P_{DERATE} derating factor changes the total continuous power dissipation (P_T) if the ambient temperature is not 70ºC. Therefore for e.g. T_{AMB}=85ºC calculate P_T at 85ºC = P_T - P_{DERATE} * (85ºC - 70ºC)

6 Electrical Characteristics

V_{VBAT} = +2.7V to +5.5V, T_{AMB} = -30ºC to +85ºC, unless otherwise specified. Typical values are at V_{VBAT} = +3.6V, T_{AMB} = +25ºC, unless otherwise specified.

Table 3. Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
General Operating Conditions						
V_{VBAT}	Supply Voltage		2.7	3.6	5.5	V
$V_{VBATREDUCED\_FUNC}$	Supply Voltage	AS3665 functionally working, but not all parameters fulfilled	2.5		2.7	V
$I_{SHUTDOWN}$	Shutdown Current			0.4	1.3	µA
I_{STANBY}	Standby mode Current	I^2C interface active		1.6	6.0	µA
I_{ACTIVE}	Active mode Current	I^2C interface active Internal oscillator running, program executed		300		µA
$I_{CP1:1.5}$	Charge Pump Current	Charge pump operating in 1:1.5 mode, no load current		0.7		mA
T_{AMB}	Operating Temperature		-30	25	85	ºC
Charge Pump						
V_{VOUT}	Charge Pump output Voltage (pin VOUT)	Internally Limited			5.5	V
I_{VOUT}	Charge Pump output current		0.0		150	mA
η	Efficiency			75		%
f_{CLK}	Operating Frequency	All internal timings are derived from this oscillator if no clock is applied on pin CLK32K	-10%	2.0	+10%	MHz
R_{CP}	Charge pump effective resistance	V_{VBAT}>=3.3V, I_{LED}=100mA, 1:1 Mode		0.65		Ω
		V_{VBAT}>=3.3V, I_{LED}=100mA, 1:1.5 Mode		3.3		Ω
Current Sources						
$I_{LED1..9}$	LED1...LED9 output current range		0.0		25.5	mA
$I_{LED1..9\Delta}$	LED1...LED9 current source accuracy	I_{LED} = 17.5mA	-7		+7	%
$I_{LED1..9\ MATCH}$	LED1...LED9 current source matching	I_{LED} = 17.5mA		2.5		%
$I_{LED1..9\ LEAKAGE}$	LED1...LED9 leakage current	current source off	-5	0	+5	µA
V_{ILED_COMP}	LED1...LED9 current source voltage compliance	Minimum voltage between pin VOUT and LED1...LED9 or VBAT and LED7...LED9			100	mV
ADC						
ADC_{RES}	ADC resolution			10		Bits
ADC_{INL}	ADC Integral non-linearity		-2	±0.2	+2	LSB
ADC_{DNL}	ADC differential non-linearity		-2	±0.25	+2	LSB
ADC_{LSB}	LSB of ADC conversion			6.1		mV

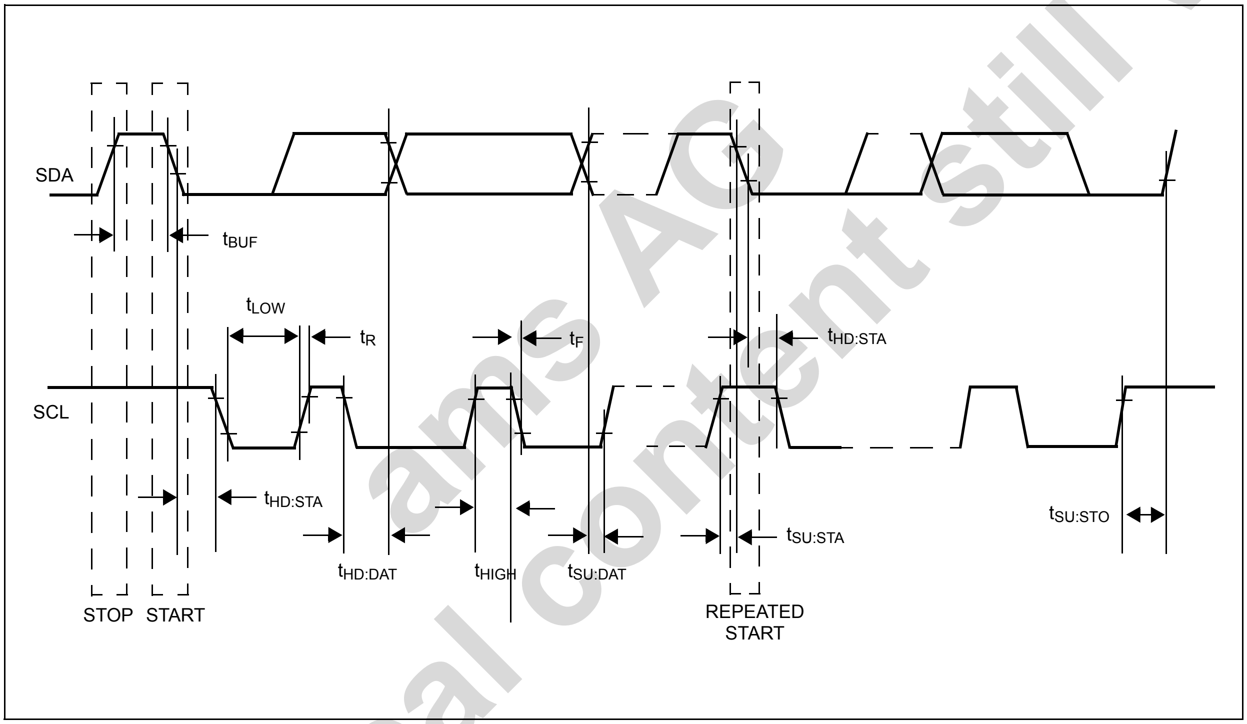
Table 3. Electrical Characteristics (Continued)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$ADC_{TOFFSET}$	ADC temperature measurement offset value			393		ºC
ADC_{TC}	Code temperature coefficient			1.322		ºC/ Code
T_{TOL}	Temperature sensor accuracy		-10		+10	ºC
Audio Input						
R_{AUDIO_IN}	Audio Input resistance	pin INT/AUDIO_IN if used as analog input; at maximum input gain (+30dB)		20		kΩ
Digital Interface						
V_{IH}	High Level Input Voltage	Pins SDA, SCL, EN, CLK32K, TRIG, INT/AUDIO_IN, GPO[1]	1.26		V_{VBAT}	V
V_{IL}	Low Level Input Voltage		0.0		0.54	V
V_{OL}	Low Level Output Voltage	Pins SDA, TRIG, INT/AUDIO_IN, GPO I_{OL}=3mA			0.2	V
I_{LEAK}	Leakage Current	Pins SDA, SCL, EN, CLK32K, TRIG, INT/ AUDIO_IN, GPO		0.01	1.0	µA
I^2C mode timings - see **Figure 3 on page 7**						
f_{SCLK}	SCL Clock Frequency		0		400	kHz
t_{BUF}	Bus Free Time Between a STOP and START Condition		1.3			µs
$t_{HD:STA}$	Hold Time (Repeated) START Condition[2]		0.6			µs
t_{LOW}	LOW Period of SCL Clock		1.3			µs
t_{HIGH}	HIGH Period of SCL Clock		0.6			µs
$t_{SU:STA}$	Setup Time for a Repeated START Condition		0.6			µs
$t_{HD:DAT}$	Data Hold Time[3]		0		0.9	µs
$t_{SU:DAT}$	Data Setup Time[4]		100			ns
t_R	Rise Time of Both SDA and SCL Signals		20 + $0.1C_B$		300	ns
t_F	Fall Time of Both SDA and SCL Signals		20 + $0.1C_B$		300	ns
$t_{SU:STO}$	Setup Time for STOP Condition		0.6			µs
C_B	Capacitive Load for Each Bus Line	C_B — total capacitance of one bus line in pF			400	pF
$C_{I/O}$	I/O Capacitance (SDA, SCL)				10	pF
$t_{TIMEOUT}$	I^2C timeout	If SCL and SDA are low for longer than this time, the AS3665 is switched into shutdown mode[5]		100		ms

1. The logic input levels VIH and VIL allow for 1.8V supplied driving circuit
2. After this period the first clock pulse is generated.
3. A device must internally provide a hold time of at least 300ns for the SDA signal (referred to the V_{IHMIN} of the SCL signal) to bridge the undefined region of the falling edge of SCL.
4. A fast-mode device can be used in a standard-mode system, but the requirement $t_{SU:DAT}$ = to 250ns must then be met. This is automatically the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line t_R max + $t_{SU:DAT}$ = 1000 + 250 = 1250ns before the SCL line is released.
5. This feature can be disabled by setting auto_shutdown (see page 13)=0

Timing Diagrams

Figure 3. I²C mode Timing Diagram



7 Typical Operating Characteristics

VVBAT = 3.6V, T_A = +25ºC (unless otherwise specified).

Figure 4. Efficiency vs. Battery voltage, ILEDS=50mA

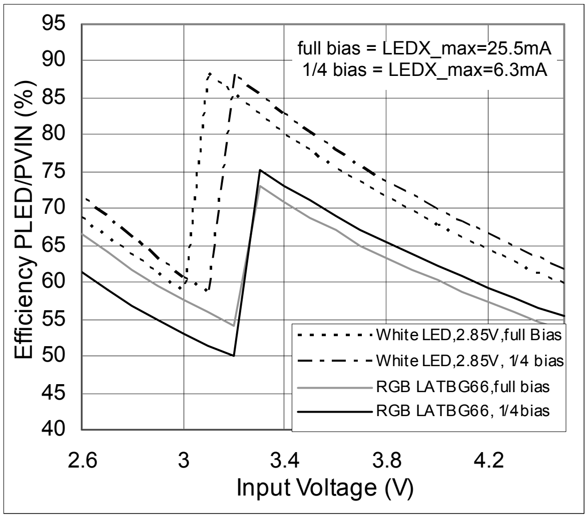


Figure 5. IVBAT vs. Battery voltage, ILEDS=50mA

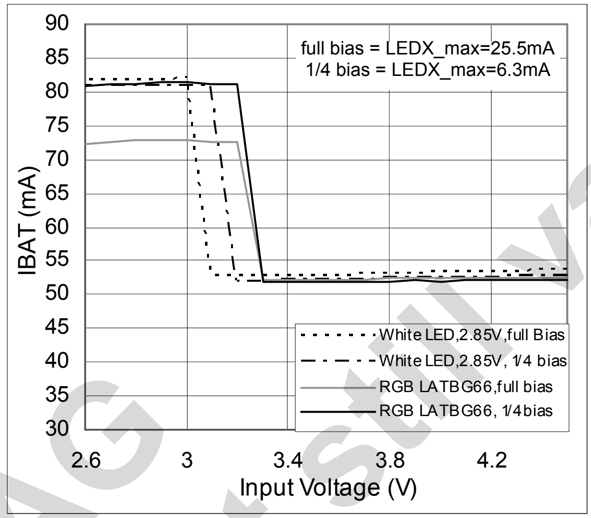


Figure 6. ILEDS vs. Battery voltage

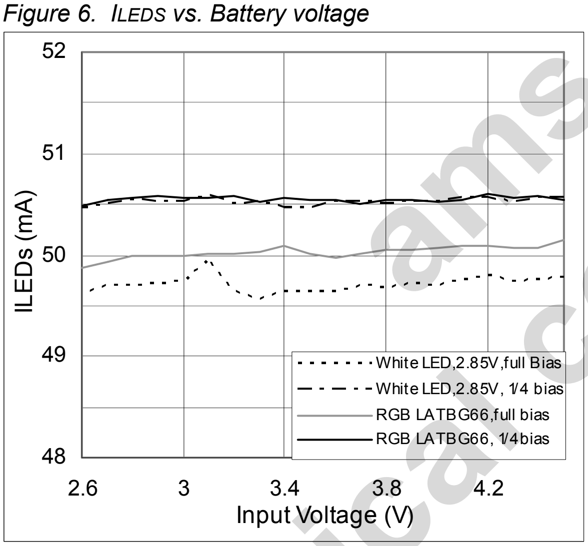


Figure 7. ILED1 Linearity of current source vs. Code

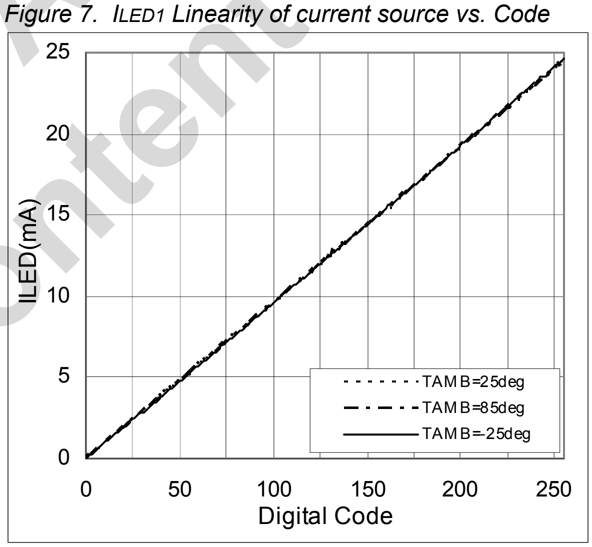


Figure 8. ILED1 Monotony of current source vs. Code

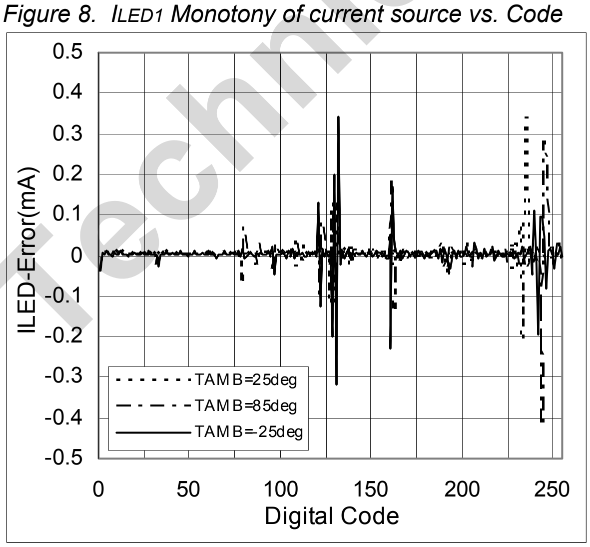


Figure 9. Logarithmic PWM ramp

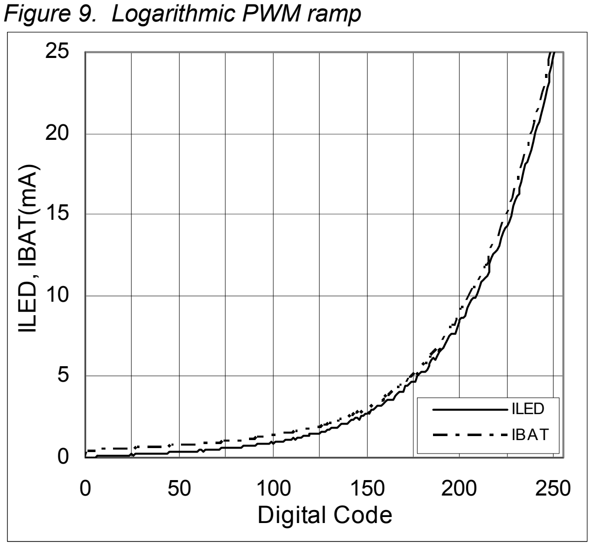


Figure 10. Logarithmic PWM ramp

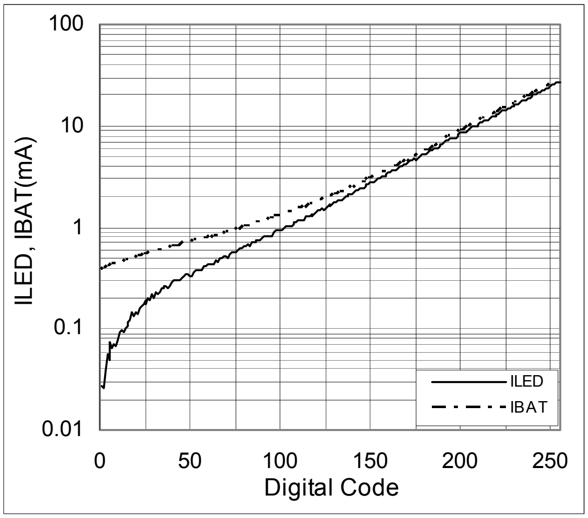


Figure 11. ILED vs. Voltage on current source

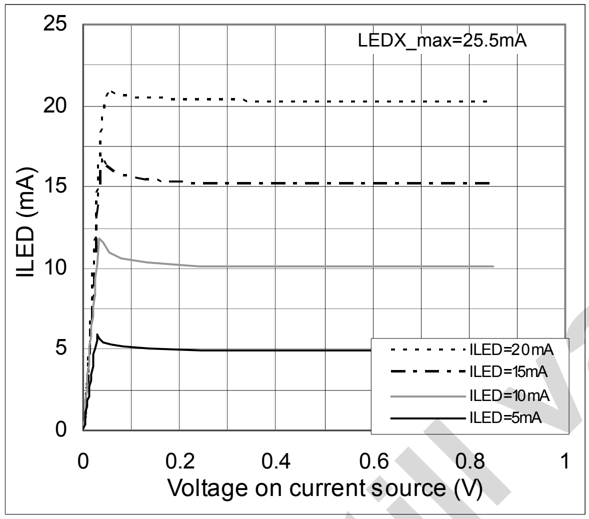


Figure 12. ILED vs. Voltage on current source

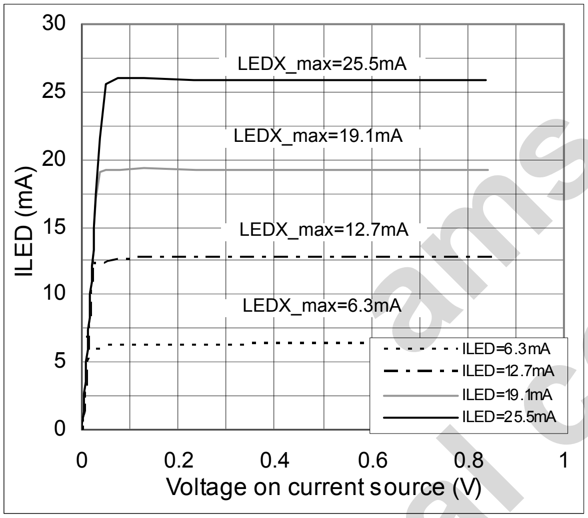


Figure 13. ILED vs. Voltage on current source

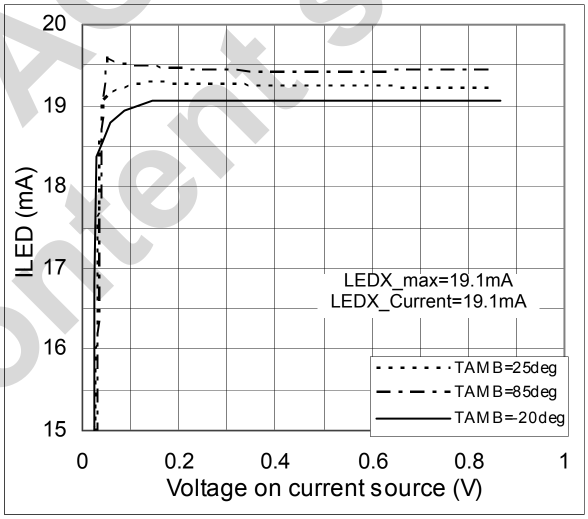
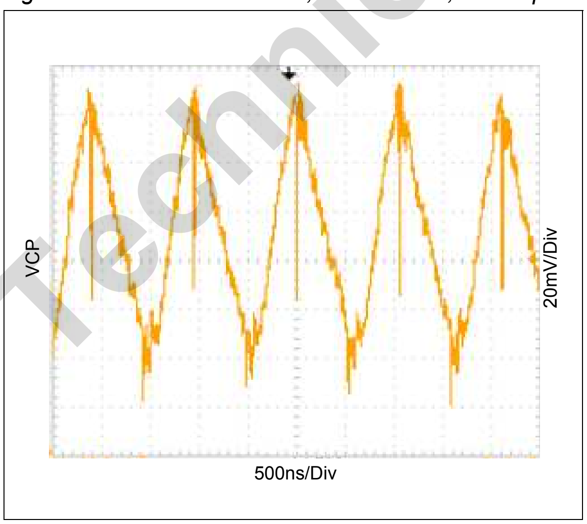


Figure 14. CP in 1:1.5 mode, 150mA load, ac-coupled



8 Detailed Description

The AS3665 is a fixed frequency charge pump. Its output (VOUT) is connected to nine current sources (LED1..LED9). A sophisticated command based pattern generator with three sequencers controls the nine PWM generators (12 bit resolution), which are connected to the current sources.

Commands are downloaded to the AS3665 internal memory space and can be executed autonomously in the three sequencers. The commands are optimized for lighting applications (e.g. a single command executes logarithmic up dimming). It supports command flow control (like unconditional and conditional jumps). Variables which are accessible through the I^2C interface allow control of the program execution by the I^2C interface and communication between the three sequencers.

The three sequencers can be dynamically assigned to any of the nine outputs (under program control).

The AS3665 supports an audio input pin INT/AUDIO_IN which allows the control of patterns depending on an audio input signal. This audio input can be feed through internal digital filters for better visual appearance.

If the audio feature is not used, the pin INT/AUDIO_IN can be used as interrupt output[1] to send interrupts.

The AS3665 is controlled by an I^2C interface and additional dedicated control lines. An EN input operates as a global enable/disable pin and with the pin TRIG several AS3665 can be synchronized in a system. A separate CLK32K input can be used to set an exact clock input frequency (all internal timings can be derived either from CLK32K or an internal oscillator). The I^2C address is selectable by the pin ADDR - see I^2C Address selection on page 40. A GPO pin can be used for external control or as an additional ADC input.

The AS3665 supports LED testing (verification of the performance of the connected LEDs in an assembled system).

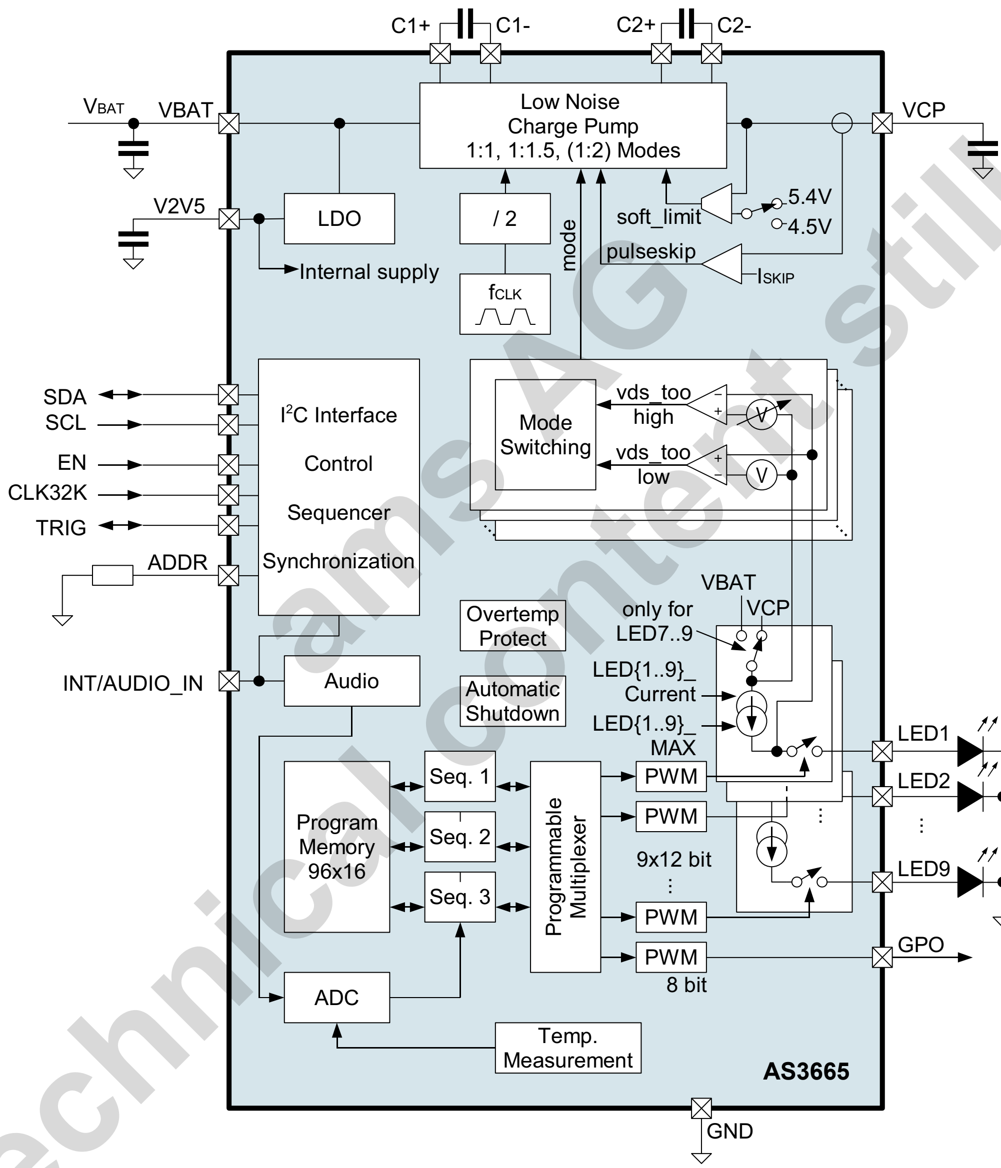
Following blocks are included inside the AS3665:

- Low Noise charge pump operating in 1:1, 1:1.5 and 1:2
- Automatic mode switching of the charge pump (up & down)
- 1MHz oscillator
- Internal LDO for powering the internal circuitry
- Audio processing of an analog input signal
- Overtemperature Protection
- Temperature Measurements of the AS3665
- 10 Bit ADC
- 9x12 bit, 1x8 bit PWM Generators
- 6 accurate current sources connected to VCP
- 3 accurate current source configurable to be connected to VBAT or VCP (to improve efficiency e.g. of red LEDs)
- Internal memory for the program execution
- 3 sequencers (3 parallel processing units)
- a fully programmable multiplexer connecting the three sequencers to the 10 PWM generators
- Automatic shutdown to safe power (if SCL and SDA=0 for 100ms)

1. INT/AUDIO_IN is an open drain output. Several interrupt can be easily combined externally.

Internal Circuit

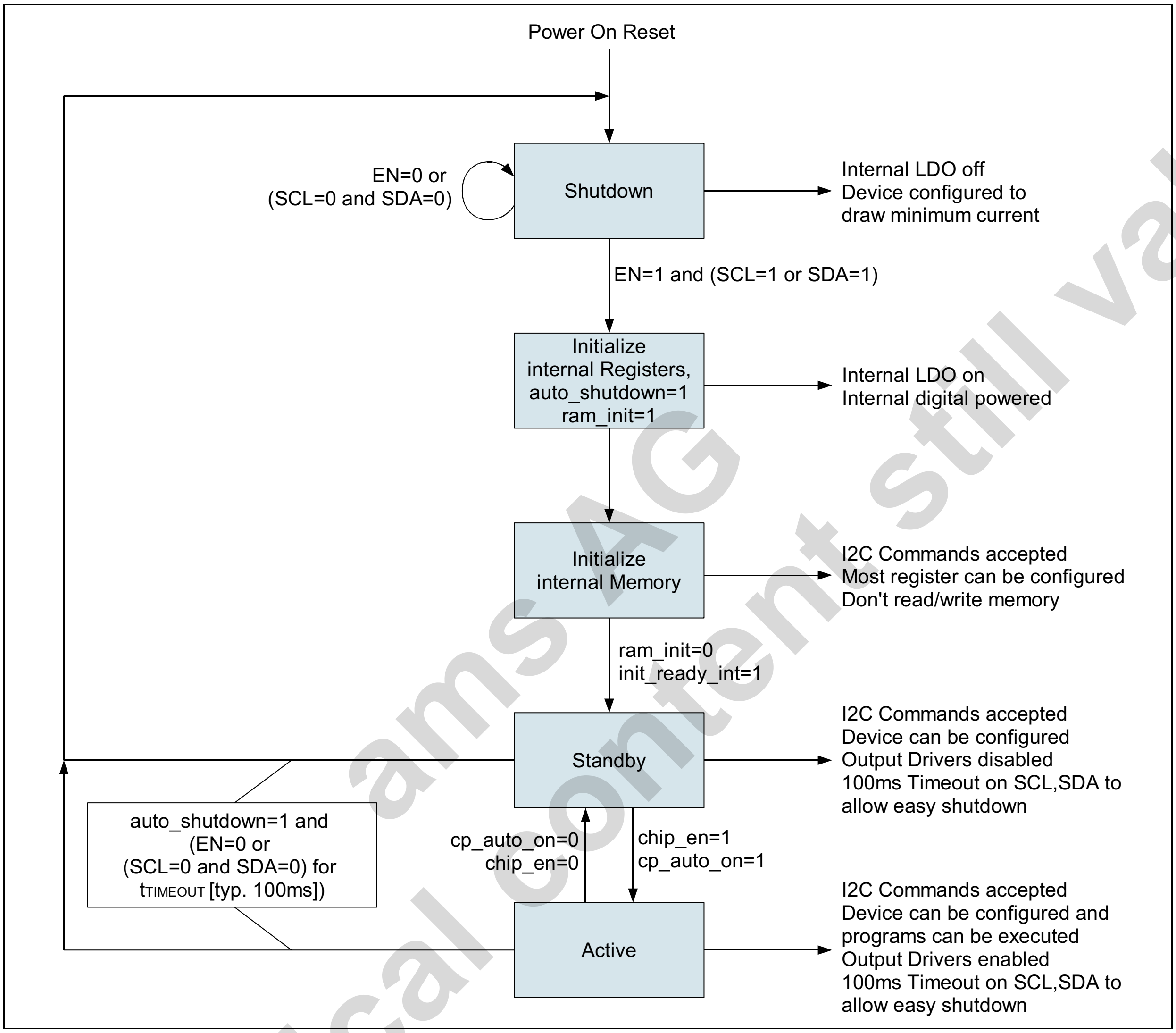
Figure 15. AS3665 internal circuit



Device Operating Mode

The operating mode is selected according to the following flowchart:

Figure 16. AS3665 operating mode selection



After power on reset, the AS3665 waits until EN=1 and SCL=1 or SDA=1[2] and then initializes its internal registers and program memory. Once standby mode is reached, the program and setup can be download to the AS3665 and by setting chip_en=1 the program can be executed.

2. SCL and SDA is monitored to detect if the I^{2}C bus is powered. Therefore if EN is not used, it can be tied to VBAT and the mode selection between shutdown and the other modes is performed by SCL and SDA.

If EN is pulled low or if the power from the I^2C bus pullup resistors is removed[3] for more than $t_{TIMEOUT}$, the AS3665 enters shutdown[4].

Table 4. Exec_Enable Register

Addr: 00h		Exec_Enable Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
6	chip_en	0h	R/W	Enables the active mode (see Figure 16)	
				0	AS3665 standby mode select. Set cp_auto_on=0 before setting chip_en=0. Output drivers disabled, I^2C communication possible
				1	AS3665 active mode select. Set cp_auto_on=1 after setting chip_en=1 All functions active, internal oscillator running.
7	ram_init	0h	R/W	Initialization of the internal memory (see Figure 16)	
				0	Memory initialization is finished
				1	Writing: Reset internal program memory and all register from 60h...FFh to their default state Reading: memory initialization ongoing; when finished an interrupt can be triggered (init_ready_int (see page 37) is set)

The bit auto_shutdown controls the automatic entering of shutdown mode if the I^2C bus is disabled:

Table 5. Supervision Register

Addr: 08h		Supervision Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
7	auto_shutdown	1h	R/W	Enables the shutdown mode (see Figure 16)	
				0	AS3665 cannot enter shutdown do not set pin EN=0 if cp_auto_on=1 or cp_on=1
				1	AS3665 can use shutdown EN=0 can be used to enter shutdown mode

A complete reset cycle can be triggered by setting bit force_reset:

Table 6. Reset_Control Register

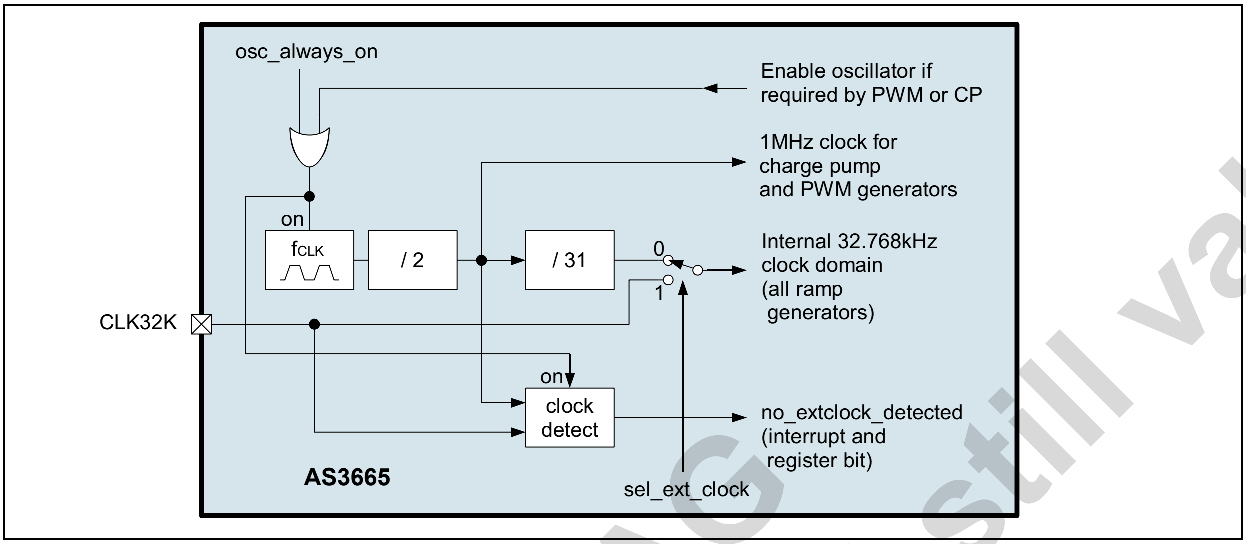
Addr: 3Ch		Reset_Control Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
0	force_reset	0	R/W	Start reset cycle (see Figure 16)	
				0	Normal operation
				1	Reset all registers from 00h...1Fh and 5Fh to their default value

3. Therefore SCL and SDA both are low.
4. Unless auto_shutdown (see page 13)=0

Clock Generation

The AS3665 has an internal oscillator running at f_{CLK} and an external clock input CLK32K:

Figure 17. Clock Generation



The charge pump and the PWM generator use the f_{CLK} clock signal from the internal oscillator. Depending on the signal sel_ext_clock, the internal timers and ramp generators use either the pin CLK32K as input or f_{CLK} divided by 2 and 31:

Table 7. GPO_Control Register

Addr: 04h		GPO_Control Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
6	sel_ext_clock	0h	R/W	Enables the external clock on CLK32K (see Figure 17)	
				0	Use internal f_{CLK} clock divided by 31*2
				1	Use external clock on CLK32K (also osc_always_on=0)[1]

1. Using an external clock has two advantages:
   a) Reduced quiescent current: the internal clock is switched off whenever possible and the timers run from CLK32K.
   b) All timings (e.g. ramp-up, wait) are as accurate as the external clock (usually derived from a crystal).

The external clock on CLK32K is monitored and if the internal clock is enabled and no valid clock are detected the register bit no_extclock_detected (see page 37) is set and an interrupt can be triggered.

The internal oscillator is enabled and disabled automatically if register bit osc_always_on is reset:

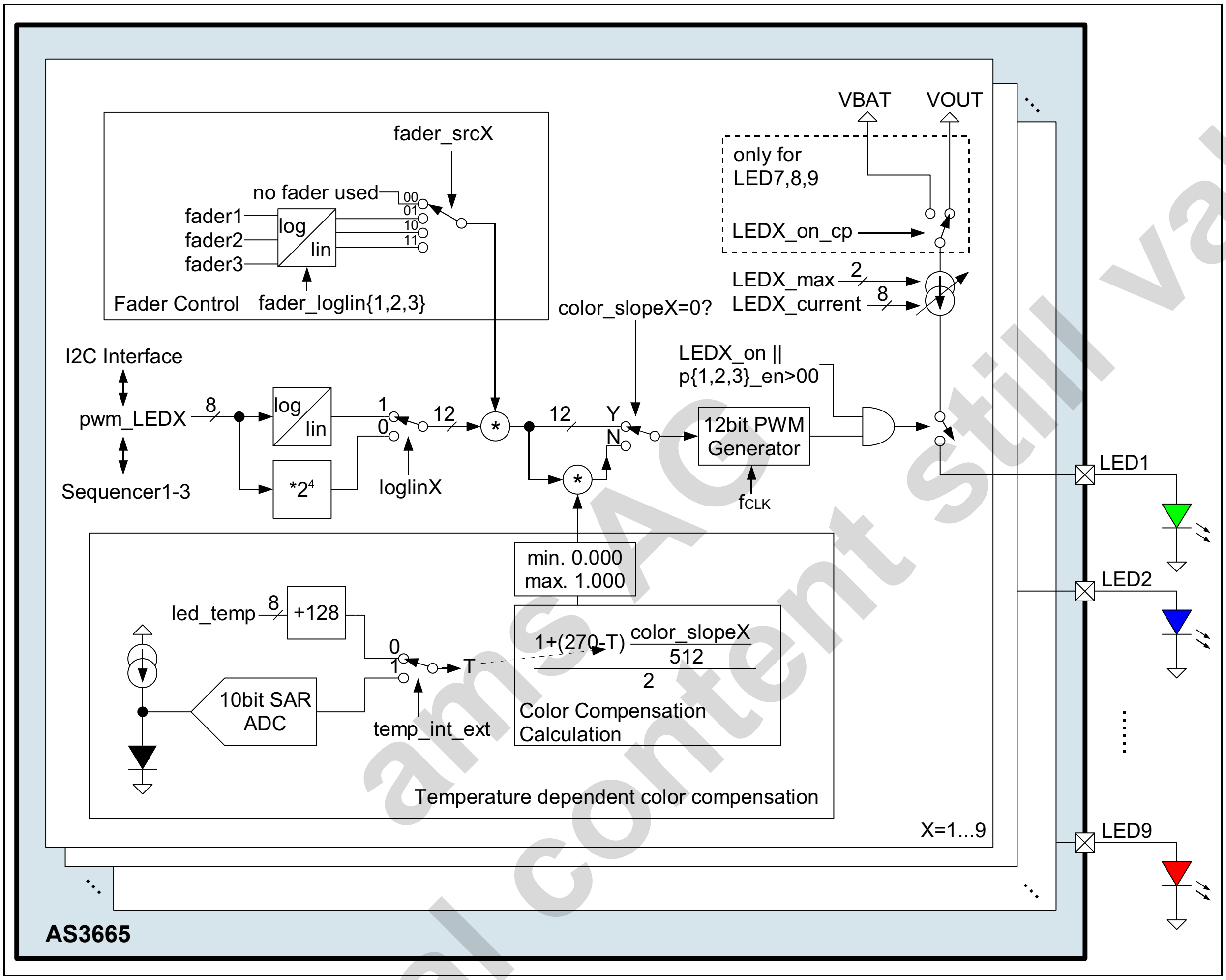
Table 8. Supervision Register

Addr: 08h		Supervision Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
5	osc_always_on	0h	R/W	Enables the internal oscillator (see Figure 17)	
				0	Enable internal oscillator only if required
				1	The internal oscillator is always running (except in shutdown mode)

Current Sources

The internal circuit of the current sources is shown in Figure 18 (one current source shown; internally there are 9 identical blocks):

Figure 18. Current Sources



The processing path consists of the following step (using current source 1 as example):

1. The input of the complete current source block is the register pwm_LED1 (see page 22). This register can be controlled by I^2C directly or by any of the three sequencers (see section Sequencers on page 48).
2. The signal is converted from logarithmic domain to linear domain (depending on signal loglin1 (see page 25)) or multiplied by 16 to obtain 12 bits.
3. It passes an adjustable fader (it can be multiplied by any of the fader registers fader1, fader2 or fader3). If fader_src1 (see page 25)=0, the fader is not used (signal is unchanged).
4. Color correction is performed (temp_int_ext (see page 24) selects either internal temperature measurement or use the register led_temp (see page 24)). The gain of the color correction can be adjusted by color_slope1 (see page 25). If color_slope1=0, color correction is disabled.
5. The resulting 12 bit signal goes to the PMW generator and then to the current source itself.
6. The current source is enabled by LED1_on[5] and its current is adjusted by LED_current1 and LED1_max.

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5. LED1_on...LED9_on have only effect if all sequencer are switched off (p1_en (see page 46)=00 and p2_en=00 and p3_en=00). This allow direct control of the LEDs if no program is executed.

7. LED7, LED8 and LED9 have the option to be powered by VBAT directly (configured by LED7_on_cp...LED9_on_cp)

Interface to sequencers

pwm_LED1 (see page 22), pwm_LED2...pwm_LED9 is the input PWM value of the current sources (8 bit value). This value can be either controlled by the I^{2}C interface or by any of the sequencers (see section Sequencers on page 48).

Logarithmic/Linear Ramping

All current sources support logarithmic or linear ramping (selected by register bits loglin1 (see page 25), loglin2...loglin9). As light is perceived logarithmically, it is recommended to keep the current sources in logarithmic mode (default setting).

RGB Color Correction

The RGB Color correction changes the output PWM value depending on the temperature (either the junction temperature if temp_int_ext (see page 24)=0, or a I^{2}C value stored in led_temp (see page 24) if temp_int_ext=1). This compensates different temperature drifts of LEDs and keep the white point over temperature. The slope of this temperature compensation is adjustable with the register color_slope1 (see page 25), color_slope2...color_slope9 (set to 0 if the color correction is not used).

Faders

There are three global faders: fader1 (see page 23), fader2 and fader3. Each current source can be configured to be multiplied by any of the three faders (controlled by fader_src1 (see page 25), fader_src2...fader_src9). Therefore a fader can operate on any number of current sources in parallel (e.g. to generate smooth fade-out effects on several LEDs). The faders can operate linear or logarithmic (defined by fader_loglin1 (see page 23), fader_loglin2 and fader_loglin3).

Analog Current Setting

All current sources can be completely enabled/disable by the register LED1_on, LED2_on...LED9_on. The actual analog current is set by LED_current1 (see page 17), LED_current2...LED_current9. The maximum current driving capability of the current sources is set by registers LED1_max (see page 20), LED2_max...LED9_max[6].

Current Source Registers

Analog Current setting registers

Table 9. LED_Control1 Register

Addr: 02h		LED_Control1 Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
0	LED1_on	0b	R/W	0	LED1 is off
				1	LED1 is enabled
1	LED2_on	0b	R/W	0	LED2 is off
				1	LED2 is enabled
2	LED3_on	0b	R/W	0	LED3 is off
				1	LED3 is enabled
3	LED4_on	0b	R/W	0	LED4 is off
				1	LED4 is enabled
4	LED5_on	0b	R/W	0	LED5 is off
				1	LED5 is enabled

6. Always use the minimum setting for LED1_max, LED2_max...LED9_max suitable for the application to reduce quiescent current of the internal current source

Table 9. LED_Control1 Register

Addr: 02h				LED_Control1 Register	
Bit	**Bit Name**	**Default**	**Access**	**Description**	
5	LED6_on	0b	R/W	0	LED6 is off
				1	LED6 is enabled
6	LED7_on	0b	R/W	0	LED7 is off
				1	LED7 is enabled
7	LED8_on	0b	R/W	0	LED8 is off
				1	LED8 is enabled

Table 10. LED_Control2 Register

Addr: 03h				LED_Control2 Register	
Bit	**Bit Name**	**Default**	**Access**	**Description**	
0	LED9_on	0b	R/W	0	LED9 is off
				1	LED9 is enabled

Table 11. LED_Current1 Register

Addr: 10h				LED_Current1 Register				
Bit	**Bit Name**	**Default**	**Access**	**Description**				
7:0	LED_current1	00h	R/W	Sets the current for current source on LED1				
					LED1_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 12. LED_Current2 Register

Addr: 11h				LED_Current2 Register				
Bit	**Bit Name**	**Default**	**Access**	**Description**				
7:0	LED_current2	00h	R/W	Sets the current for current source on LED2				
					LED2_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 13. LED_Current3 Register

Addr: 12h				LED_Current3 Register				
Bit	Bit Name	Default	Access	Description				
7:0	LED_current3	00h	R/W	Sets the current for current source on LED3				
					LED3_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 14. LED_Current4 Register

Addr: 13h				LED_Current4 Register				
Bit	Bit Name	Default	Access	Description				
7:0	LED_current4	00h	R/W	Sets the current for current source on LED4				
					LED4_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 15. LED_Current5 Register

Addr: 14h				LED_Current5 Register				
Bit	Bit Name	Default	Access	Description				
7:0	LED_current5	00h	R/W	Sets the current for current source on LED5				
					LED5_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 16. LED_Current6 Register

Addr: 15h				LED_Current6 Register				
Bit	**Bit Name**	**Default**	**Access**	**Description**				
7:0	LED_current6	00h	R/W	Sets the current for current source on LED6				
					LED6_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 17. LED_Current7 Register

Addr: 16h				LED_Current7 Register				
Bit	**Bit Name**	**Default**	**Access**	**Description**				
7:0	LED_current7	00h	R/W	Sets the current for current source on LED7				
					LED7_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 18. LED_Current8 Register

Addr: 17h				LED_Current8 Register				
Bit	**Bit Name**	**Default**	**Access**	**Description**				
7:0	LED_current8	00h	R/W	Sets the current for current source on LED8				
					LED8_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 19. LED_Current9 Register

Addr: 18h		LED_Current9 Register						
Bit	**Bit Name**	**Default**	**Access**	**Description**				
7:0	LED_current9	00h	R/W	Sets the current for current source on LED9				
					LED9_max			
					00	01	10	11
				0	Current source off			
				1	0.1mA	74.9µA	49.8µA	24.7µA
				...				
				255	25.5mA	19.1mA	12.7mA	6.3mA

Table 20. LED_MaxCurr1 Register

Addr: 19h		LED_MaxCurr1 Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
1:0	LED1_max	00b	R/W	Sets the maximum current for current source on LED1 (see LED_current1 on page 17)	
				00	I_{LED1} = 0...25.5mA
				01	I_{LED1} = 0...19.1mA
				10	I_{LED1} = 0...12.7mA
				11	I_{LED1} = 0...6.3mA
3:2	LED2_max	00b	R/W	Sets the maximum current for current source on LED2 (see LED_current2 on page 17)	
				00	I_{LED2} = 0...25.5mA
				01	I_{LED2} = 0...19.1mA
				10	I_{LED2} = 0...12.7mA
				11	I_{LED2} = 0...6.3mA
5:4	LED3_max	00b	R/W	Sets the maximum current for current source on LED3 (see LED_current3 on page 18)	
				00	I_{LED3} = 0...25.5mA
				01	I_{LED3} = 0...19.1mA
				10	I_{LED3} = 0...12.7mA
				11	I_{LED3} = 0...6.3mA
7:6	LED4_max	00b	R/W	Sets the maximum current for current source on LED4 (see LED_current4 on page 18)	
				00	I_{LED4} = 0...25.5mA
				01	I_{LED4} = 0...19.1mA
				10	I_{LED4} = 0...12.7mA
				11	I_{LED4} = 0...6.3mA

Table 21. LED_MaxCurr2 Register

Addr: 1Ah		LED_MaxCurr2 Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
1:0	LED5_max	00b	R/W	Sets the maximum current for current source on LED5 (see LED_current5 on page 18)	
				00	I_{LED5} = 0...25.5mA
				01	I_{LED5} = 0...19.1mA
				10	I_{LED5} = 0...12.7mA
				11	I_{LED5} = 0...6.3mA
3:2	LED6_max	00b	R/W	Sets the maximum current for current source on LED6 (see LED_current6 on page 19)	
				00	I_{LED6} = 0...25.5mA
				01	I_{LED6} = 0...19.1mA
				10	I_{LED6} = 0...12.7mA
				11	I_{LED6} = 0...6.3mA
5:4	LED7_max	00b	R/W	Sets the maximum current for current source on LED7 (see LED_current7 on page 19)	
				00	I_{LED7} = 0...25.5mA
				01	I_{LED7} = 0...19.1mA
				10	I_{LED7} = 0...12.7mA
				11	I_{LED7} = 0...6.3mA
7:6	LED8_max	00b	R/W	Sets the maximum current for current source on LED8 (see LED_current8 on page 19)	
				00	I_{LED8} = 0...25.5mA
				01	I_{LED8} = 0...19.1mA
				10	I_{LED8} = 0...12.7mA
				11	I_{LED8} = 0...6.3mA

Table 22. LED_MaxCurr3 Register

Addr: 1Bh		LED_MaxCurr3 Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
1:0	LED9_max	00b	R/W	Sets the maximum current for current source on LED9 (see LED_current9 on page 20)	
				00	I_{LED9} = 0...25.5mA
				01	I_{LED9} = 0...19.1mA
				10	I_{LED9} = 0...12.7mA
				11	I_{LED9} = 0...6.3mA

PWM Data Input Registers

Table 23. PWM_LED1, PWM_LED2...PWM_LED9, PWM_GPO Registers

Addr: 80h-89h			PWM_LED1, PWM_LED2...PWM_LED9, PWM_GPO Register			
Addr	**Bit**	**Name**	**Default**	**Access**	**Description**	
80h	7:0	pwm_LED1	00h	R/W	PWM value for Current source on LED1	
					0	LED1 Off
					...	
					255	LED1 Full Scale
81h	7:0	pwm_LED2	00h	R/W	PWM value for Current source on LED2	
					0	LED2 Off
					...	
					255	LED2 Full Scale
82h	7:0	pwm_LED3	00h	R/W	PWM value for Current source on LED3	
					0	LED3 Off
					...	
					255	LED3 Full Scale
83h	7:0	pwm_LED4	00h	R/W	PWM value for Current source on LED4	
					0	LED4 Off
					...	
					255	LED4 Full Scale
84h	7:0	pwm_LED5	00h	R/W	PWM value for Current source on LED5	
					0	LED5 Off
					...	
					255	LED5 Full Scale
85h	7:0	pwm_LED6	00h	R/W	PWM value for Current source on LED6	
					0	LED6 Off
					...	
					255	LED6 Full Scale
86h	7:0	pwm_LED7	00h	R/W	PWM value for Current source on LED7	
					0	LED7 Off
					...	
					255	LED7 Full Scale
87h	7:0	pwm_LED8	00h	R/W	PWM value for Current source on LED8	
					0	LED8 Off
					...	
					255	LED8 Full Scale
88h	7:0	pwm_LED9	00h	R/W	PWM value for Current source on LED9	
					0	LED9 Off
					...	
					255	LED9 Full Scale

Table 23. PWM_LED1, PWM_LED2...PWM_LED9, PWM_GPO Registers (Continued)

Addr: 80h-89h			PWM_LED1, PWM_LED2...PWM_LED9, PWM_GPO Register			
Addr	**Bit**	**Name**	**Default**	**Access**	**Description**	
89h	7:0	pwm_GPO	00h	R/W	PWM value for GPO PWM generator (8 bits)	
					0	PWM GPO Off
					...	
					255	PWM GPO Full Scale

RGB Color correction, Fader and Logarithmic/Linear Registers

Table 24. LED_Control2 Register

Addr: 03h		LED_Control2 Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
3	temp_comp_mode[1]	0	R/W	Temperature compensation operating mode	
				0	Normal Mode
				1	Positive Values of correction: Normal operation Negative values of correction: correction value divided by 2
4	fader_loglin1	0	R/W	Fader 1 linear / logarithmic control	
				0	Linear Operation
				1	Logarithmic Operation
5	fader_loglin2	0	R/W	Fader 2 linear / logarithmic control	
				0	Linear Operation
				1	Logarithmic Operation
6	fader_loglin3	0	R/W	Fader 3 linear / logarithmic control	
				0	Linear Operation
				1	Logarithmic Operation

1. Its safe to keep temp_comp_mode at default '0'

Table 25. Fader1, Fader2 and Fader3 Registers

Addr: 9B-9Dh			Fader1, Fader2 and Fader3 Register			
Addr	**Bit**	**Name**	**Default**	**Access**	**Description**	
9Bh	7:0	fader1	00h	R/W	Global Fader1 value	
					0	Off
					...	
					255	Full Scale
9Ch	7:0	fader2	00h	R/W	Global Fader2 value	
					0	Off
					...	
					255	Full Scale

Table 25. Fader1, Fader2 and Fader3 Registers (Continued)

Addr: 9B-9Dh			Fader1, Fader2 and Fader3 Register			
Addr	**Bit**	**Name**	**Default**	**Access**	**Description**	
9Dh	7:0	fader3	00h	R/W	Global Fader3 value	
					0	Off
					...	
					255	Full Scale

Table 26. Temp_Sense_ Control Register

Addr: 0Eh		Temp_Sense_ Control Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
0	temp_int_ext	0b	R/W	The RGB color correction uses internal/external source for temperature compensation (see RGB Color Correction on page 16)	
				0	I^2C register led_temp is used
				1	internal junction temperature measured[1]
1	temp_sens_on	0b	R/W	Internal temperature sensor enable	
				0	Internal temperature sensor off
				1	Internal temperature sensor on
2	temp_meas_busy	0b	R	Internal temperature sensor busy status signal	
				0	Internal temperature sensor off or not busy
				1	Internal temperature sensor busy

1. Set temp_sens_on=1

Table 27. LED_Temp Register

Addr: 1Fh		LED_Temp Register			
Bit	**Bit Name**	**Default**	**Access**	**Description**	
7:0	led_temp	00h	R/W	Value used for RGB color correction if temp_int_ext=1 (see RGB Color Correction on page 16)	
				185	-30ºC
				142	25ºC
				96	+85ºC