AN EFFICIENT SELF-CONFIGURABLE DRIVER FOR COLOR LIGHT EMITTING DIODES

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DOCTOR OF PHILOSOPHY

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We hereby declare that we have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Untuk mengatur arus beban yang tepat untuk perbezaan LED warna, pemandu LED yang cekap mesti memudahkan perkongsian arus antara rentetan LED menggunakan sumber arus tetap. Penggunaan kuasa yang berkesan dalam warna LED sangat penting untuk panel paparan kerana ia menentukan besarnya fenomena peralihan berkedip yang tidak di ingini. Pemacu LED yang cekap dan boleh dimalapkan sesuai untuk pemacu lampu belakang LED di panel paparan LED telah dibentangkan dalam tesis ini. Tesis ini mencadangkan pemacu LED warna dengan konfigurasi diri cermin arus ditingkatkan dalam pelbagai rentetan LED. Dalam kerja yang dicadangkan ini, arus beban telah seimbang secara seimbang antara beban LED warna yang serupa dan tidak sama. Dalam cermin arus tradisional, penukar buck dihubungkan dengan beban arus tetap. Walaupun demikian, dalam cermin arus yang dapat disesuaikan yang ditingkatkan, variasi rentetan beban LED dapat ditangani dengan menggunakan penukar tunggal. Peningkatan ini berdasarkan rangkaian kombinasi transistor dan op-amp dengan bias skema yang betul. Litar peredupan yang lebih baik kemudiannya dicadangkan untuk mengeksploitasi rangkaian peredupan pada tahap rentetan dan modul. Selanjutnya, litar pengimbangan arus yang dicadangkan tidak termasuk bekalan kuasa yang terpisah untuk mengawal arus dalam rentetan beban LED yang berbeza (merah / hijau / biru). Oleh kerana rangkaian pendekatan sama dan modular, ia dapat ditingkatkan ke sejumlah sumber arus selari. Penggerak berdenyut dua tahap yang berbeza telah dilakukan untuk mengurangkan kerugian semasa menjalankan LED pada arus puncak tinggi. Ini adalah untuk membuat dua parameter penggerak, yang merupakan tahap arus rendah / tinggi (modulasi lebar nadi) dan kitaran tugas yang berkaitan, dengan kemampuan untuk mengendalikan cahaya dengan berkesan. Ini dapat dilihat, teknik sebelumnya telah meningkatkan keberkesanan LED dengan menggunakan teknik pemanduan tahap-n tetapi pada pertukaran kecekapan dengan pengenalan perintang (pemboleh ubah dalam siri) untuk mewujudkan fenomena dua peringkat bagi pemandu. Oleh itu, dalam tesis ini, mencadangkan untuk mengganti perintang dengan litar peredupan pendekatan baru untuk mendapatkan peningkatan yang signifikan dalam kecekapan sistem keseluruhan yang dapat membantu meredupkan rentetan LED individu berdasarkan warna LED (merah atau hijau atau biru) yang ditentukan . Sementara itu, dalam meningkatkan pencahayaan melalui peredupan, hibridisasi lebar denyut dimodulasi (PWM) dan amplitud dimodulasi (AM) telah diusulkan. Sebagai hasilnya, pemandu LED yang dicadangkan telah menunjukkan keseimbangan arus yang berkesan melalui rentetan LED warna dengan memanfaatkan jarak peredupan yang besar. Analisis pencahayaan juga menunjukkan peningkatan yang lebih tinggi jika dibandingkan dengan PWM (berdenyut dua peringkat). Kecekapan pengiraan untuk rentetan LED biru iklan merah, hijau berkisar antara 92% hingga 99%.

ABSTRACT

To arrange an accurate load current for the different sets of color LEDs, an efficient LED driver must facilitate the current sharing among the LED strings using a constant current source. Effective utilization of power in an LED string is vital for display panels as it defines the magnitude of the undesirable phenomenon of flickering switching. An efficient and dimmable LED driver suitable for LED back-light drivers in the LED display panel is presented in this thesis. This thesis proposed a color LEDs driver with a self-configuration of the enhanced current mirror in multiple LED strings. In this proposed work, the load currents have been efficiently balanced among the identical and unequal loads of color LEDs. In a traditional current mirror, the buck converter is linked with a fixed current load. Nonetheless, in the proposed improved self-adjustable current mirror, the variation of LEDs load string could be addressed using a single buck converter. The improvement is based on the combinational circuits of transistor and op-amp with proper scheme biasing. The improved dimming circuit is then proposed for exploiting the range of dimming at the string and module level. Furthermore, the proposed current-balancing circuits excluded a separate power supply to control current in different load strings of LEDs (red/green/blue). Since the approach circuit is identical and modular, it could be scaled to any number of parallel current sources. The different bi-level pulsating driving have been performed to reduce the loss while running the LEDs at the high peak current. It is to create two driving parameters, which are the low/high current levels (pulse width modulation) and associated duty cycles, in having the capability to control luminosity effectively. It can be seen, the previous techniques had improved the luminous efficacy of LEDs by using *n*-level driving techniques but at the trade-off of losing efficiency with the introduction of resistors (variables in series) to create a bi-level phenomenon for the driver. Therefore, this thesis proposes to replace the resistors with the new approach dimming circuit to get a significant improvement in the overall system's efficiency that can assist to dim an individual LEDs string based on designated color (red or green or blue) LEDs. Meanwhile, in improving illuminance through dimming, the hybridization of pulse width modulated (PWM) and amplitude modulated (AM) has been proposed. As a result, the proposed LEDs driver has shown effective current balancing through the color LEDs string with exploiting a large dimming range. The illumination analysis has also shown a significantly higher when compared with PWM (bi-level pulsating). The computation efficiency for red, green, and blue LEDs strings around range 92% to 99%.

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LIST OF SYMBOLS

R_B	Base Resistance
I_B	Base current
B_n	Base current amplification factor
V_{BE}	Base emitter voltage
V_{CE}	Collector-emitter voltage
I_C	Collector current
I_e	Emitter current
V_E	EMITTER VOLTAGE
I_B	BASE CURRENT
I_{CEO}	Collector to emitter leakage current
V_{CE}	Collector to emitter voltage
V_{CC}	Collector voltage
V_{CB}	Collector to base voltage
I_{CB}	Collector to bas current
η	Efficiency
$V_{FORWARD}$	Forward voltage
$I_{LOAD_{CURRENT}}$	Load current
Ω	Ohms
P_{LED}	Power of LED
P_{STRING}	Power dissipated across the string
P_{STRING}	Resistance of the LED load
R_{S_STRING}	Sum of power dissipated in string
R_{EQU1}	Sum of series resistances in a string
R_{OUT}	Sum of parallel loads of LEDs
V_{ac}	voltage-alternate current

LIST OF ABBREVIATIONS

AM	amplitude Modulation
CCT	correlated color temperature
CLFTS	coordinated low-frequency and time-sharing
CST	current balancing transformer
CM	current mirror
CCB	current charge balancing
DC	DIRECT CURRENT
T_{dim}	dimming period
EMI	electromagnetic interference
HFTS	high-frequency-timesharing
HF	HIGH-FREQUENCY
IDR	instant-duty-restoration
LCD	liquid crystal display
LFS	low-frequency sequential
LEDs	light emitting diodes
Mt	matrix transformer
PWM	pulse width modulation
RGB	Red Green Blue
SCD	sequential scanning color display
SIMO	single input multiple output

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