DN55
A high efficiency Royer driver for a scanner CCFL

Ken White, Systems Engineer, Zetex Semiconductors

This design note has been updated to include additional choices of transistors to provide greater efficiency.

This is a practical application using Zetex low $V_{CE(sat)}$ transistors for driving a Harrison 4.5W CCFL lamp (240mm x 3mm) which is used in scanners.

The circuit shown in Figure 1 can be modified for alternative CCFL lamps or fluorescent tubes typically used in LCD displays and emergency lighting.

Using a 12V DC supply, this circuit provides a sinusoidal lamp current of 5mA RMS with a DC supply current of 370mA. The resonant frequency is approximately 65kHz after the lamp has struck. This can vary slightly according to the lamp condition. At resonance, the voltage peak at the collector of each transistor is approximately three times the supply voltage. Therefore the VCEO of Q1 and Q2 should be around 40 volts.

A benefit of this circuit is that when Q1 is conducting, Q2 base is at a negative voltage and therefore the much higher V_{CBO} rating could be used; typically twice V_{CEO}. In practice, because of the dynamic load and possible loss of load altogether, it is prudent to keep the voltage rating higher than the circuit suggests. The efficiency, measured with a 150KΩ load (to give 5mA) in place of the lamp, is greater than 80% when using FMMT619 low saturation (maximum 200mV at 1A @ 25°C) SOT23 device.

Since $V_{CE(sat)}$ x collector current represents the majority of the power loss in this circuit, a more recent Zetex device with lower saturation would be a better choice to improve efficiency. The ZXTN2031FTA has an impressive 40mV saturation at 1A @ 25°C and would increase efficiency towards 90%. If cost is a critical factor, the ZXTN25040DFH (maximum 210mV saturation at 1A @ 25°C) which has a small die size is an alternative to the FMMT619.

Although heat dissipation in these SOT23 devices can be achieved using PCB alone, it is worth noting that a 50mm square pad of 1oz copper is approximately equivalent to a heatsink rated at 110°C per watt. Similarly, the same size pad using 2oz copper is approximately equivalent to a heatsink rated at 70°C per watt. Double sided or multilayer PCBs should utilize thermal vias to aid dissipation where possible. Remember to keep the SOT23 pad geometry correct for soldering with short track leading outward towards the larger copper areas. Ground planes under the SOT23 (tracking permitting) is an additional method of removing heat.

On initial inspection of the Royer circuit it would appear possible that on power-up, if both Q1 and Q2 turn on together they would conduct with only the DC resistance of the coils to limit the current. In practice however, this condition rarely occurs and is virtually eliminated by the connection of R1 direct into the base of Q1. Q1 conducts first because the base drive of Q2 is delayed through the feedback winding T1-B inductance.

For additional circuits (eg an op amp) requiring a low current voltage supply higher than 12 volts, the collectors of Q1 and Q2 can be rectified and smoothed providing approximately 36 volts. An additional benefit is that voltage spikes reflected back through the transformer created by lamp loss or failure would be absorbed in the smoothing capacitor and will protect Q1 and Q2 from excessive voltage.

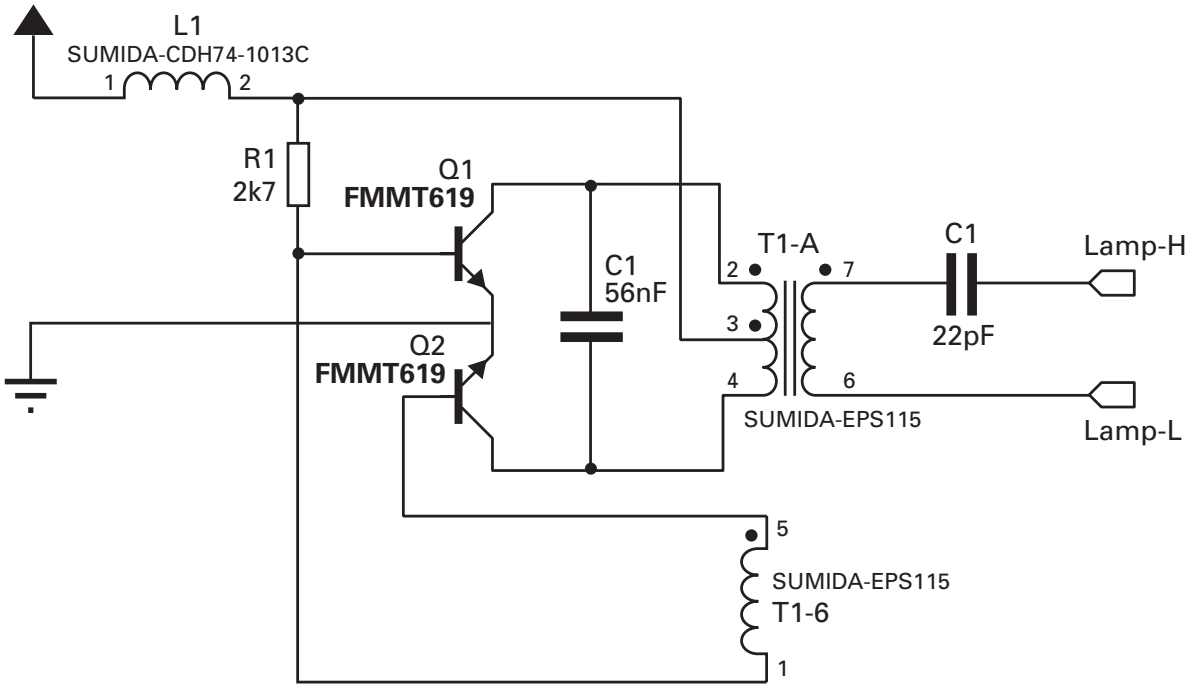

Figure 1 Application circuit

Intentionally left blank

Definitions

Product change

Zetex Semiconductors reserves the right to alter, without notice, specifications, design, price or conditions of supply of any product or service. Customers are solely responsible for obtaining the latest relevant information before placing orders.

Applications disclaimer

The circuits in this design/application note are offered as design ideas. It is the responsibility of the user to ensure that the circuit is fit for the user's application and meets with the user's requirements. No representation or warranty is given and no liability whatsoever is assumed by Zetex with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Zetex does not assume any legal responsibility or will not be held legally liable (whether in contract, tort (including negligence), breach of statutory duty, restriction or otherwise) for any damages, loss of profit, business, contract, opportunity or consequential loss in the use of these circuit applications, under any circumstances.

Life support

Zetex products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Zetex Semiconductors plc. As used herein:

A. Life support devices or systems are devices or systems which:
   1. are intended to implant into the body

or

   2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labelling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Reproduction

The product specifications contained in this publication are issued to provide outline information only which (unless agreed by the company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or be regarded as a representation relating to the products or services concerned.

Terms and Conditions

All products are sold subjects to Zetex' terms and conditions of sale, and this disclaimer (save in the event of a conflict between the two when the terms of the contract shall prevail) according to region, supplied at the time of order acknowledgement.

For the latest information on technology, delivery terms and conditions and prices, please contact your nearest Zetex sales office .

Quality of product

Zetex is an ISO 9001 and TS16949 certified semiconductor manufacturer.

To ensure quality of service and products we strongly advise the purchase of parts directly from Zetex Semiconductors or one of our regionally authorized distributors. For a complete listing of authorized distributors please visit: **www.zetex.com/salesnetwork**

Zetex Semiconductors does not warrant or accept any liability whatsoever in respect of any parts purchased through unauthorized sales channels.

ESD (Electrostatic discharge)

Semiconductor devices are susceptible to damage by ESD. Suitable precautions should be taken when handling and transporting devices. The possible damage to devices depends on the circumstances of the handling and transporting, and the nature of the device. The extent of damage can vary from immediate functional or parametric malfunction to degradation of function or performance in use over time. Devices suspected of being affected should be replaced.

Green compliance

Zetex Semiconductors is committed to environmental excellence in all aspects of its operations which includes meeting or exceeding regulatory requirements with respect to the use of hazardous substances. Numerous successful programs have been implemented to reduce the use of hazardous substances and/or emissions.

All Zetex components are compliant with the RoHS directive, and through this it is supporting its customers in their compliance with WEEE and ELV directives.

Product status key:

"Preview"	Future device intended for production at some point. Samples may be available
"Active"	Product status recommended for new designs
"Last time buy (LTB)"	Device will be discontinued and last time buy period and delivery is in effect
"Not recommended for new designs"	Device is still in production to support existing designs and production
"Obsolete"	Production has been discontinued

Datasheet status key:

"Draft version"	This term denotes a very early datasheet version and contains highly provisional information, which may change in any manner without notice.
"Provisional version"	This term denotes a pre-release datasheet. It provides a clear indication of anticipated performance. However, changes to the test conditions and specifications may occur, at any time and without notice.
"Issue"	This term denotes an issued datasheet containing finalized specifications. However, changes to specifications may occur, at any time and without notice.

Zetex sales offices

Europe	**Americas**	**Asia Pacific**	**Corporate Headquarters**
Zetex GmbH Kustermann-park Balanstraße 59 D-81541 München Germany	Zetex Inc 700 Veterans Memorial Highway Hauppauge, NY 11788 USA	Zetex (Asia Ltd) 3701-04 Metroplaza Tower 1 Hing Fong Road, Kwai Fong Hong Kong	Zetex Semiconductors plc Zetex Technology Park, Chadderton Oldham, OL9 9LL United Kingdom
Telefon: (49) 89 45 49 49 0 Fax: (49) 89 45 49 49 49 europe.sales@zetex.com	Telephone: (1) 631 360 2222 Fax: (1) 631 360 8222 usa.sales@zetex.com	Telephone: (852) 26100 611 Fax: (852) 24250 494 asia.sales@zetex.com	Telephone: (44) 161 622 4444 Fax: (44) 161 622 4446 hq@zetex.com