FAIRCHILD™

The Power to Amaze.

FL5150/60 IGBT and MOSFET AC Phase Cut Dimmer Controller

Offline Power Solutions

May 2016

Fairchild Lighting Products

FL5150 & FL5160 IGBT / MOSFET AC Phase-Cut Dimmer Controller

- Fairchild has a new Dimmer Controller IC in development to address new lighting requirements for non-resistive loads: LED products
- Engineering Sample is ready
- Product Release by June, 2016

Fairchild Lighting Products

- The Key FL5150 & FL5160 Features Include:
  - IGBT or HVMOS Symmetric AC current control

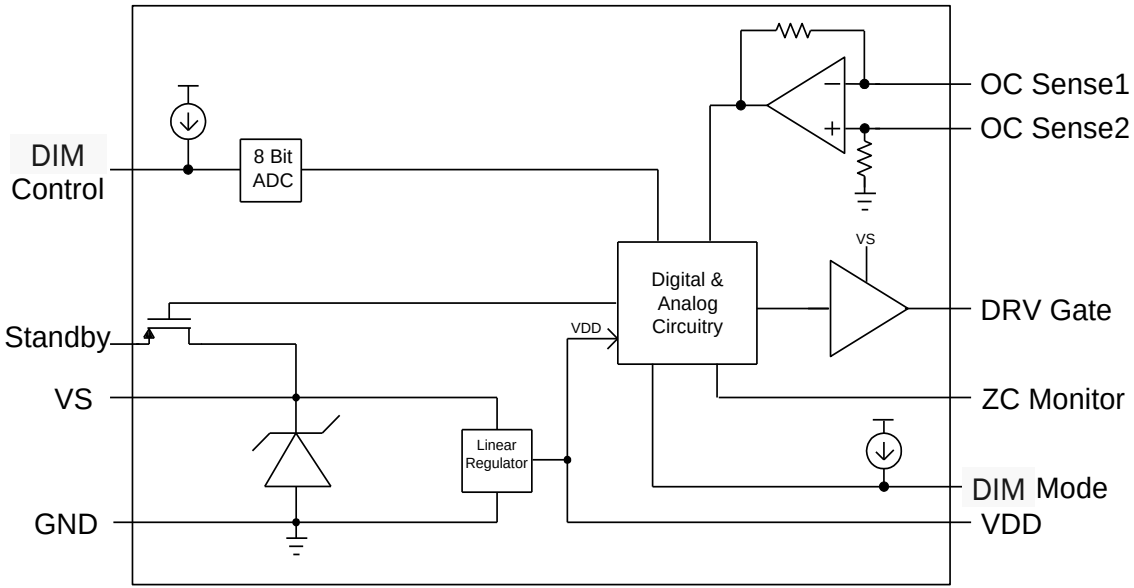
    - Selectable Trailing or leading edge phase cut dimming
    - 8 Bit ADC with ~226 dimming pulse widths
    - Line Hot or Earth GND ZC detection
    - Over current and temperature protection
    - Soft start-up / turn-off
    - Automatically Max Gate Pulse Width control(Auto Max)
    - Force 100% duty cycle for 3-wire applications
    - Min & max ZC window comparator
    - Low power mode
    - SOIC10 Package
    - Minimum External components

AC Mains input frequency

50Hz – FL5150
60Hz – FL5160

FL5150 & FL5160 Product Development Update

Internal Block Diagram



Brief Description for the FL5160 circuitry:

A 17V shunt regulator generates the bias for the gate drive and a 5V linear regulator provides bias for the CMOS digital logic.

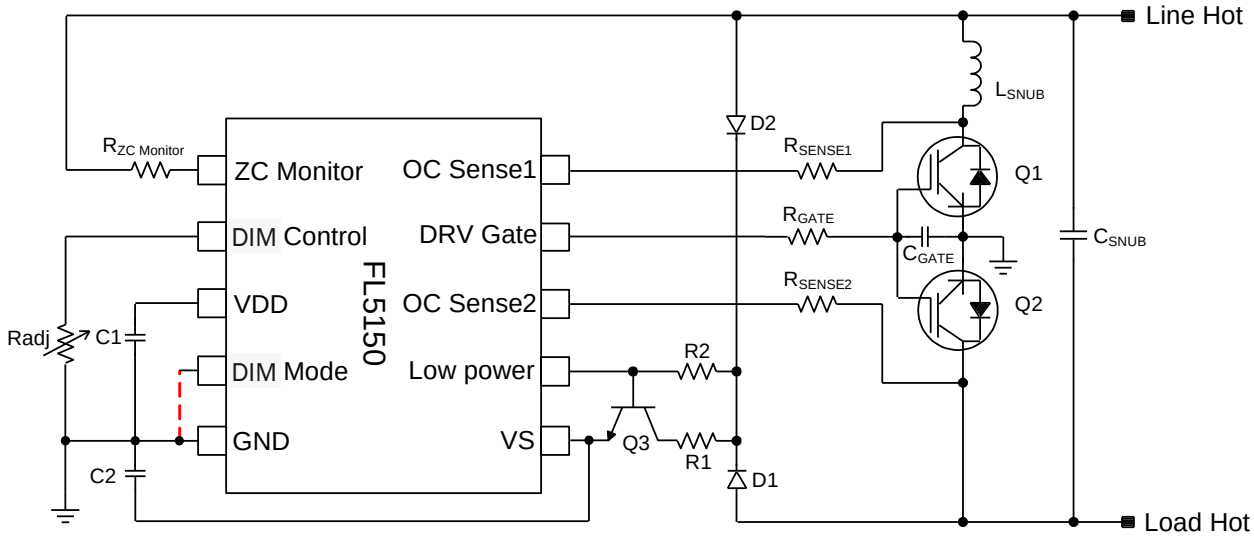
There is a 10uA current source for the DIM Control pin. A 0 to 250KΩ adjustable resistor connected to this pin provides for min and max PW dimming via an 8 Bit ADC

At POR the DIM Mode pin is checked and if low, TE mode is selected (~75ms). If this pin is connected to VDD, LE mode is selected. Also at start up the ZC Monitor pin's phase is compared to the OC Sense 1 pin's phase and the appropriate internal circuitry is selected for Earth or Line Hot ZC detection.

The DIFF AMP monitors the voltage across the drains (collectors) of Q1 & Q2 and provides for over current and temperature protection

FL5150 & FL5160 Product Development Update

230VAC typical 2-wire 50Hz Application



Typical Values:

R1: 35KΩ
R_{SENSE1}: 2MΩ
Q1&Q2: NGTB10N60FG
L_{SNUB} and C_{SNUB} are optional

R2: 350KΩ
R_{SENSE2}: 2MΩ

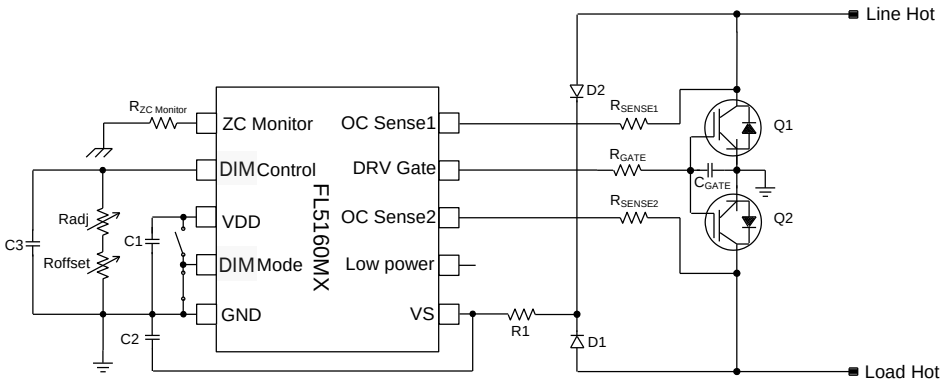
Radj: 0Ω–350KΩ
C1: 100nF

$R_{ZCMonitor}$: 4.7MΩ
C_{GATE}: 22nF

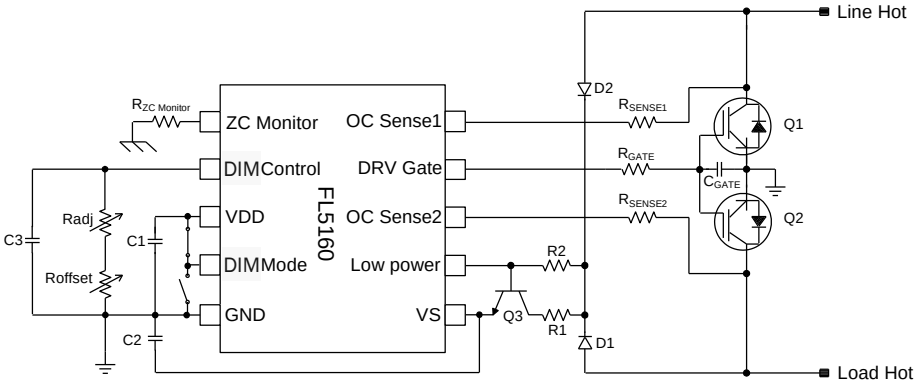
R_{GATE}: 1KΩ
C2: 2.2µF

FL5150 & FL5160 Product Development Update

120VAC typical 60Hz 2-wire Application



(TE mode selected)



Low Power app. (LE mode selected)

Typical Values :

R1: 15 kΩ
$R_{ZC\ Monitor}$: 1 MΩ
C1: 100 nF
Q1: FDPF33N25

R2: 150 kΩ
R_{GATE}: 1 kΩ
C2: 1.5 mF
Q2: FDPF33N25

R_{ADJ}: 0 to 250 kΩ
R_{SENSE1}: 1 MΩ
C3: 22 nF

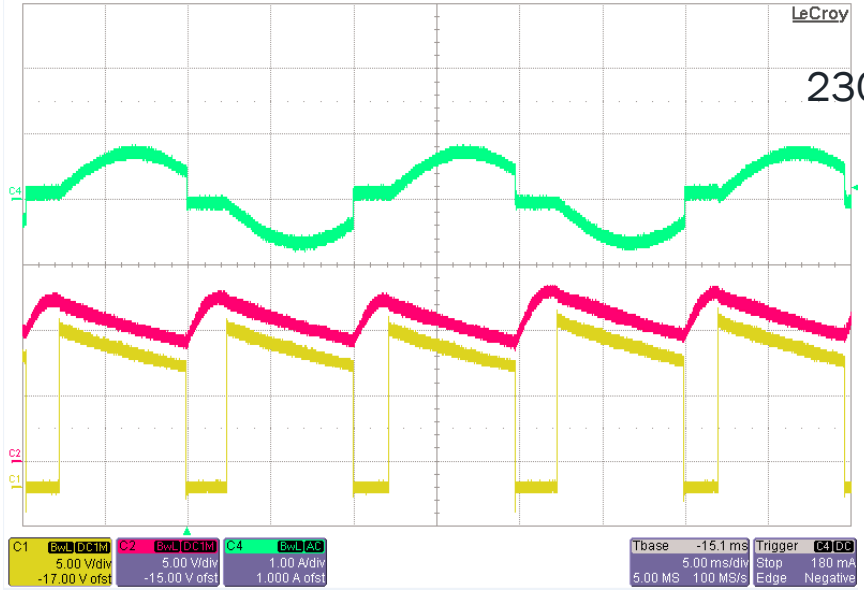
R_{OFFSET}: 0 to 50 kΩ
R_{SENSE2}: 1 MΩ
C_{GATE}: 22 nF

Note:
UL1472 update in Sep. 2015 to allow up to 500uA of ground leakage current This would allow the ZC monitor resistor to be connected to earth ground (green safety wire)

FL5150 & FL5160 Product Development Update

2-wire application, Steady State with Incandescent lamp

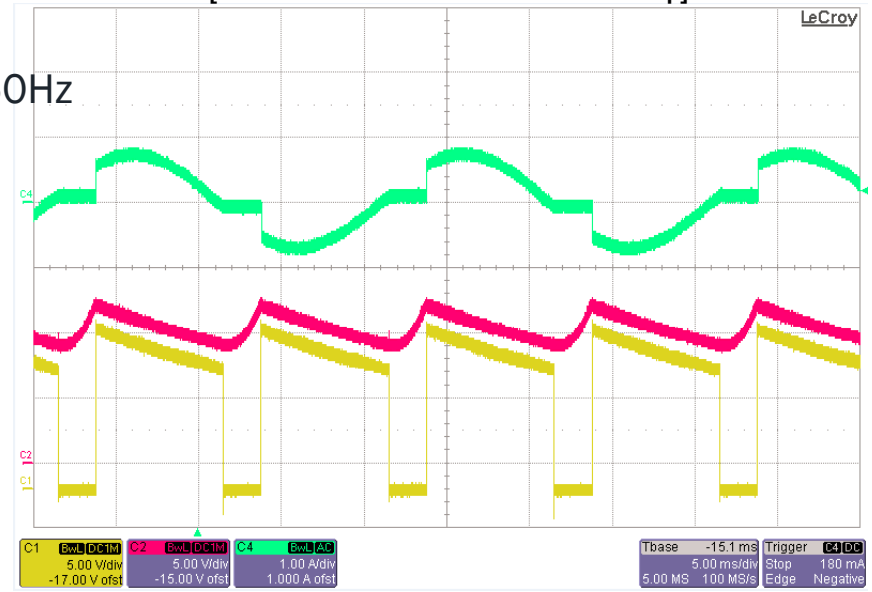
[FL5150 TE mode at 2 wire with 100W lamp]



C1[DRV]C2[VS]C4[I_{LOAD}]

230VAC, 50Hz

[FL5150 LE mode at 2 wire with 100W lamp]

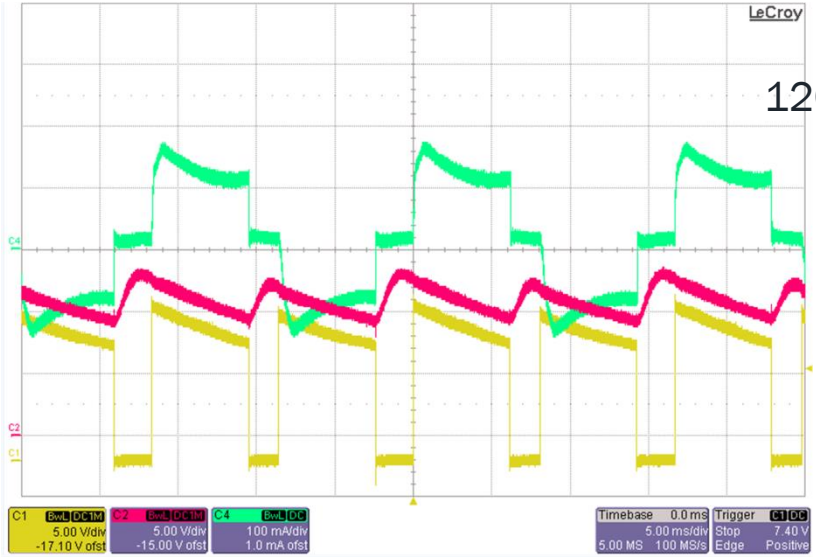


C1[DRV]C2[VS]C4[I_{LOAD}]

FL5150 & FL5160 Product Development Update

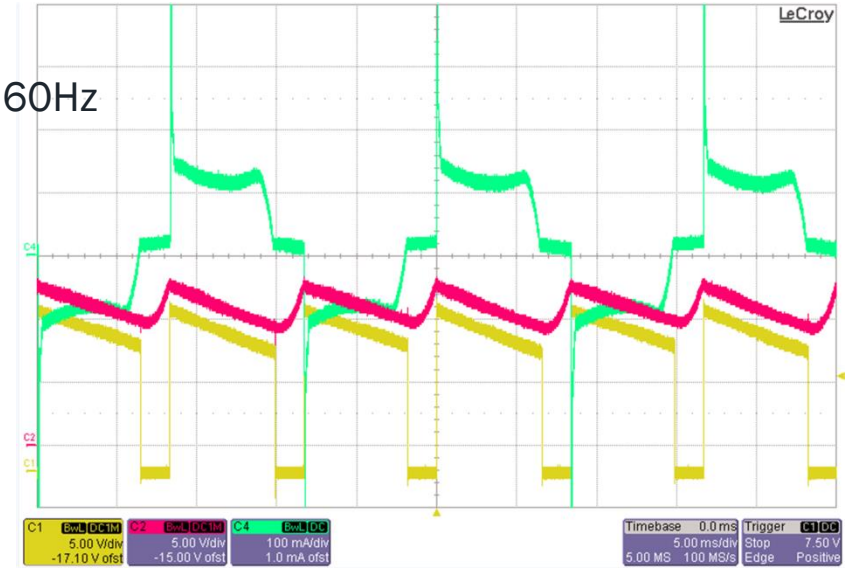
2-wire Application, steady state with LED bulb

Trailing Edge



120VAC, 60Hz

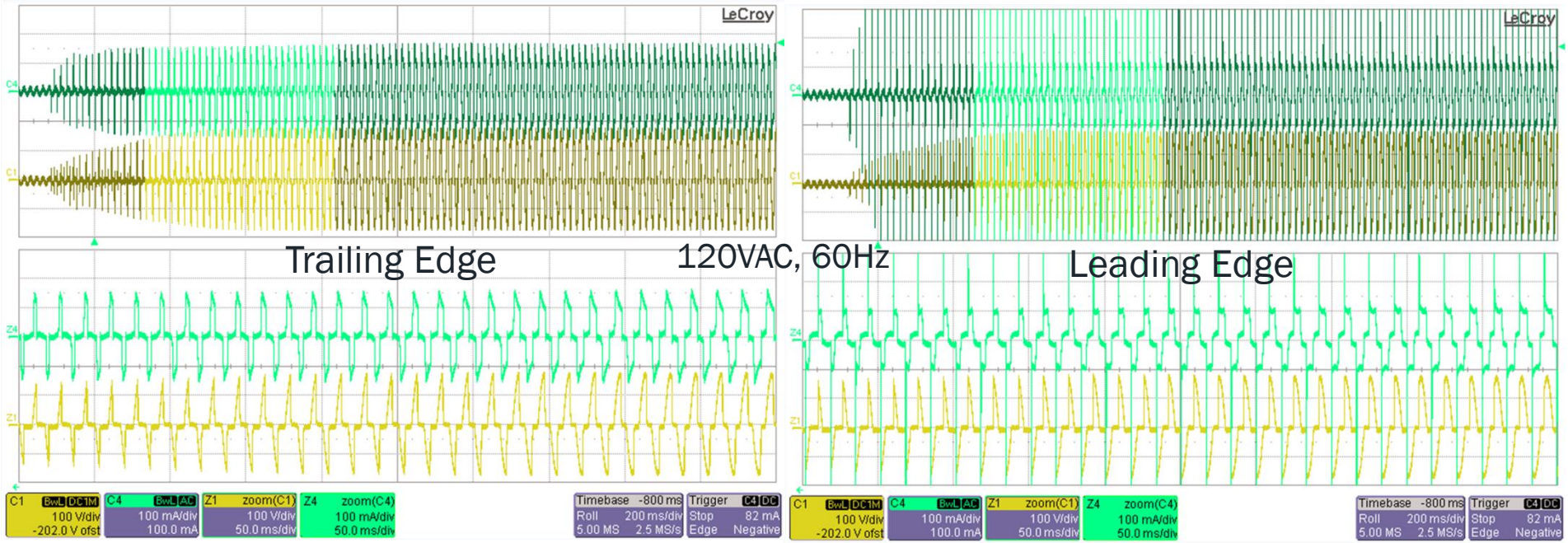
Leading Edge



C1[DRV] C2[VS] C4[I_{LOAD}]

FL5150 & FL5160 Product Development Update

2-wire application, start-up with LED bulb

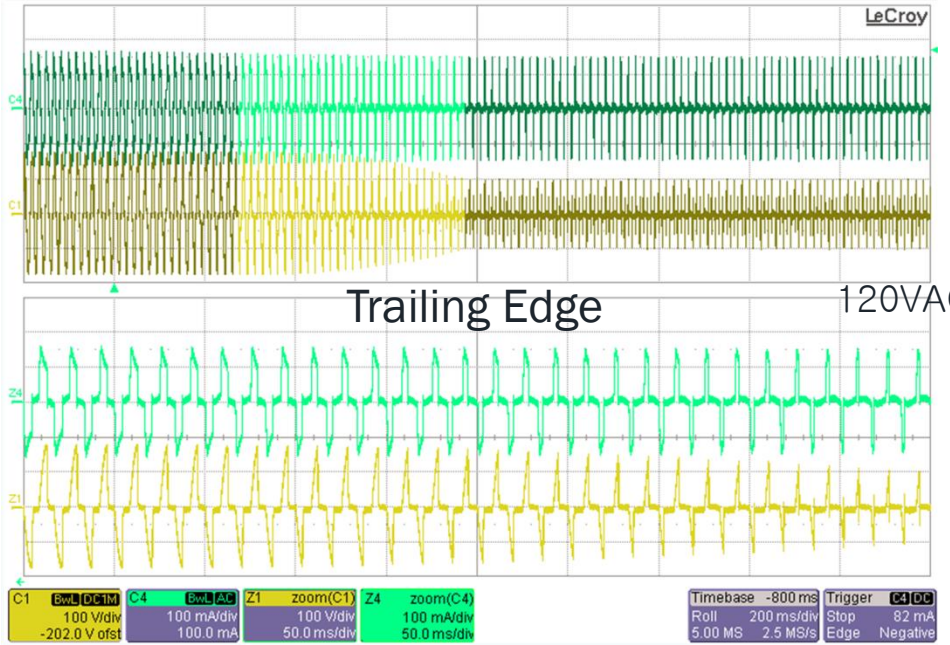


$C1[V_{LOADHOT}]$ $C4[I_{LOAD}]$

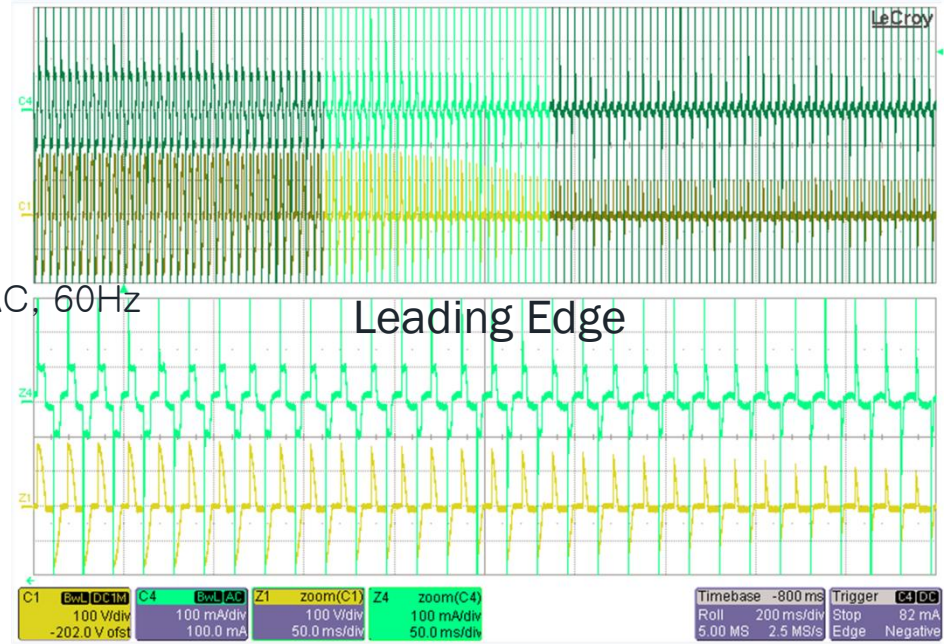
Soft-Start function: Pulse width increases gradually

FL5150 & FL5160 Product Development Update

2-wire application, Turn-off with LED bulb



120VAC, 60Hz



C1[$V_{LOADHOT}$] C4[I_{LOAD}]

Pulse width decreases gradually during turn-off as well

FL5150 & FL5160 Product Development Update

AUTO MAX Control

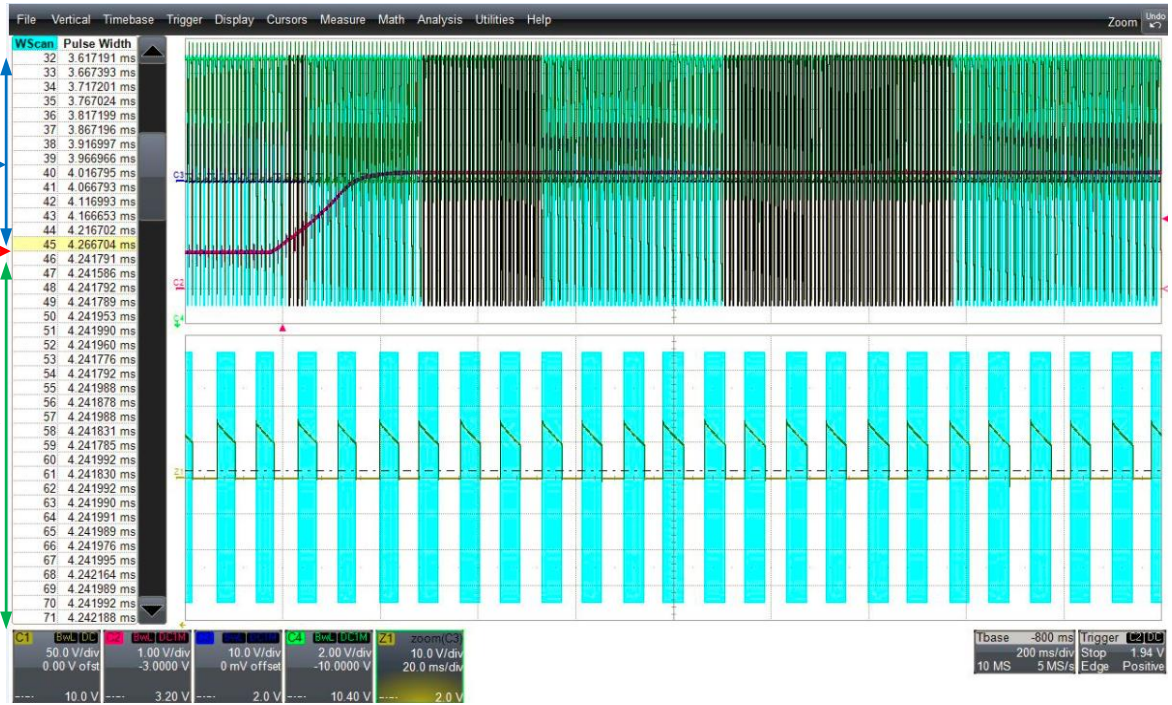
2-wire, 120VAC, 60Hz, TE mode

1 step of pulse width down automatically

50us increment

25us reduction

Steady state (No change)



C1[$V_{LOAD\ HOT}$]C2[PWC]C3[DRV]C4[VS]

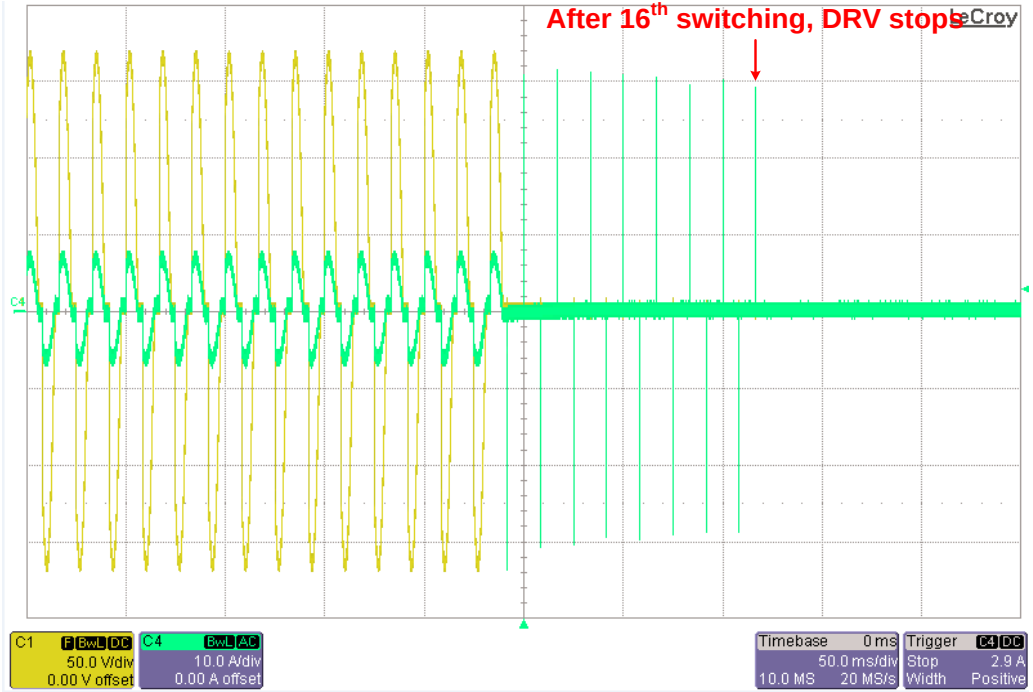
If VS becomes lower than threshold while pulse width increase, then pulse width is controlled automatically in order not to create flicker

FL5150 & FL5160 Product Development Update

Over Current Protection

LE mode

120VAC, 60Hz



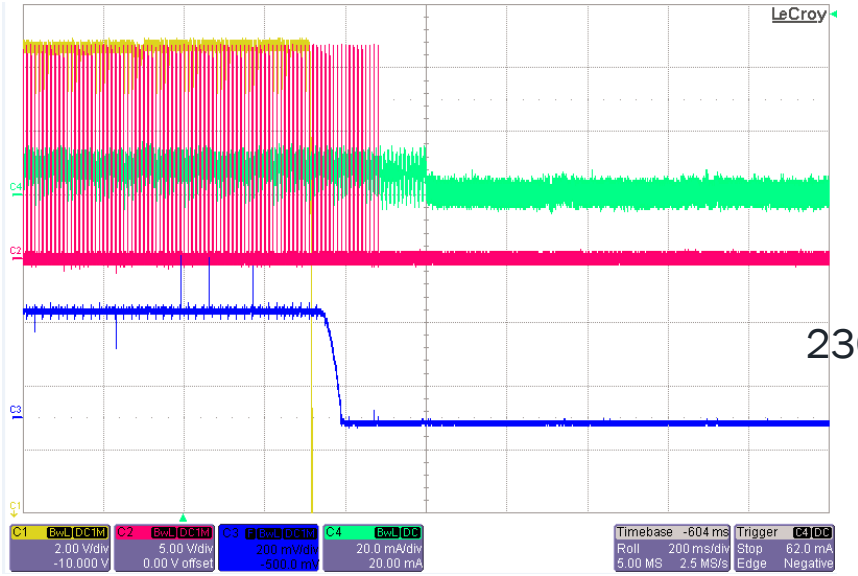
C1[$V_{LOAD\ HOT}$]C4[I_{LOAD}]

OC triggered after a load increased from 600 to 900W

FL5150 & FL5160 Product Development Update

2-wire application, Low Power mode

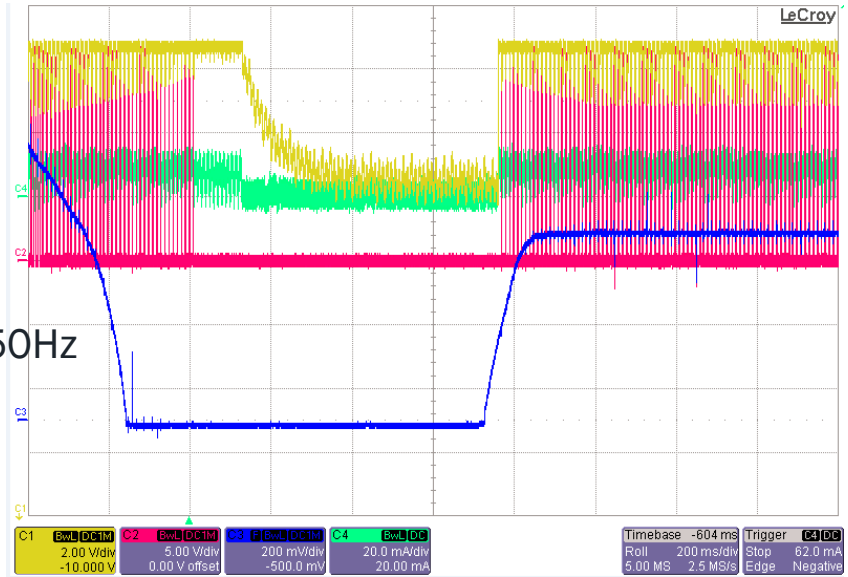
[FL5150 LE mode at 2 wire with 100W lamp]



C1[VS]C2[DRV]C3[DIM Control]C4[I_{VS}]

230VAC, 50Hz

[FL5150 LE mode at 2 wire with 100W lamp]

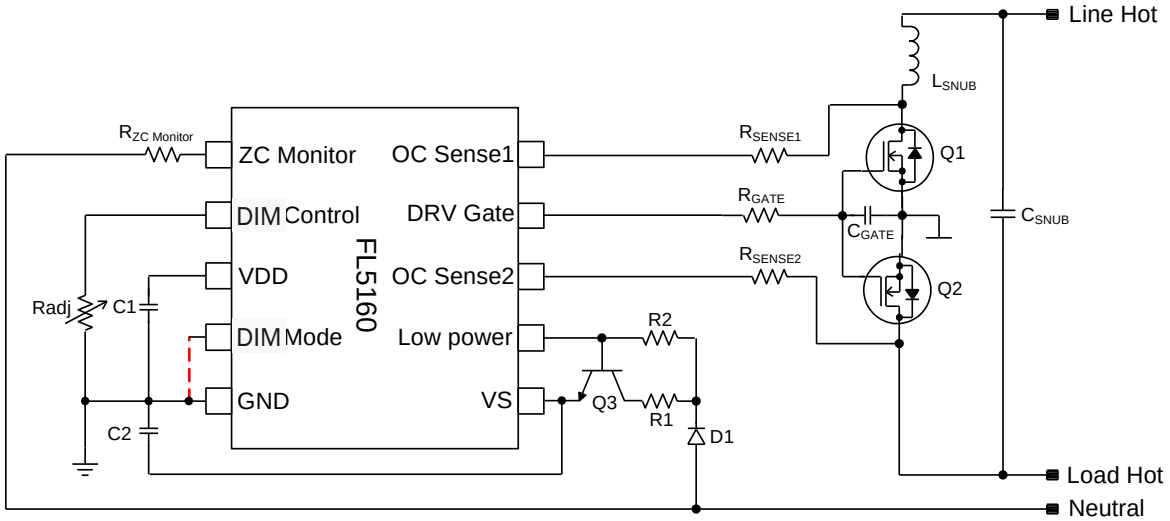


C1[VS]C2[DRV]C3[DIM Control]C4[I_{VS}]

When Dim control reaches 0V, Low Power mode is enabled to reduce power dissipation at VS resistor after around 100 ms

FL5150 & FL5160 Product Development Update

120VAC typical 60Hz 3-wire Application



Typical Values :

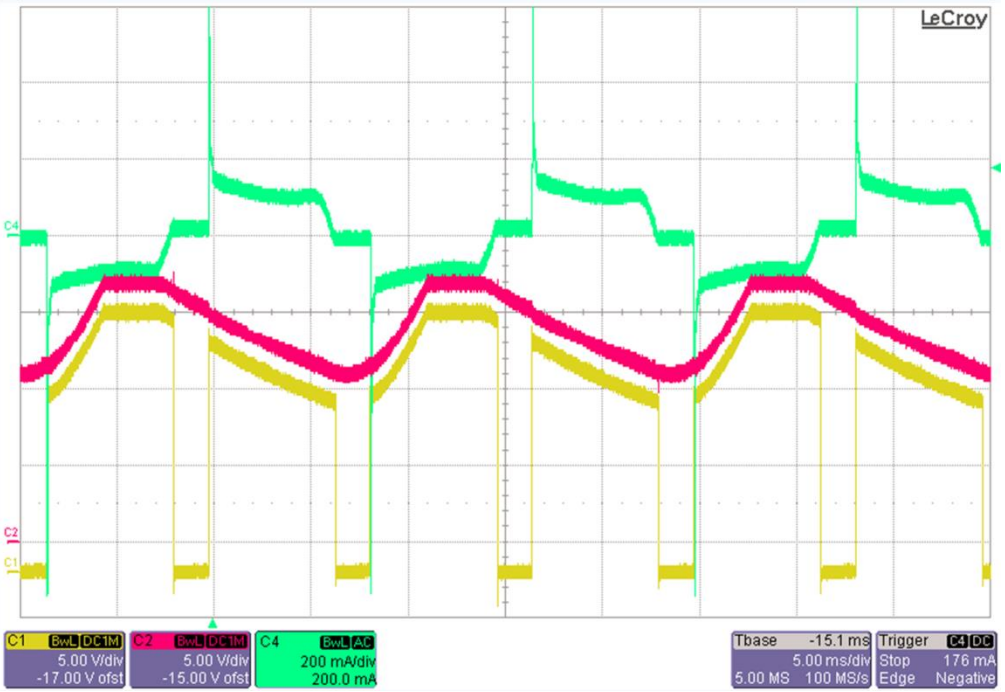
R1: 30 kΩ
R2: 150 kΩ
R_{ADJ}: 0 to 250 kΩ
$R_{ZC\ Monitor}$: 1 MΩ
R_{GATE}: 1 kΩ
R_{SENSE1}: 1 MΩ
R_{SENSE2}: 1 MΩ
C1: 100 nF
C2: 4.7 uF
C3: 22 nF
C_{GATE}: 22 nF
Q1: FDPF33N25
Q2: FDPF33N25
Q3: KSP44
L_{SNUB} and C_{SNUB} are optional

FL5150 & FL5160 Product Development Update

3-wire application, steady State waveform with LED bulb

LE mode

120VAC, 60Hz



C1[DRV] C2[VS] C4[I_{LOAD}]

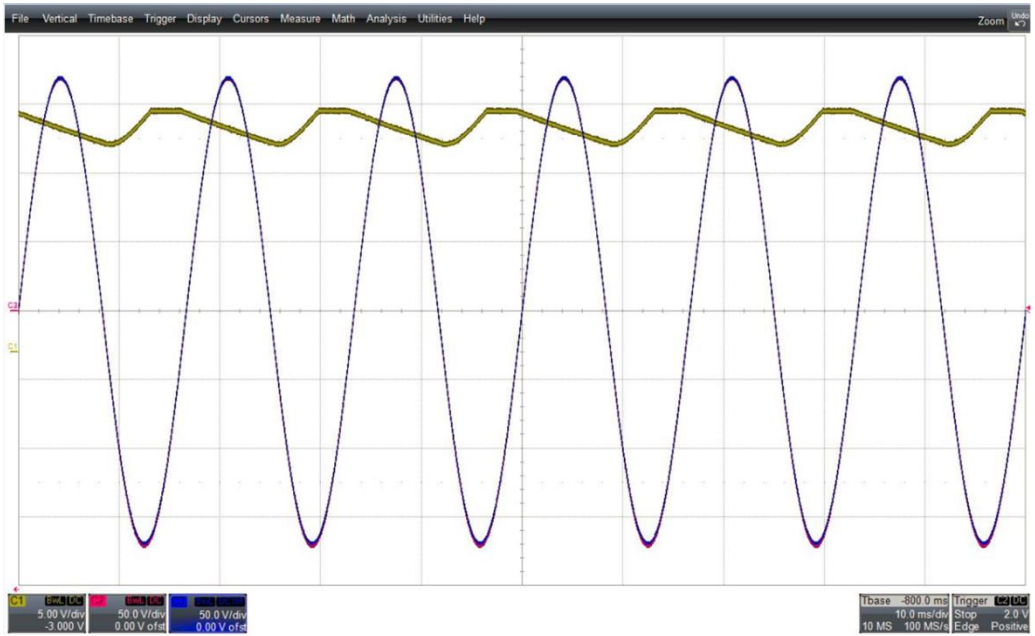
VS charged for every half cycle and discharged for the every next cycle

FL5150 & FL5160 Product Development Update

3-wire application, 100% Duty Control

TE mode

120VAC, 60Hz



C1[DRV] C2[$V_{LINE\ HOT}$] C3[$V_{LOAD\ HOT}$]

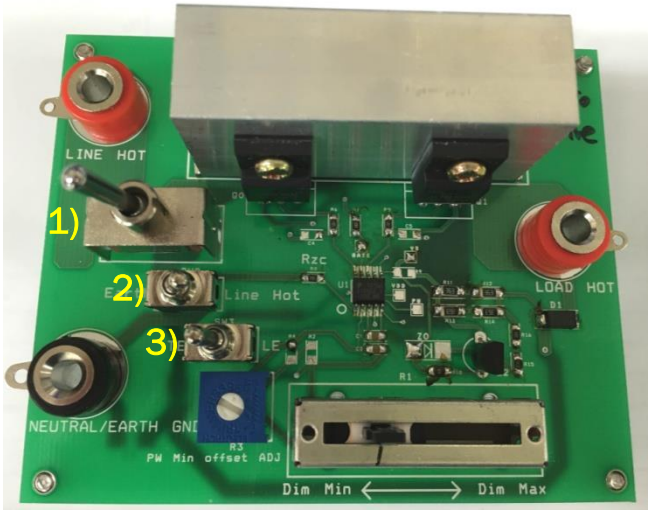
When DIM Control pin is open, then it operates 100% pulse width

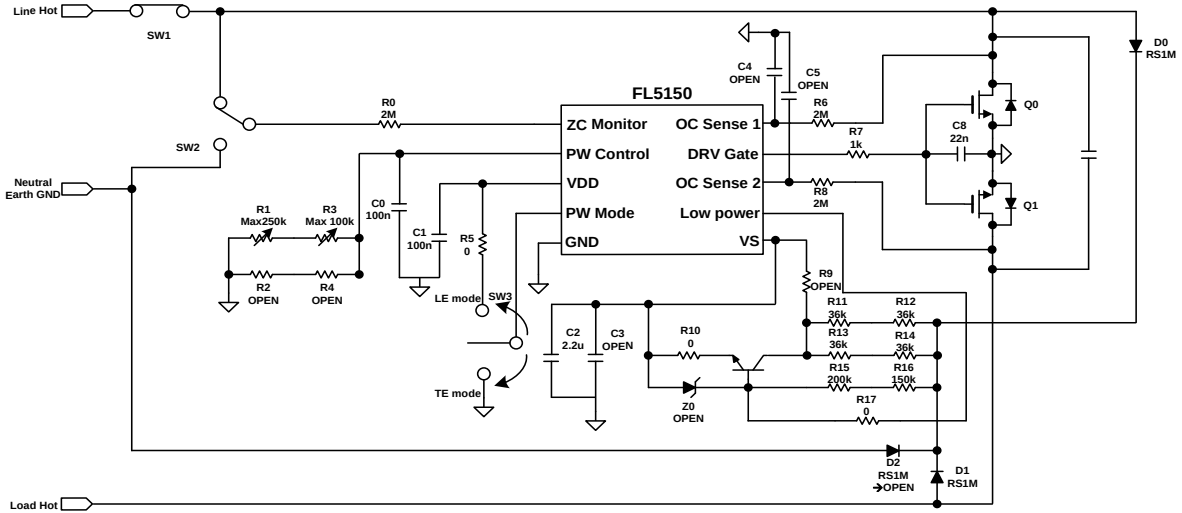
FL5150 & FL5160 Product Development Update

230VAC 2-wire 50Hz FL5150 Demo board Schematic

Switches for:

1) Power ON/OFF
2) Earth GND or Line Hot ZC Monitor
3) LE or TE mode





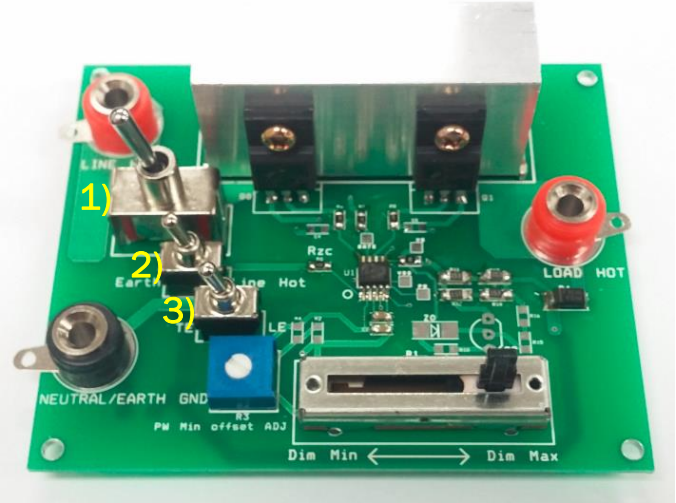
Note: For a 2-wire application, the DIM_Control pin voltage can not exceed 3.0V

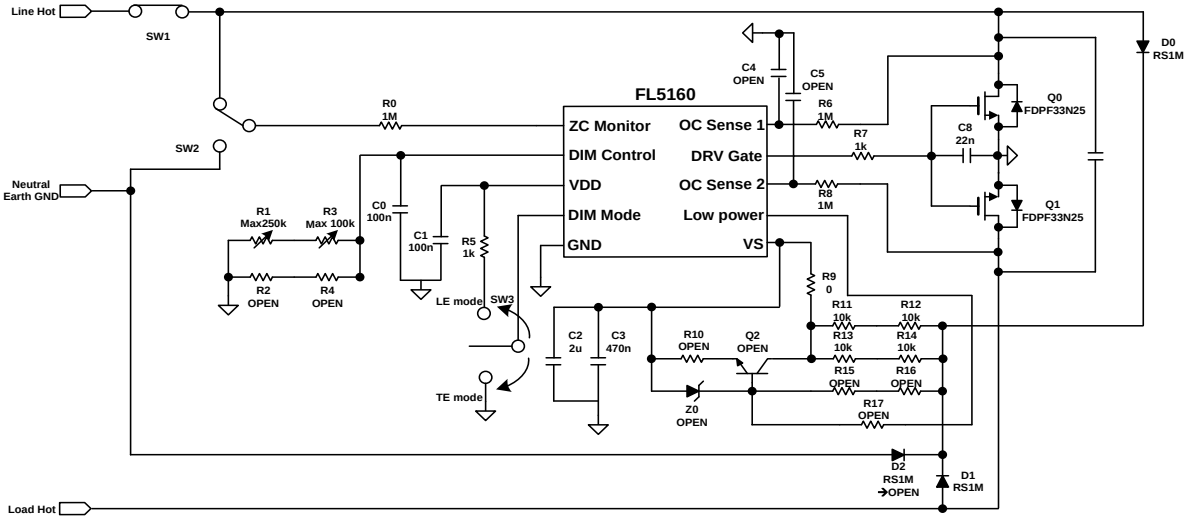
FL5150 & FL5160 Product Development Update

120VAC 2-wire 60Hz FL5160 Demo board Schematic

Switches for:

1) Power ON/OFF
2) Earth GND or Line Hot ZC Monitor
3) LE or TE mode





Note: For a 2-wire application, the DIM_Control pin voltage can not exceed 3.0V

Summary

- Fairchild's new FL5150/60 dimmer controller will provide for a very competitive next generation lighting AC dimmer design

THANK YOU