



Using LinkSwitch-PH with PWM Dimming

November 2010

PWM Dimming

■ PWM – Analog

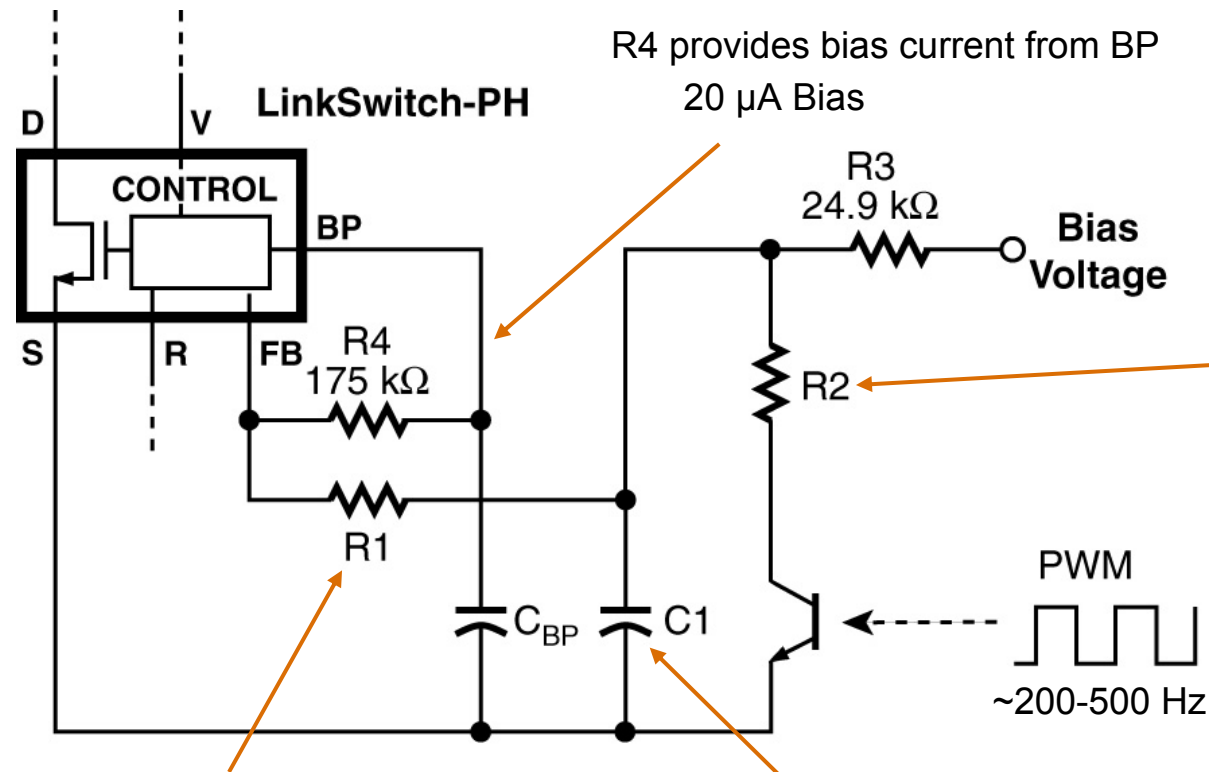
- PWM signal modifies FB Pin current to change output current
- Same concept for 0 to 10 V dimming
- Advantages
 - Do not need to reduce transformer's flux density for audible noise
 - Power Factor > 0.8 over dimming range
- Disadvantages
 - Limited dimming range <20:1

■ PWM – Digital

- PWM signal inhibits operation of LinkSwitch-PH
- Advantages
 - Large dimming range
- Disadvantages
 - Need to reduce transformer's flux density for audible noise
 - » Limited data less than BM 2000 Gauss recommended
 - Poor Power Factor during dimming



PWM Signal Reduces FB Pin Current to Control Output Current (PWM-Analog)



$$2.5 = V_{BIAS(FD)} \cdot \frac{R2}{R2 + R3}$$

$$2.5(R2 + R3) = V_{BIAS(FD)} \cdot R2$$

$$R2 = \frac{2.5 \cdot R3}{V_{BIAS(FD)} - 2.5}$$

Where:
 $V_{BIAS(FD)}$ = Bias voltage at full dimming, assume $V_{BIAS}/3$

$$R1 = ((V_{BIAS} - V_{FB}) / (I_{FB} - 20 \mu A)) - R3$$

Where:

V_{BIAS} = Bias voltage (from PIXIs)

I_{FB} = FB pin current (from PIXIs)

V_{FB} = FB pin voltage (2.4 V_{TYP})

20 μA is the current through R4

$$C1 \geq 5 / (f_{PWM} \cdot R2)$$

Where:

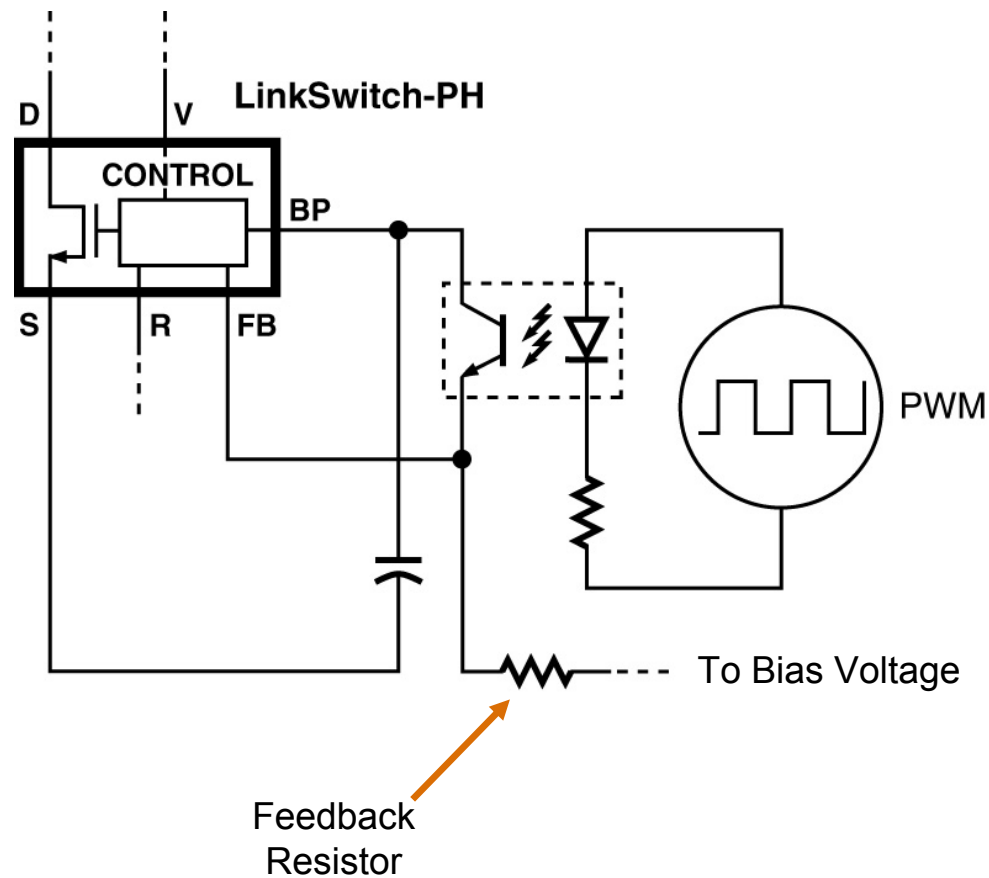
f_{PWM} = PWM Frequency

Dimming range can be increased by simultaneously decreasing FB Pin current and increasing V Pin current

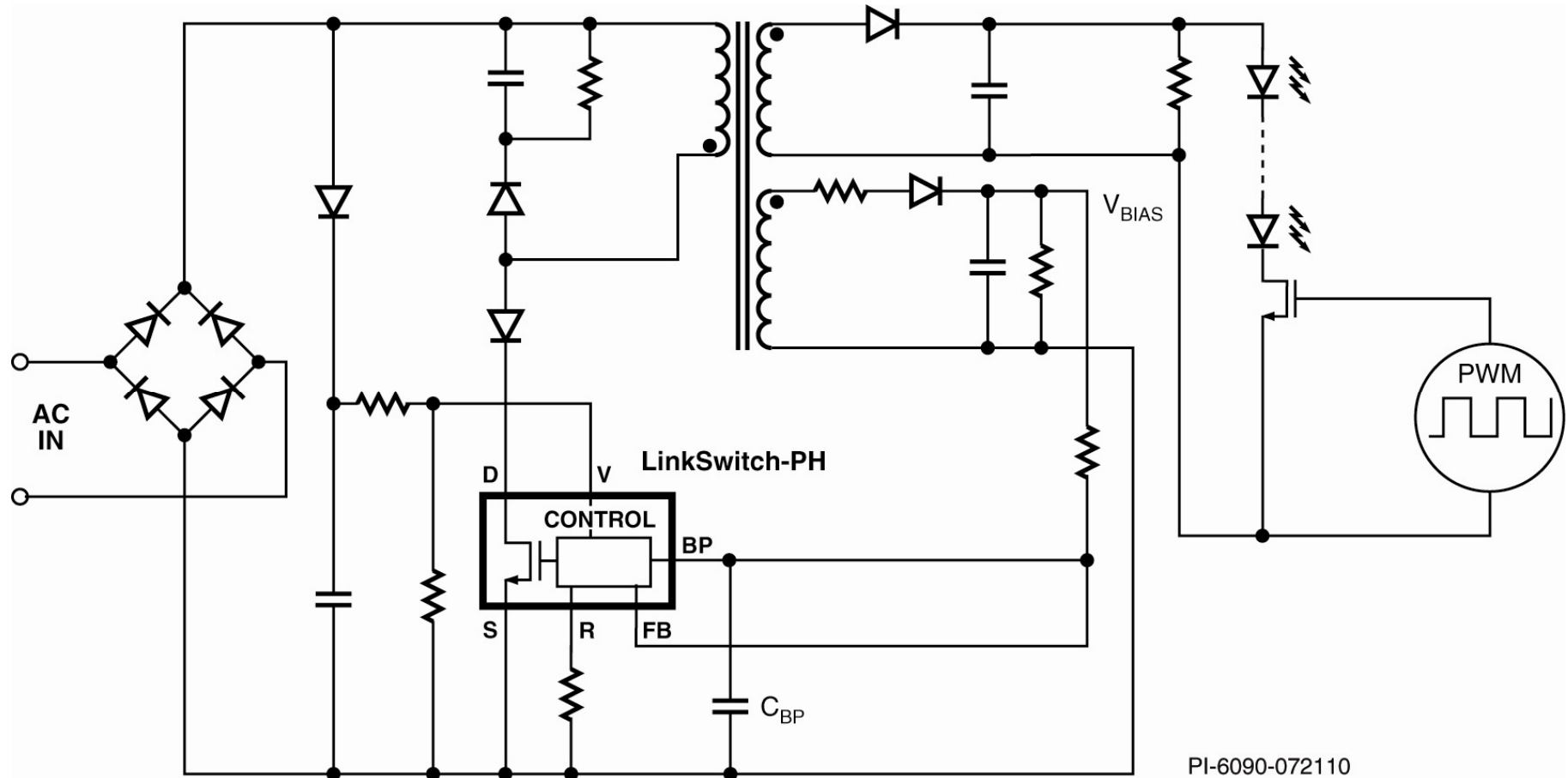


Modulating LinkSwitch-PH PWM Dimming

PWM-Digital



PWM of the LED String Does **Not** Work

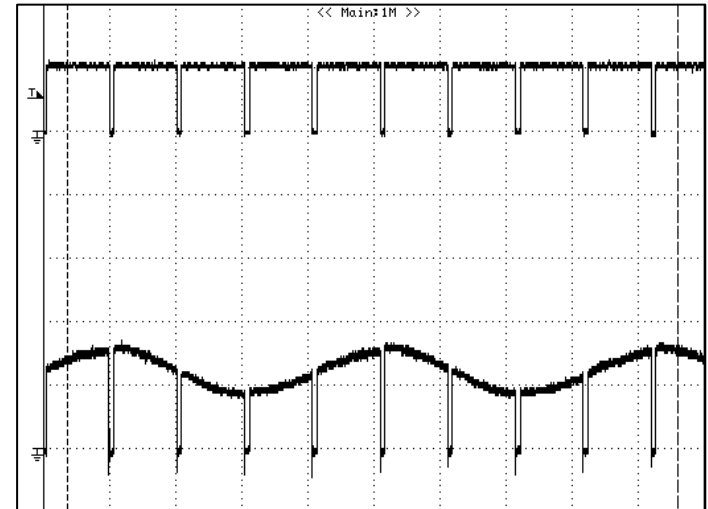


Power Supply Continues to Deliver Energy to Output Caps When LED String is Turned Off, Causes High LED Peak Currents When Turned On

93% DC: $I_{OUT} = 1.15 \text{ A}$

LED PWM Signal
93% Duty Cycle

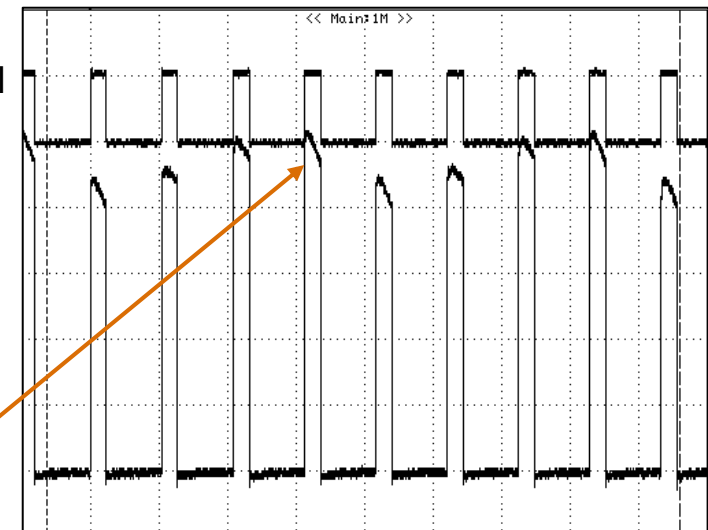
Output Current
Average $I_{OUT} = 1.15 \text{ A}$



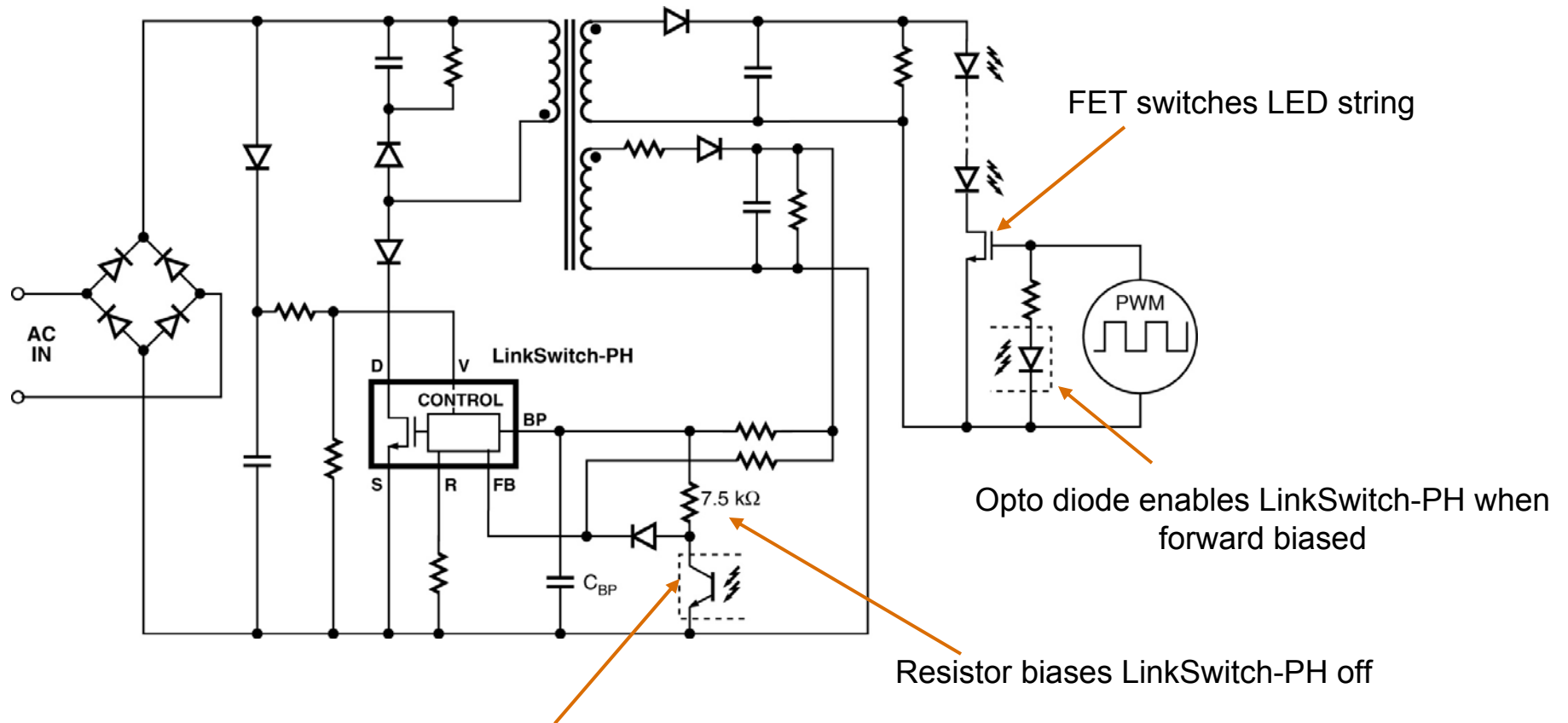
23% DC: $I_{OUT} = 1.03 \text{ A}$

LED PWM Signal
23% Duty Cycle

Output Current
Average $I_{OUT} = 1.03 \text{ A}$
Peak $I_{OUT} = 5 \text{ A}$



PWM Control of LinkSwitch-PH and LED Load



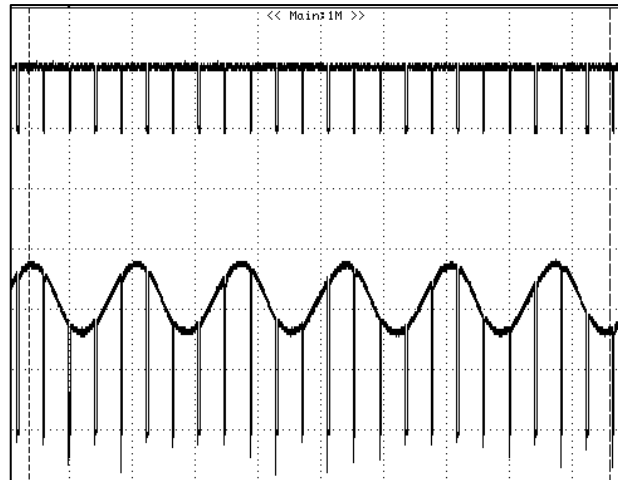
Opto transistor enables LinkSwitch-PH by pulling disable signal low



Peak LED Current is Constant

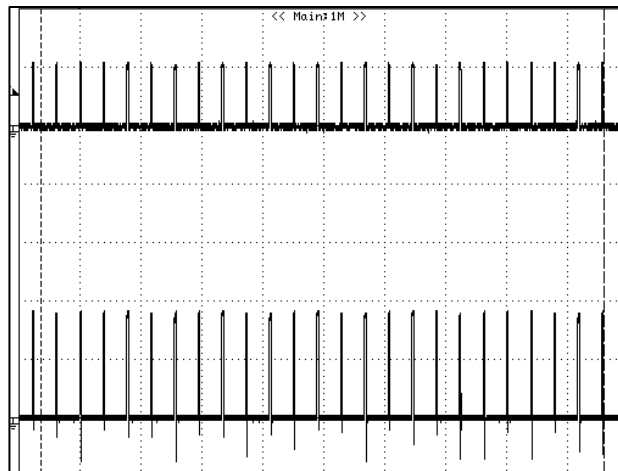
PWM Signal
Duty Cycle = 93%

LED Output Current
Average $I_{OUT} = 1.01\text{ A}$



PWM Signal
Duty Cycle = 7%

LED Output Current
Average $I_{OUT} = 58\text{ mA}$



Peak LED Current = 900 mA

Regulation of peak LED current maintains good LED color temperature over dimming range

