High VOLT Interactive

Where power supply design meets collaboration

When to consider general purpose PWMs

What will I get out of this session?

- Purpose:

  How to use general-purpose PWM controllers in different system solutions and probable multi-topologies and what are the benefits.

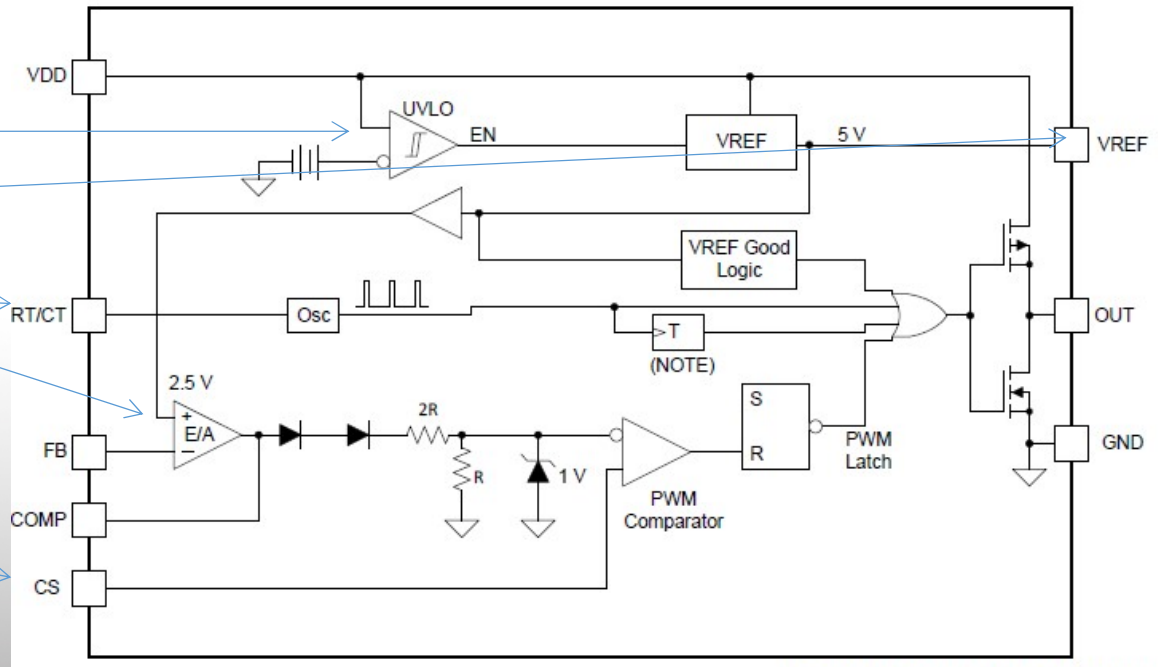
- Part numbers mentioned:
  - UCC38C42, UCC38C44,
  - LM25037-Q1, LM5030
- Reference designs mentioned:
  - PMP1083, PMP1141
- Relevant End Equipments:
  - Telecoms, Automotive, Industrial, Consumer

What are General Purpose PWM Controllers

- Simple controllers that are easy to use
- Flexibility without complexity. In many applications, this can be exactly what a power-supply designer needs. Their flexibility allows them creation of a number of application variations.
- Long history, reliable, can have multiple vendors…
- General PWM controllers can be leveraged across multiple designs resulting in a high-volume sourced component in a high mix product portfolio.
- Using general PWM controllers can decrease development time, easy to run open loop and control externally during development debug.
- Can be used in a topology where no specific PWM controller exists.

General Purpose PWM Block Diagram

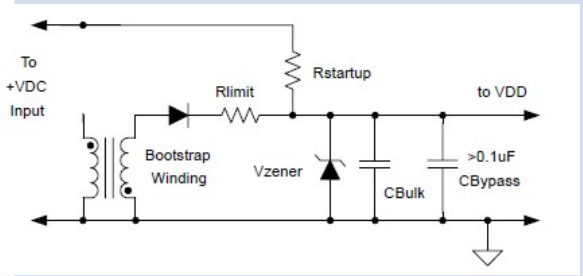
- Basic building block
  - VDD with UVLO Protection
  - External Vref
  - Timing Pin RT/CT
  - Internal Error amplifier
    - Comp, FB
    - 2.5V internal reference
  - Current sense pin
    - Current mode control



Toggle flip-flop used only in UCCx8C41, UCCx8C44, and UCCx8C45

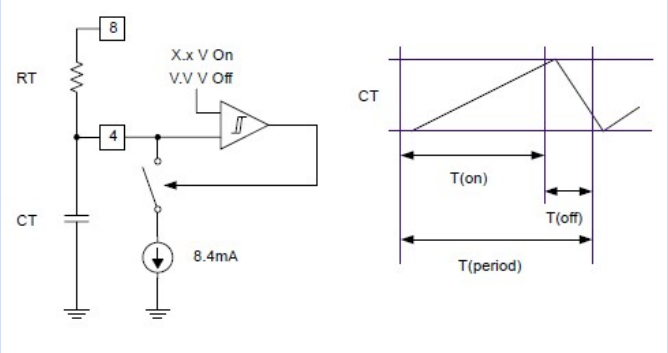
External Circuits

Start-up



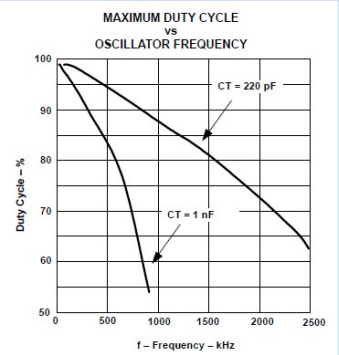
- Rstart connected to DC input or rectified AC line
- Auxiliary winding rectified to provide Vdd after start-up

Oscillator



- Simple RC network
- Use stable capacitor dielectric, COG, NPO
- Place the R&C close to the pin of the IC

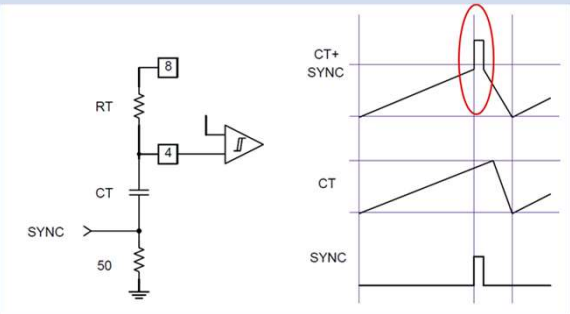
Max Duty Cycle



- The ratio of the charging to discharging current specifies the maximum duty cycle.
- During the discharge time of CT, the output is always off.
- Deadtime is the minimum off time of the switch

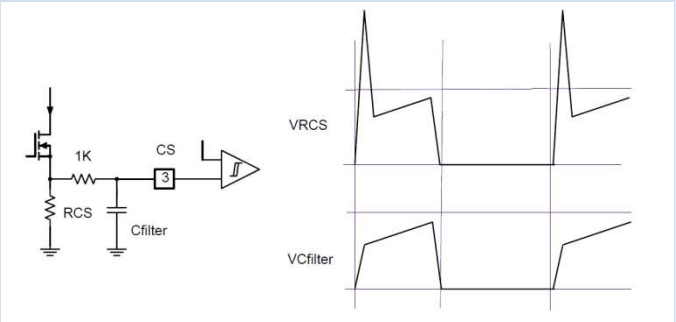
External Circuits

Synchronisation



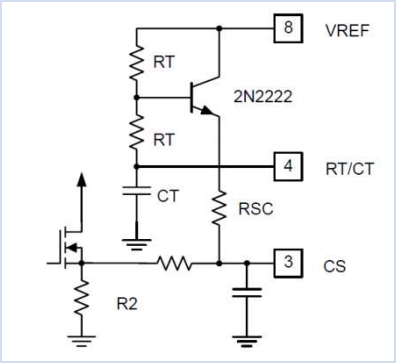
- Sync two power stages to eliminate beat frequency, interference
- Tighter tolerance on oscillator frequency

Current Sense Filter



- Current sense signal contains a large amplitude leading edge spike
- Allows tuning of CS waveform filtering to each application

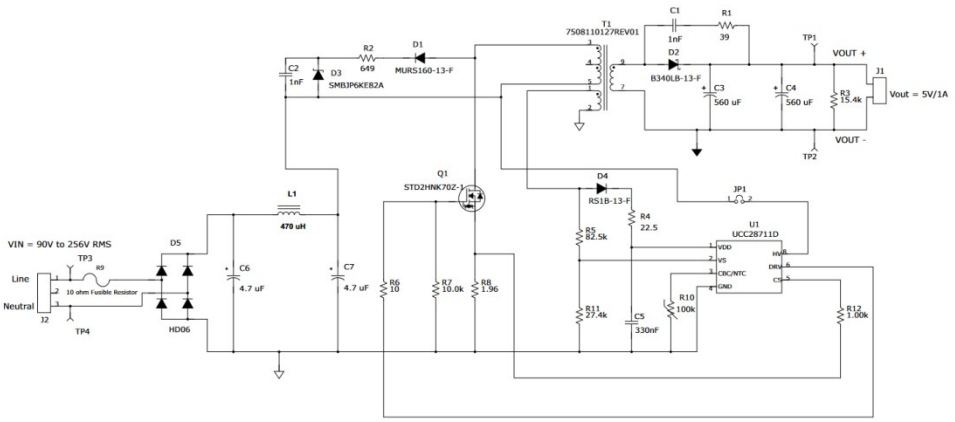
Slope Compensation

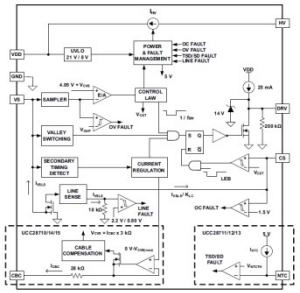


- Slope Comp is required to stabilize the overall loop with duty cycles exceeding 50%.
- Injecting a portion of the oscillator waveform to the actual sensed primary current

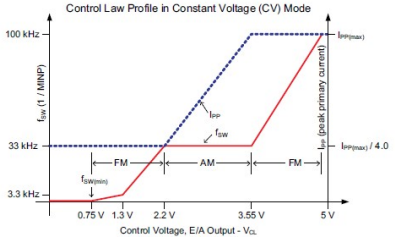
UCC28710 Dedicated Controller

- Flyback Primary Side Regulation
  - No Opto or TL431 –lower cost
  - Sense from aux winding
- Internal control loop
  - Require minimum value of output capacitance
- Internal Oscillator, variable switching frequency
- Specific control law to maximise light load efficiency
- High Voltage start-up – 700V
- Pin to programme Cable compensation / NTC thermal sensor





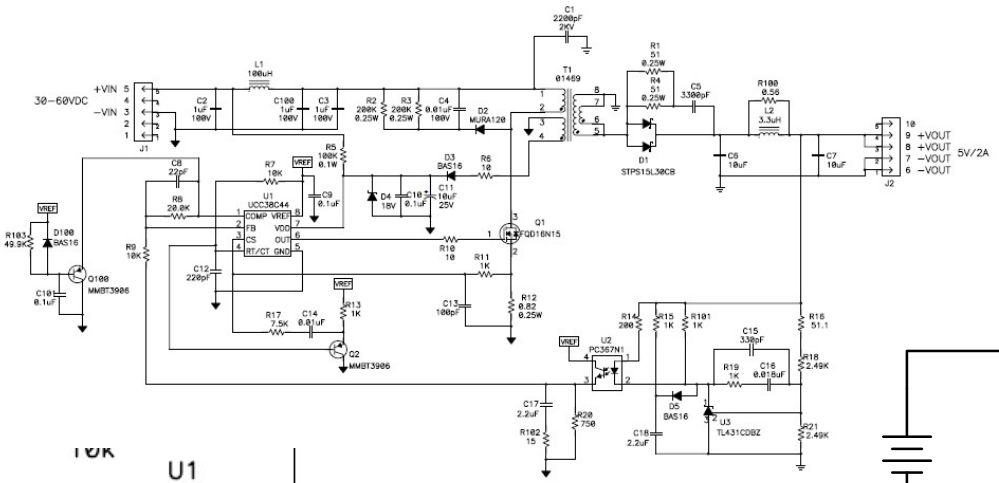
<30 Components

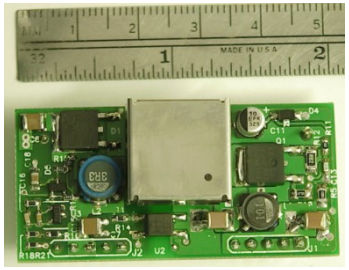


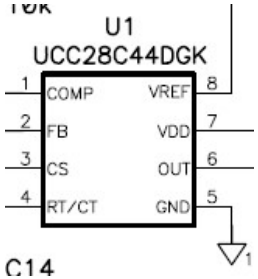
5V, 2A Universal AC input Isolated Flyback PMP1141

Advantages
- Low component count, small footprint
- No output Inductor
- No reset winding in transformer
- Good for multiple output designs

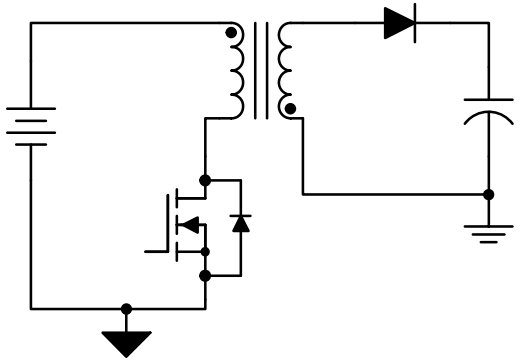
Disadvantages
- High ripple currents
- Higher output voltage ripple
- Limited to <150W
- High voltage stress on primary switch
- Requires snubber/clamp







$$V_{OUT} = \frac{Ns}{Np}\frac{D}{1-D}V_{IN}$$

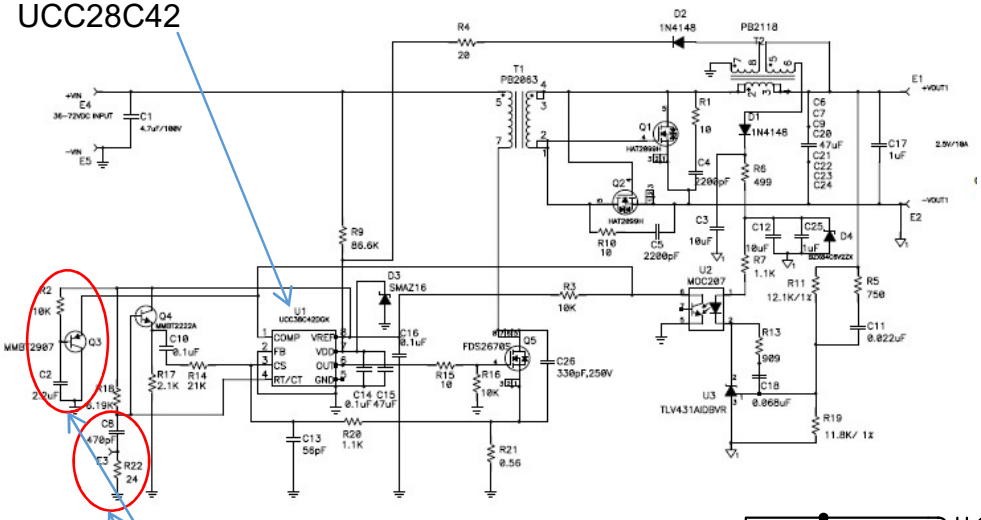


Forward

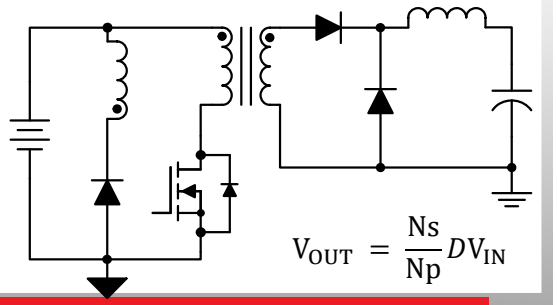
- Advantages
  - Continuous output current
  - Suited for high load current
  - Self-Driven Synchronous Rectification
  - Good cross regulation with coupled inductor
- Disadvantages
  - Need two rectifiers and two magnetics
  - Poor core utilization
  - D < 50% unless reset mechanism used, reset winding or RCD snubber
  - DC magnetic bias needs core reset by external means such as reset winding or clamp circuit

http://www.ti.com/lit/an/slua276/slua276.pdf

UCC28C42



- Telecoms 36V to 72Vdc
- 2.5Vout, 10A
- 525kHz Switching Frequency
- Soft start
- Synchronisation Input



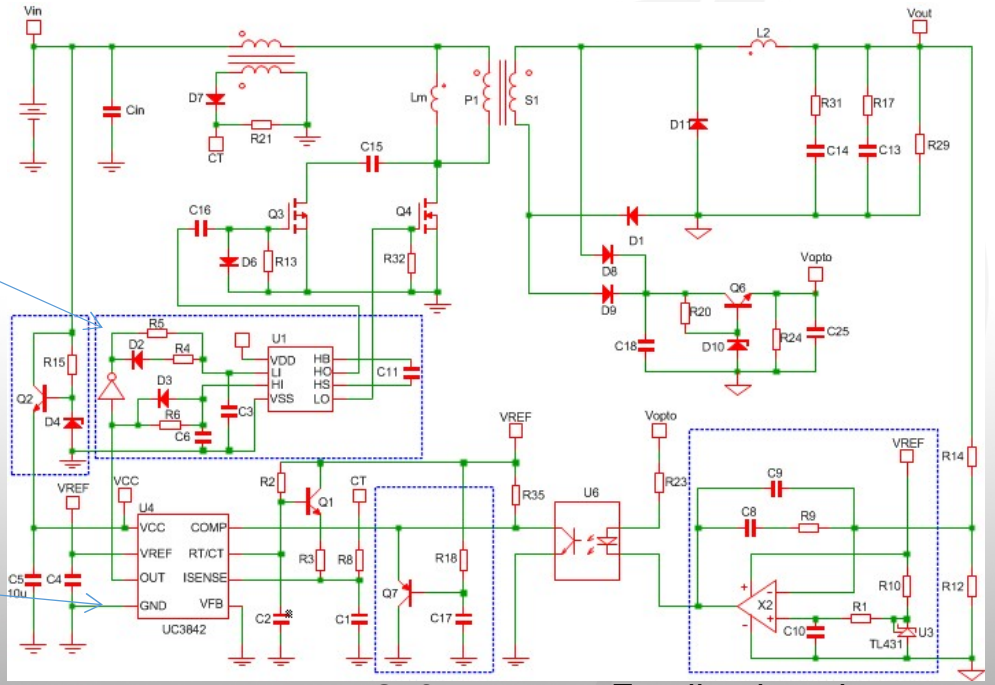
$$V_{OUT} = \frac{Ns}{Np} D V_{IN}$$

Discrete Active Clamp Forward

External driver
And dead-time
control circuitry

HV start up

UC3842



Soft-start

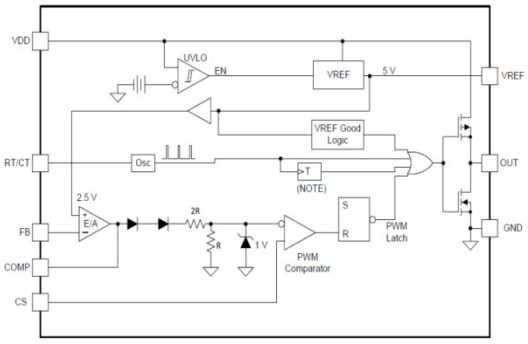
Feedback and compensation

High VOLT Interactive

5Vout, 1Aout, AC-DC Fly-Buck™ Converter PMP1083

Features:

- Non-Isolated AC/DC Flybuck
- Dual Output, 5V and 10V
- AC Line, 85V to 265V
- Less than 45C temperature rise
- 1% output regulation
- Use all standard components



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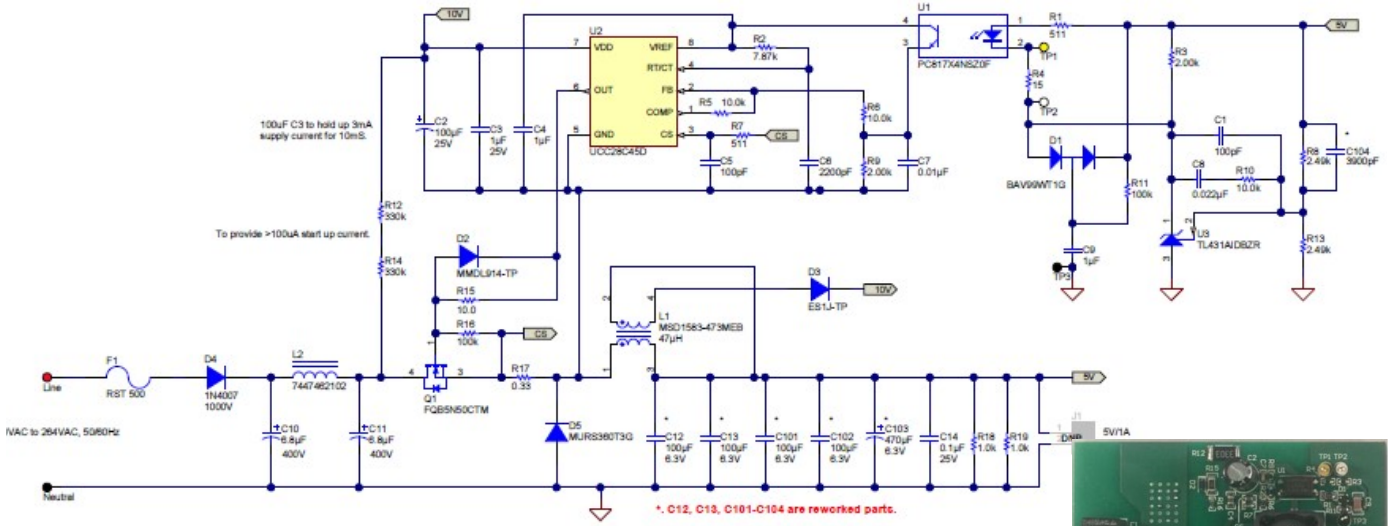
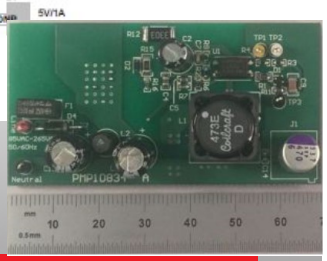
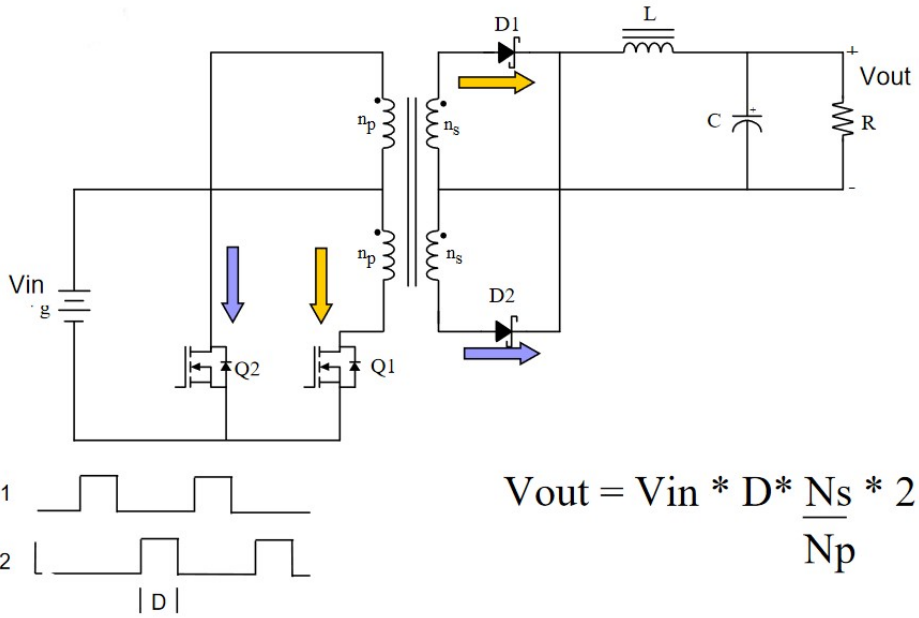




ti.com/fly-buck.

Push Pull

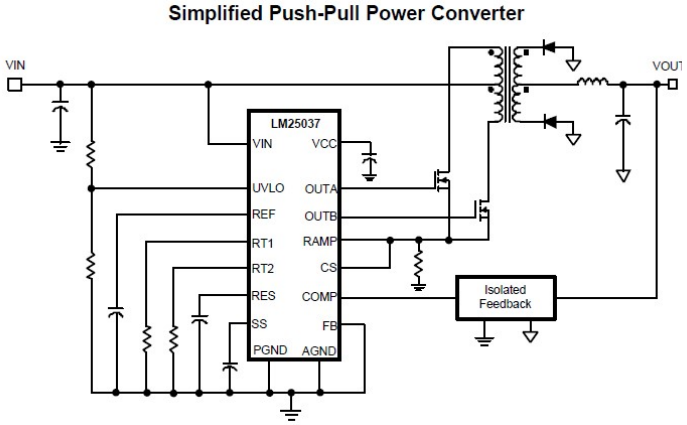
- When to consider Push Pull
- 25W to 500W, medium to high power
- Low input voltage 12V auto or high output current
  - Voltage can drop to 6V during cold start – not good for half bridge/full bridge topologies with high side drive
- Advantages
  - Lower ripple current in input and output capacitors
  - Primary side mosfet are low side- easy to drive
  - Good transformer utilisation
- Caution
  - Voltage stress on FETS is twice Vin
  - Beware of flux imbalance, use current mode controller



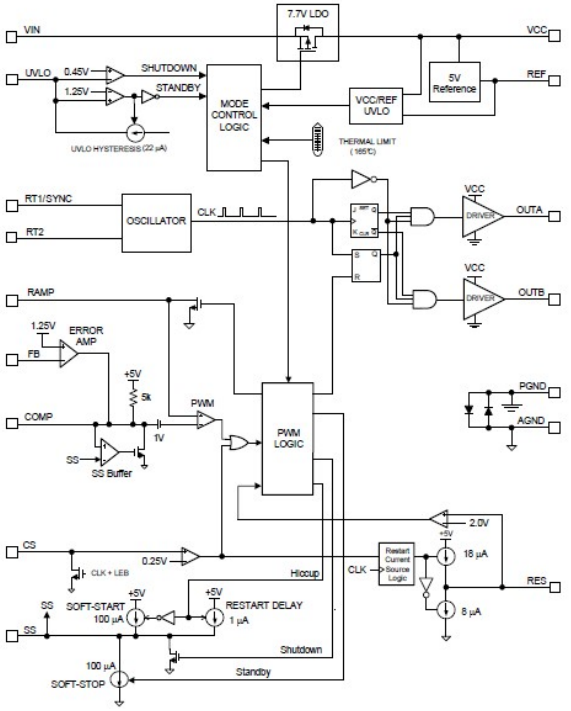
$$Vout = Vin * D * \frac{Ns}{Np} * 2$$

LM25037 & -Q1 Auto Qualified

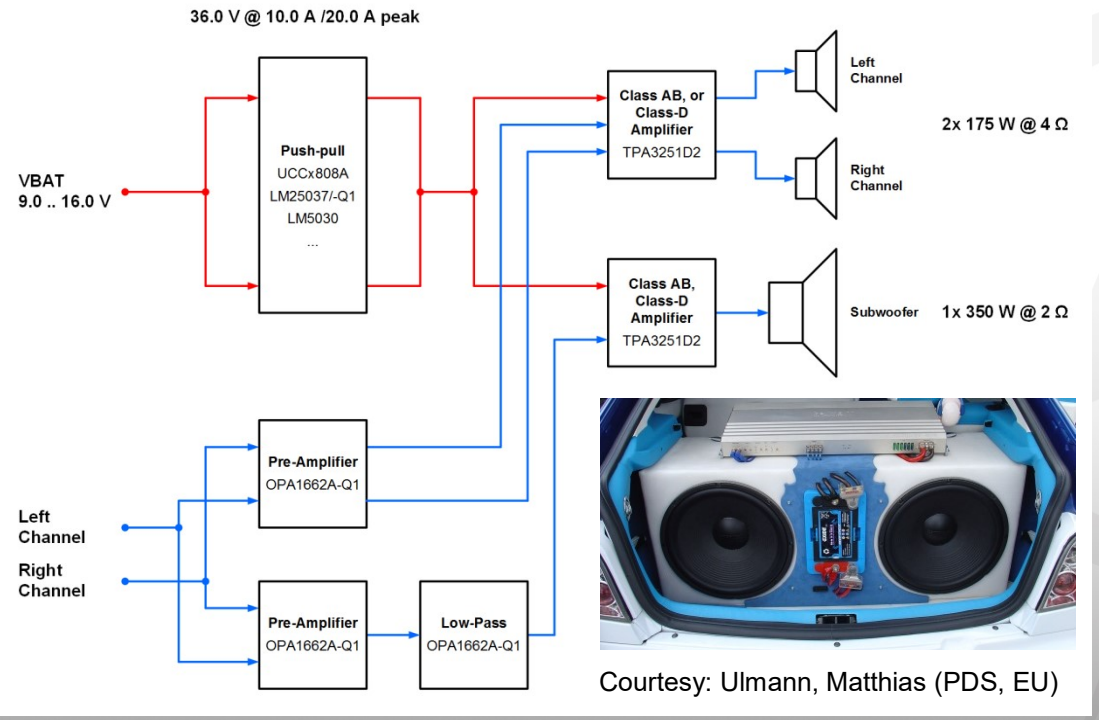
- Wide Input operating range 5.5V to 75V
- Current Mode or Voltage Mode with feed forward
- Programmable
  - Max Duty Cycle
  - Line UVLO
  - Soft Start
- Internal filtering (LEB) on CS pin
- 5V reference
- 2MHz Oscillator
- External synchronisation



Configured for Current Mode



Premium Audio - Analog Input External Amplifier



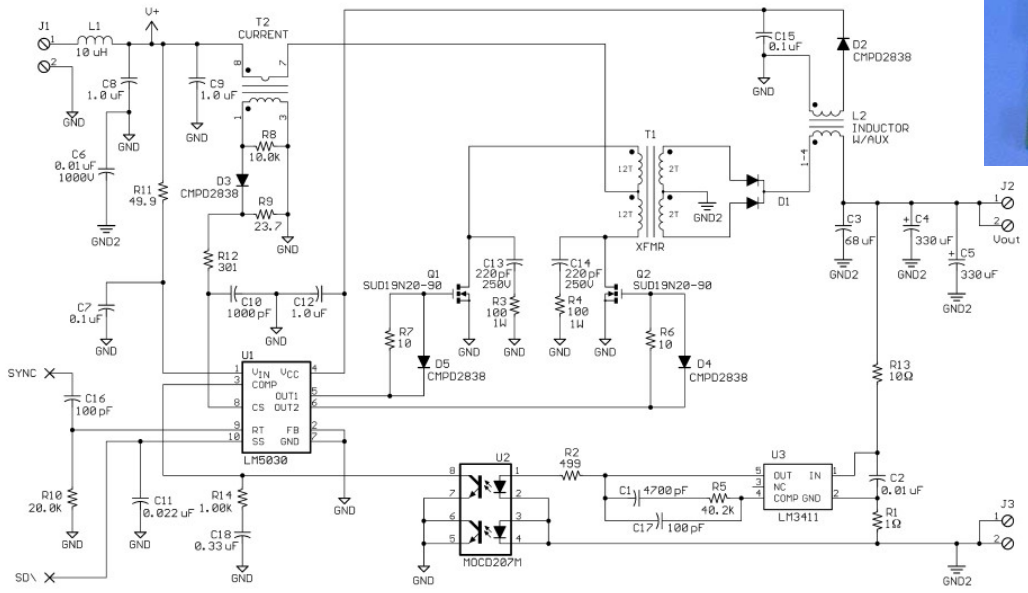
Courtesy: Ulmann, Matthias (PDS, EU)

Pull-pull is preferred:

- If positive and negative supply voltage are needed such as in Class AB audio amplifier
- If high control bandwidth is needed as the frequency of the audio current draw increases up to 40kHz (80kHz+ for HD audio)
- LM25037-Q1 advantages
- Higher duty cycle, strong gate drivers and programmable soft start.
- Can operate in current mode or volatge voltage mode

LM5030 Telecoms Demo Board 36V-75Vin, 3.3V @ 10A

Input Range: 36 to 75V
Output Voltage: 3.3V
Output Current: 0 to 10A
Efficiency (48V Input):
82.5% @ 10A and 84.5% @5A
Board Size: 2.4 x 2.4 x 0.45
Load Regulation: 0.2%
Line Regulation: 0.1%
Current Limit ~11A



Key Take Aways

- General purpose PWM controllers still have a place in power supply systems where simplicity, robustness and flexibility are the dominant concerns
- We have seen how a couple of variants of the UCC38C4x family can provide solutions for Flyback, Forward and Fly-Buck designs, they can also do boost but it was not covered in this presentation
- Dedicated controllers like the UCC28710 flyback controllers provide a focused low component count design but at the expense of flexibility.
- General purpose controllers are ideally suited to supporting a high mix of different designs