

MPS Digital Multiphase VR Introduce

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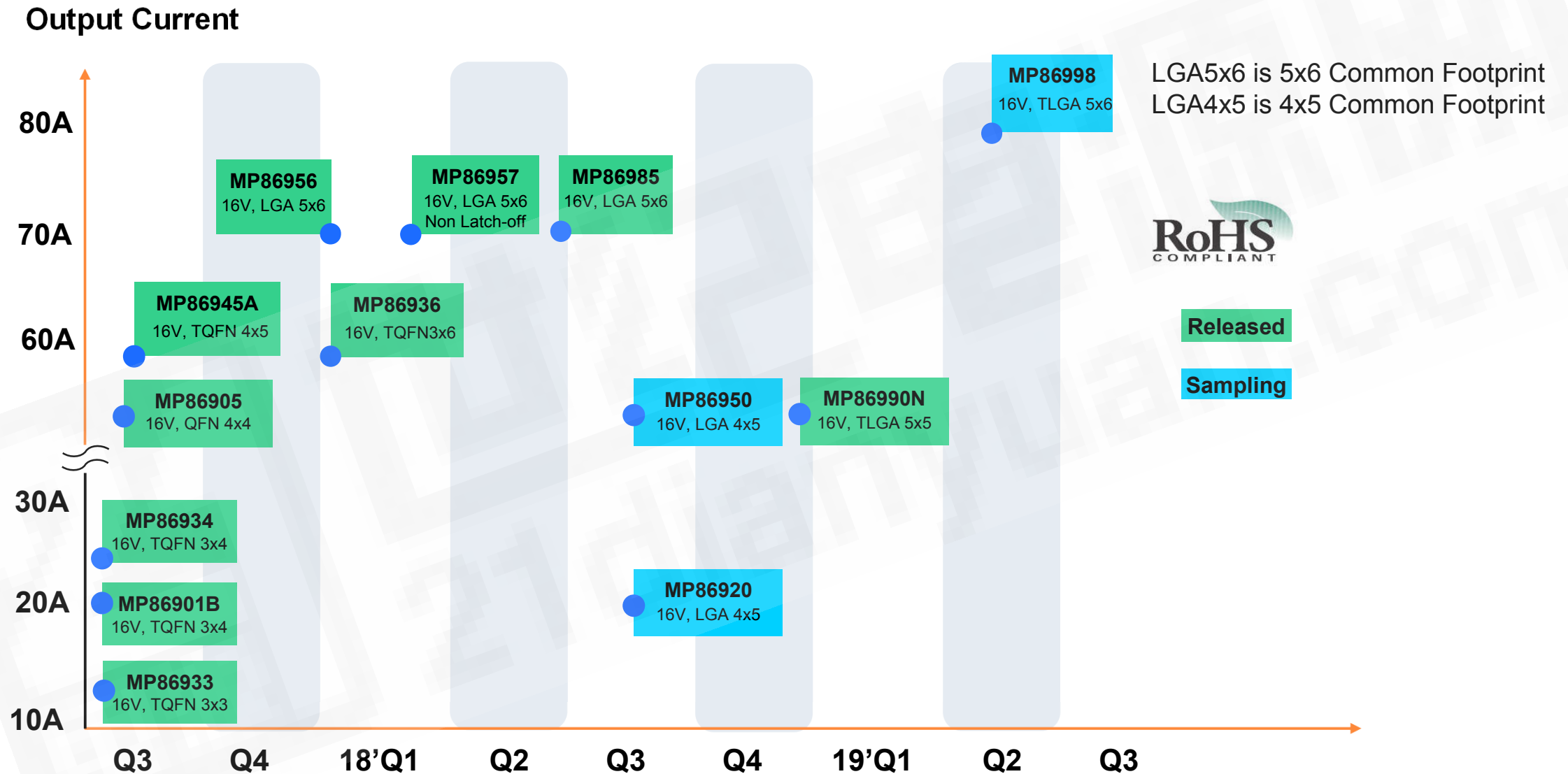


Outlines

- MPS multiphase VR road map
- Basic terminologies
- Multiphase VR control methods
- Multiphase VR current balance

MPS Multiphase VR Road Map

Multiphase VR Road Map – Intelli Phase



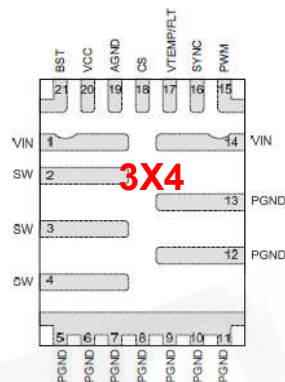
Multiphase VR Road Map – Intelli Phase

30A

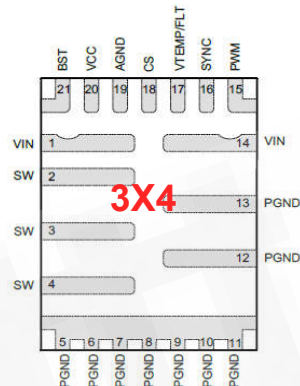
25A

12A

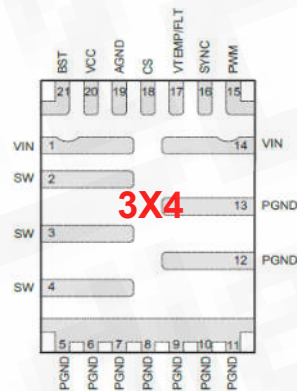
MP86902B



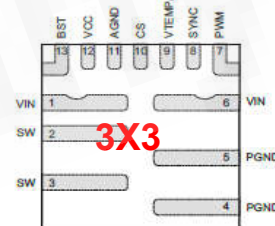
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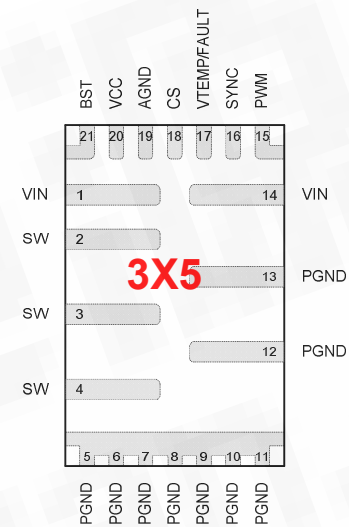
MP86901B



MP86901A



MP86941

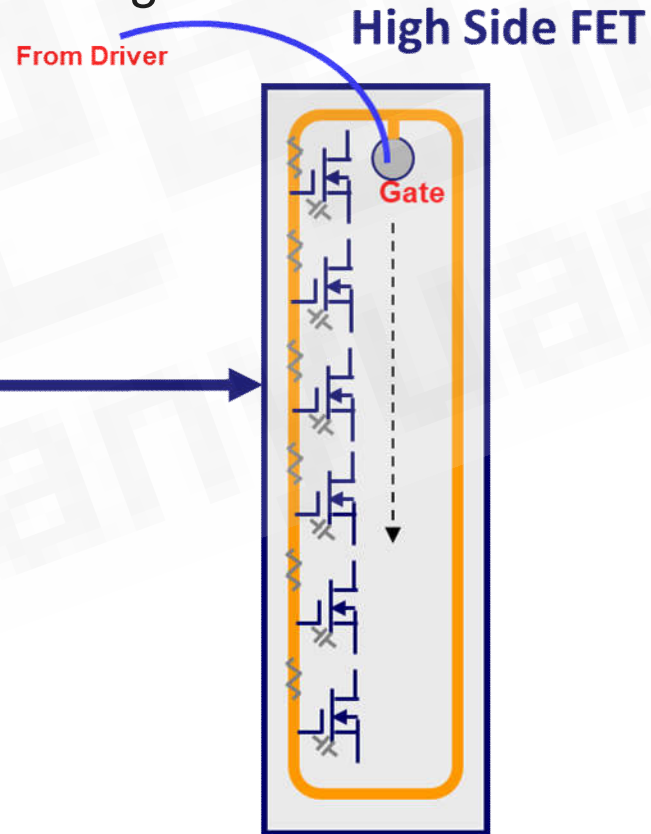
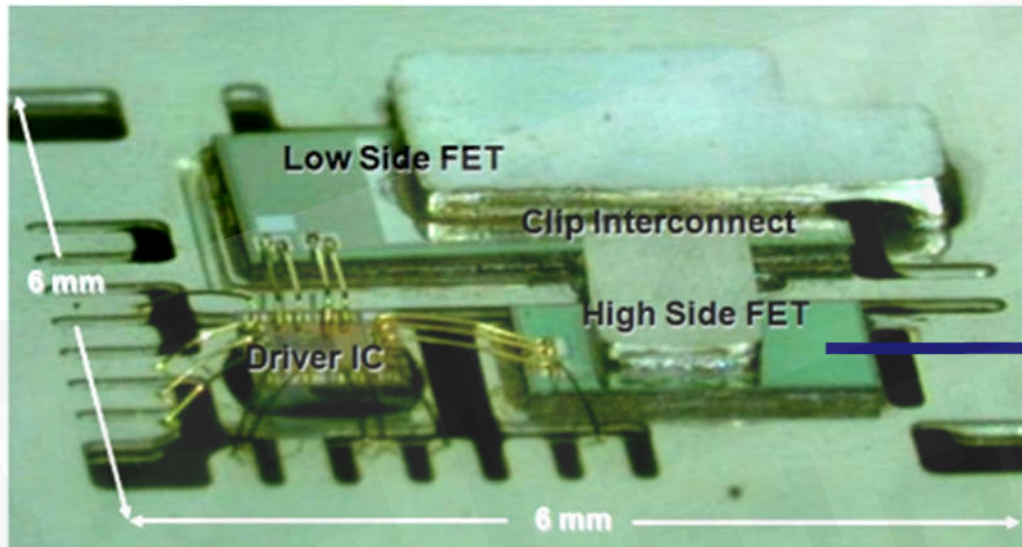


12V

19V

Co-package vs. Monolithic

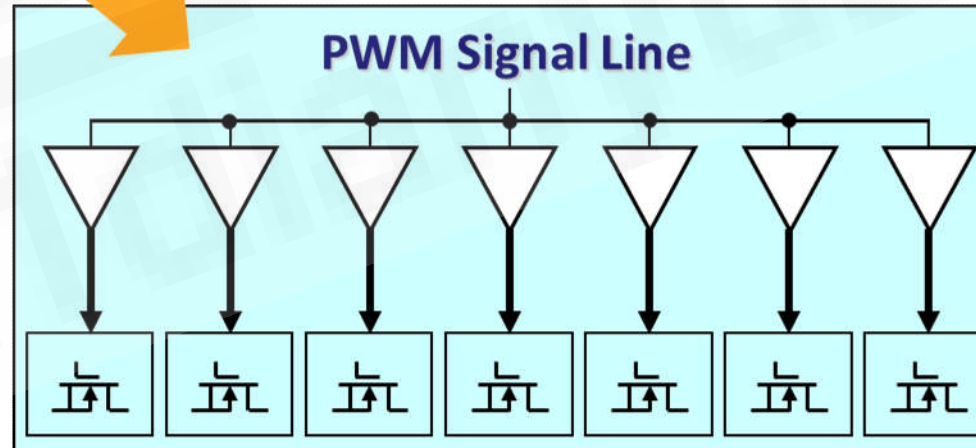
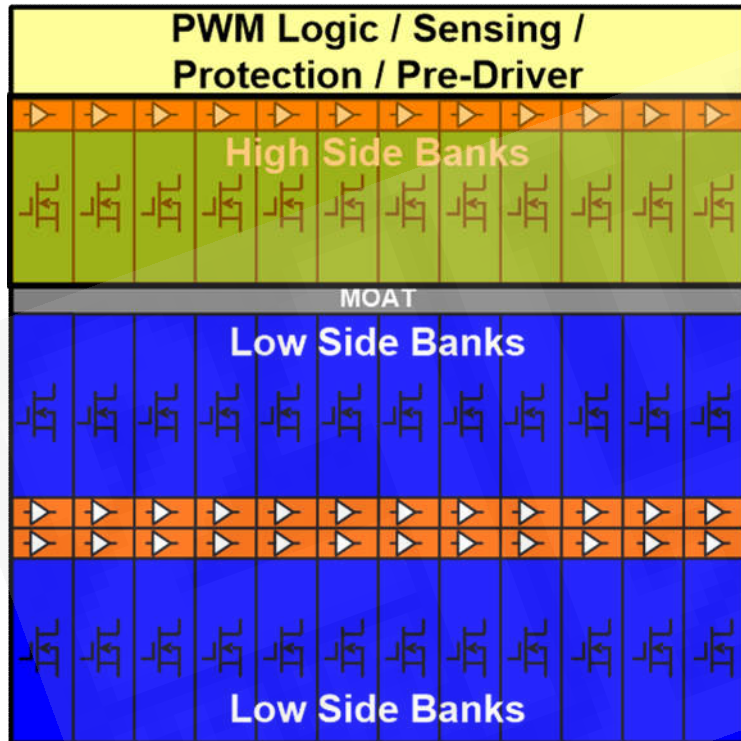
- Separate driver IC can't provide simultaneous on/off across the entire FET due to the gate delay.
- Need large dead time to ensure no shoot-through



Co-package vs. Monolithic

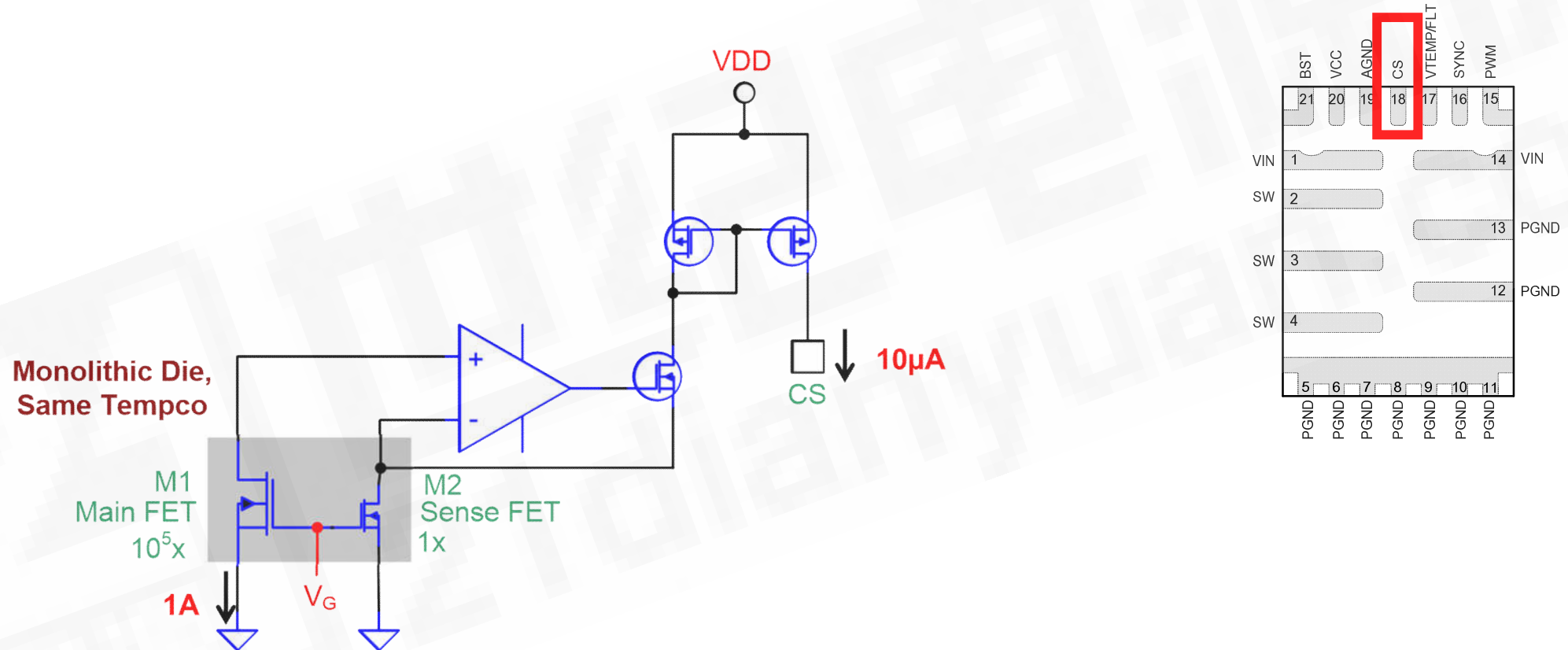
- Distributed Gate Driver (DGD) minimizes the Gate Delay to $<2\text{ns}$, therefore ensures even current distribution among cells

Intelli-Phase®

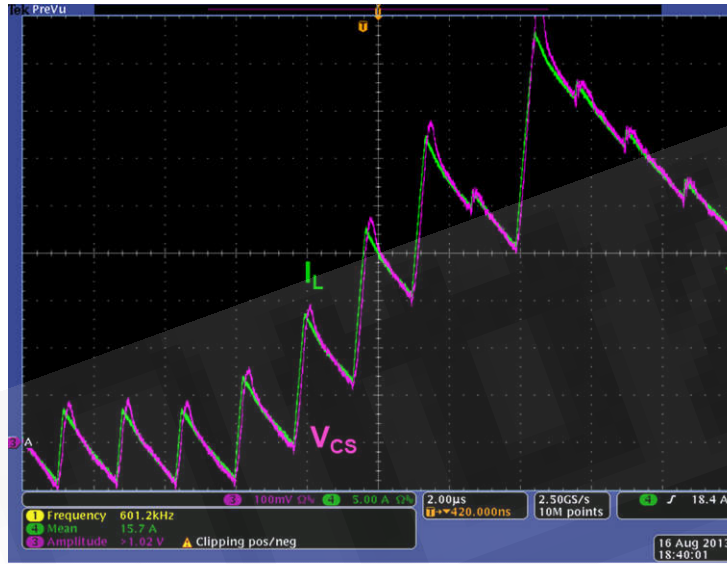


Monolithic Current Sense Principle

- Zero tempco due to monolithic die current sensing



Monolithic Current Sense Advantages

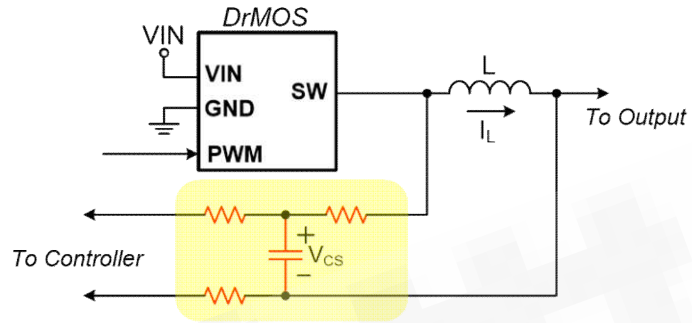


- CS outputs current proportional to inductor current. ($10\mu\text{A/A}$)
- Tracks cycle by cycle.
- Independent of the Temperature, $R_{ds(on)}$, Inductor DC resistance, Duty-cycle and Frequency variations.

CS output matches inductor current very well during transient

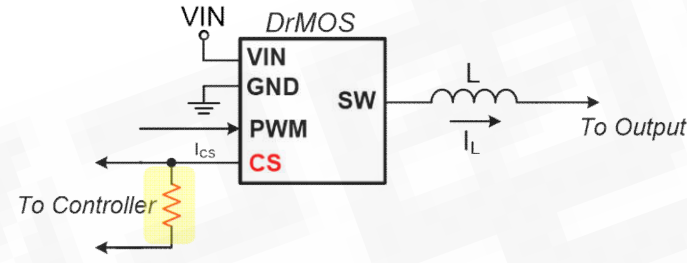
Monolithic Current Sense Advantages

DCR Sensing



- Need 21 Components (Rx15 + Cx5 + NTC)
- 6%-8% DCR sensing error (at 25C)
- Noisy
- Hard to tune

MPS Accu-Sense

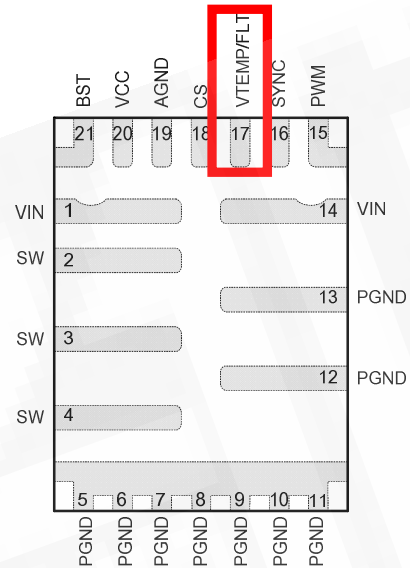


- Only need 5 Resistors
- 3% current sensing error over temp.
- Clean signal
- Very easy to use

Saves Component
Count & Cost!

Monolithic Temperature Sense Advantages

- Vtemp directly report intelli-phase junction temperature, but NTC solution just report Drmos case temperature.
- Better thermal management performance.



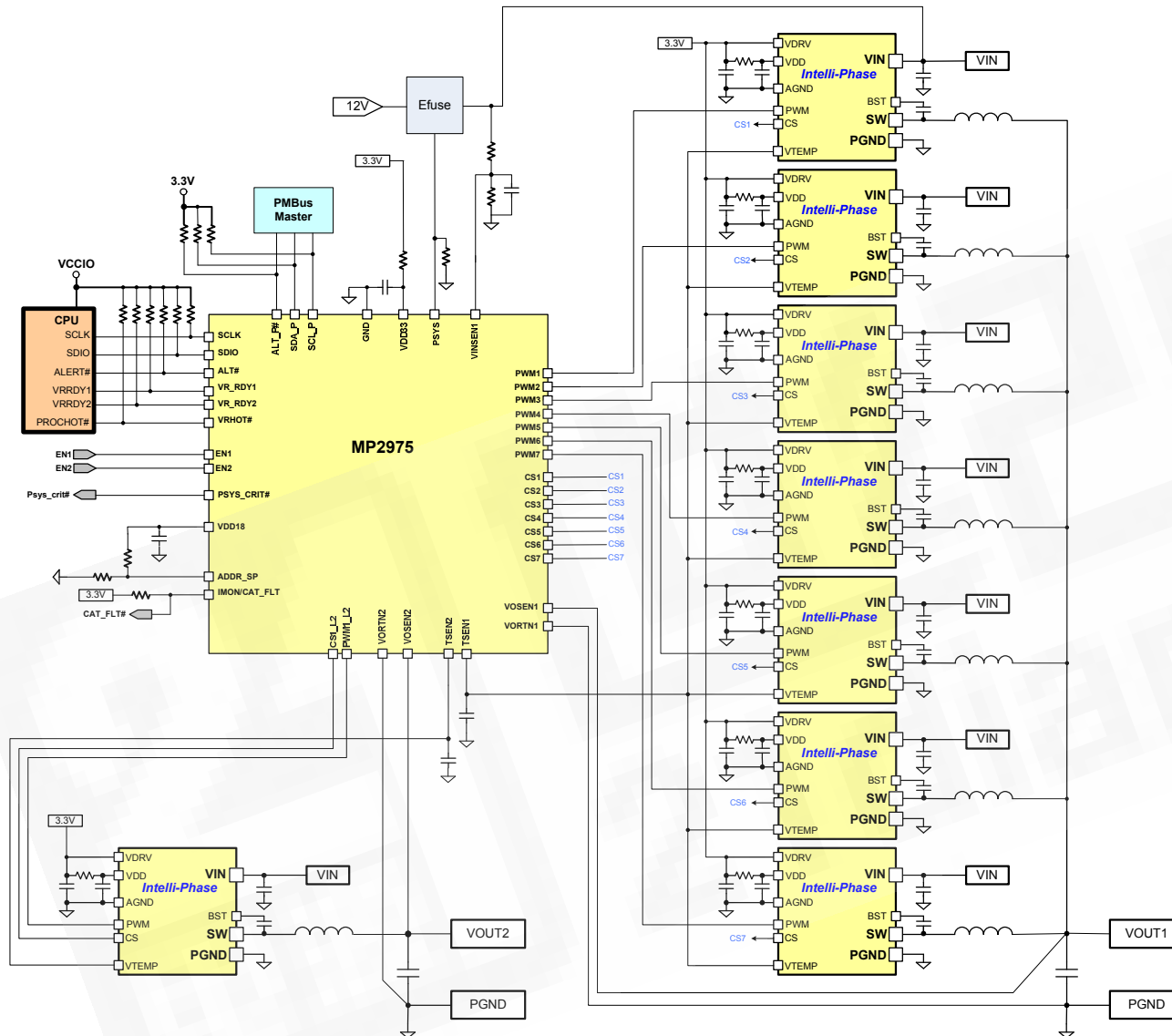
$$T_{\text{JUNCTION}} = \frac{V_{\text{TEMP}} + 100\text{mV}}{10\text{mV}/^{\circ}\text{C}}$$

for $T_{\text{JUNCTION}} > 10^{\circ}\text{C}$

Multiphase VR Road Map - Controller

	2017				2018				2019				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Intel Xeon Processor	MP2955A 7-ph/ 2-rail VR13	MP2965 7-ph/ 2-rail VR13.HC			MP2975 8-ph/ 2-rail VR13.HC	MP2972 12-ph/ 2-rail VR13.HC			MP2971 8-ph/ 2-rail VR14		MP2973 12-ph/ 2-rail VR14		Released
Intel IMVP	MP2949A 6-ph/ 3-rail IMVP8					MP2979A 6-ph/ 3-rail IMVP8	MP2940A 3-ph/ 1-rail IMVP9		MP2950A 6-ph/ 1-rail IMVP9				Sampling
AMD Gaming SoC	MP2853 5-ph/ 2-rail SVI2	MP2945 5-ph/ 2-rail SVI2							MP2852 13-ph/ 2-rail SVI2		MP2855 9-ph/ 2-rail SVI2		
AMD Server Processor	MP2853 5-ph/ 2-rail SVI2								MP2852 13-ph/ 2-rail SVI2		MP2855 9-ph/ 2-rail SVI2		
Nvidia GPU	MP2888A 10-ph/ 1-rail OVR4+	MP2886A 6-ph/ 1-rail OVR4+	MP2884A 4-ph/ 1-rail OVR4+		MP2988 3-ph/ 1-rail OVR3i								
AI Processor	MP2965 7-ph/ 2-rail AVS				MP2975 8-ph/ 2-rail AVS	MP2978 5-ph/ 2-rail AVS	MP2972 12-ph/ 2-rail AVS		MP2852 13-ph/ 2-rail AVS	MP2926 6-ph/ 3-rail AVS	MP2882 16-ph/ 2-rail AVS		

Multiphase VR Road Map - Controller



Advantages

- Best transient in the market
- Minimized external components
- All digital control via PMBUS
- Built-in NVM, multi- programmable
- Automatic loop compensation
- Flexible phase assignment

Basic Terminologies

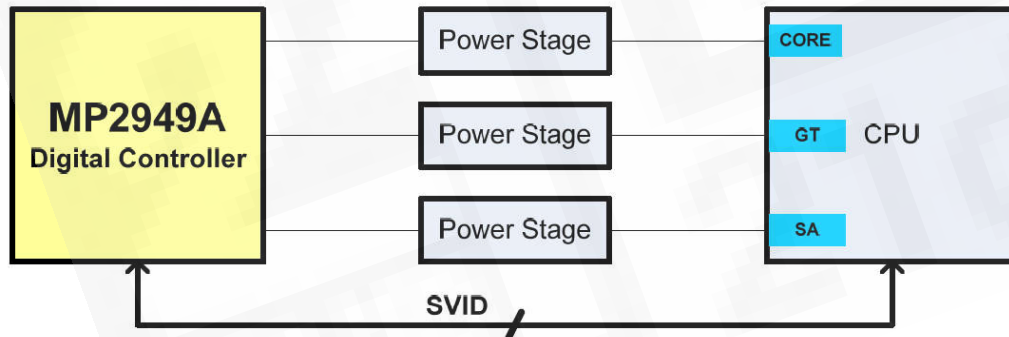
Phase and Rail

MP2949A

Tri-Loop Digital Multi-Phase Controller
with PMBus Interface for IMVP8/9

FEATURES

- Up to 6-Phase Triple-Rail Digital PWM Controller
- Configurable Phase Number: 3+2+1, 4+1+1, 2+1+1, 1+1+1, etc.

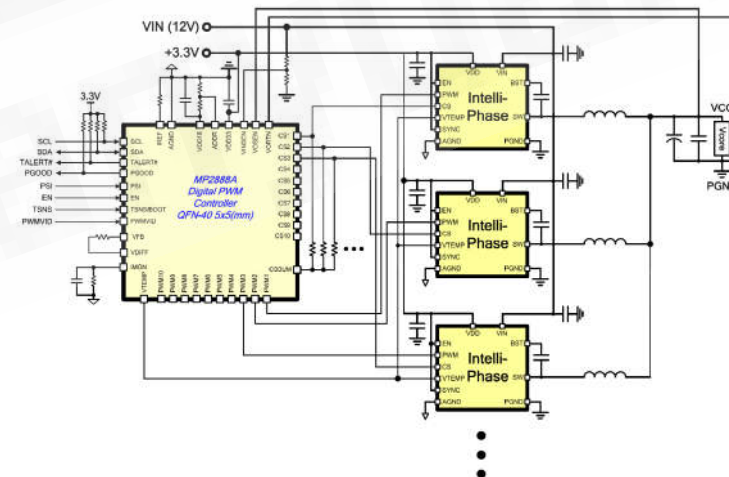


MP2888A

Digital, Multi-Phase PWM Controller
with PMBus and PWM-VID

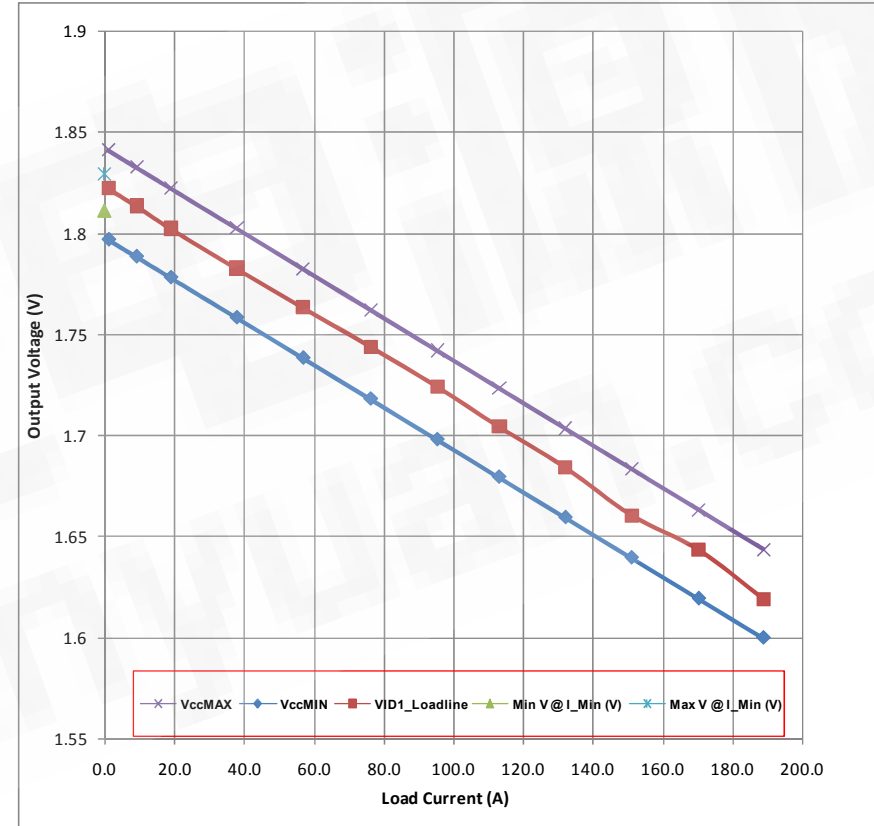
FEATURES

- Programmable Multi-Phase up to 10 Phases



VR/MTP/VID/DVID/CS/APS/Loadline(droop resistor)

- VR means voltage regulator
- MTP means multiple-time programmer
- VID is same as Vref of DCDC converter
- DVID means dynamic VID
- CS means current sense
- APS means auto phase shedding
- Loadline(droop resistor) shows as picture



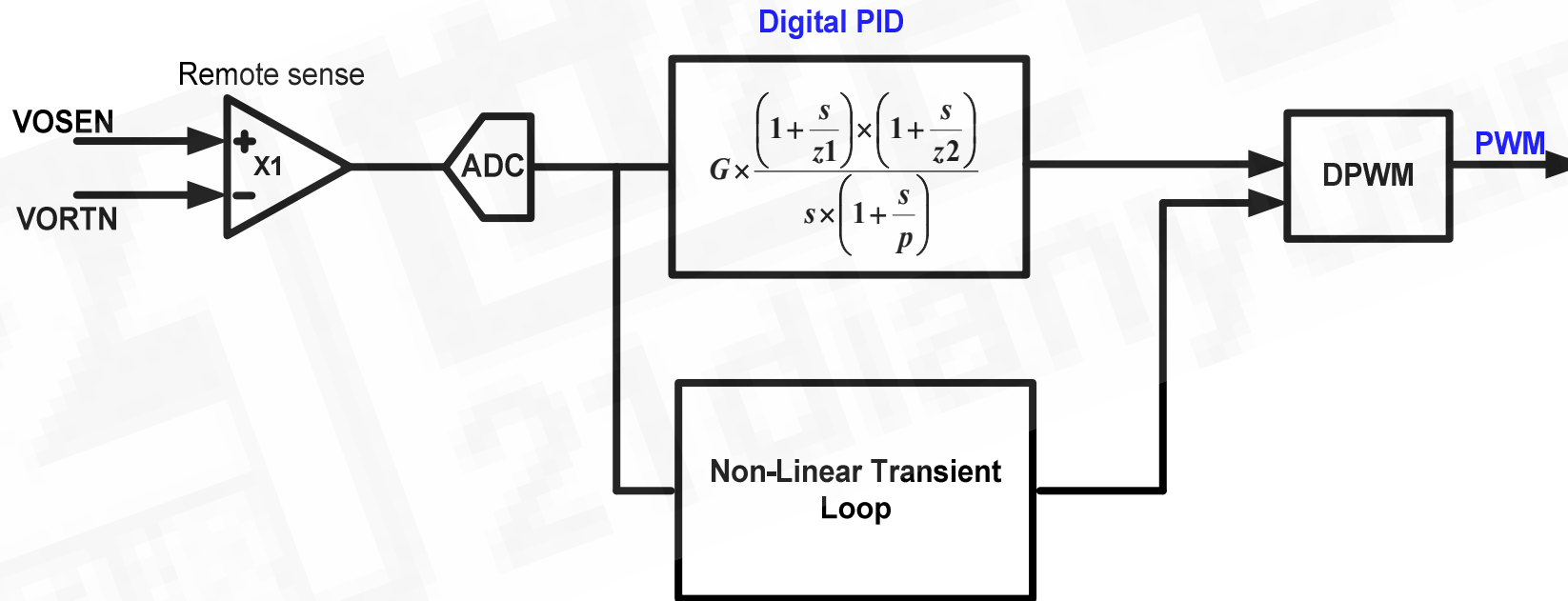
Protocols: SVID/SVI2/3/OVR/PVID/AVS/PMBUS

- SVID→ Intel
- SVI2/3→ AMD
- OVR→ NVidia
- PVID→ early Intel/POL
- AVS→ Arm-base IC
- PMBUS→ MPS and so on

Multiphase VR Control Methods

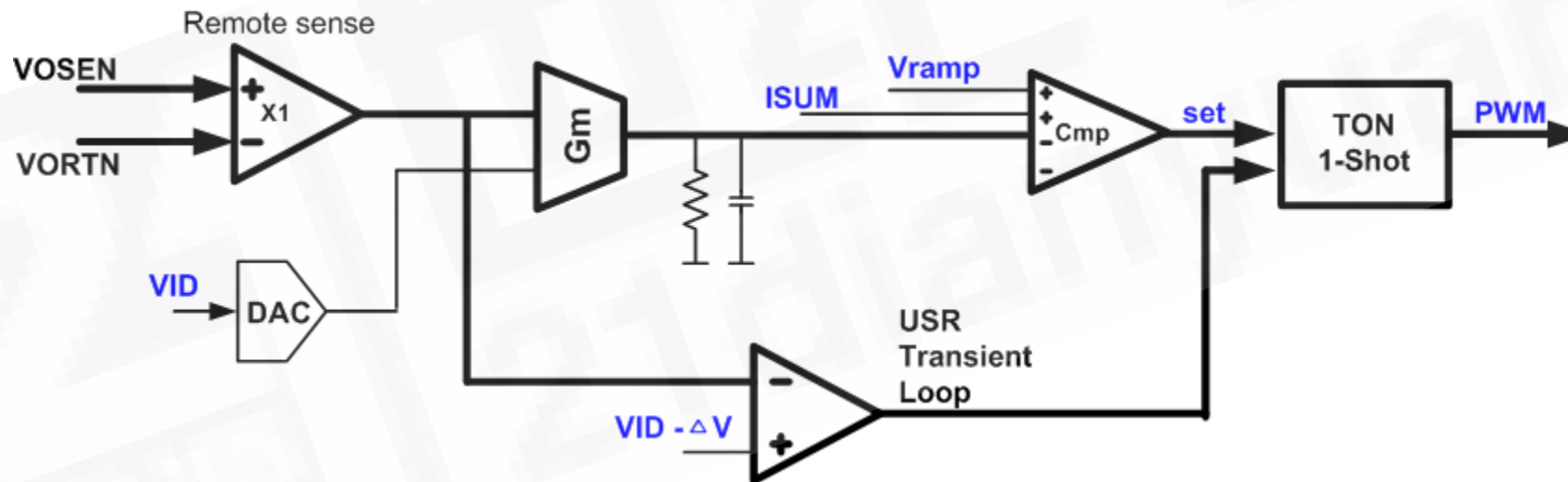
Typical Voltage Mode Digital Control

- Sophisticated pole and zero adjustment during operation
- Separated non-linear loop creates undershoot or ringback during transient
- Voltage mode control doesn't guarantee cycle by cycle current sharing



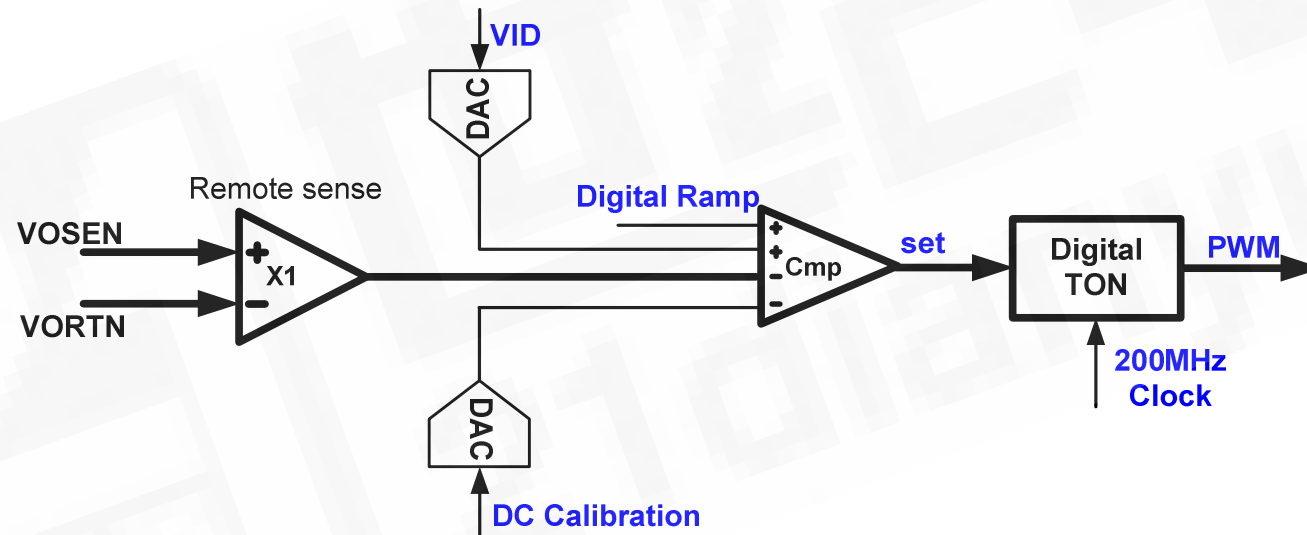
Dual Loop COT Control

- Separated non-linear loop creates undershoot or ringback during transient

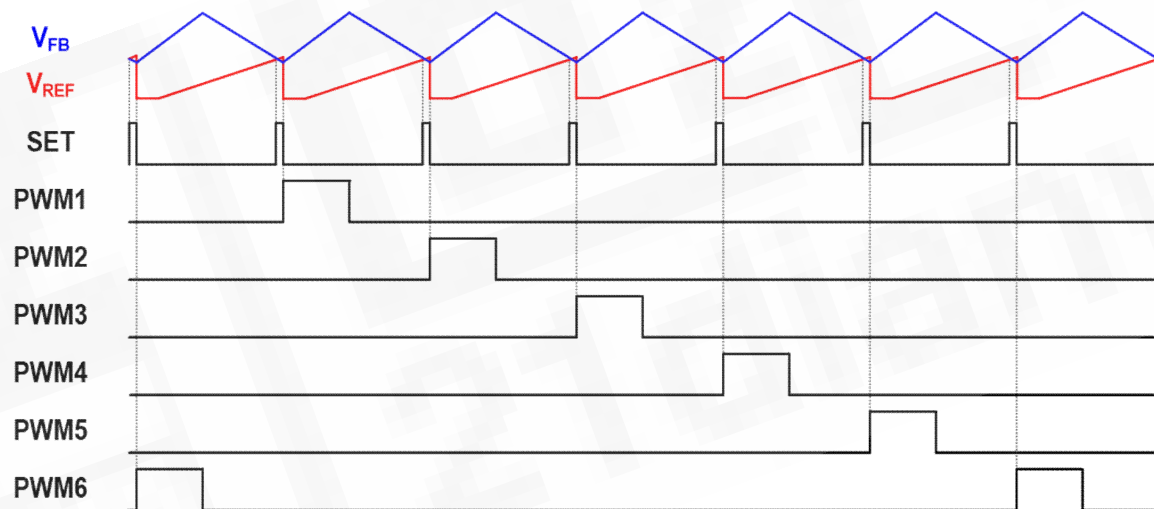
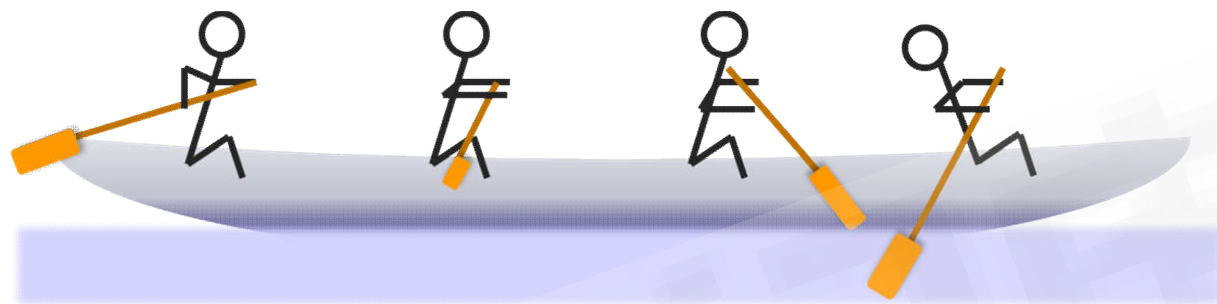


MPS Digital COT Control

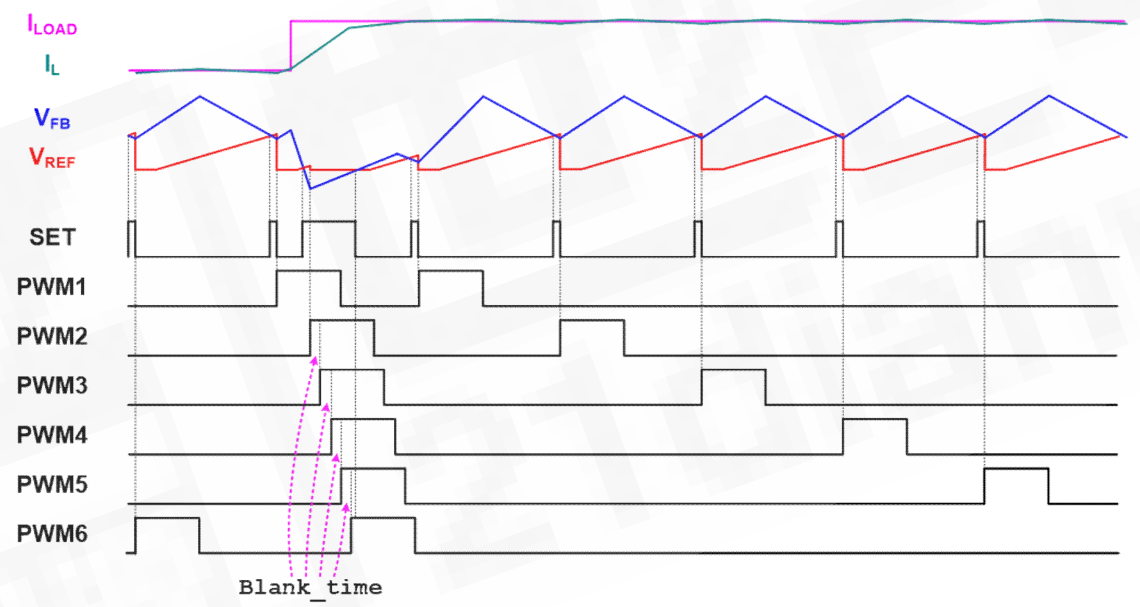
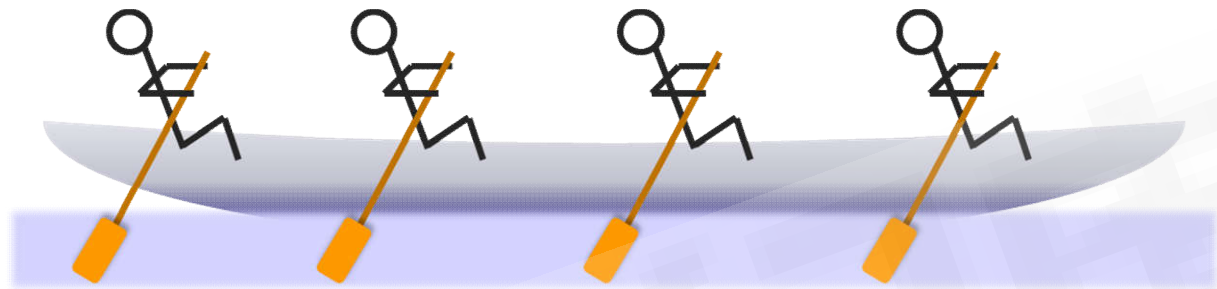
- One fast loop takes care of both steady state and load transient
- MPS patented Technology-Simple, Fast and Fully Digital.



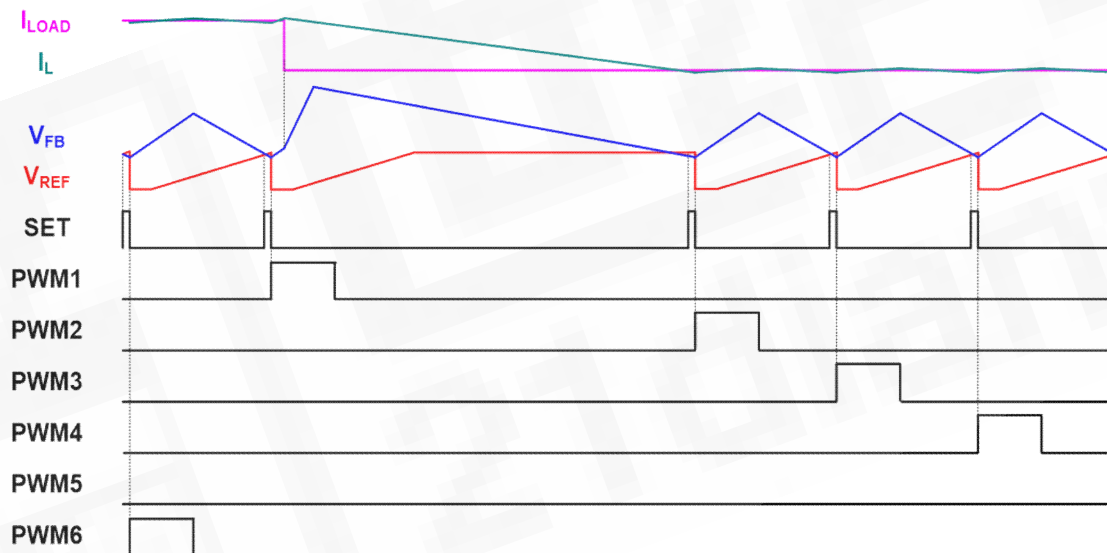
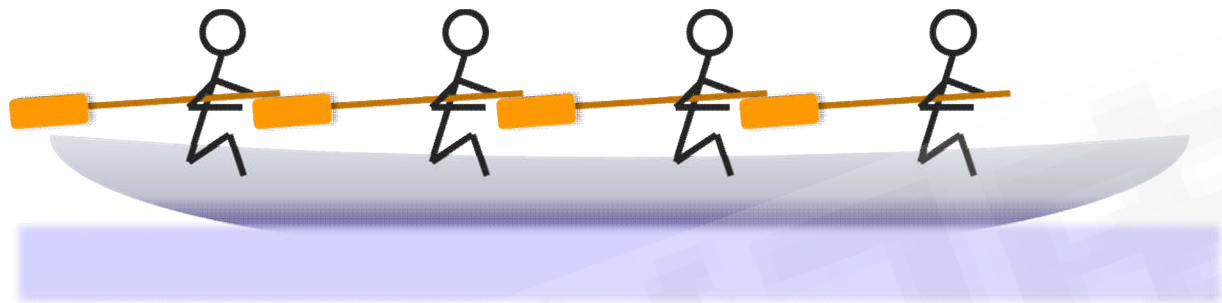
Digital COT Control – Steady State



Digital COT Control – Load Step Up

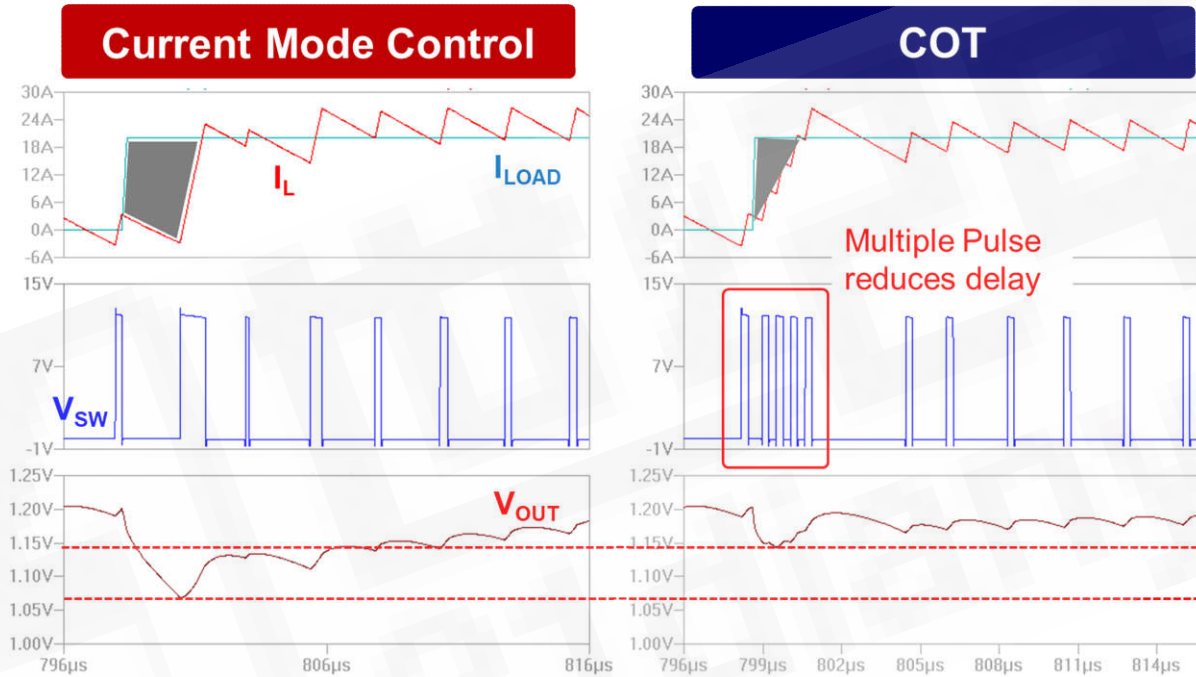


Digital COT Control – Load Step Down



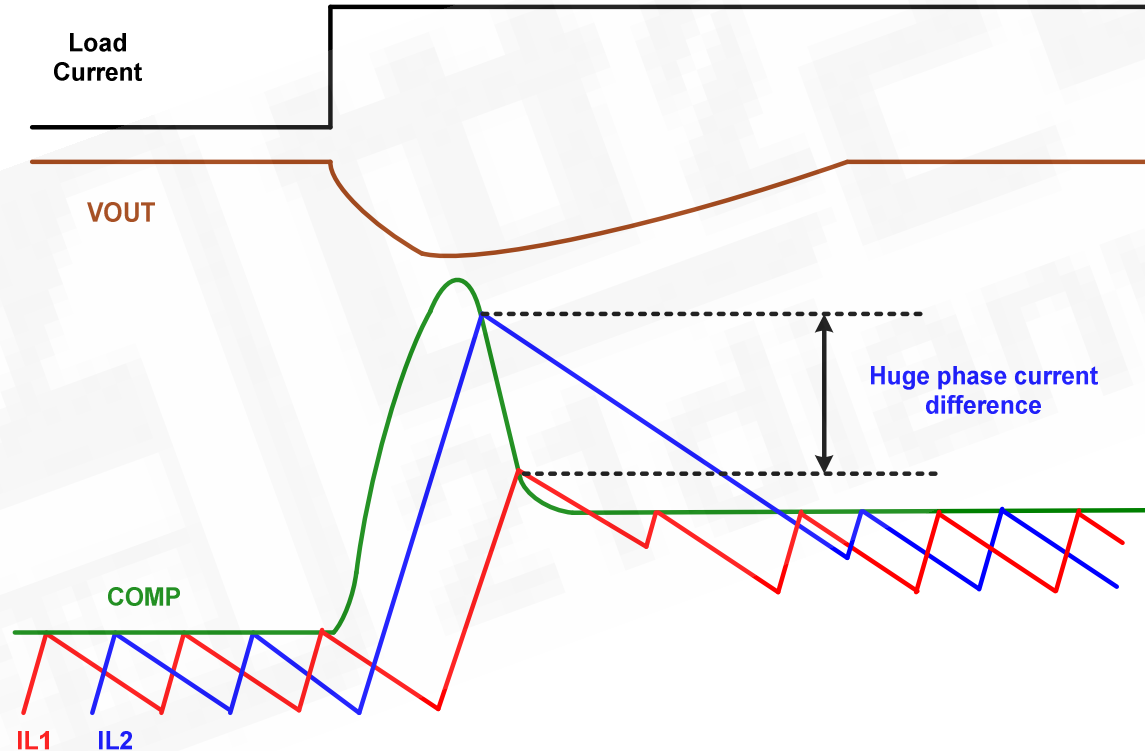
Multiphase VR Current Balance

Current Balance Introduce



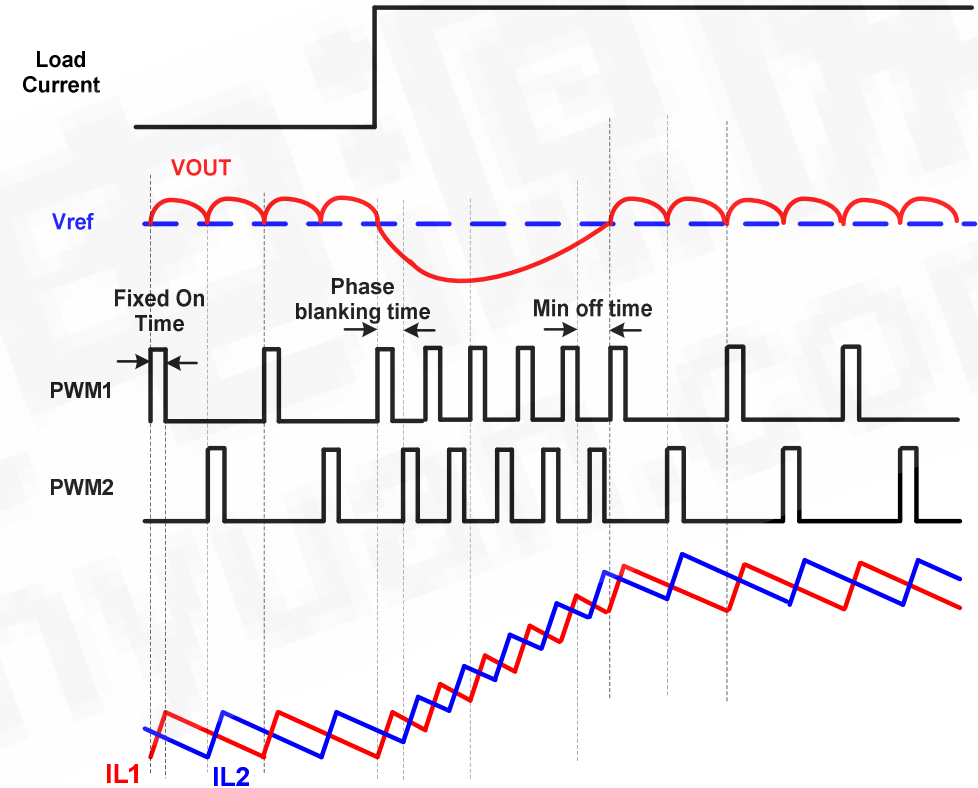
Current Balance Introduce

- Why dynamic current sharing for multiphase is difficult for voltage and current control
- In load step up mode, the leading phase would increase PWM on time dramatically, but due to PWM switching cycle delay, the lagging phase supports less current
- Huge current stress on one phase during fast load step up



Current Balance Introduce

- Reducing PWM off time to support load step up, while PWM on time keeps constant
- PWMs are evenly distributed to each phase , so each phase carries the average current even transient
- Inherently much better dynamic current sharing than voltage and current control



Thank you