Power is Not Simply Black or White, Microchip Highlights Analog/Digital Hybrid Power Supply
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電源不是只有黑白
類比/數位混合型電源強勢登場

Discover Your Power
Flexibility to Choose the Desired Power Solution

POWER UP
What Defines Intelligent Power?

Sometimes a cow is just a cow… But sometimes we need something else
Hybrid Control

Bringing the Best of Both Worlds Together

Analog Feedback Loop and Protection

Hybrid Control (Analog + Digital)

Intelligent Power
The World isn’t Just Black & White

Digitally Enhanced Control, Diagnostics and Runtime Adaptability

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What Defines Intelligent Power?

Power supply units which have one or more of the following features and/or characteristics:

- **Product-Level Features**
  - Enhanced features
  - Communication
  - Non-linear operation profiles
  - Auto-adaptive behavior
    - Process synchronization
    - Self-tuning
    - Self-optimization
  - Enhanced diagnostics
    - Failure prediction
    - Self-protection

- **Product Management Aspects**
  - Customization without hardware modification (e.g. programmable parameters)
  - On-site tailoring (e.g. field-programmable operation modes)
  - Field failure troubleshooting (e.g. diagnostics with error logs)
High-Level Product Concept

LED Driver Section

Intelligent, Self-Sustaining LED Micro-Management IC

- Binning
- Optimized Dimming
- Color Management
- Diagnostics
- Fault Handling
- Complex Operation

Flexibly Configurable Interface

Analog Control

Analog Status

PC, SPI, UART

CAN, LIN

PCMC Power Supply

FET Drive

Inductor Current Feedback

Average Current Feedback

RC Compensation Network
Professional Lighting Applications

- **Industrial Image Processing**
  - Selectable spectrum (IR, UV, blue, red, green, wide-spectrum white)
  - Camera frame-rate desynchronization
  - Pulsed operation for reduced energy consumption
  - Communication and remote control
  - Long-term stability
  - Long-term availability
Microchip Hybrid
PWM Controller Families

Highly Integrated Hybrid PWM Controllers (DEPA)

- Dedicated, vertical applications
  - DC/DC POL converters
  - USB port power
  - LED driver
  - Battery charger
- Dedicated topologies
  - Buck
  - Boost
  - Buck/Boost
  - Flyback, Ćuk, SEPIC

Discrete Hybrid PWM Controllers (CIP Hybrid Power)

- Maximum design flexibility across all power ranges and topologies
  - Single stage converters
  - Multi-stage converters
  - Multi-rail converters
  - Multi-phase converters
- Most flexible PWM configuration
  - Single-ended, half-bridge, full bridge
  - Push-pull, redundant and phase shifting modes
- Free configuration of all building blocks
What is DEPA?

Digitally-Enhanced Power Analog

Hybrid Control (Analog + Digital)

Fully Digital Control

“Digital” Control

Supervisory Microcontroller

PWM Generator Peripheral

Controller - MCU (Coefficients & Operating Set point)

“Aalog” Control

V

MOSFET Driver

Error Amp

Compensator

Internal LDO

MOSFETs

V

Comp

V

FB

V

REF
DEPA Introduction
MCP19118/19/22/23

MCP19118/9, Digitally Enhanced Power Analog
Analog Control and Power Stage

- 8-Bit MCU
- A/D Inputs
- GPIO
- DAC \( V_{REF} \)
- Comm Interface
- Flexible Topology (Buck, Buck-Boost)
- Synchronous Buck Topology

- \( V_{IN} \)
- \( V_{BATT} \)
- \( I_{SENSE} \)

- Internal Bias Supply
- Current Sense
- Slope Compensation
- Error Amp
- Adjustable Compensation Network
- PWM Generator
- Synchronous MOSFET Driver

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DEPA Introduction
MCP19124/19125

MCP19124/5, Digitally Enhanced Power Analog

Analog Control and Power Stage

- Internal Bias Supply
- Synchronous Low-Side MOSFET Driver
- PWM Generator
- Error Amp
- Current Opamp
- Slope Compensation

Flexible Topology Support, including:
- Cuk
- Flyback
- SEPIC
- Boost
- Forward

- 8-Bit MCU
- A/D Inputs
- GPIO
- DAC V_REF
- Comm Interface

V_IN

V_OUT

Compensation Network
Compensation Network

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DEPA Introduction
MCP19116/19117

MCP19114/5/6/7, Digitally Enhanced Power Analog

Analog Control and Power Stage

- Internal Bias Supply
- Synchronous Low-Side MOSFET Driver
- PWM Generator
- Error Amp
- Slope Compensation
- Current Op amp
- Compensation Network

Flexible Topology Support, including:
- Cuk
- Flyback
- SEPIC
- Boost
- Forward

8-Bit MCU
A/D Inputs
GPIO
DAC
VREF
Comm Interface

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DEPA Topology Introduction

- **High and Low Side**
  - MCP19118/9
  - MCP19122/3

- **Low Side**
  - MCP19116/7
  - MCP19124/5
  - MCP19214/5

Low Side (with synchronous rectification support)

Low Side (asynchronous rectification support)
DEPA Controller Families

- **Mixed High/Low Drive Capability**
  - MCP19110/1
    - 32V Synchronous Controller for Step-Down Topologies
    - 4Kw Program Memory
  - MCP19118/19
    - 40V Synchronous Controller for Step-Down Topologies
    - 4Kw Program Memory
  - MCP19122/3
    - 40V Synchronous Controller for Step-Down Topologies
    - 4Kw Program Memory

- **Low-Side Drive Capability**
  - MCP19114/5
    - 42V Synchronous Controller for Step-Up Topologies
    - 4Kw Program Memory
  - MCP19116/7
    - 42V Synchronous Controller for Step-Up Topologies
    - 8Kw Program Memory & Improved Regulation Accuracy
  - MCP19124/5
    - 42V Synchronous Controller for Step-Up Topologies
    - 4Kw Program Memory
    - Voltage & Current Regulation
  - MCP19214/5
    - 42V Synchronous Controller for Step-Up Topologies
    - 8Kw Program Memory
    - Voltage & Current Regulation

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Demo Board Block Diagram
MCP19215

Hybrid (Digital + Analog)

Encoder

OLED Panel

I\(^2\)C

USB (MCP2221A)

ICSP

Temperature Sensor (MCP9701)

MCP19215
5x5mm

DR1

DR2

ISN1

ISN2

VSN1

VSN2

Current Loop

Voltage Loop

Current Loop

Voltage Loop

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Hybrid PWM Controllers Tools Ecosystem

1. Demonstration and Evaluation Board MCP19xxx
2. Evaluation Board Schematic and Source Code
3. Design and Simulation Tools

MPLAB® Harmony Graphics Suite (MHGS)

MPLAB PICkit™ 3 & PICkit 4 In-Circuit Debugger

MPLAB ICD 3 & ICD 4 In-Circuit Debugger

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MPLAB® Mindi ™
Analog Simulator

- Enable analog circuit design with Microchip
  - Engineers can test ideas, changes or tradeoffs in simulation prior to creating hardware
  - Problems can be found in simulation, saving time and effort from hardware fixes
  - Hardware bugs can be compared to analog simulation results to help troubleshoot development problems

www.microchip.com/Mindi
MPLAB® Mindi™
Analog Simulator
MPLAB® Code Configurator
MCP19215

Enable MCC

PWM Frequency Setting

Pin Manager
User can select the output pins they desire
MPLAB® Code Configurator
PWM Frequency Setting

System Module

System
- Interrupt Module
- Pin Module
- System Module

Peripherals
- MSSP [MCP19XXX by Microchip Technology]
- VIN
- IVOUT1 (8 bit)
- ADC [MCP19XXX by Microchip Technology]
- IVOUT2 (8 bit)

Easy Setup

INTERNAL_OSCILLATOR

SYSTEM CLOCK
- Current System Clock is 8 MHz

OUTPUT SWITCHING
- PWM Clock Prescaler: 1:1
- Switching Frequency [kHz]: 300 kHz
  Actual Switching Frequency: 296.3 kHz

PWM Frequency Setting
PRG Slope Compensator
Sub-Harmonic Oscillation

Vout error amplifier

Ideal inductor current

Inductor current with disturbance

PWM

1

2

MCC

Slope Compensation
4.47~478.33 mv/us

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The Files Generated

- **main.c**
- **MCC generate files:**
  - mcc.c
  - mcc.h
  - Pin_manager.c
  - Pin_manager.h
Measurement / Start Up
Signal

![Graph showing signal measurement and start-up signal](image)

Note: The graph illustrates the measurement and start-up signal, with various signal values and parameters displayed on the axes.
Summary

- Power is not simply black or white
- Hybrid power controller advantages
- How to implement hybrid power system
- Microchip hybrid power solutions update
- Design tools introduction
Thank you!