

VIpower™ M0-5: the smart power device

Dedicated product portfolio for car lighting applications

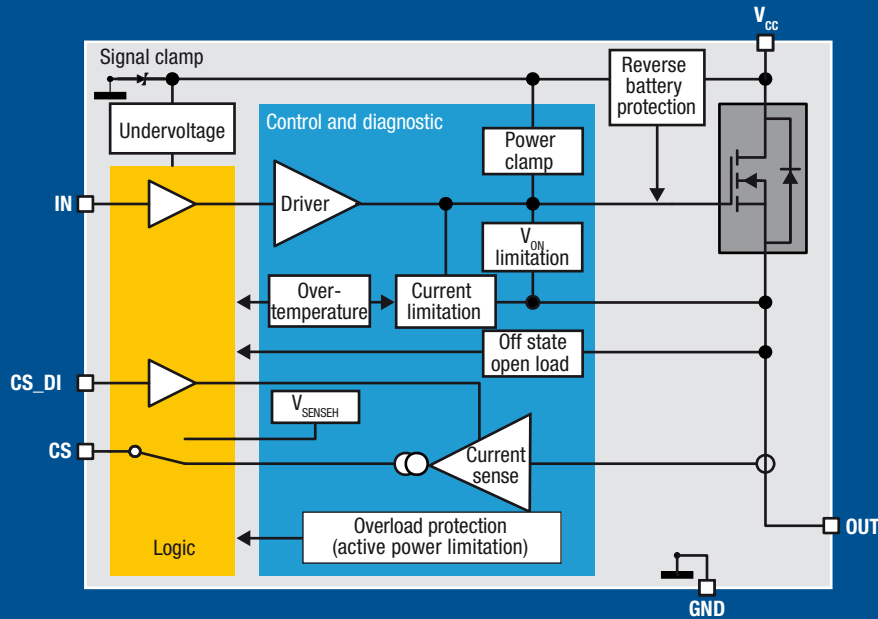


January 2010

Automotive smart power switches for lighting

STMicroelectronics offers a wide family of innovative smart power switches, designed in VIPower™ M0-5 technology, for automotive applications. These products introduce a new and effective protection strategy assuring an excellent standard of reliability, so meeting the growing market demand, increasingly focused on intelligent power switches (IPS) able to protect themselves and the load against hazardous conditions (such as overload or short circuit). The product portfolio includes single-, dual- and quad-channel solutions with several options in terms of on-resistance, diagnostic features and packages. Enriching this offer, the portfolio has been completed with a dedicated smart multiplexer (L99PD08) designed to drive up to 8 channels through the SPI.

Typical block diagram for single channel options



General features

- Inrush current active management by power limitation
- Very low standby current (~2 μ A)
- Very low current sense leakage
- 3 V CMOS compatible inputs
- Optimized electromagnetic emissions
- Very low electromagnetic susceptibility

Diagnostic functions

- Proportional load current sense
- High current-sense precision for wide current range
- Open-load detection
- Thermal shutdown indication
- Fast overload/short-to-ground detection (for Enhanced option)

Protection features

- Undervoltage shutdown
- Overvoltage clamp
- Load current limitation
- Self limiting of fast thermal transients
- Protection against loss of ground and loss of V_{CC}
- Over-temperature shutdown with auto-restart (thermal shutdown)
- Electrostatic discharge protection
- Reverse battery protection

Best in class in protection strategy

Standard IPS, during overload or heavy short circuit, are not protected against thermal stress (fast thermal transients), the main cause of silicon degradation. VIPower M0-5 devices have an internal control, called Power Limitation (patent IP), that reduces silicon degradation by turning off the internal vertical power MOSFET when the junction temperature increases suddenly. Moreover, an additional protection is implemented through two different current-limitation values. During the load inrush, the current is limited at I_{LIMH} (high), but when thermal shutdown is triggered, the limitation current is decreased to I_{LIML} (low), in order to reduce the thermal stress during permanent overload. Compared to standard IPS, M0-5 ensures a longer lifetime under hazardous conditions.

Real benefits

Scalability and flexibility

- $R_{DS(on)}$ granularity with HW and SW compatibility
- Multiple diagnostic options for $R_{DS(on)}$ size
- Selectable current limitation by part numbers, for extended load coverage

Unsurpassed ruggedness - 10 times longer life time!

- Innovative protection strategy based on:
 - Power Limitation (ST IP)
 - Dual current limitation

Advanced tiny power packages

- Eco-friendly solutions: up to 70% of body size reduction for PCB shrinkage and system weight reduction
- Wide offer including:
 - PowerSSO-12/16/24/36
 - HPAK
 - PowerSO-10/16
 - PQFN
 - MultipowerSO-30

Simplified design with L99PD08

- Synchronous pre-processing diagnosis and fault detection (MCU workload reduction ~25%)
- Light software for shorter time-to-market
- System modularity

Automotive applications

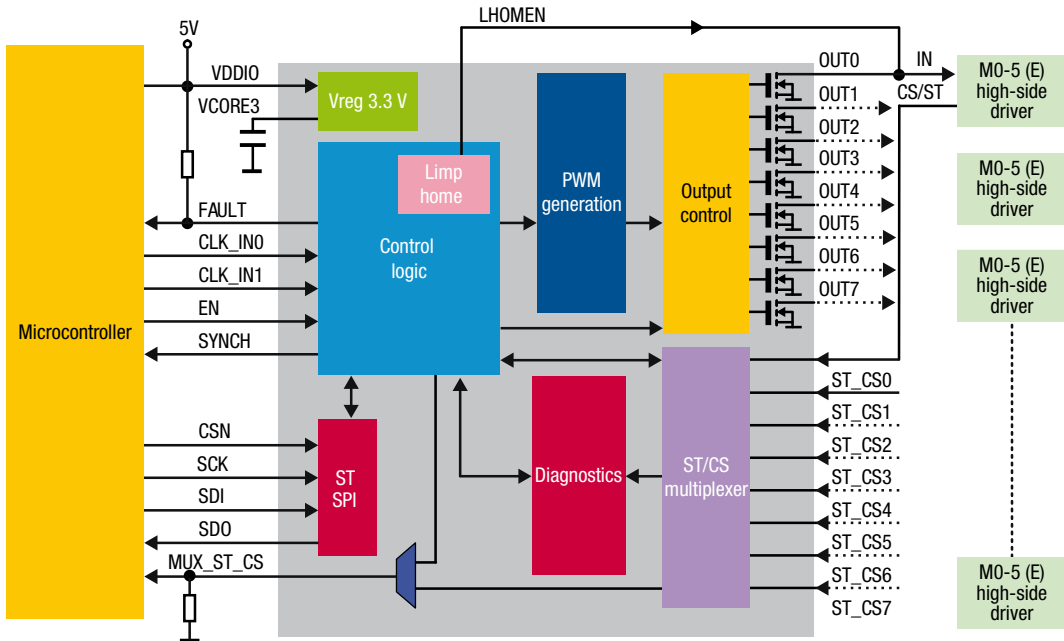
- Junction boxes
- Body controllers
- Interior lighting (bulbs, LEDs)
- Door systems
- ABS
- Domes
- Seat heating
- Power management
- Diesel glow plugs
- Climate control
- All types of resistive, inductive and capacitive loads



Simplify your design using L99PD08

Tailored for VIPOWER™ M0-5 high-side drivers, the L99PD08 is a coprocessor that controls and monitors eight driver channels via the SPI. The onboard synchronous diagnosis provides reliable, filtered and detailed information on the high-side drivers without intervention of the microcontroller. The microcontroller's task can thus be reduced to the simple monitoring of a fault pin, decreasing the workload associated with driver diagnosis. The circuit also provides phase-shifted PWM, and two independent frequencies are applicable to any of the 8 channels, supporting the control of LEDs and bulbs. Limp-home functions are also embedded, making system fail-safe management easy. The fast reaction time of the L99PD08 to a short circuit (below 100 μs) increases system robustness under short-circuit conditions. Moreover, wrong overload diagnosis caused by positive ISO-pulses 2 and 3, are rejected by the on-board filter.

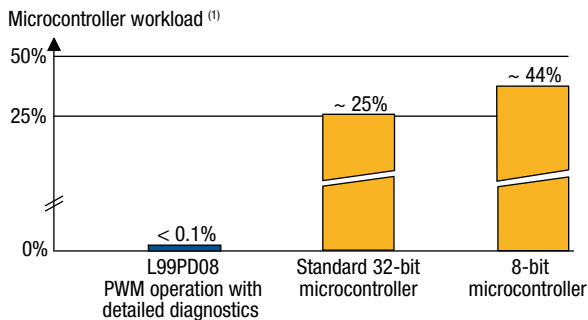
L99PD08 block diagram



Key features

- Intelligent multiplexer
 - SPI interface to microcontroller
 - Parallel I/O to control and diagnose M0-5 and M0-5E high-side drivers
- PWM generation
 - 8 independent channels
 - Programmable phase shift
- Diagnostics
 - Synchronous and detailed diagnostics
 - Programmable fault detection thresholds
 - Analog sense multiplexing
- Safety
 - Timeout watchdog for system integrity
 - Limp-home mode
 - Programmable thermal latch off

Workload comparison for diagnostic tasks with 40 high-side driver channels



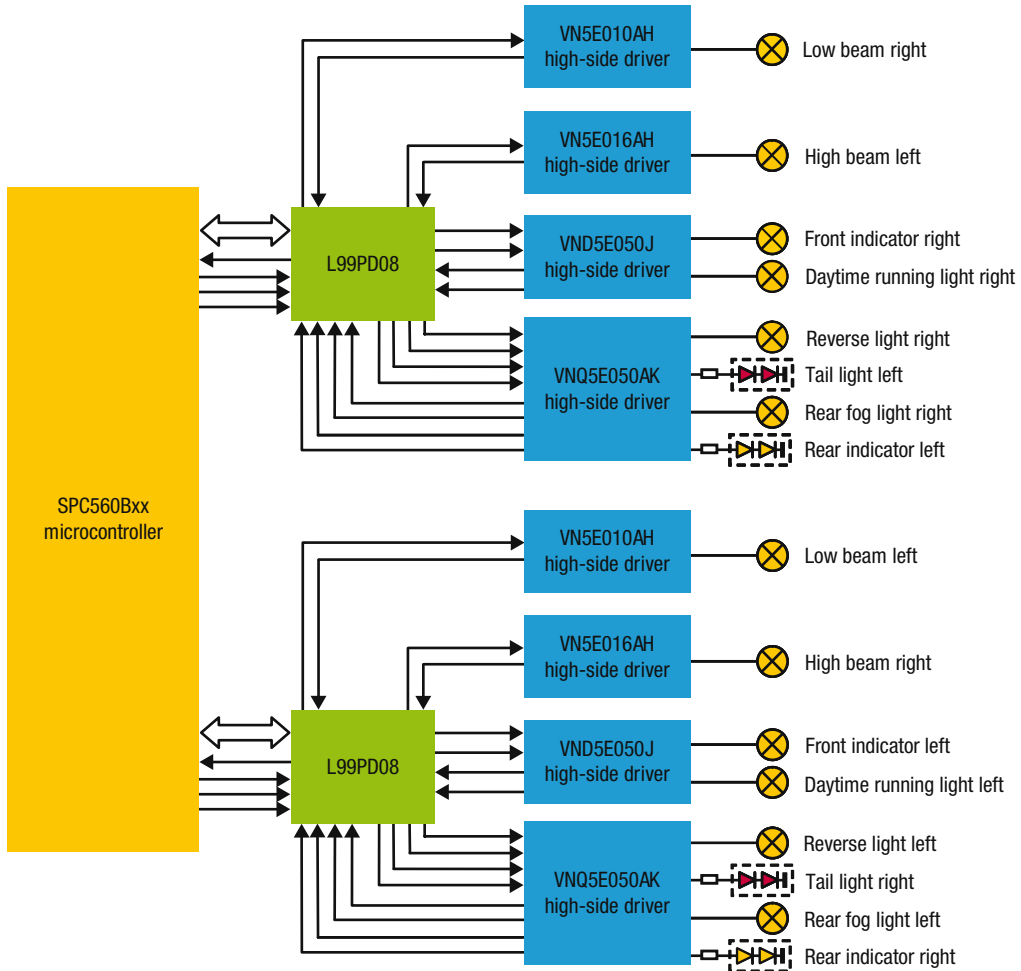
⁽¹⁾ Measurement and estimated values based on datasheets

Application benefits

- Enhanced short-circuit robustness through fast reaction time
- Extremely low microcontroller workload with simplified software
- Microcontroller pin-count reduction by SPI interface
- Full benefit of M0-5 and M0-5E portfolio
 - High-side driver to load optimization
- Full partitioning flexibility
 - Different supply lines for the high-side drivers
 - Suitable for single, dual and quad high-side drivers
- LED and bulb compatibility without external components
- Enhanced system reliability
- Cost reduction at system level

The L99PD08 enables optimal high-side driver partitioning in terms of $R_{DS(on)}$, supply lines, and number of channels in one package, with respect to the loads. This scalability is an answer to the growing number of variants and options within a car platform.

L99PD08 typical application diagram



Required microcontroller pins for the control of 16 current-sense high-side drivers

	Control and diagnosis by microcontroller ⁽⁸⁾	Control and diagnosis by L99PD08 ⁽⁹⁾
Microcontroller total pins	32	9
Digital IO	16	8
Analog inputs	16	1

(8) Required for the control of 16 high-side driver channels with only current sense, without use of CS_Dis

(9) Required for the control of 16 high-side driver channels (current sense or digital status)

Make your selection according to your needs

<p>M0-5 standard</p>	<p>Standard M0-5 is a complete product portfolio suitable to address any typical load in automotive applications (such as high beam, low beam, turn indicator, interior lighting). For each $R_{DS(on)}$ size, single-, dual- and quad-channel options are available. Moreover, the devices are equipped with digital diagnostics or with analog current sense.</p>
<p>M0-5Enhanced</p>	<p>In addition to the standard protection and diagnostic features, the M0-5Enhanced products offer:</p> <ul style="list-style-type: none"> ■ Extended load compatibility due to higher current limitation ■ Immediate diagnosis reaction over short-to-ground or overload (power limitation detection) ■ Open-load/short-to-V_{CC} detection in off-state for analog current sense option as well
<p>M0-5Enhanced M version</p>	<p>The M versions complete the product portfolio with devices having the same specification as M0-5Enhanced except for the open-load detection in off state.</p>

Packages

Nowadays the automotive market is focusing on solutions that minimize the overall car dimensions and weight in order to significantly reduce pollution. In line with these requirements, the VIPower™ M0-5 family offers an eco-friendly product portfolio of lead-free packages ensuring outstanding thermal performance in really tiny SMD packages ($R_{thj-amb} = 16 \text{ }^\circ\text{C/W}$ for the PowerSSO-24^(*))



(*) Device mounted on PCB: FR4 10 x 15 cm; thickness 1.6 mm; 4 layers (70 μm external, 35 μm internal); thermal vias and 90% of copper area coverage.

High-side switch portfolio

Part number	Package	Channels	Operating voltage range V_{CC} (V)	Max supply voltage V_{CC} (max) (V)	Max on-state resistance $R_{DS(on)}$ (max) ($m\Omega$)	Current limitation I_{LIMH} (typ) (A)	Diagnosis(*)	Open load in off state
VN5160S	S0-8	1	4.5 to 36	41	160	5	DS	●
VN5050J	PowerSS0-12	1	4.5 to 36	41	50	18	DS	●
VN5050AJ	PowerSS0-12	1	4.5 to 36	41	50	18	CS	
VN5025AJ	PowerSS0-12	1	4.5 to 36	41	25	40	CS	
VN5016AJ	PowerSS0-12	1	4.5 to 36	41	16	60	CS	
VN5012AK	PowerSS0-24	1	4.5 to 36	41	12	65	CS	
VN5010AK	PowerSS0-24	1	4.5 to 36	41	10	65	CS	
VN5E160S	S0-8	1	4.5 to 28	41	160	10	DS	●
VN5E160AS	S0-8	1	4.5 to 28	41	160	10	CS	●
VN5E050J	PowerSS0-12	1	4.5 to 28	41	50	27	DS	●
VN5E050AJ	PowerSS0-12	1	4.5 to 28	41	50	27	CS	●
VN5E025AJ	PowerSS0-12	1	4.5 to 28	41	25	60	CS	●
VN5E016AH	H-PAK	1	4.5 to 28	41	16	73	CS	●
VN5E010AH	H-PAK	1	4.5 to 28	41	10	85	CS	●
VN5E006ASP (**)	PowerS0-10	1	4.5 to 28	41	6	100	CS	●
VN5E160MS	S0-8	1	4.5 to 28	41	160	10	CS	
VN5E050MJ	PowerSS0-12	1	4.5 to 28	41	50	27	CS	
VN5E025MJ	PowerSS0-12	1	4.5 to 28	41	25	60	CS	
VN5E016MH	H-PAK	1	4.5 to 28	41	16	73	CS	
VN5E010MH	H-PAK	1	4.5 to 28	41	10	85	CS	
VND5160J	PowerSS0-12	2	4.5 to 36	41	160	5	DS	●
VND5160AJ	PowerSS0-12	2	4.5 to 36	41	160	5	CS	
VND5050J	PowerSS0-12	2	4.5 to 36	41	50	18	DS	●
VND5050AJ	PowerSS0-12	2	4.5 to 36	41	50	18	CS	
VND5050K	PowerSS0-24	2	4.5 to 36	41	50	18	DS	●
VND5050AK	PowerSS0-24	2	4.5 to 36	41	50	18	CS	
VND5025AK	PowerSS0-24	2	4.5 to 36	41	25	40	CS	
VND5025LAK	PowerSS0-24	2	4.5 to 36	41	25	60	CS	
VND5012AK	PowerSS0-24	2	4.5 to 36	41	12	60	CS	
VND5004BSP30	MultiPowerS0-30	2	4.5 to 28	41	4	100	CS	
VND5004B	PQFN	2	4.5 to 28	41	4	100	CS	
VND5E160J	PowerSS0-12	2	4.5 to 28	41	160	10	DS	●
VND5E160AJ	PowerSS0-12	2	4.5 to 28	41	160	10	CS	●
VND5E050J	PowerSS0-12	2	4.5 to 28	41	50	27	DS	●
VND5E050AJ	PowerSS0-12	2	4.5 to 28	41	50	27	CS	●
VND5E050K	PowerSS0-24	2	4.5 to 28	41	50	27	DS	●
VND5E050AK	PowerSS0-24	2	4.5 to 28	41	50	27	CS	●
VND5E025AK	PowerSS0-24	2	4.5 to 28	41	25	60	CS	●
VND5E012AY	PowerSS0-36	2	4.5 to 28	41	12	74	CS	●
VND5E008AY	PowerSS0-36	2	4.5 to 28	41	8	85	CS	●
VND5E006ASP	PowerS0-16	2	4.5 to 28	41	5.5	100	CS	●
VND5E004A30	MultiPowerS0-30	2	4.5 to 28	41	4	100	CS	●
VND5E004A	PQFN	2	4.5 to 28	41	4	100	CS	●

High-side switch portfolio (cont'd)

Part number	Package	Channels	Operating voltage range V_{CC} (V)	Max supply voltage V_{CC} (max) (V)	Max on-state resistance $R_{DS(on)}$ (max) ($m\Omega$)	Current limitation I_{LIMH} (typ) (A)	Diagnosis(*)	Open load in off state
VND5E160MJ	PowerSS0-12	2	4.5 to 28	41	160	10	CS	
VND5E050MJ	PowerSS0-12	2	4.5 to 28	41	50	27	CS	
VND5E050MK	PowerSS0-24	2	4.5 to 28	41	50	27	CS	
VND5E025MK	PowerSS0-24	2	4.5 to 28	41	25	60	CS	
VND5E012MY	PowerSS0-36	2	4.5 to 28	41	12	74	CS	
VND5E008MY (**)	PowerSS0-36	2	4.5 to 28	41	8	85	CS	
VNQ5160K	PowerSS0-24	4	4.5 to 36	41	160	5	DS	●
VNQ5050K	PowerSS0-24	4	4.5 to 36	41	50	18	DS	●
VNQ5050AK	PowerSS0-24	4	4.5 to 36	41	50	18	CS	
VNQ5027AK	PowerSS0-24	4	4.5 to 36	41	27	40	CS	
VNQ5E250AJ	PowerSS0-16	4	4.5 to 28	41	250	5	CS	●
VNQ5E160K	PowerSS0-24	4	4.5 to 28	41	160	10	DS	●
VNQ5E160AK	PowerSS0-24	4	4.5 to 28	41	160	10	CS	●
VNQ5E050K	PowerSS0-24	4	4.5 to 28	41	50	27	DS	●
VNQ5E050AK	PowerSS0-24	4	4.5 to 28	41	50	27	CS	●
VNQ5E160MK	PowerSS0-24	4	4.5 to 28	41	160	10	CS	
VNQ5E050MK	PowerSS0-24	4	4.5 to 28	41	50	27	CS	

Low-side switch portfolio

Part number	Package	Channels	Voltage clamp V_{clamp} (typ) (V)	Max on-state resistance $R_{DS(on)}$ (max) ($m\Omega$)	Current limitation I_{lim} (typ) (A)	Digital status
VNL5160N3-E	SOT-223	1	46	160	5	
VNL5160S5-E	S0-8	1	46	160	5	●
VNL5050N3-E	SOT-223	1	46	50	27	
VNL5050S5-E	S0-8	1	46	50	27	●

(*) DS: Digital status feedback; CS: Analog current sense

(**) Coming soon



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