ON Semiconductor®

Automotive Driver Requirements, Topologies and Applications

Driver Topologies

Low-Side

Powertrain Loads

- Motors
- Solenoids
- Heaters
- Lighting

Pros

- Easy to Drive

Challenges

- No Protection from shorts to ground
- Inductive Energy
- Parasitics
- Reverse Battery

High-Side

Body Loads

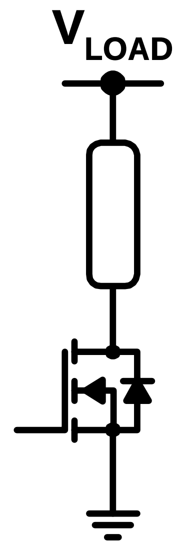
- Motors
- Solenoids
- Heaters
- Lighting

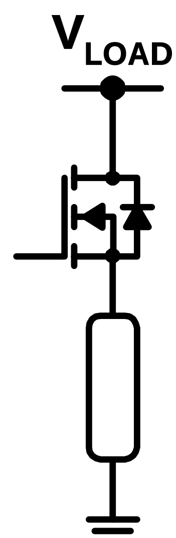
Pros

- Protection from shorts to ground

Challenges

- Less Easy to Drive
- Inductive Energy
- Negative Clamp
- ESD Protection
- Reverse Battery





Driver Topologies

<u>Half-Bridge</u>

Powertrain or Body

Pros

- Hs or LS Drive

Challenges

- Inductive Energy
- Parasitics
- Reverse Battery

<u>Full-Bridge</u>

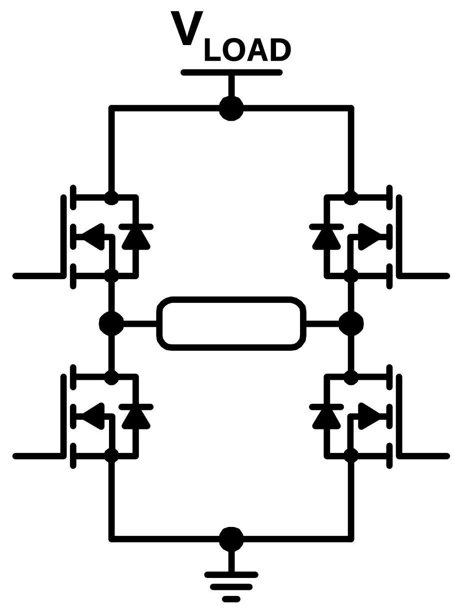
Powertrain or Body

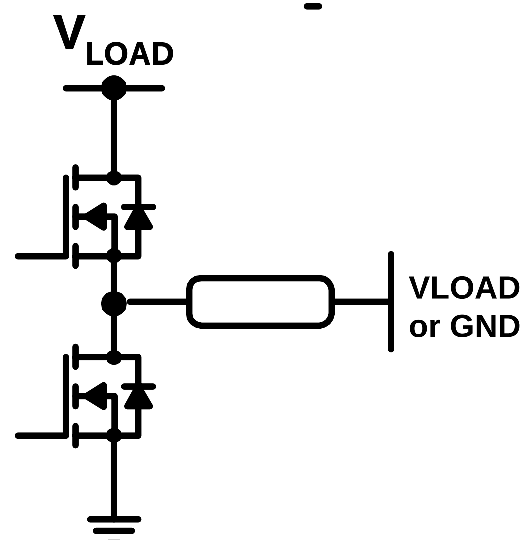
Pros

- Hs or LS Drive
- Bi-Directional

Challenges

- Inductive Energy
- Parasitics
- PWM Losses from drops in HS and LS & non-overlap concerns
- Reverse Battery





ON Semiconductor Automotive Driver Part Selection

DRIVERS

Device	Description	Output Current	RDS(ON) @ 25°C	Sleep Mode	On-Chip Flyback Diode	Active Output Clamp	Parallel Inputs	SPI	Fault Reporting	Undervoltage Lockout	Open Load Detect	Current Limit	Overvoltage	Overtemperature	Low Duty Cycle Overcurrent Mode	Peak Transient	AEC-PPAP	Package(s)[1]
NCV7708A	Double Hex Driver	500 mA	0.8 Ω	♦	♦	♦		♦	♦	♦	♦	●	●	●		40 V	Note 1	SOIC-28 Fused
NCV1413	Darlington Transistor Array	500 mA	–		♦		♦									50 V	Note 1	SOIC-16
NCV7702B	Dual Half-Bridge Driver	1 A	–	♦	♦		♦		♦			●	●	●	●	60 V	Note 1	SOIC-24 Fused
NCV7703	Triple Half-Bridge Driver	500 mA	0.8 Ω	♦				♦	♦	♦	♦	●	●	●		40 V	Note 1	SOIC-14 Fused
AMIS-39100	Octal High-Side Driver	350 mA	1 Ω	♦		♦	♦	♦	♦	♦	♦	●		●		35 V	Note 2	SOIC-28

NOTE 1: Devices are AEC-Qualified and PPAP-Capable. Contact ON Semiconductor for details.
NOTE 2: Contact ON Semiconductor for AEC and PPAP status.

Drivers connect to loads directly,
while pre-drivers are intended to drive discrete FETs which drive loads.

PRE-DRIVERS

Device	Description	Output Current	RDS(ON) @ 25°C	Sleep Mode	On-Chip Flyback Diode	Active Output Clamp	Parallel Inputs	SPI	Fault Reporting	Undervoltage Lockout	Open Load Detect	Current Limit	Overvoltage	Overtemperature	Low Duty Cycle Overcurrent Mode	Peak Transient	Package(s)
NCV7512	Quad Low-Side MOSFET Driver	1.9 mA	1.8 kΩ	♦			♦	♦	♦	♦	♦	●				6.5 V	LQFP-32
NCV7513A	Hex Low-Side MOSFET Driver	1.9 mA	1.8 kΩ	♦			♦	♦	♦	♦	♦	●				6.5 V	LQFP-32
NCV7517	Hex Low-Side MOSFET Driver	1.9 mA	1.8 kΩ	♦			♦	♦	♦	♦	♦	●				6.5 V	LQFP-32
NCV33152	High Speed Dual MOSFET Drivers	1.5 A	-	♦	♦		♦									20 V	SOIC-8

NOTE: All devices in this table are AEC-Qualified and PPAP-Capable. Contact ON Semiconductor for details.

Note the higher current ratings for the drivers, except for the high-speed pre-driver which is high current.

Load & Driver Spectrum

Percent of Loads

	65%	31%	4%
Hybrid (Multi-die Package)		Occasionally Motor drivers > 10A	High Penetration Ease of Use
MOSFET	Standard	Standard	Standard
Integrated	Smart	Smart	Smart
Highly Integrated	Drivers Pre Drivers + MOSFETs	Some Drivers Pre Drivers + MOSFETs	Pre Drivers + MOSFETs

Load Current: 0 | 5 | 20

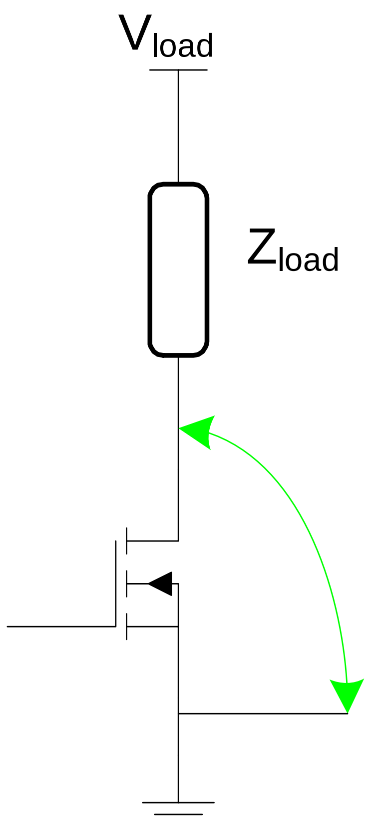
Deciding on your Driver

- Evaluate your current level as per the chart on the previous page.
  - This will result in your choice of a driver, pre-driver, or hybrid solution.
- Do you need to be able to survive fault conditions?
  - A no here will add a discrete solution as a possibility.
- Investigate what happens during faults and the implications on your system.
  - This will result in your decision of a high-side or low-side driver.
- What are your requirements for reporting faults?
  - This will result in your choice of a SmartFET or SPI controllable driver.

Evaluating Faults - Short to Ground

Low-Side Driver

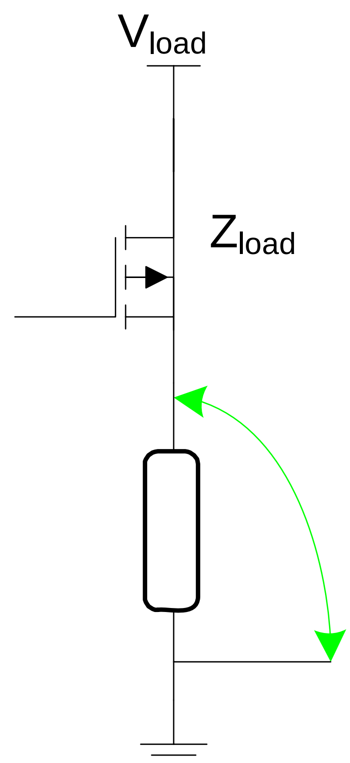
- Load is continuously on during an output short to ground



High-Side Driver

- Output Driver is shorted to ground. Requires protection for the output driver.

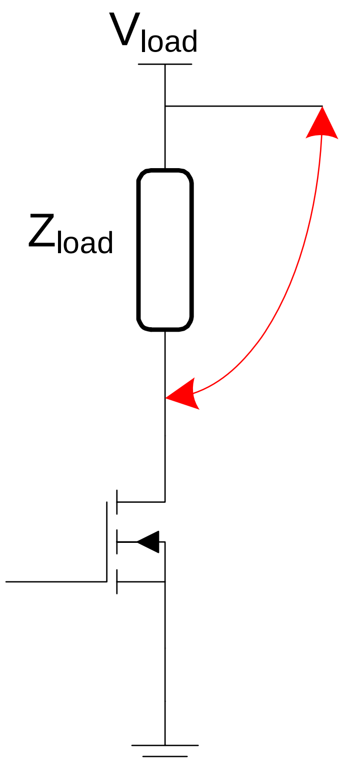
Shorts to ground are more likely to occur than shorts to battery due to the abundance of sheet metal from the automobile.



Evaluating Faults - Short to Supply

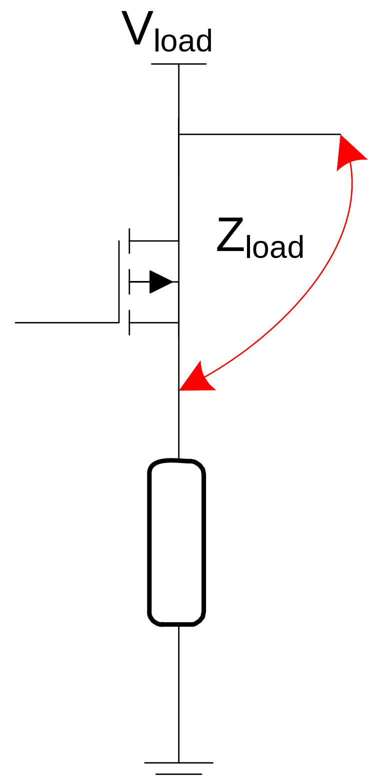
Low-Side Driver

- Output Driver is shorted to supply. Requires protection for the output driver.



High-Side Driver

- Load is continuously on during an output short to ground



Applications

Powertrain

•Historically Low Side Drivers

•Cheaper (Less Die Area & Easier to Drive)

Body

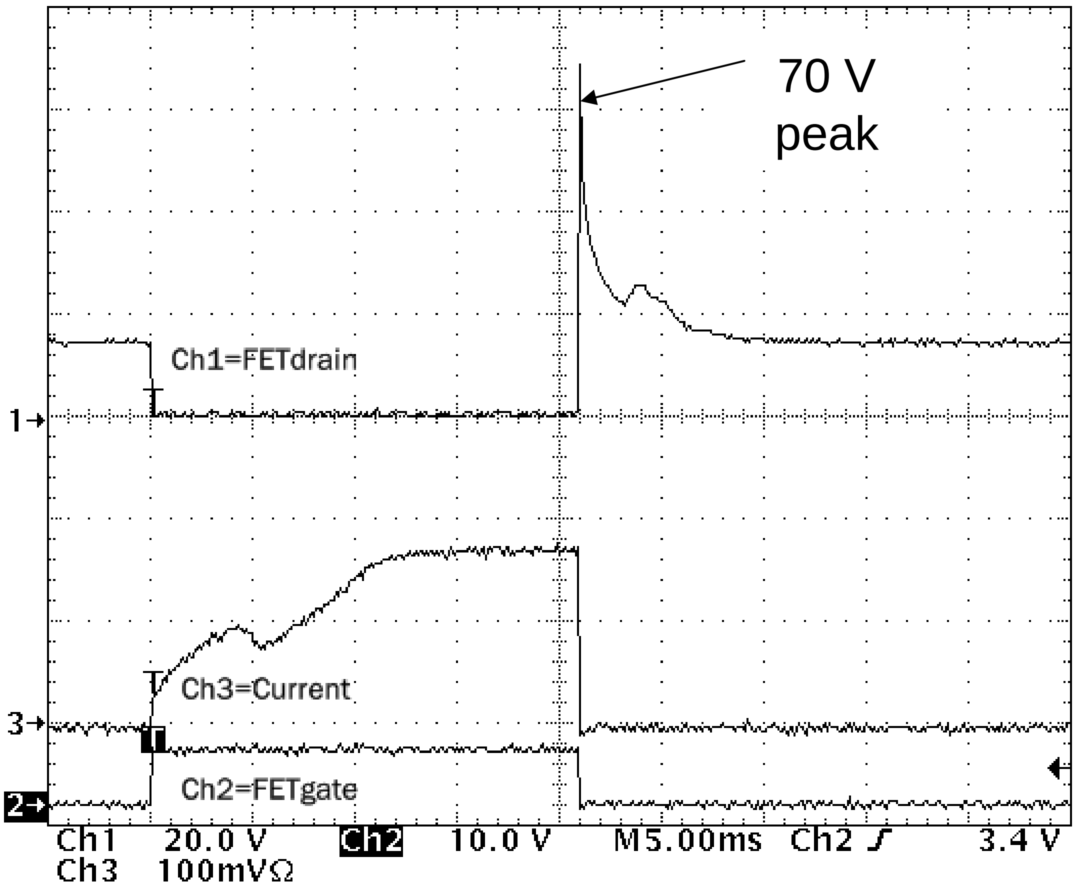
•Historically High-Side Drivers

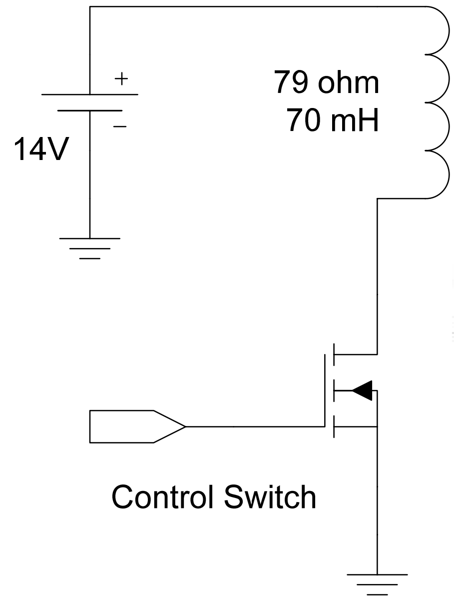
•Don't suffer from the effects of always on when shorted to ground.

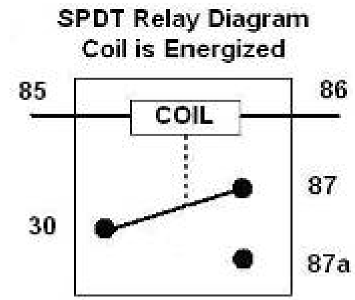
Driver Loads

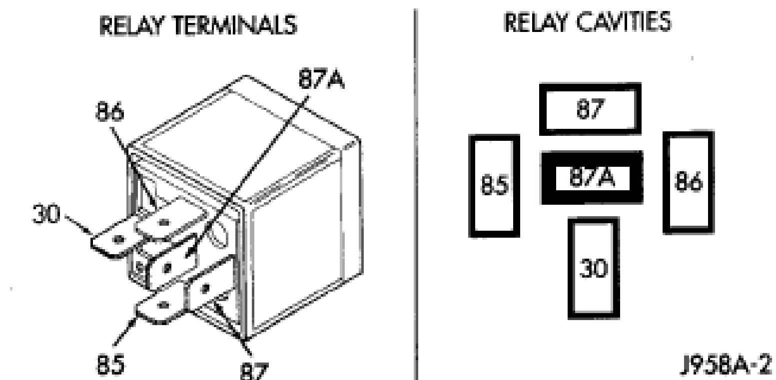
- Types of Loads and their special requirements
  - Resistive loads.
    - No special needs. Only need to evaluate IC Power.
  - Relays
    - Inductive loads. Need to be concerned about stored energy in the coils. ICs need protection from high voltage (positive for LS and negative for HS) caused by inductors turning off.
  - Lamps
    - Variable resistance. Need to be concerned about in-rush current. Lamp drivers typically need a blanking time in which to ignore high current events.
  - LED
    - Constant current. Need to be concerned about maintaining a constant current. Some systems require all LEDs in a system to turn off when one fails (opens). This simulates a bulb and does not allow operation at minimal illumination.

Unprotected Inductive Loads





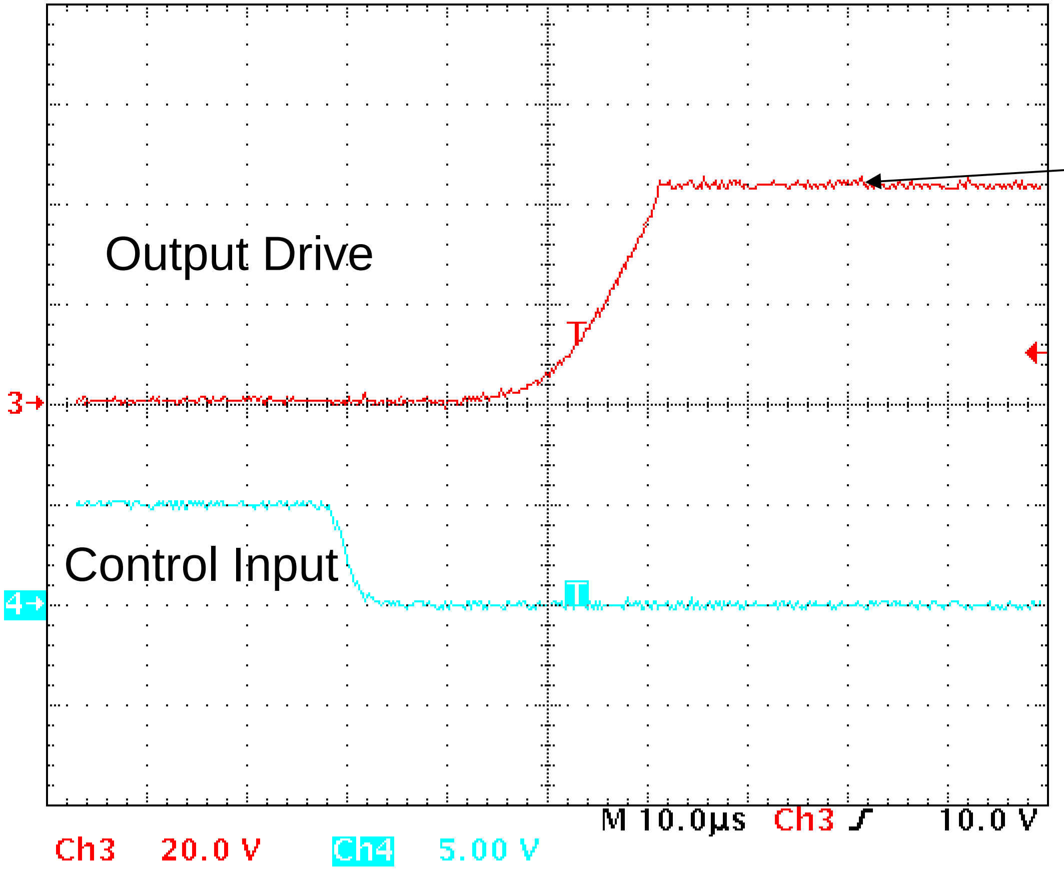




TERMINAL LEGEND	
NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

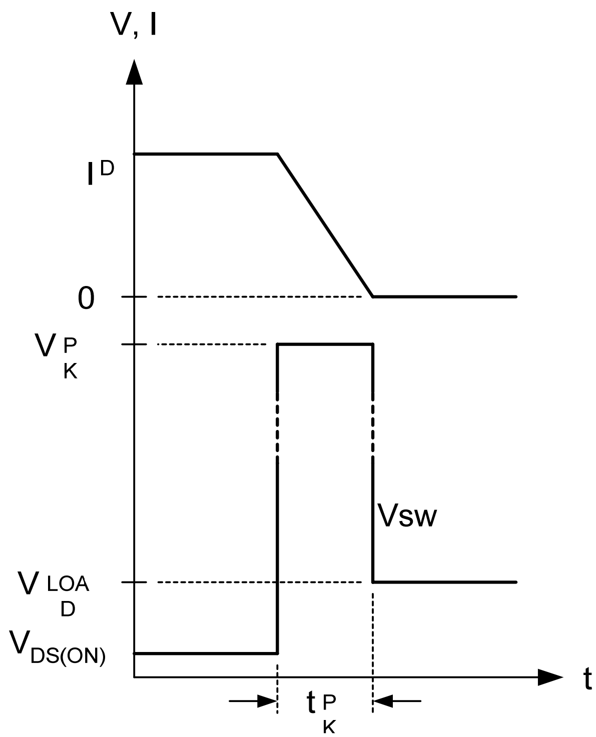
High Speed Blower Motor Relay

Adding a clamp to the output of your LS Switch



The inductively loaded low-side drive is switched off causing the voltage on the output drive pin to spike up.

The spike is clamped here at 44 V.



High-Side Driver Performance

Concerns:

Repetitive High Power Switching

Clamp Voltage is below ground for HS switching of inductor.

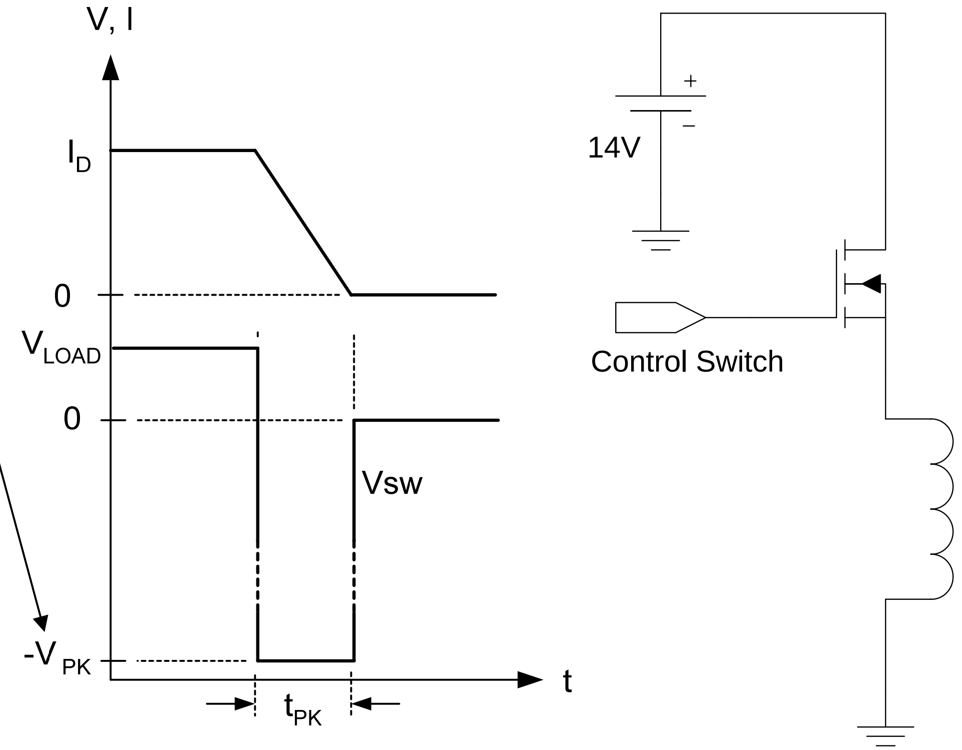
This is more difficult to the IC manufacturer for clamping both the Gate and Source nodes as well as parasitic suppression in the circuit.

Benefits:
Lower clamp voltage allows faster Inductive current decay $\frac{dI}{dt} = \frac{V}{L}$

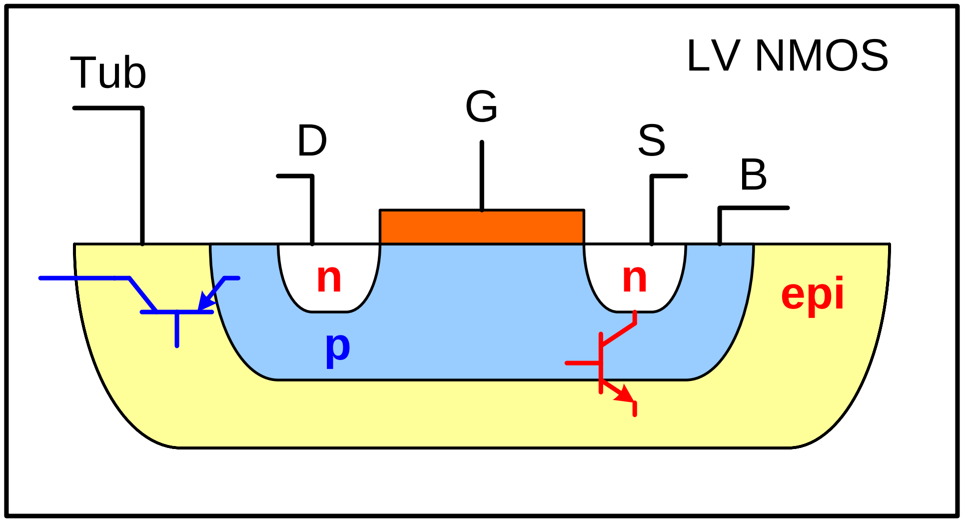
Integrated Power
Supplier characterizes performance. Performance is determined by technology.

System Level Consideration
Pre-driver / FET Need to match the FET and Pre-driver performance.

Evaluate FET conduction and switching losses with the devices energy capability.



Transients can cause unforeseen performance



All transistors are a collection of PN junctions.

Keeping them isolated is the challenge.

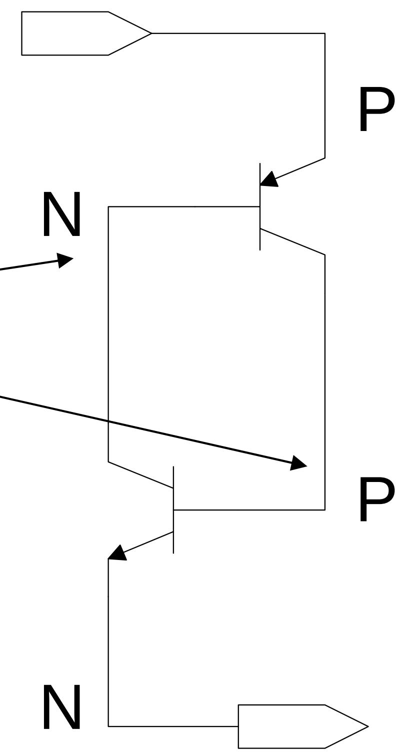
The NMOS transistor above shows the parasitic bipolar devices which are inherently always there.

Worst Case Parasitics

The worst situation outside of permanent damage is for the device to activate a latch made up of a PNP and an NPN device.

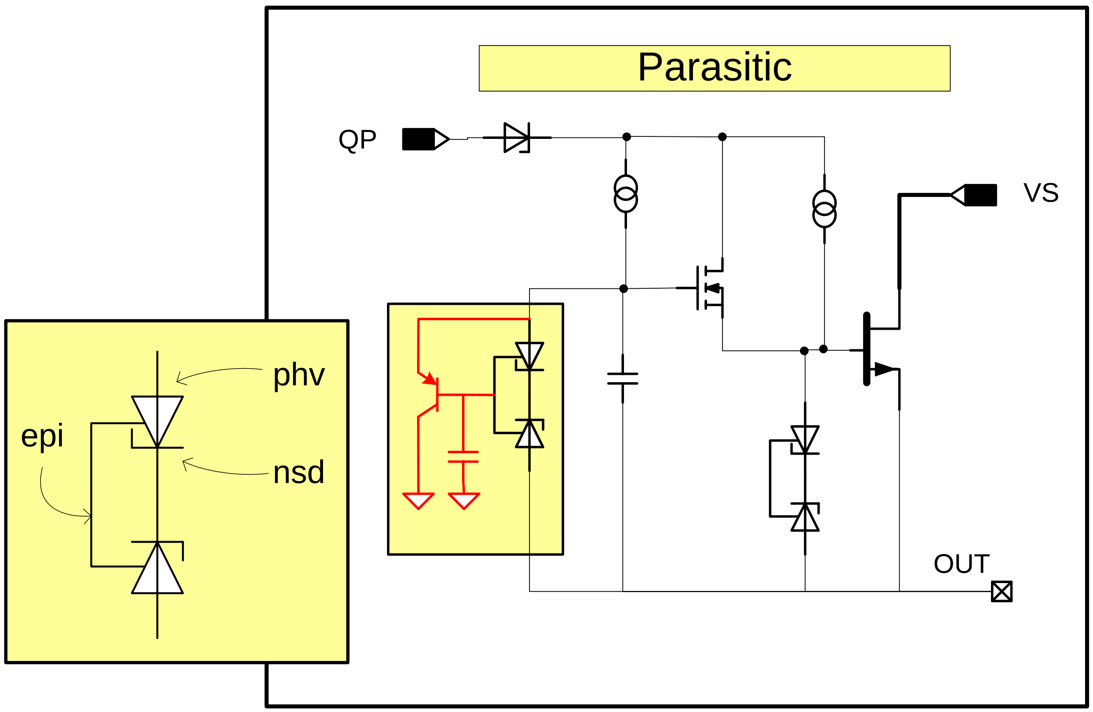
In a typical parasitic latch, the two bipolar transistors typically share the N and P junctions.

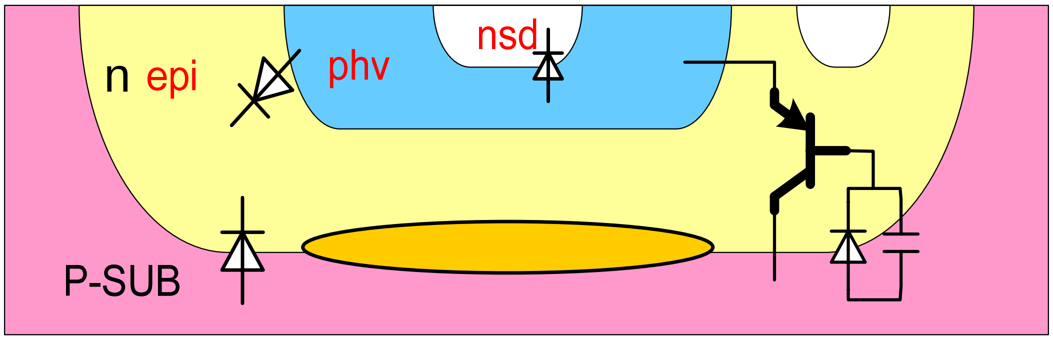
Once activated, the device must be powered down to turn off.



A PNPN latch

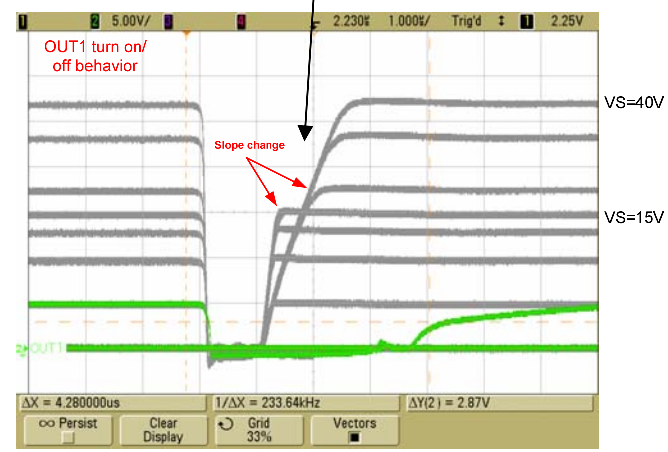
Transients can be bad for an integrated circuit





This example shows a parasitic PNP formed from 2 back to back diodes impacting the expected performance of the driver.

The parasitic PNP shown was shown to steal drive current away from the FET causing significant switching transition discrepancies with increased supply voltage.

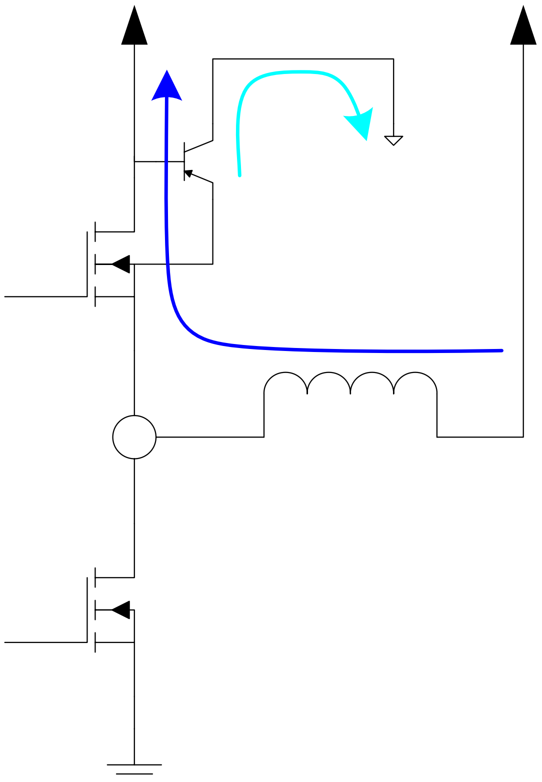


Overlayed pots of OUT1 Turn on/off Behaviour with varying VS

Other Sources of Parasitic Transistors

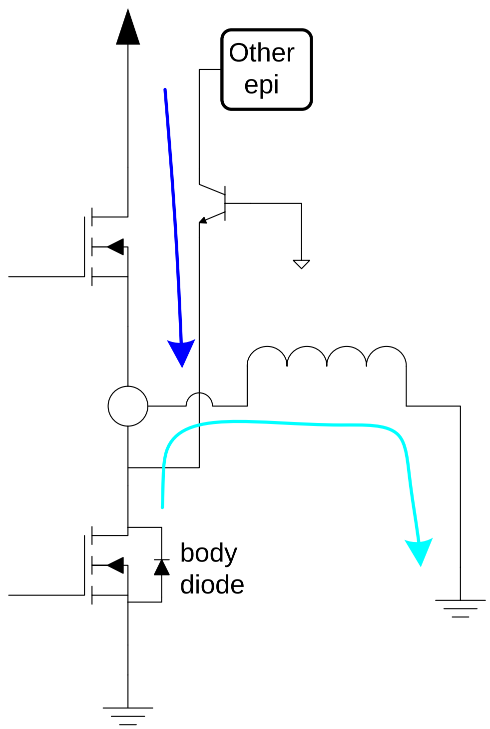
HS Recirculation

When the LS transistor turns off



LS Recirculation

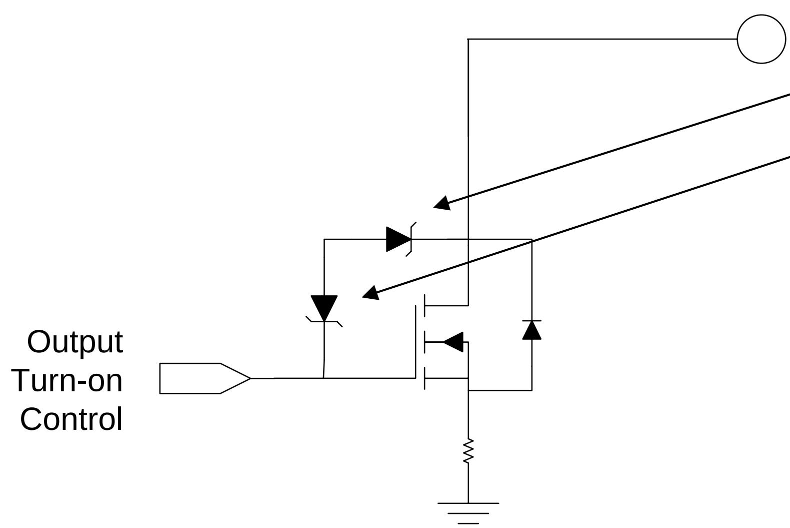
When the HS transistor turns off



IC Solutions for Flyback

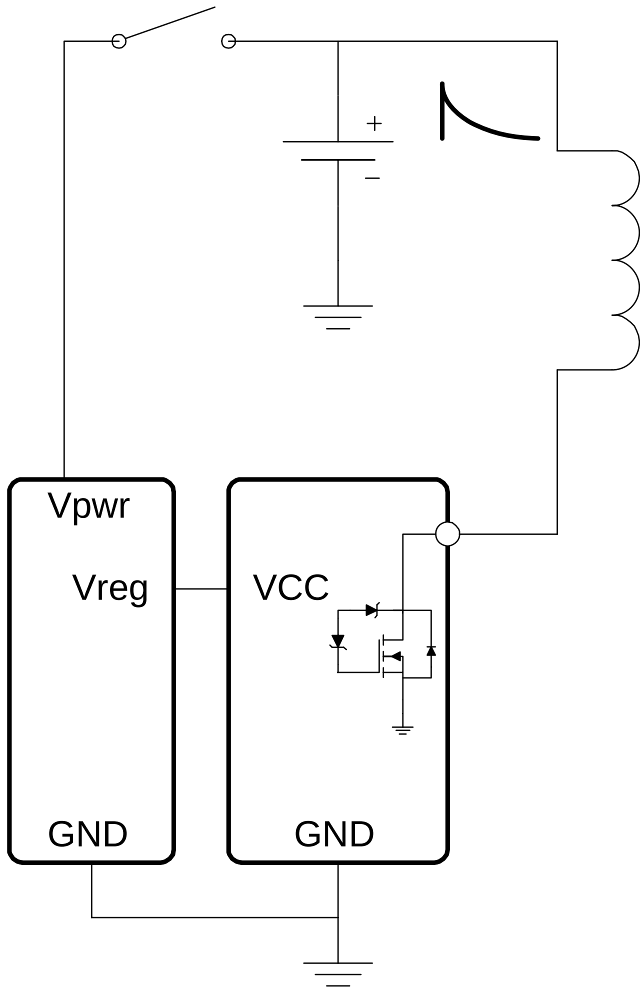
MAXIMUM RATINGS

Rating	Value	Unit
Power Supply Voltage (V_S) (DC) (AC), t < 500 ms, Ivs > −2 A	 −0.3 to 40 −1	V
Output Pin OUTx (DC) (AC), t < 500 ms, IOUTx > −2 A	 −0.3 to 40 −1	V
Pin Voltage (Logic Input pins, SI, SCLK, CSB, SO, EN, V_{CC})	−0.3 to 7	V
Output Current (OUTx) (DC) (AC) (50 ms pulse, 1 s period)	 −1.8 to 1.8 Internally Limited	A



- 1st diode clamps the output
- 2nd diode prevents the gate from being pulled down by the drain as it is being turned on.

Load Dump



Be aware of conditions during load dump.

The setup at left will experience a load dump through the inductor (relay) without power applied to the IC.

The clamp condition of your driver IC **may** not clamp at the same voltage under the 2 conditions (powered and unpowered) depending on the technology used in the IC.

If the output clamp is trimmed and stored in memory, the clamp voltage will be less than a powered IC.

If you exceed the clamp threshold, current will flow through the inductor. This will be a high power event as it occurs at the clamp voltage.

Insuring Robustness

- Automotive Requirements
  - ISO 16750-2 (the International Organization for Standardization), Road vehicles – Environmental conditions and testing for electrical and electronic equipment. Part 2: Electrical Loads.
  - Our main level of focus:
    - **Supply Voltages** (12 V systems and 24 V systems) (car and truck).
      - Rating of Code A = 6 V to 16 V (car), Rating of Code A=10 V to 32 V (truck)
        - » These are the typical power supply ranges we are expected to perform within. although recently the low voltage level requirements at the OEM are going lower.
    - **Jump Start**
      - 24 V for 60 seconds
        - » Historically these voltage levels were used by tow vehicles to get vehicles started which were immobile at the side of the road.
    - **Slow Decrease and Increase of Supply Voltage**
      - 0.5 V/minute from 0 V to Vmax and Vmax to 0 V
        - » All functionality must perform in predictable manner.
    - **Short Circuit Protection**
      - Connect all relevant inputs and outputs to Vmax for 60 seconds.
    - **Short Circuit Protection** (Also AEC-Q101 Automotive Electronics Council) SHORT CIRCUIT RELIABILITY CHARACTERIZATION OF SMART POWER DEVICES FOR 12 V SYSTEMS
      - Rating of Grade A >1,000,000 cycles with 0 fails.

Further ISO16750-2 Requirements

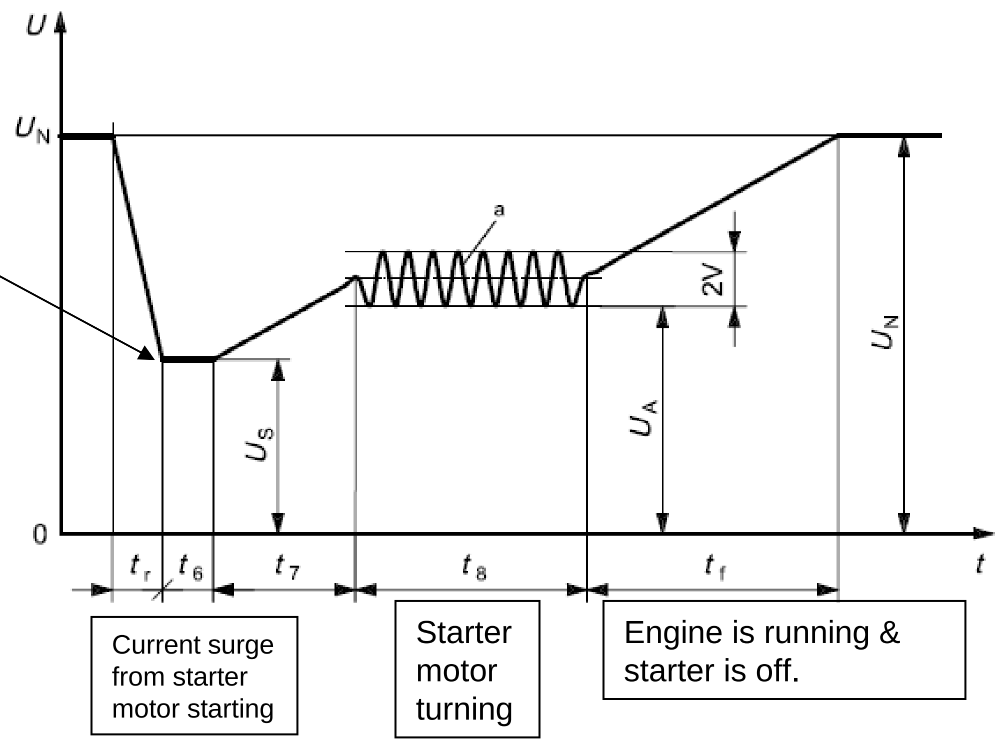
Engine Cranking

Voltage can dip down to 4.5 V for >15 msec.

Maintaining operation at this reduced level is frequently being requested now.

This is the most difficult level for integrated circuit compliance.

Head room issues limit IC operation.



[a] f = 2 Hz,

Figure 7 — Starting profile

Industry Guidelines

Repetitive Clamping

Normal operation of a relay driver will activate the clamp to dissipate energy stored in the inductor. Customer driven specifications are becoming the norm for this activity. There is no standard at this time.

The typical specification will be included in the absolute maximum ratings table of the datasheet.

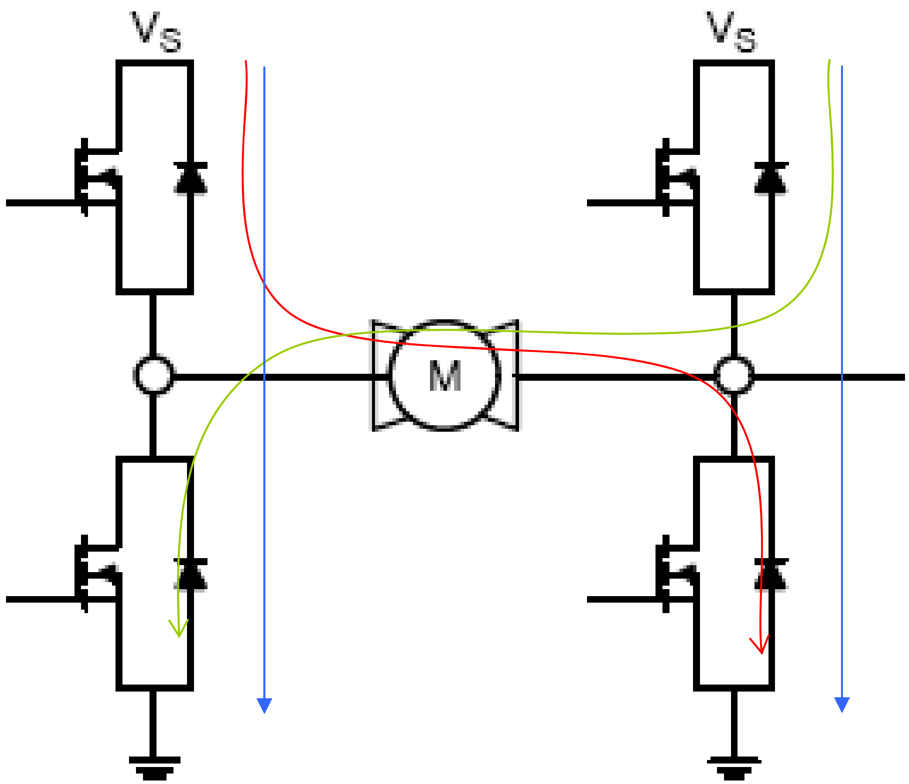
This is a relatively new test. Some of our older parts will not include this.

Clamping Energy
Maximum (single pulse)
Repetitive (multiple pulse)***

*** 2M pulses (triangular), VS = 15V, 58Ω, 430mH, T_A = 25ºC.

Shoot- Through Current

In normal operation, the motor changes direction as the drivers switch on and off in the sequence such that current flows as per the red and green paths.



Potentially destructive events can occur (blue) if:

1) the bottom driver turns on before the top driver turns off.

2) the bottom driver is not shut off before the top driver turns on.

Integrated circuits should have specifications which protect for this.

Also note putting high limits on these parameters can limit switching speed.

NonOverlap Time	High Side Turn Off to Low Side Turn On	1.0	–	–	µs
NonOverlap Time	Low Side Turn Off to High Side Turn On	1.0	–	–	µs

H-Bridge Turn-Off Current

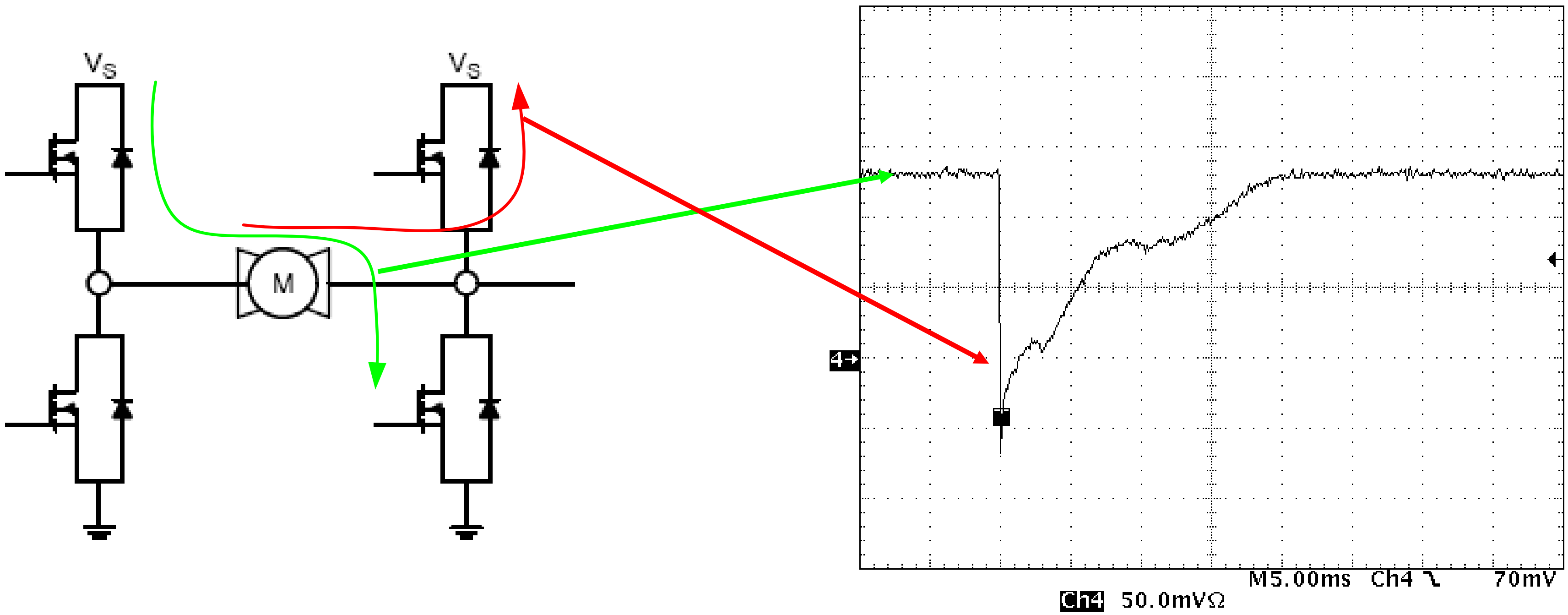
Current flow in an H-Bridge configuration.

scope capture –current from the power supply VS.

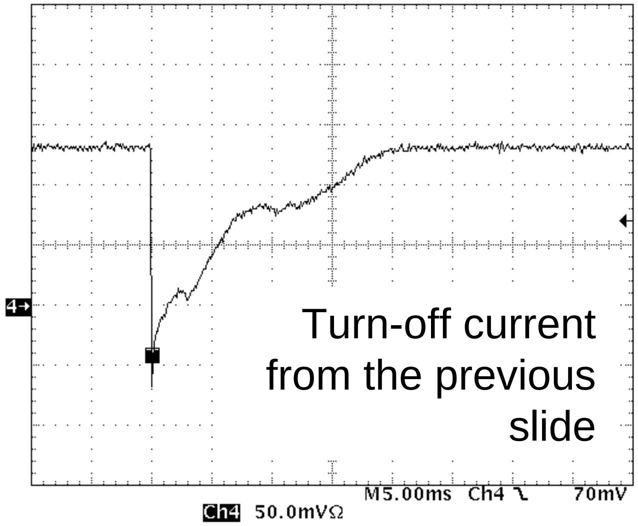
green – normal current flow through the motor.

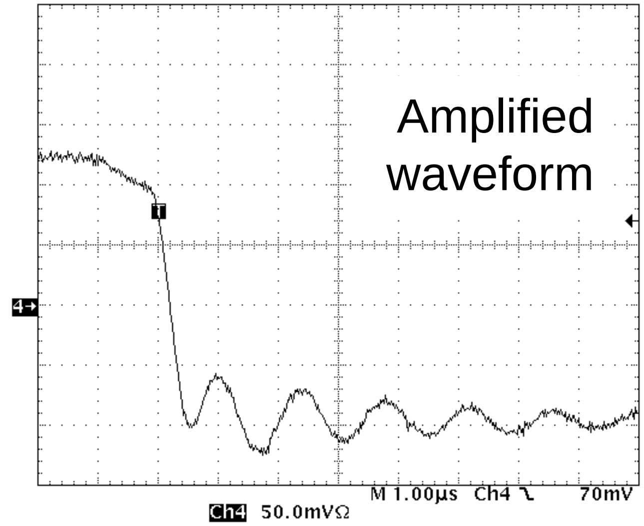
red – the current wants to continue to flow through the inductance of the motor and finds a path through the body diode of the top FET. Note the polarity of the current as it goes negative (out of the IC pin).

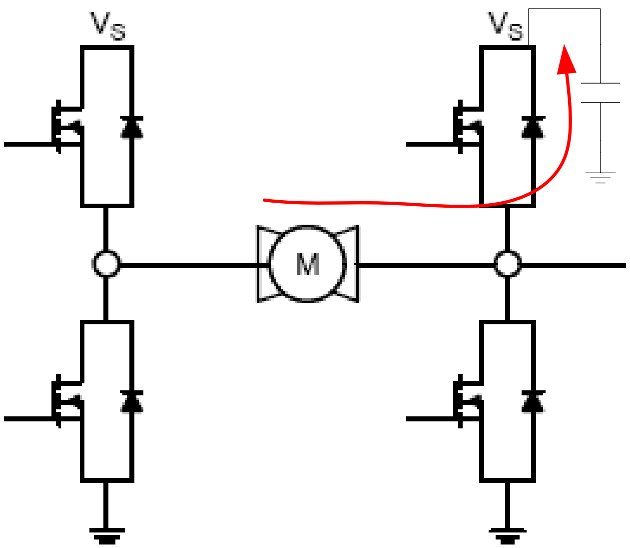
I(VS) (50 mA/div)



How does this current effect your system?







When the current goes out of the pin, it typically goes to the external filter capacitor.

The impact on voltage "noise" will be determined by the external capacitor value.

I = 100 mA, dt = 0.5 usec

User define C = 10 uF

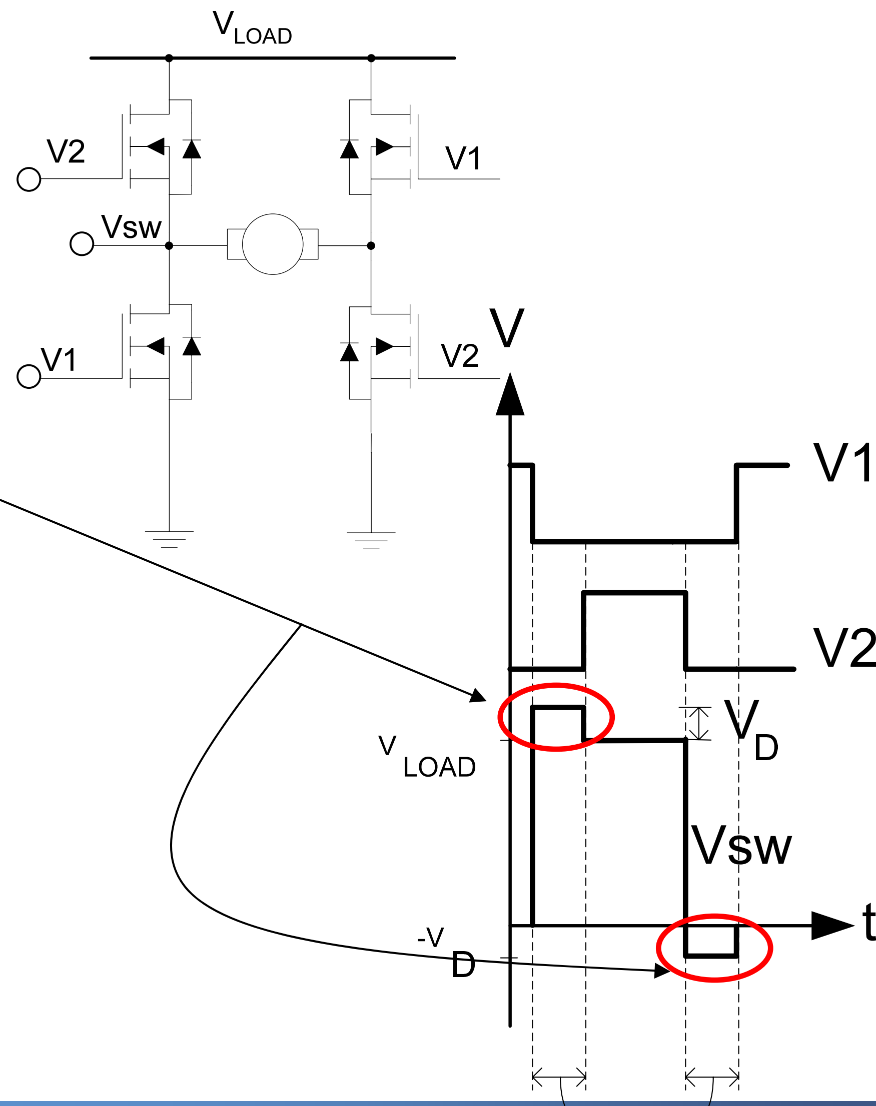
$$I = C\frac{dV}{dT} \qquad dV = I\frac{dT}{C}$$

Yield dV = 5 mV

Power Considerations

In addition to the power dissipated across the FETs during on time (Rdson*I_{load}), recirculation currents must be considered in thermal calculations.

Power is generated when current flows through the body diodes when energy is released form the coil.



<u>Pre-driver / FET system level consideration</u>

FET and Pre-driver performance should be matched. Confirm Cross-over delay times and Gate drive currents complement External Gate Capacitance.

Smart Drivers and Drivers with SPI fault Reporting

Smart Drivers, such as the NCV8401, NCV8402, and NCV8403 offer 3 features over a discrete component.

1) Current Limit
2) Thermal Shutdown
3) Voltage Clamping

(These are manufactrered on our HDPlus technology.)

(A fabrication technology developed for high power with added analog functionality.)

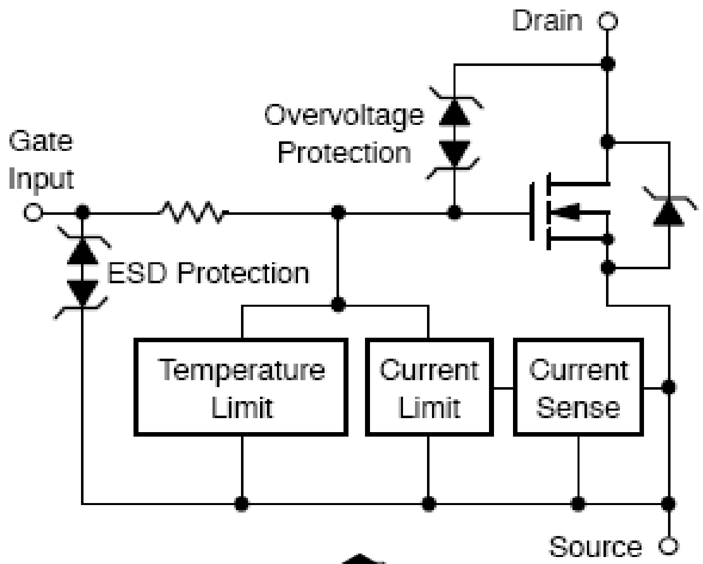
SPI Drivers, such as the NCV7703, NCV7708A, NCV7512, NCV7513A, and NCV7515 offer the same feature set as the Smart Drivers with the added capability of offering logic fault reporting for

1) Over load conditions
2) Under load conditions.
3) Thermal issues.
4) Power supply status (under voltage and over voltage).

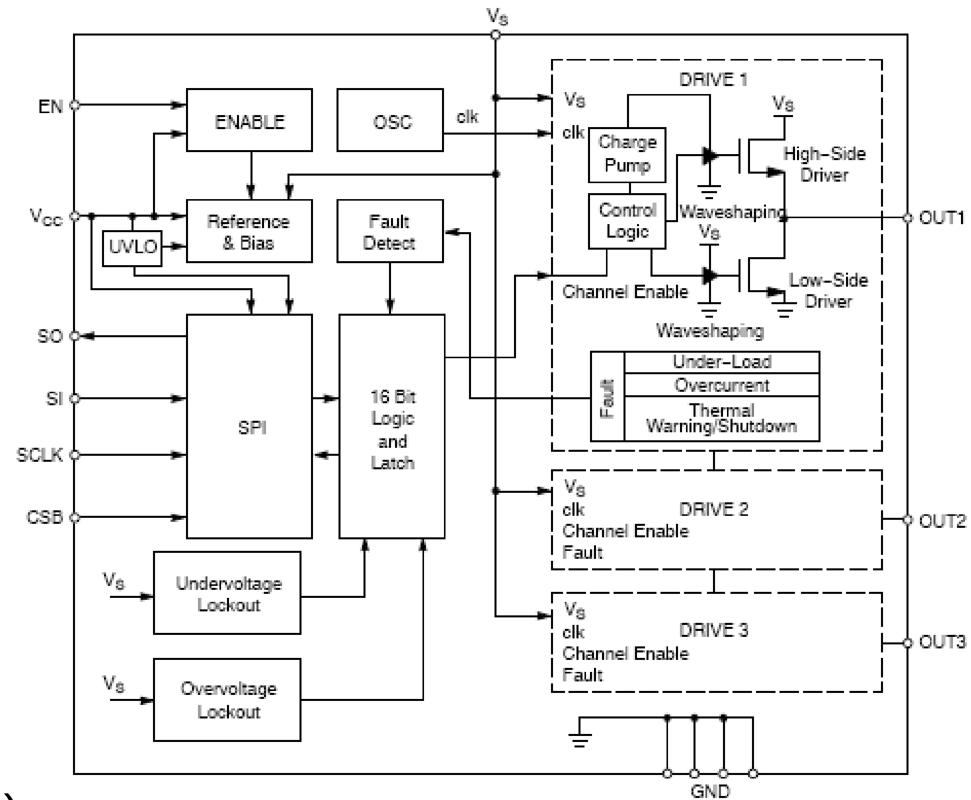
(These are manufactured on our Powersense and IxTyy processes).

(A fabriacation technology developed for logic with added power capability).

Smart Drivers vs SPI Communication

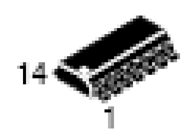


DPAK
CASE 369C
STYLE 2



Examples of a Smart Driver (NCV8401)

and an IC with SPI Communication (NCV7703).



SOIC−14
D2 SUFFIX
CASE 751A

The Smart Driver is much simpler (similar to a discrete component) as compared to a device with SPI Communication.

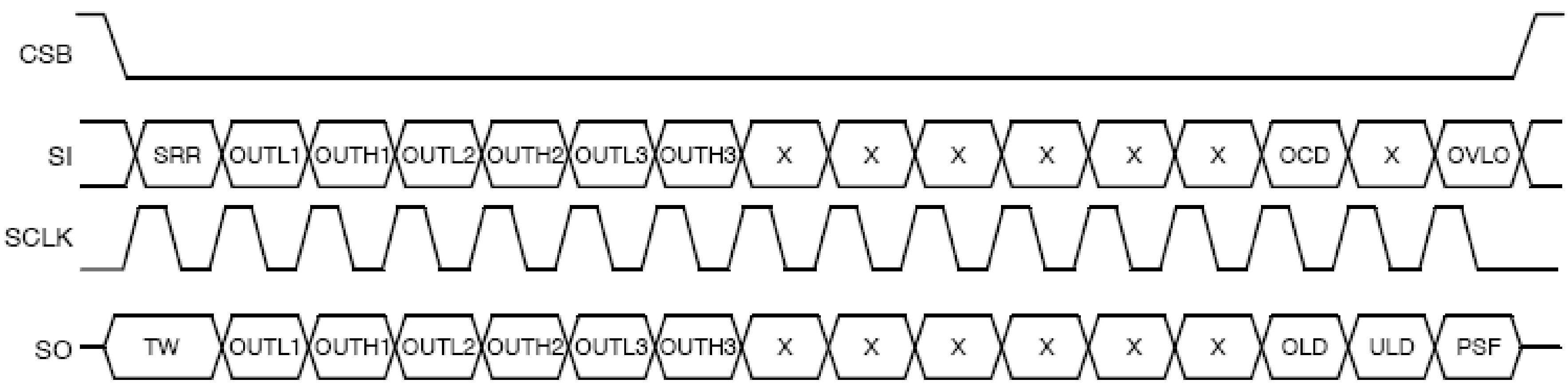
SPI Communication

There are 4 logic pins associated with SPI (serial peripheral communication)

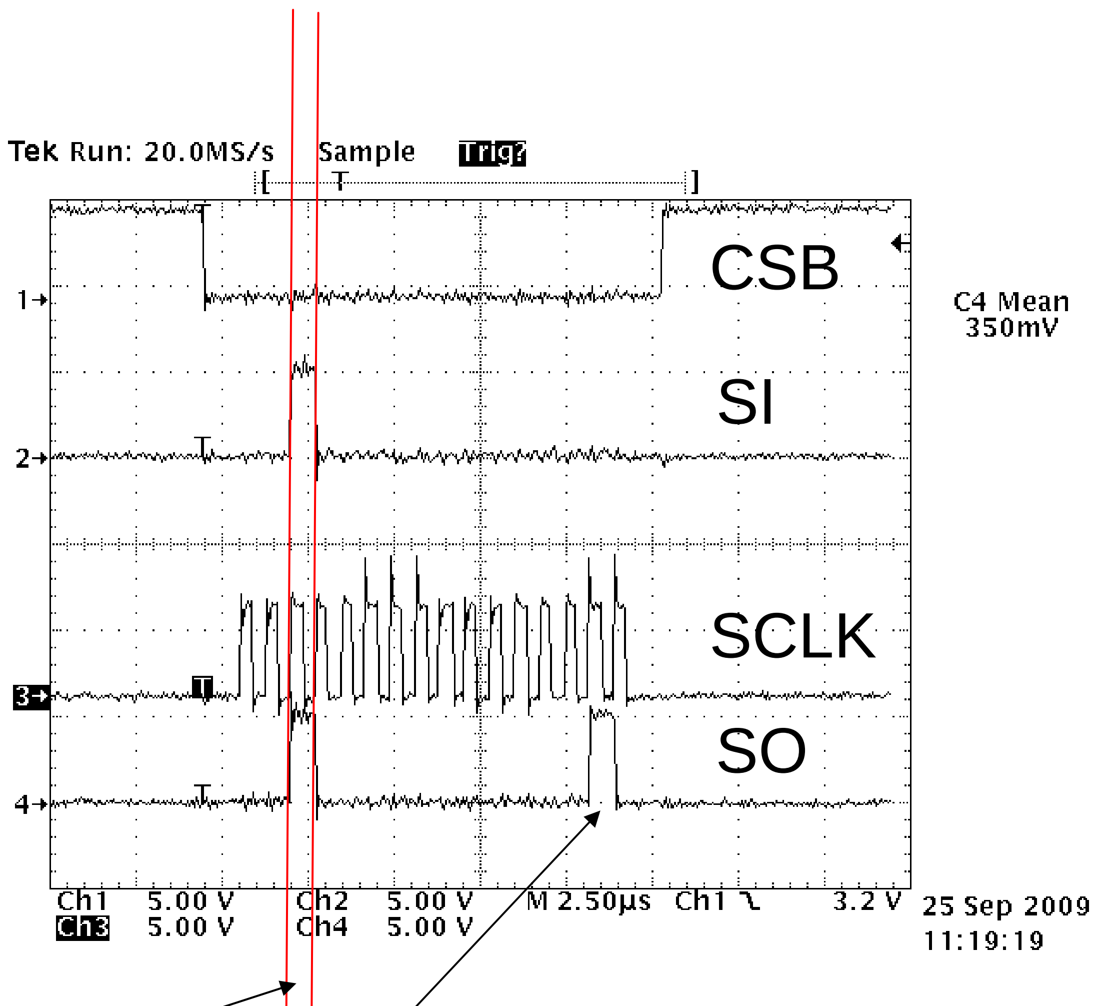
1) Chip Select Bar (CSB)
2) Serial Input (SI)
3) Serial Clock (SCLK)
4) Serial Output (SO)

Input Pins – CSB, SI, SCLK

Output Pin - SO



SPI Operation



1) SPI operation is activated by CSB going low.
    a) This can mean an operation is being input to the IC or information fault information is being requested on SO (or both).
2) A command signal is input (clocked in) into the SI port.
    b) Note we are addressing the 3rd bit with a one.
3) Fault and state information is output of the SO pin.

Note the 3rd and 15th bit is high (to be used on the next slide)

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SPI Table

Table 1. SPI Bit Description

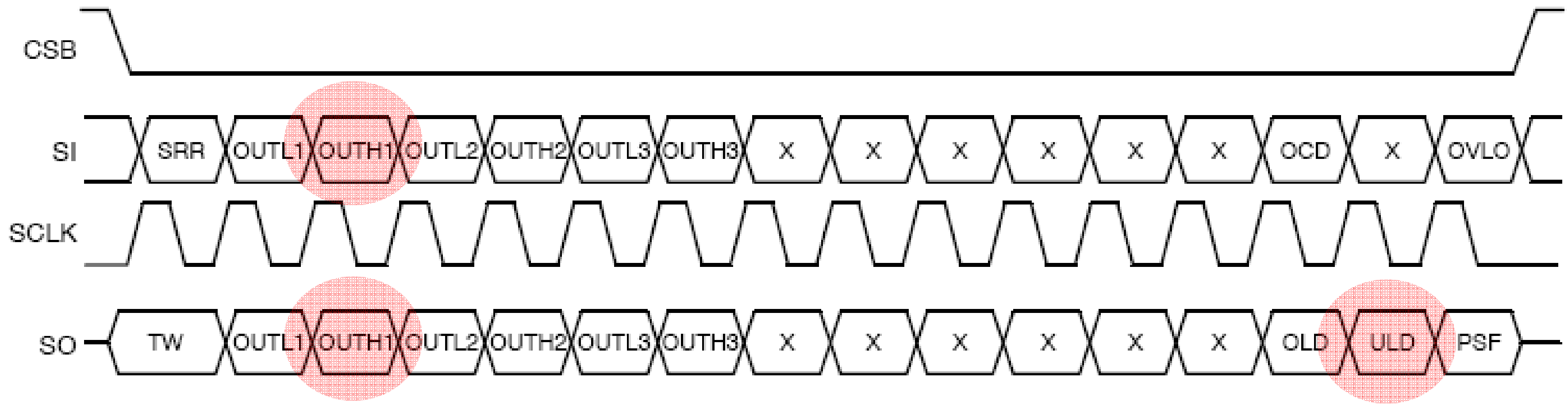
Input Data			Output Data		
Bit Number	Bit Description	Bit Status	Bit Number	Bit Description	Bit Status
15	Over Voltage Lock Out Control (OVLO)	0 = Disable	15	Power Supply Fail Signal (PSF for OVLO or UVLO)	0 = No Fault
		1 = Enable			1 = Fault
14	Not Used		14	Under Load Detect Signal (ULD)	0 = No Fault
					1 = Fault
13	Over Current Detection Shut Down Control (OCD)	0 = Disable	13	Over Load Detect Signal (OLD)	0 = No Fault
		1 = Enable			1 = Fault
12	Not Used		12	Not Used	
11	Not Used		11	Not Used	
10	Not Used		10	Not Used	
9	Not Used		9	Not Used	
8	Not Used		8	Not Used	
7	Not Used		7	Not Used	
6	OUTH3	0 = Off	6	OUTH3	0 = Off
		1 = On			1 = On
5	OUTL3	0 = Off	5	OUTL3	0 = Off
		1 = On			1 = On
4	OUTH2	0 = Off	4	OUTH2	0 = Off
		1 = On			1 = On
3	OUTL2	0 = Off	3	OUTL2	0 = Off
		1 = On			1 = On
2	OUTH1	0 = Off	2	OUTH1	0 = Off
		1 = On			1 = On
1	OUTL1	0 = Off	1	OUTL1	0 = Off
		1 = On			1 = On
0	Status Register Reset (SRR)	0 = No Reset	0	Thermal Warning (TW)	0 = Not in TW
		1 = Reset			1 = In TW

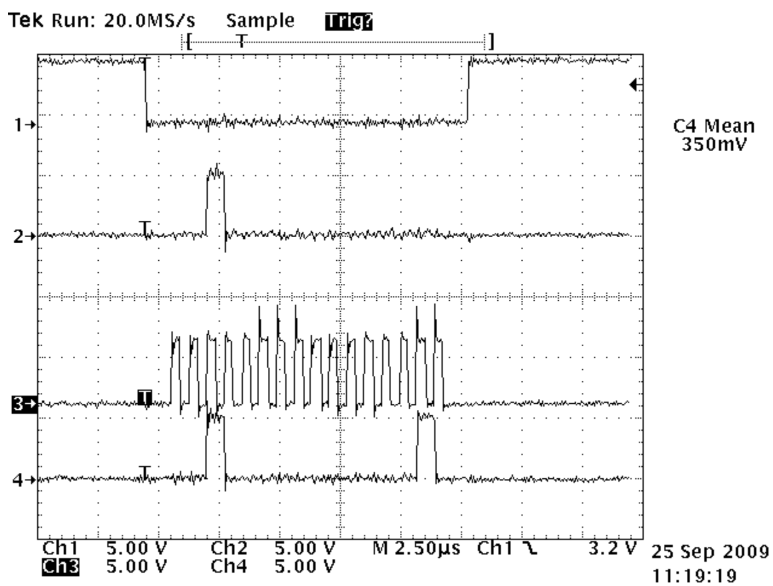
The left column is the Input Data (SI)

The right column is the Output Data (SO)

1) OUTH1 is told to turn on.
2) OUTH1 turns on.
3) There is an under load condition present.

Deciphering the SPI information





SI - This SPI frame is telling OUTH1 to turn on.

SO – This is reporting OUTH1 is on (OUTH1) and is in an underload (ULD) condition.

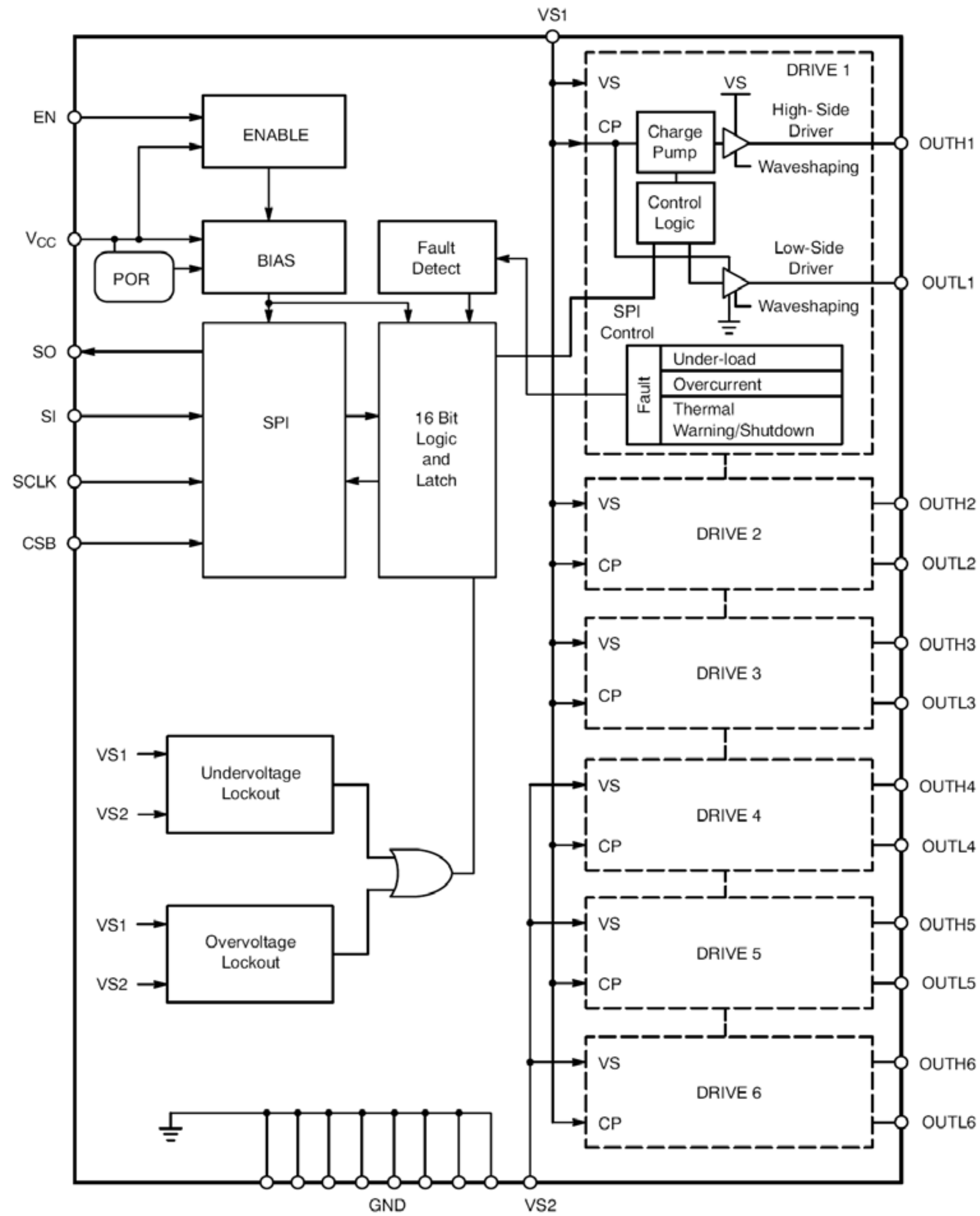
ON Semiconductor Automotive Driver Portfolio

Drivers	Pre-Drivers
NCV7708A **Double Hex Driver**	**NCV7512** **FLEXMOS™ Quad Low-Side Pre-Driver**
MC1413, MC1413B, NCV1413B **High Voltage, High Current Darlington Transistor Arrays**	**NCV7513A** **FLEXMOS™ Hex Low-Side MOSFET Pre-Driver**
NCV7702B **1 A Dual H-Bridge Driver**	**NCV7517** **FLEXMOS™ Hex Low-Side MOSFET Pre-Driver**
NCV7703 **Triple Half-Bridge Driver with SPI Control**	**MC34152, MC33152, NCV33152** **High Speed Dual MOSFET Drivers**
AMIS-39100 **Octal High Side Driver with Protection**	

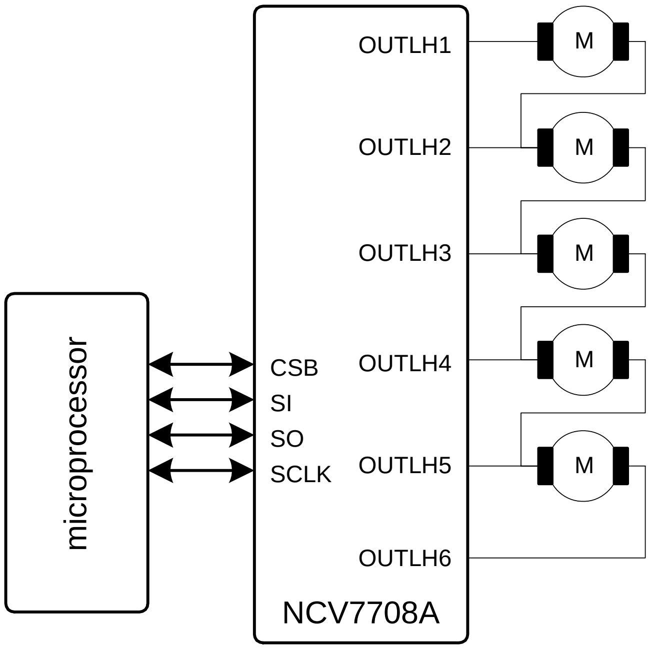
NCV7708A
Double Hex Driver

Features

- Ultra Low Quiescent Current Sleep Mode
- Six Independent High-Side and Six independent Low-Side Drivers
- Integrated Freewheeling Protection (LS and HS)
- Internal Upper and Lower Clamp Diodes
- Configurable as H-Bridge Drivers
- 0.5 A Continuous (1 A peak) Current
- $R_{DS(on)}$ = 0.8 Ω (typ)
- 5 MHz SPI Control
- SPI Valid Frame Detection
- Compliance with 5 V and 3.3 V Systems
- Overvoltage Lockout
- Undervoltage Lockout
- Fault Reporting
- Current Limit
- Overtemperature Protection
- These are Pb-Free Devices*



NCV7708A Applications



Right Temperature

Defroster

Left Temperature

Floor and Ventilation

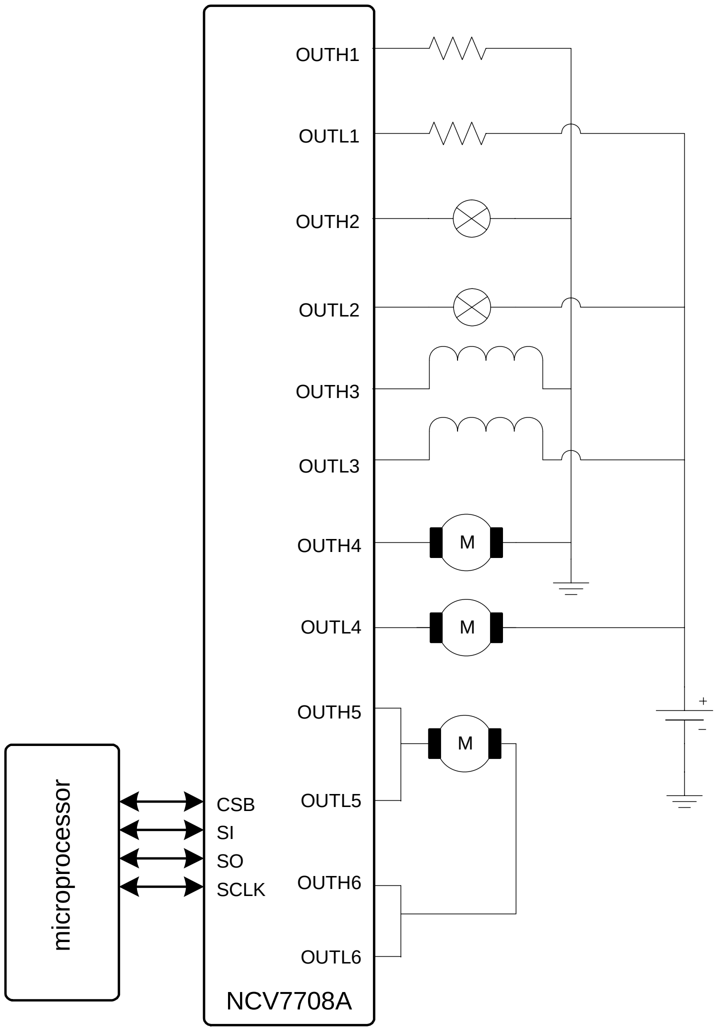
Recirculation Shutter

HVAC systems

heating, ventilating, and air conditioning

The primary application for this device is for HVAC systems to control DC motors to guide air flow through out the automobile. The other motor in the system (the blower motor) is typically controlled with a high-side switch.

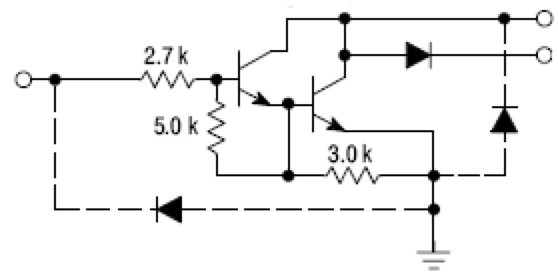
NCV7708A Applications



Secondary applications allow the device to drive any combination of loads

- Motor
- Inductive (relays)
- Resistive
- Lamp

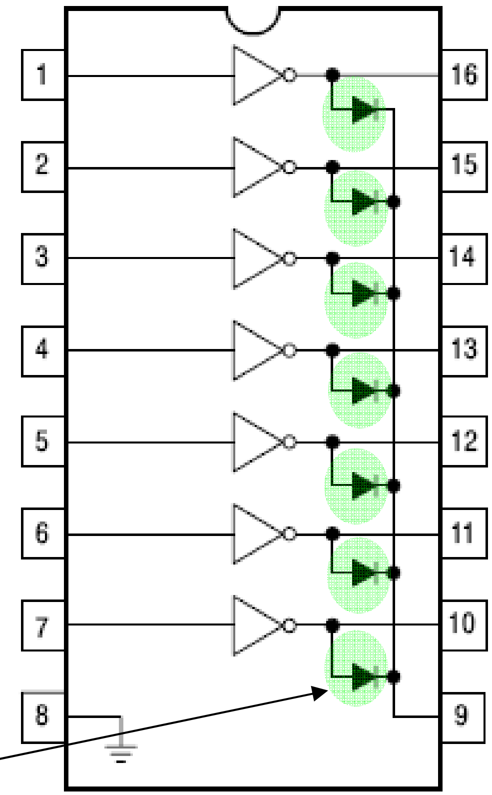
NCV1413 Darlington Transistor Array



MAXIMUM RATINGS (T_A = 25°C, and rating apply to any one device in the package, unless otherwise noted.)

Rating	Symbol	Value	Unit
Output Voltage	V_O	50	V
Input Voltage	V_I	30	V
Collector Current − Continuous	I_C	500	mA

Collector−Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 350 mA, I_B = 500 μA)	All Types		–	1.1	1.6	
(I_C = 200 mA, I_B = 350 μA)	All Types		–	0.95	1.3	
(I_C = 100 mA, I_B = 250 μA)	All Types		–	0.85	1.1	



(Top View)

Internal flyback clamps on each output for inductive loads

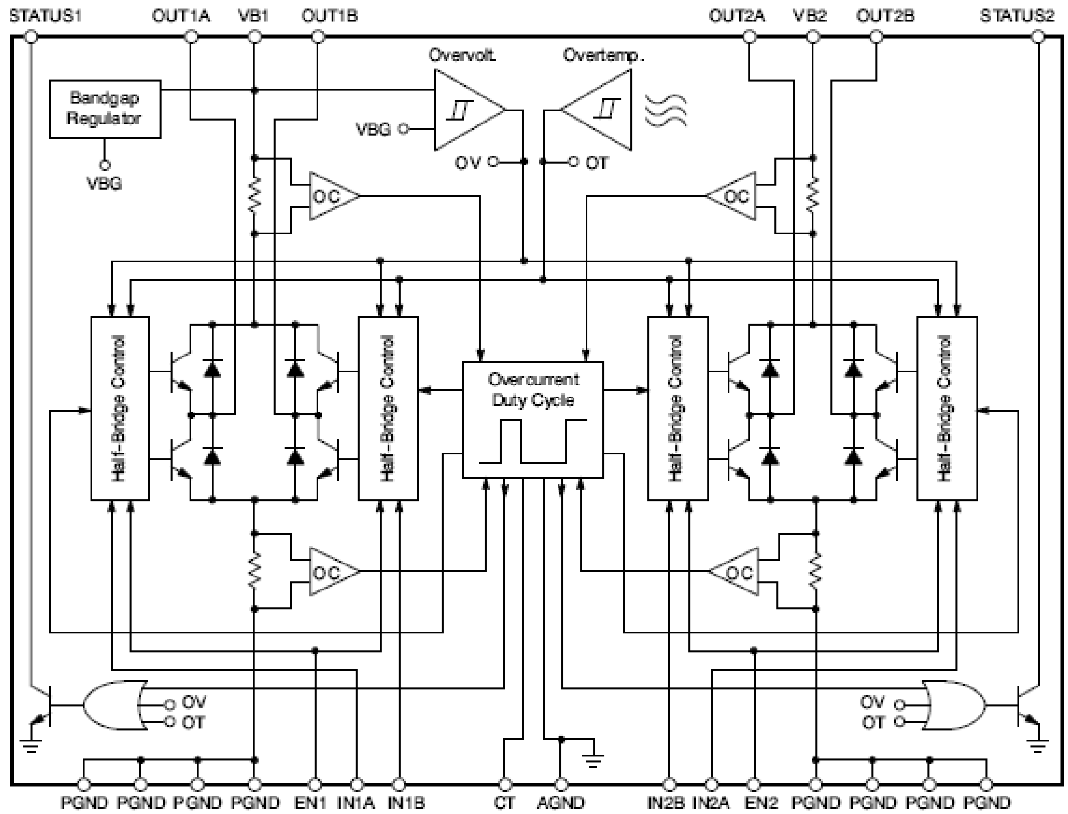
NCV7702 Dual H-Bridge

Features

- Single 7 V–16 V Supply
- Low Standby Current:
  - < 1.0 μA Typically
- 3.3 V / 5 V Compatible Inputs
- Independent Channel Enable
- Channels Configurable as:
  - Full–Bridge Drive
  - Half–Bridge, High Side or Low Side Drive
- On–Chip Recirculation Diodes
- Fault Protection with Automatic Recovery for:
  - Overcurrent
  - Overvoltage
  - Overtemperature
- Fault Diagnostic STATUS Outputs
- Internally Fused Leads in SO–24L Package
- AEC Qualified
- PPAP Capable
- These are Pb–Free Devices*

Half–Bridge Drivers

The half–bridge drivers of each OUT_X are comprised of an NPN Darlington driver on the low–side and a compound PNP–NPN driver on the high–side. Each half–bridge driver is capable of 1 A (min) peak current and is overcurrent protected against load and system faults. Cross conduction currents within each half–bridge are suppressed by the use of a dead–band timer. Each IN_X input contains an independent dead–band timer that is activated on either edge of the input transition.



MAXIMUM RATINGS

Rating	Value	Unit
Power Supply Voltage, VB	-0.5 to 30	V
Peak Transient Voltage (46 V Load Dump @ VB = 14 V)	60	V

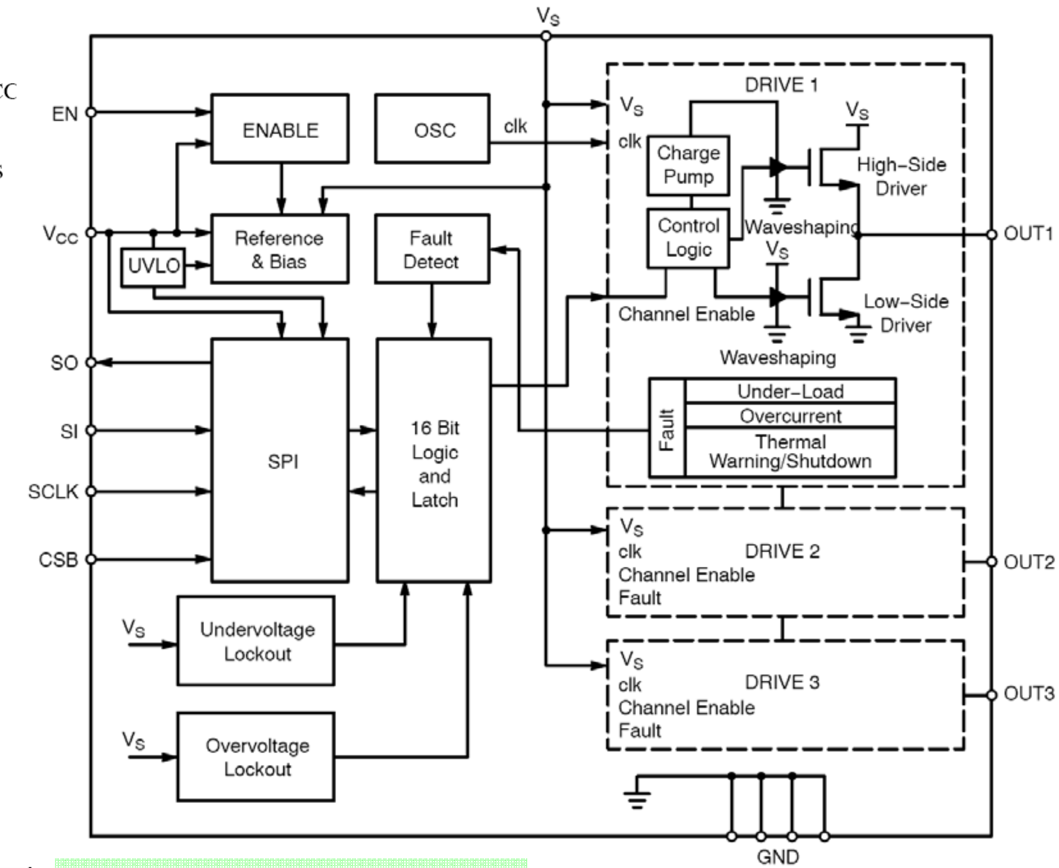
Overcurrent Threshold, I_{OC}	Low Side, Each Channel High Side, Each Channel	0.9 0.775	1.25 0.900	1.6 1.10	A

Bipolar devices also can report diagnostic data. The Status pins here report diagnostic information.

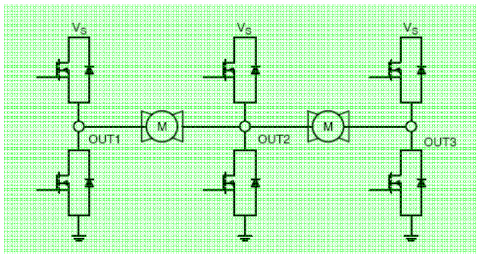
NCV7703 Triple Half Bridge Driver

Features

- Ultra Low Quiescent Current in Sleep Mode, 1 µA for V_S and V_{CC}
- Power Supply Voltage Operation down to 5 V
- 3 High−Side and 3 Low−Side Drivers Connected as Half−Bridges
- Internal Free−Wheeling Diodes
- Configurable as H−Bridge Drivers
- 0.5 A Continuous (1 A peak) Current
- $R_{DS(on)}$ = 0.8 Ω (typ)
- 5 MHz SPI Control with Daisy Chain Capability
- Compliance with 5 V and 3.3 V Systems
- Overvoltage and Undervoltage Lockout
- Fault Reporting
- 1.4 A Overcurrent Threshold Detection with Optional Shutdown
- 3 A Current Limit with Auto Shutdown
- Overtemperature Warning and Protection Levels
- Internally Fused Leads in SOIC−14 Package for Better Thermal Performance
- ESD Protection up to 6 kV
- This is a Pb−Free Device

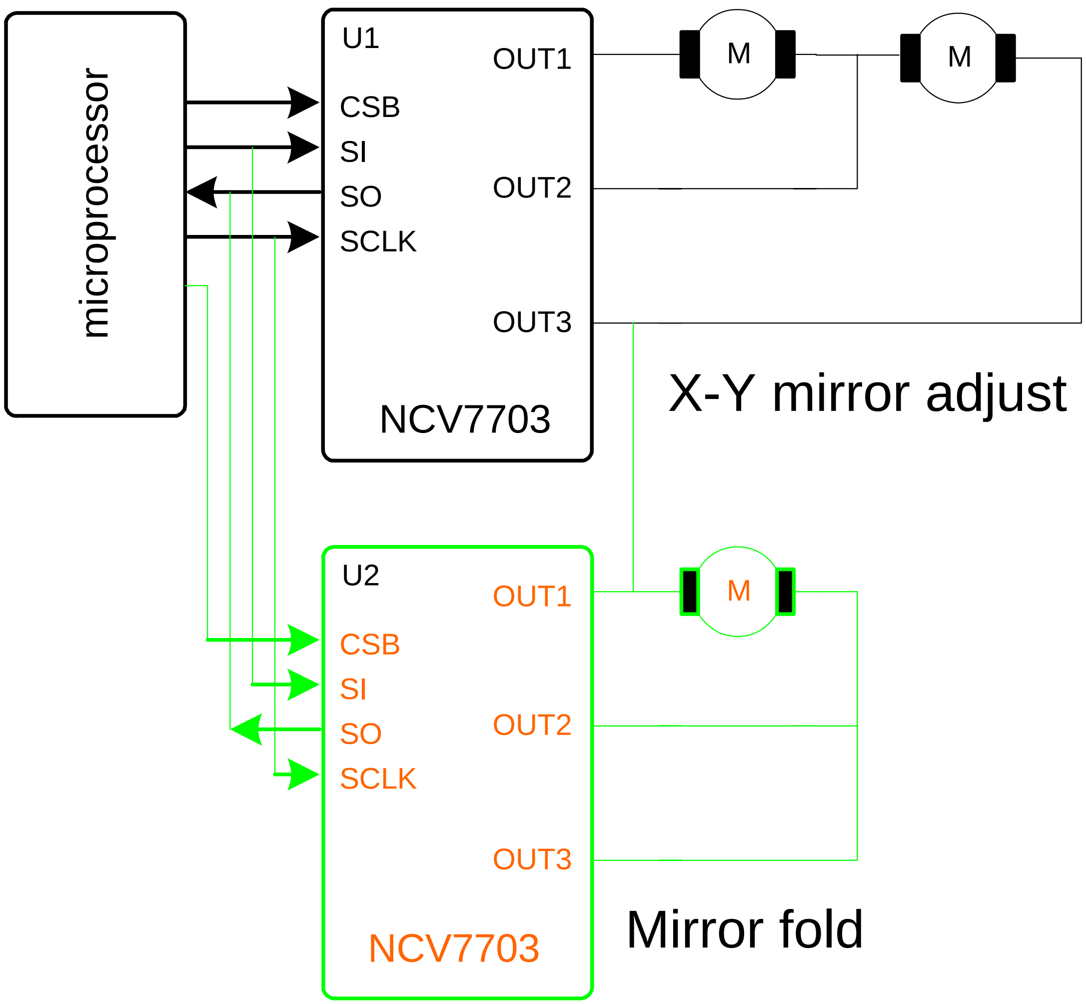


Power Supply Voltage (V_S) (DC) (AC), t < 500 ms, Ivs > −2 A	−0.3 to 40 −1	V
Output Pin OUTx (DC) (AC), t < 500 ms, IOUTx > −2 A	−0.3 to 40 −1	V



Typical Application is for automotive side-view mirror control

NCV7703 Mirror Adjust and Fold Application



This design can be used for high end applications with x-y mirror adjust **and** mirror fold applications using two NCV7703 devices (U1&U2) populated on the PC board.

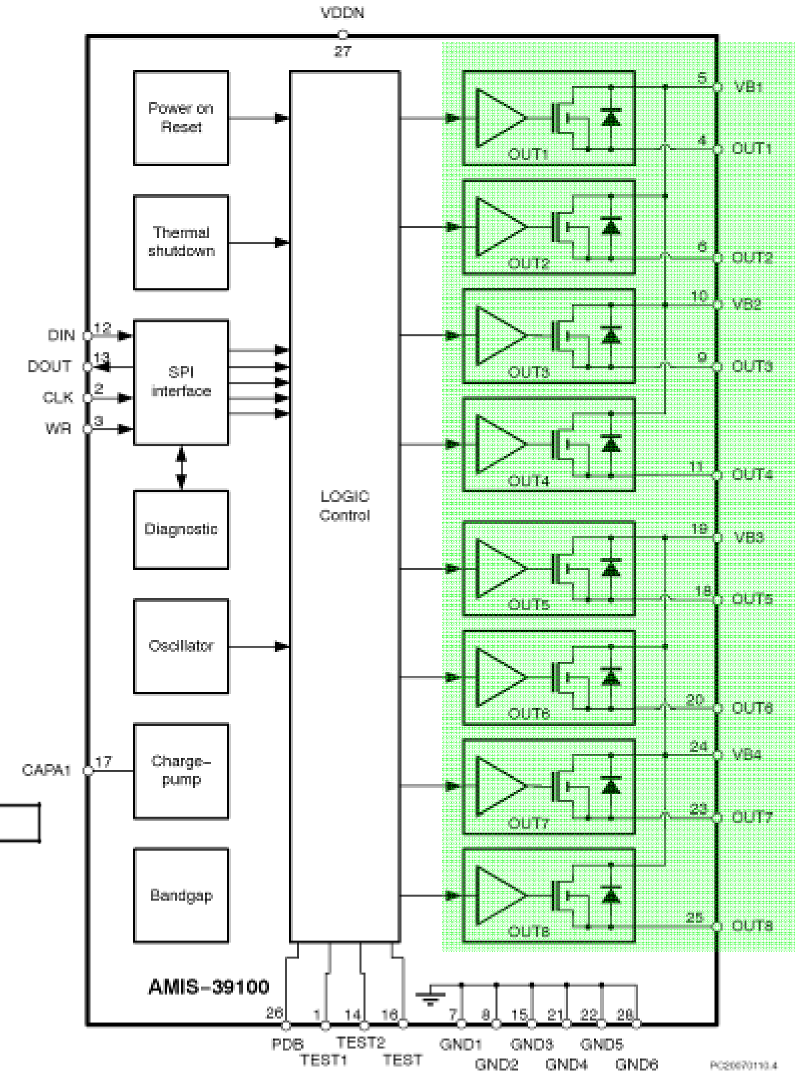
For low end applications, with **only** x-y mirror adjust, the same PC board can be used by simply **not** populating (U2) the 2nd NCV7703 device.

AMIS-39100 Octal High-Side Driver

Features

- Eight HS drivers
- Up to 830 mA Continuous Current Per Driver Pair (Resistive Load)
- Charge Pump with One External Capacitor
- Serial peripheral interface (SPI)
- Short−Circuit Protection
- Diagnostic Features
- Powerdown Mode
- Internal Thermal Shutdown
- 3.3 V and 5 V Microcontroller Compliant
- Excellent System ESD
- Automotive Compliant
- SOIC 28 Package with Low R_{thja}
- This is a Pb−Free Device*

VB	DC Battery Supply on Pins VB1 to VB4 Load Dump, Pulse 5b 400 ms	GND − 0.3	35	V



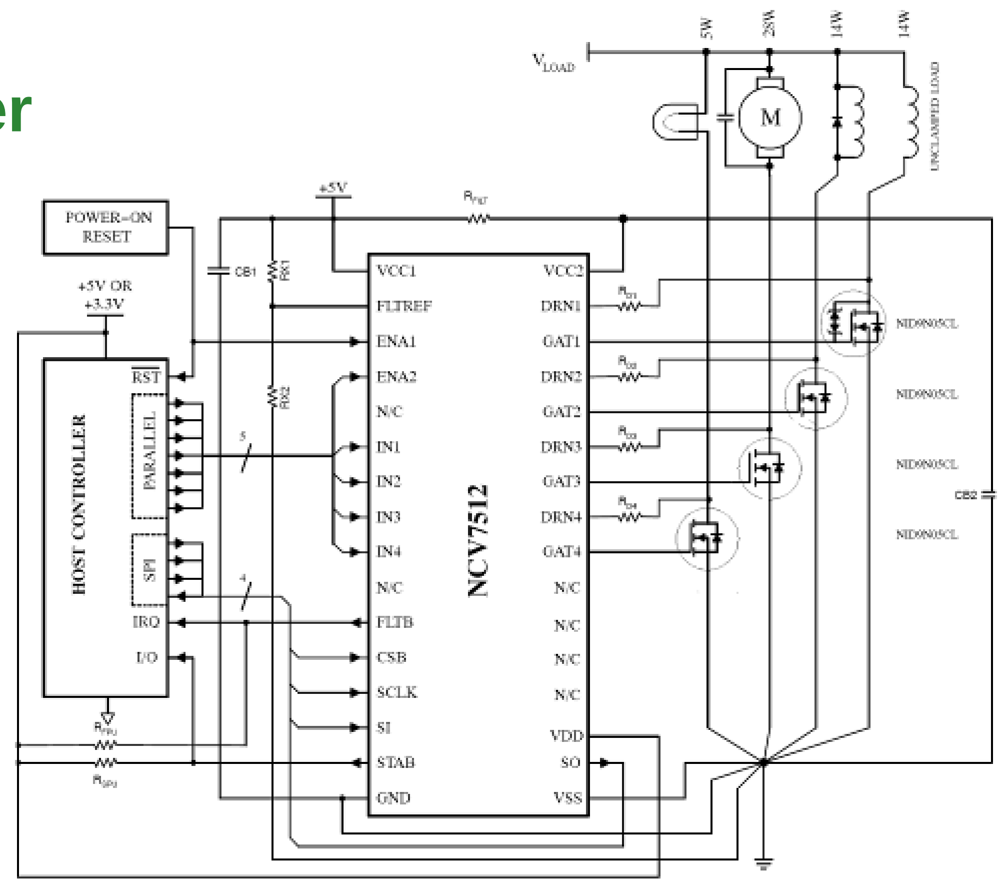
CHARGE PUMP

The HS drivers use floating NDMOS transistors as power devices. To provide the gate voltages for the NDMOS of the HS drivers, a charge pump is integrated. The storage capacitor is an external one. The charge pump oscillator has typical frequency of 4 MHz.

C_{charge_pump}	Charge Pump Capacitor (Note 6)	0.47		47		nF

High-Side Drivers require a charge pump to provide a sufficient voltage in which to drive the output.

NCV75xx Series (NCV7512/13A/17)
Quad/HexLow-Side Pre-Driver



Features

- 16−Bit SPI with Frame Error Detection
- 3.3 V/5 V Compatible Parallel and Serial Control Inputs
- 3.3 V/5 V Compatible Serial Output Driver
- Two Enable Inputs
- Open−Drain Fault and Status Flags
- Programmable
  - Shorted Load Fault Detection Thresholds
  - Fault Recovery Mode
  - Fault Retry Timer
  - Flag Masking
- Load Diagnostics with Latched Unique Fault Type Data
  - Shorted Load
  - Open Load
  - Short to GND
- Scalable to Load by Choice of External MOSFET
- These are Pb−Free Devices*
- NCV Prefix for Automotive
  - Site and Change Control
  - AEC−Q100 Qualified

Gate Driver Outputs

GAT_X Output Resistance		Output High or Low	1.0	1.80	2.5	kΩ
GAT_X High Output Current		$V_{GATX} = 0$ V	−5.25	–	−1.9	mA
GAT_X Low Output Current		$V_{GATX} = V_{CC2}$	1.9	–	5.25	mA

Drain Feedback Clamp Voltage (DRNx) (Note 1)	−0.3 to 40	V

NCV7512 – Four Low-Side Drivers

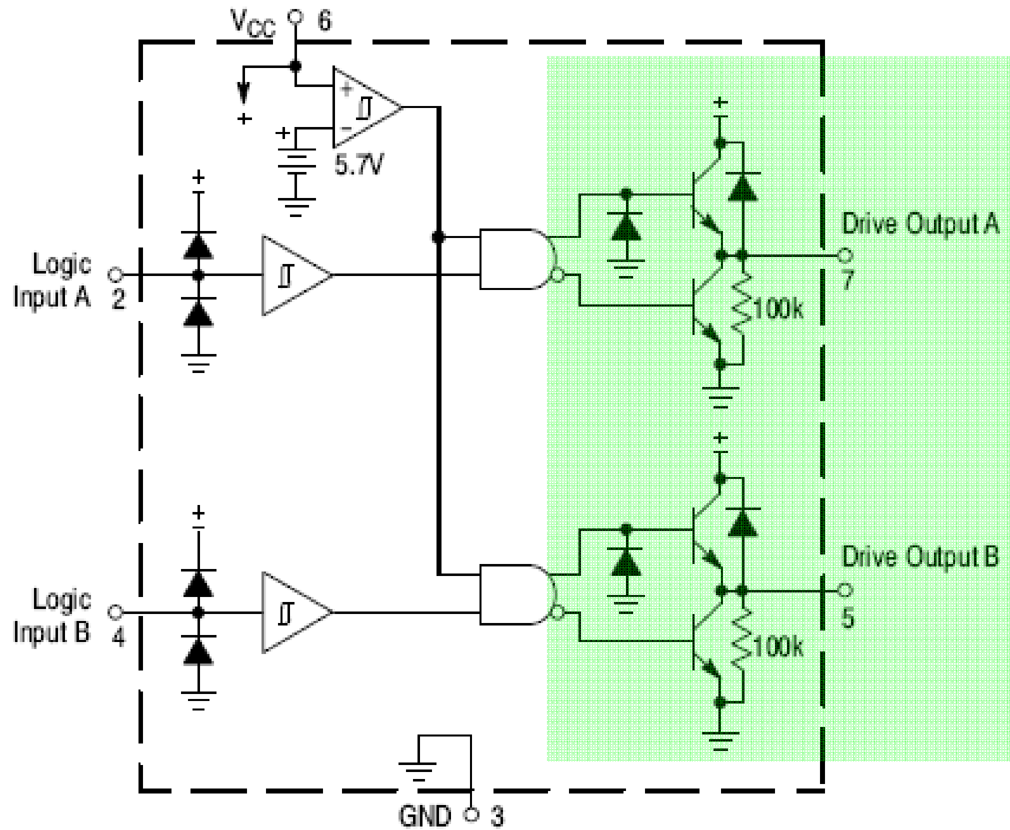
NCV7513A – Six Low-Side Drivers

NCV7517 – Improved NCV7513A (blanking timer modifications and Higher gate drive capability)

NCV33152 Dual High Speed MOSFET Driver

Features

- Two Independent Channels with 1.5 A Totem Pole Outputs
- Output Rise and Fall Times of 15 ns with 1000 pF Load
- CMOS/LSTTL Compatible Inputs with Hysteresis
- Undervoltage Lockout with Hysteresis
- Low Standby Current
- Efficient High Frequency Operation
- Enhanced System Performance with Common Switching Regulator Control ICs
- NCV Prefix for Automotive and Other Applications Requiring Site and Change Controls
- Pb−Free Packages are Available



Drive Outputs (Note 2) Totem Pole Sink or Source Current Diode Clamp Current (Drive Output to V_{CC})	I_O $I_{O(clamp)}$	1.5 1.0			A
Power Supply Voltage	V_{CC}	20			V
Operating Voltage	V_{CC}	6.1	–	18	V

For More Information

- View the extensive portfolio of power management products from ON Semiconductor at www.onsemi.com

- View reference designs, design notes, and other material supporting automotive applications at www.onsemi.com/automotive