EECS192 Lecture 3
Jan. 31, 2017

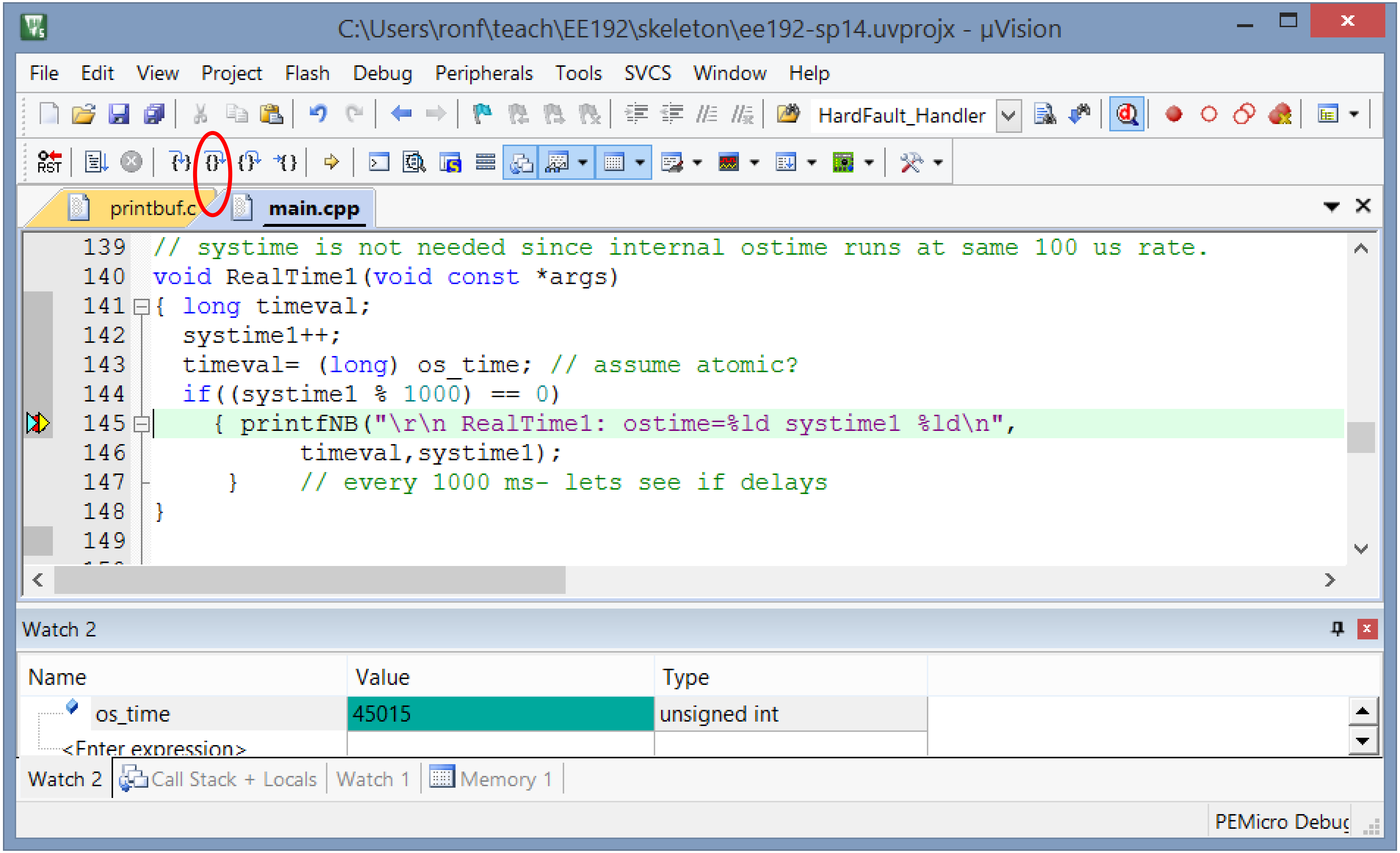
Notes:
Rob Wood Wed 4 pm 306 Soda ``The Mechanical Side of AI’’
Check off-

- 2/3 project proposal – upload bcourses 5 pm
- 2/10: Motor drive/stall, steering servo
- Quiz 1: motor behavior Tues 2/7

Topics

- Keil hint: timing using *os_time*
- Motor Electrical Model
- Back EMF
- Motor electromechanical behavior
- MOSFETs and motor drive
- H bridge
- PWM
- Back EMF measurement

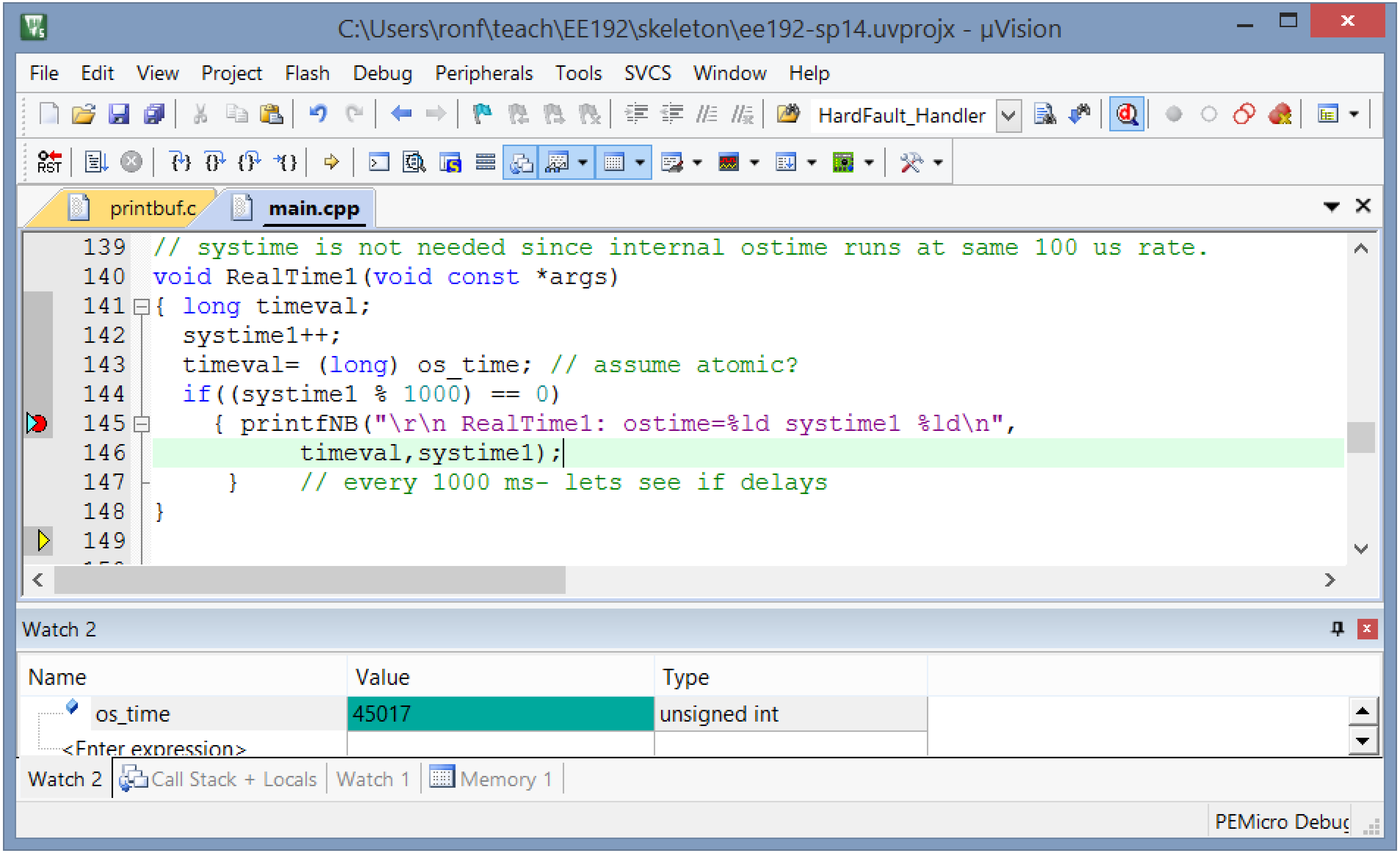
Timing from Keil Tools



```
// systime is not needed since internal ostime runs at same 100 us rate.
void RealTime1(void const *args)
{ long timeval;
  systime1++;
  timeval= (long) os_time; // assume atomic?
  if((systime1 % 1000) == 0)
    { printfNB("\r\n RealTime1: ostime=%ld systime1 %ld\n",
            timeval,systime1);
     }    // every 1000 ms- lets see if delays
}
```

Name	Value	Type
os_time	45015	unsigned int
<Enter expression>		

Timing from Keil Tools



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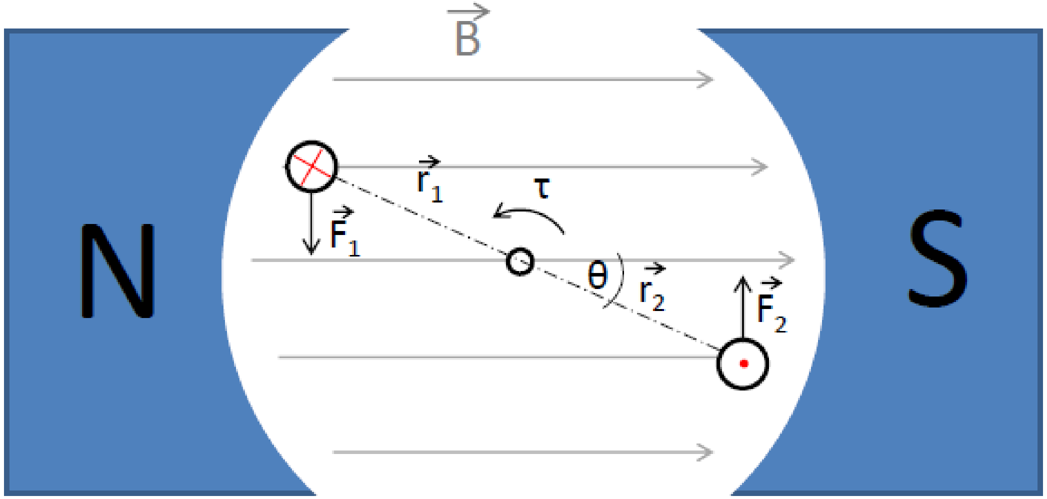
          timeval,systime1);
     }    // every 1000 ms- lets see if delays
}
```

Name	Value	Type
os_time	45017	unsigned int
<Enter expression>		

~50 us (check depends on clock rate?)

DC Motor Physical Model-review

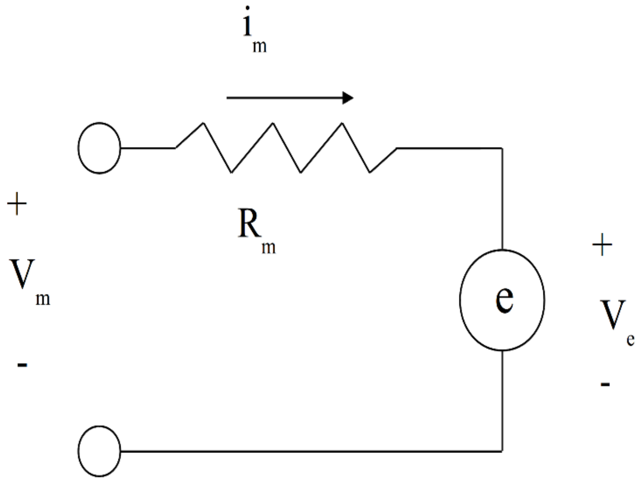


$$\vec{F} = i\vec{l} \times \vec{B}$$

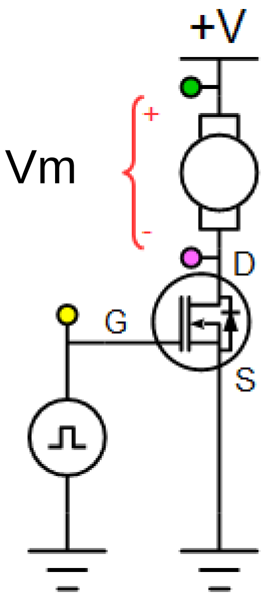
$$\tau = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2$$

Motor Electrical Model

Motor Electrical Model
Back EMF
Motor electromechanical behavior



Continued on board
Also- see motor worksheet……

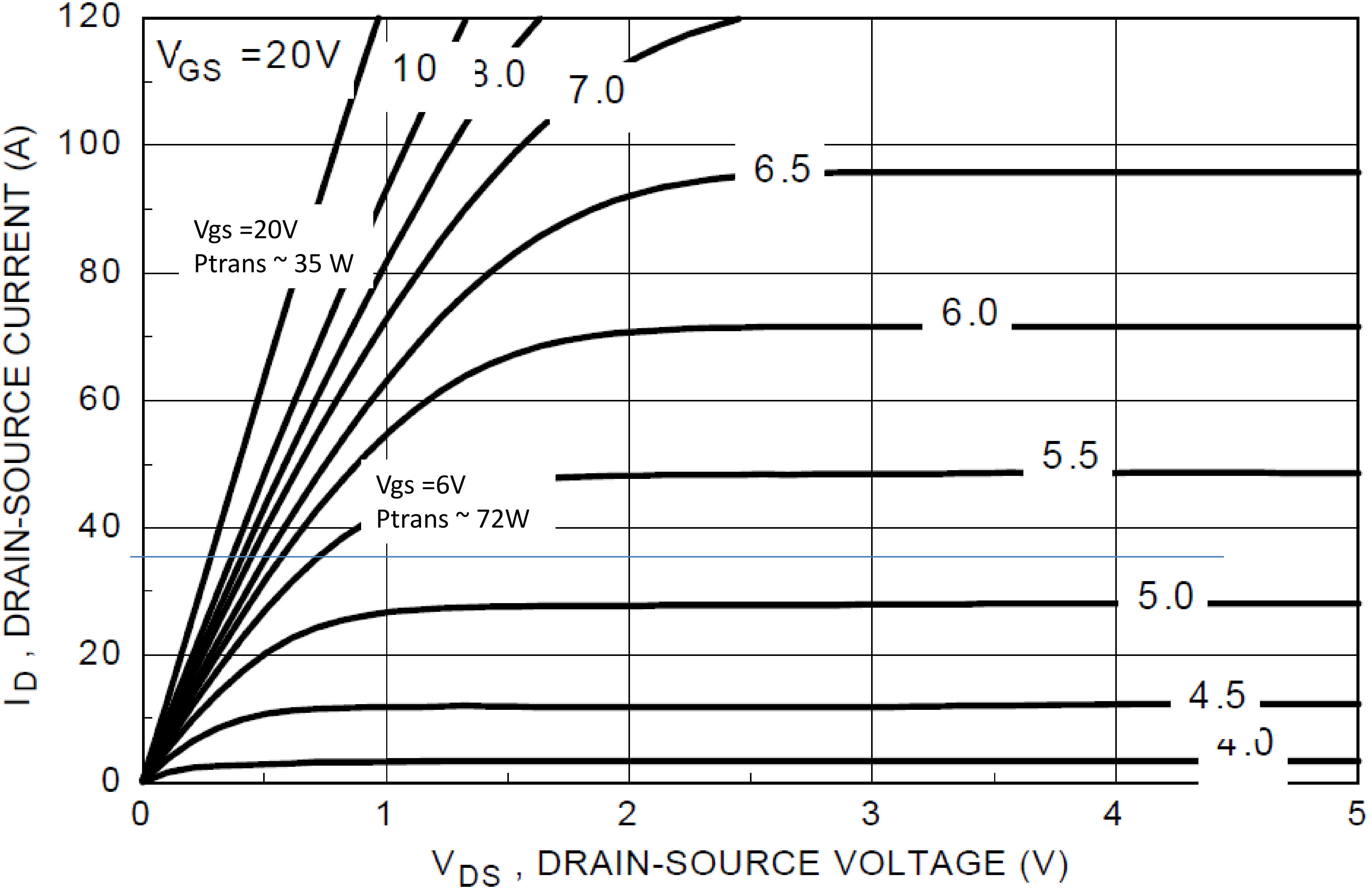


Note: missing e-stop!

MOSFETs and motor drive

Given: Rm = 0.1 ohms, Vbatt = 7.2 V, Rbat = 0.

Vds = ? ➔ Ids = ? amps

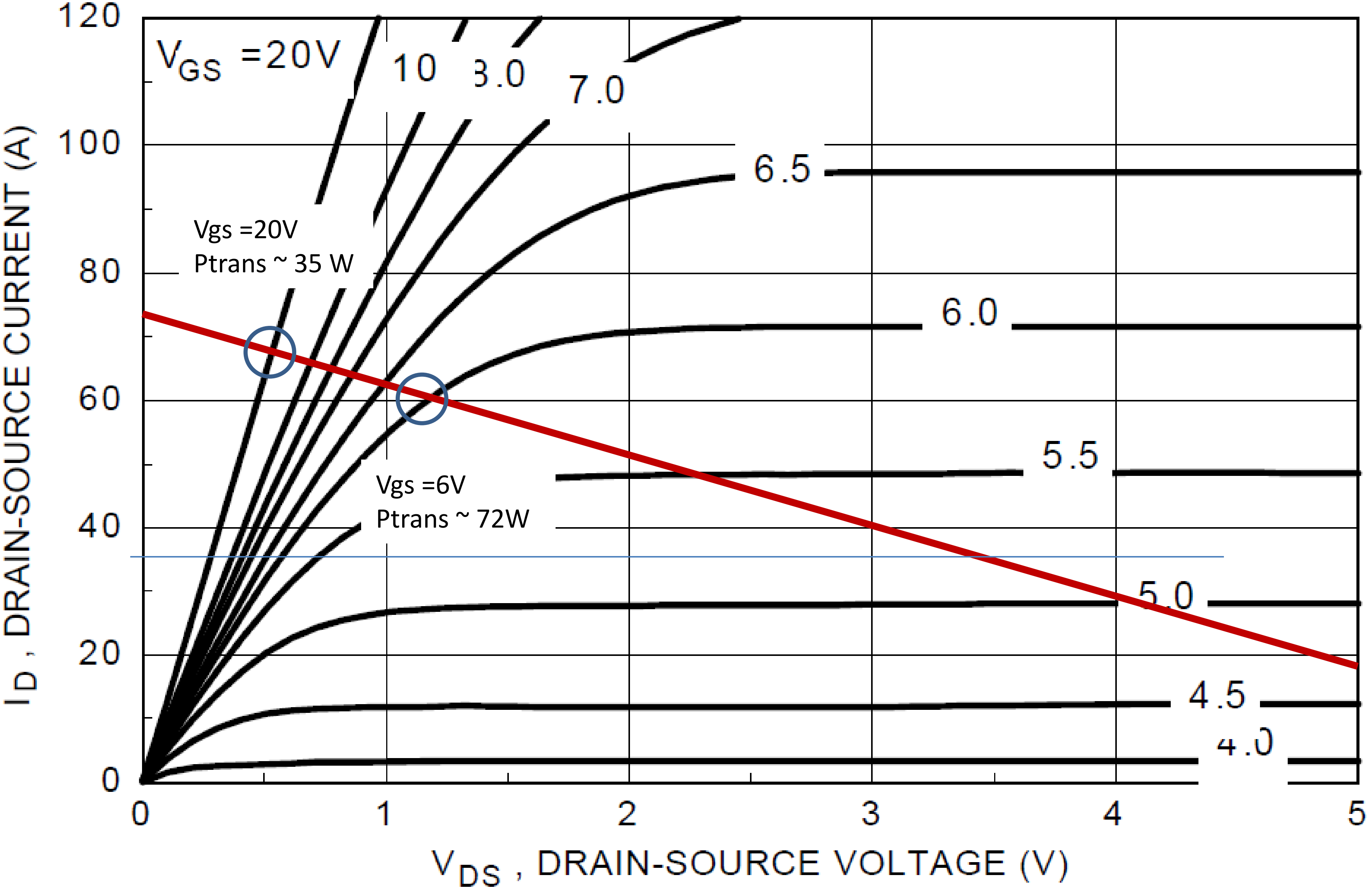


Vgs =20V
Ptrans ~ 35 W

Vgs =6V
Ptrans ~ 72W

Rm = 0.1 ohms, Vbatt = 7.2 V, Rbat = 0.

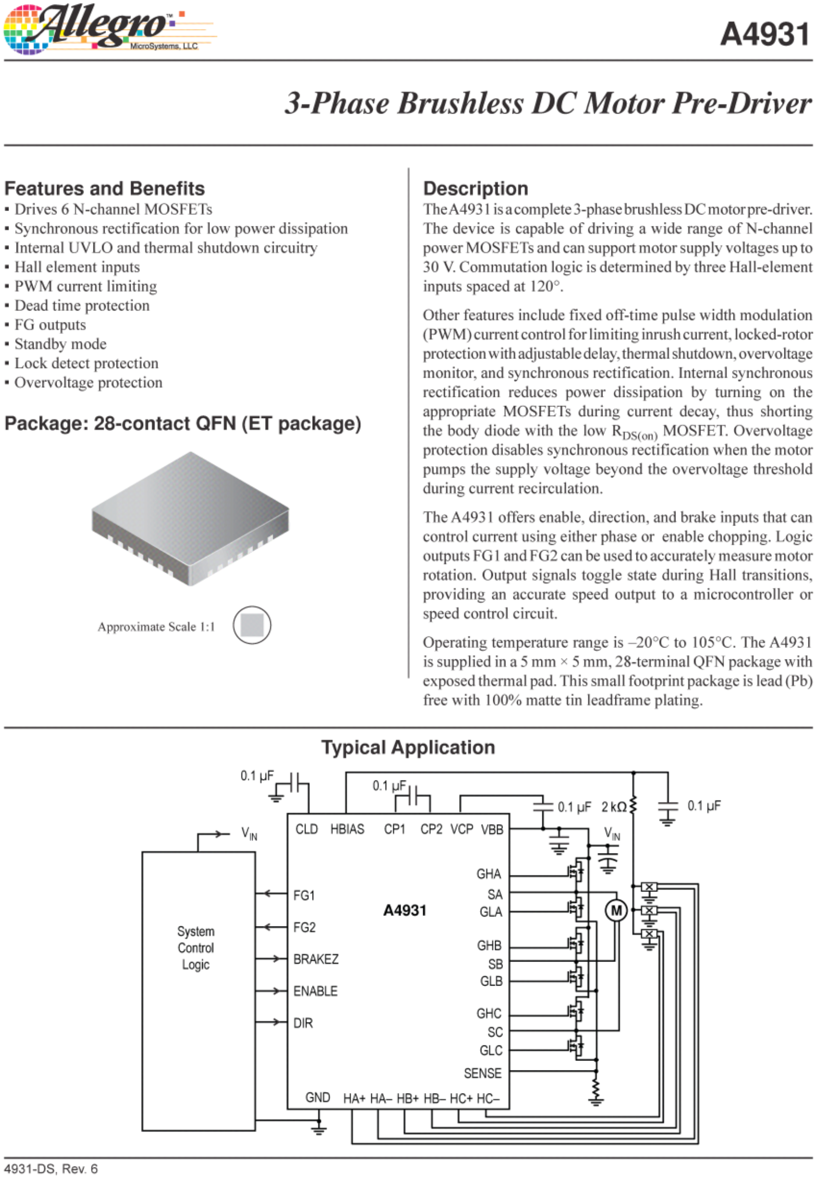
Vds = 3.6V ➔ Ids = (7.2-3.6V)/(0.1 ohm) = 36 amps



Vgs =20V
Ptrans ~ 35 W

Vgs =6V
Ptrans ~ 72W

H bridge gate driver devices



Allegro MicroSystems, LLC

A4931

3-Phase Brushless DC Motor Pre-Driver

Features and Benefits

- Drives 6 N-channel MOSFETs
- Synchronous rectification for low power dissipation
- Internal UVLO and thermal shutdown circuitry
- Hall element inputs
- PWM current limiting
- Dead time protection
- FG outputs
- Standby mode
- Lock detect protection
- Overvoltage protection

Package: 28-contact QFN (ET package)

Approximate Scale 1:1

Description

The A4931 is a complete 3-phase brushless DC motor pre-driver. The device is capable of driving a wide range of N-channel power MOSFETs and can support motor supply voltages up to 30 V. Commutation logic is determined by three Hall-element inputs spaced at 120°.

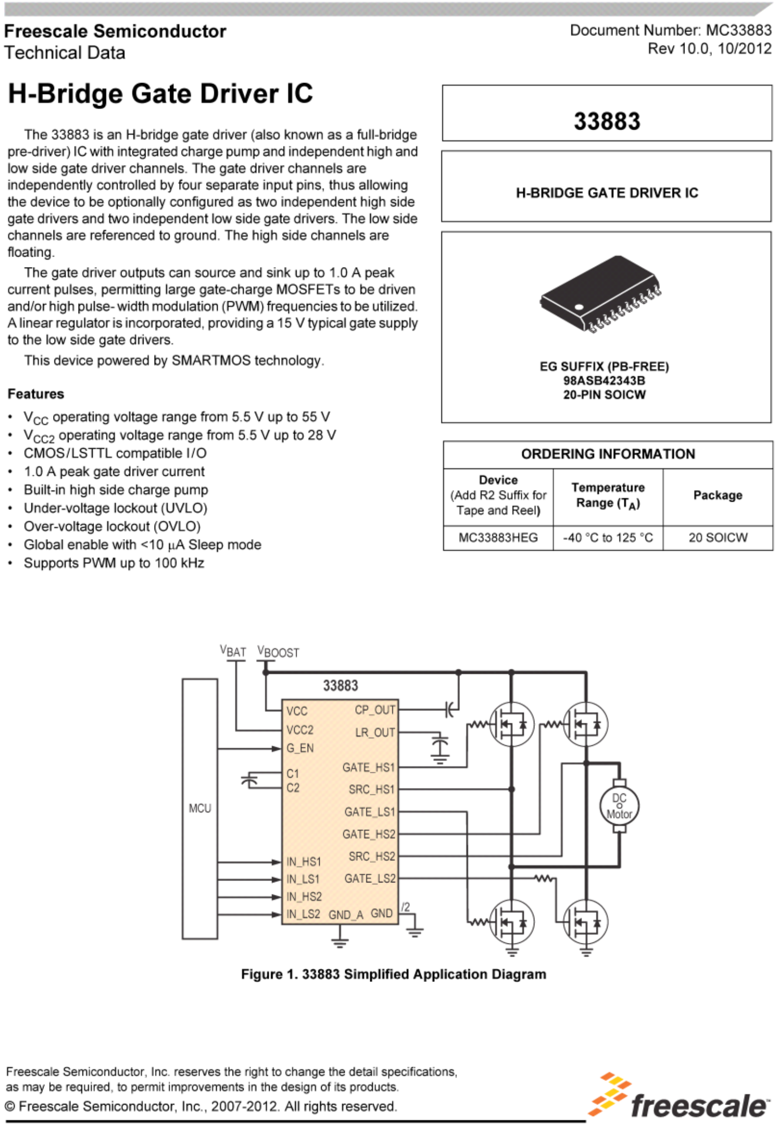
Other features include fixed off-time pulse width modulation (PWM) current control for limiting inrush current, locked-rotor protection with adjustable delay, thermal shutdown, overvoltage monitor, and synchronous rectification. Internal synchronous rectification reduces power dissipation by turning on the appropriate MOSFETs during current decay, thus shorting the body diode with the low $R_{DS(on)}$ MOSFET. Overvoltage protection disables synchronous rectification when the motor pumps the supply voltage beyond the overvoltage threshold during current recirculation.

The A4931 offers enable, direction, and brake inputs that can control current using either phase or enable chopping. Logic outputs FG1 and FG2 can be used to accurately measure motor rotation. Output signals toggle state during Hall transitions, providing an accurate speed output to a microcontroller or speed control circuit.

Operating temperature range is –20°C to 105°C. The A4931 is supplied in a 5 mm × 5 mm, 28-terminal QFN package with exposed thermal pad. This small footprint package is lead (Pb) free with 100% matte tin leadframe plating.

Typical Application

4931-DS, Rev. 6



Freescale Semiconductor
Technical Data

Document Number: MC33883
Rev 10.0, 10/2012

H-Bridge Gate Driver IC

The 33883 is an H-bridge gate driver (also known as a full-bridge pre-driver) IC with integrated charge pump and independent high and low side gate driver channels. The gate driver channels are independently controlled by four separate input pins, thus allowing the device to be optionally configured as two independent high side gate drivers and two independent low side gate drivers. The low side channels are referenced to ground. The high side channels are floating.

The gate driver outputs can source and sink up to 1.0 A peak current pulses, permitting large gate-charge MOSFETs to be driven and/or high pulse- width modulation (PWM) frequencies to be utilized. A linear regulator is incorporated, providing a 15 V typical gate supply to the low side gate drivers.

This device powered by SMARTMOS technology.

Features

- V_{CC} operating voltage range from 5.5 V up to 55 V
- V_{CC2} operating voltage range from 5.5 V up to 28 V
- CMOS/LSTTL compatible I/O
- 1.0 A peak gate driver current
- Built-in high side charge pump
- Under-voltage lockout (UVLO)
- Over-voltage lockout (OVLO)
- Global enable with <10 µA Sleep mode
- Supports PWM up to 100 kHz

33883

H-BRIDGE GATE DRIVER IC

EG SUFFIX (PB-FREE)
98ASB42343B
20-PIN SOICW

ORDERING INFORMATION		
Device (Add R2 Suffix for Tape and Reel)	**Temperature Range (T_A)**	**Package**
MC33883HEG	-40 °C to 125 °C	20 SOICW

Figure 1. 33883 Simplified Application Diagram

Freescale Semiconductor, Inc. reserves the right to change the detail specifications, as may be required, to permit improvements in the design of its products.

freescale

MC3383 protection

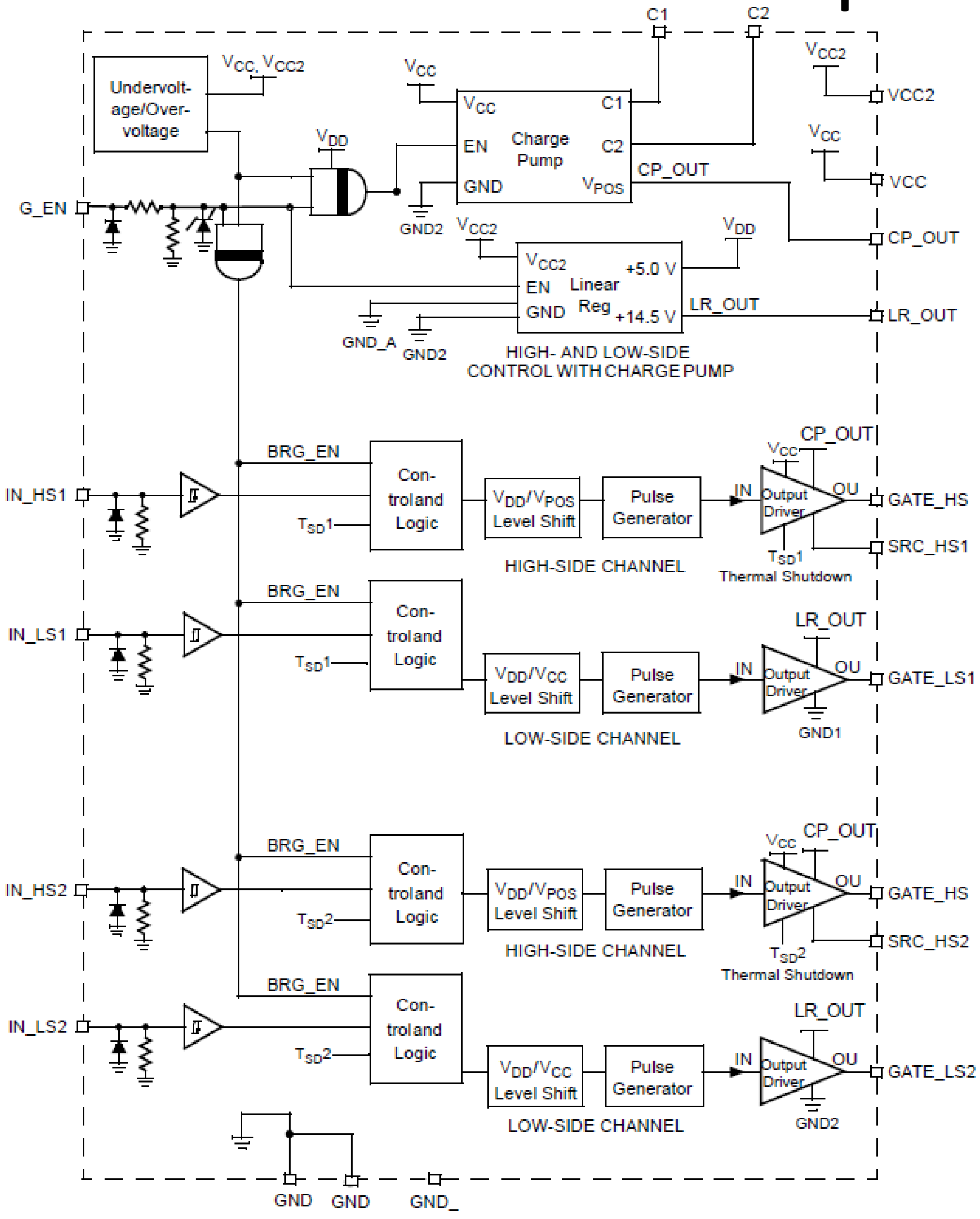


Figure 2. 33883 Simplified Internal Block Diagram

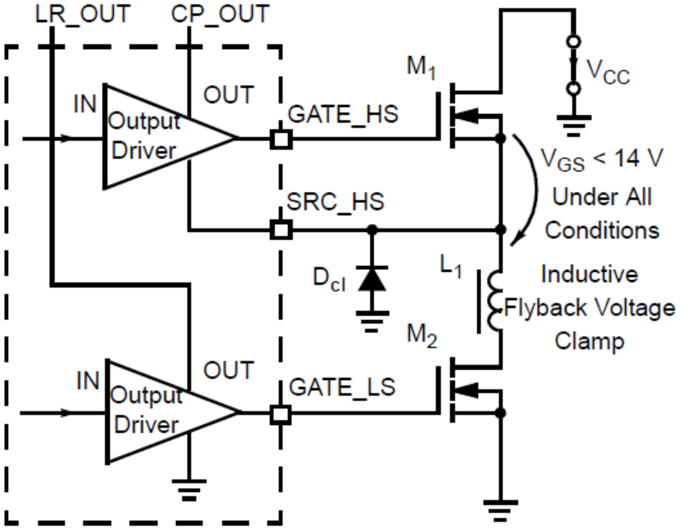


Figure 12. Gate Protection and Flyback Voltage Clamp

MC3383 H bridge

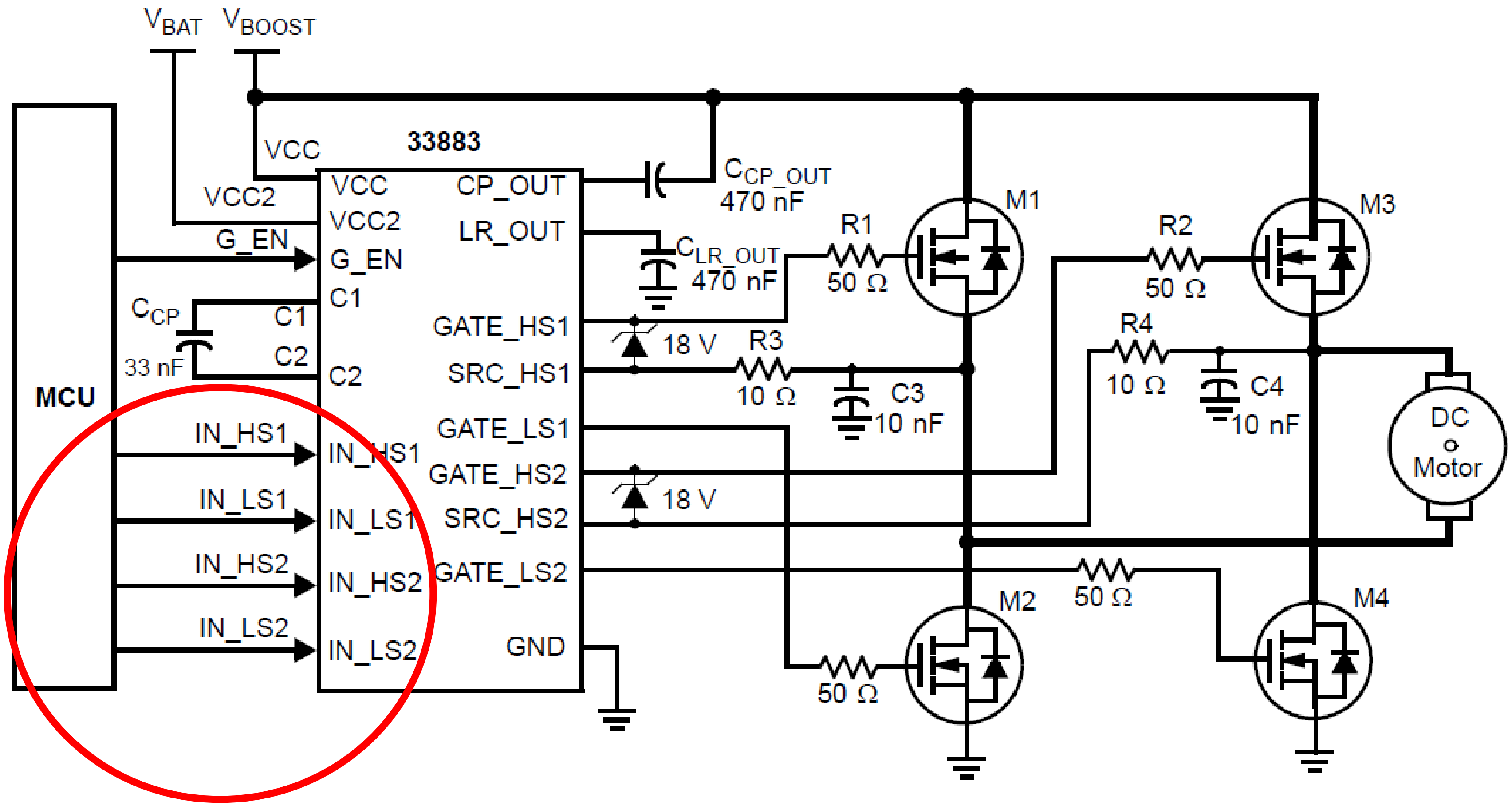
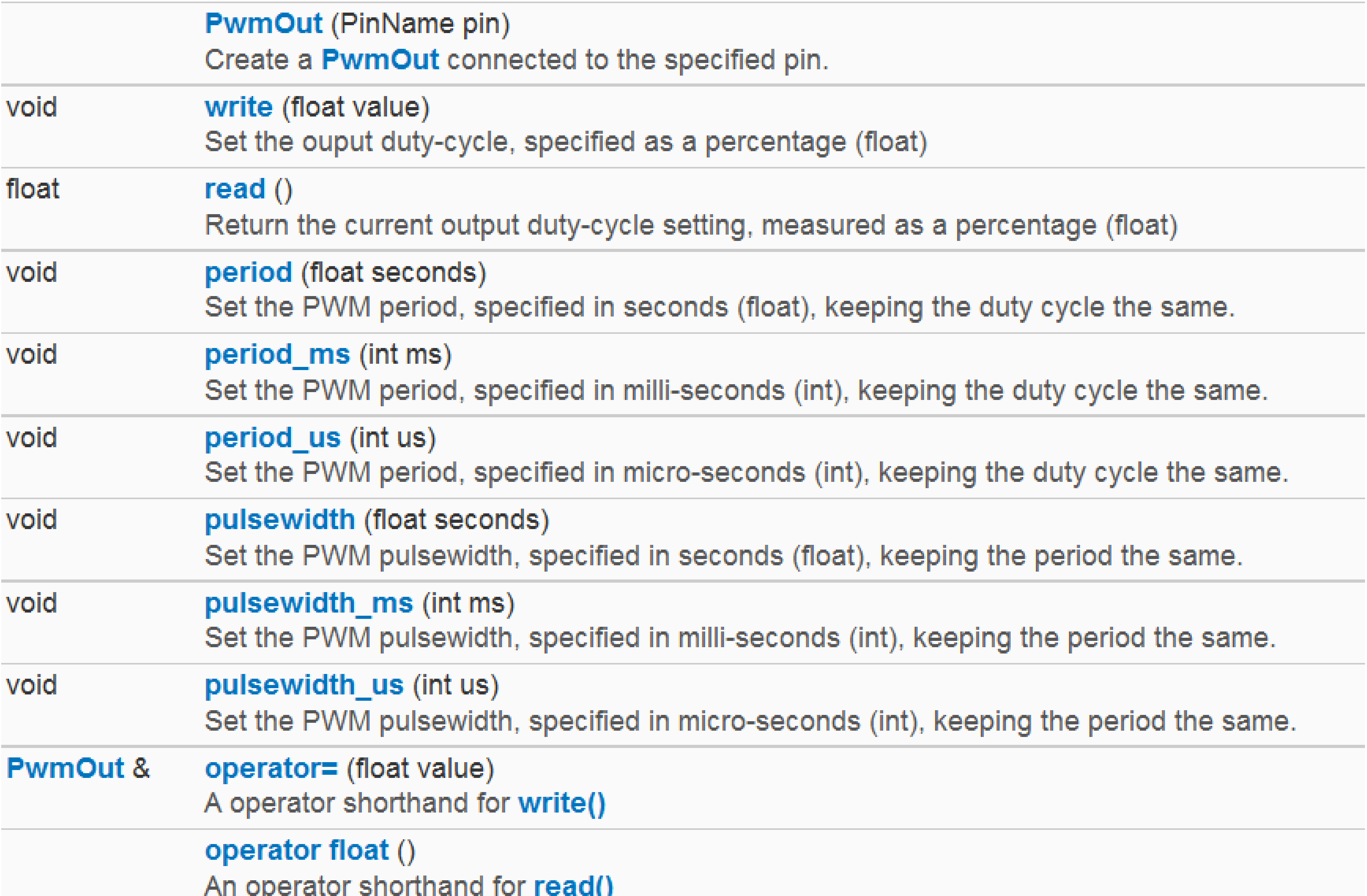


Figure 14. Application Schematic with External Protection Circuit

!!!!CAUTION!!!!
Software fries hardware….

PWM

https://developer.mbed.org/handbook/PwmOut



	PwmOut (PinName pin) Create a PwmOut connected to the specified pin.
void	write (float value) Set the ouput duty-cycle, specified as a percentage (float)
float	read () Return the current output duty-cycle setting, measured as a percentage (float)
void	period (float seconds) Set the PWM period, specified in seconds (float), keeping the duty cycle the same.
void	period_ms (int ms) Set the PWM period, specified in milli-seconds (int), keeping the duty cycle the same.
void	period_us (int us) Set the PWM period, specified in micro-seconds (int), keeping the duty cycle the same.
void	pulsewidth (float seconds) Set the PWM pulsewidth, specified in seconds (float), keeping the period the same.
void	pulsewidth_ms (int ms) Set the PWM pulsewidth, specified in milli-seconds (int), keeping the period the same.
void	pulsewidth_us (int us) Set the PWM pulsewidth, specified in micro-seconds (int), keeping the period the same.
PwmOut &	operator= (float value) A operator shorthand for write()
	operator float () An operator shorthand for read()