1.FEATURE

The NJM2626 is a controller and pre-driver for speed control 3-phase blushless DC motor. The device provides the proper sequencing of 3-phase drive output with external hall ICs inputs.(120degree turn-on mode)

It is possible to control of 3-phase blushless DC motor by added external output buffers.

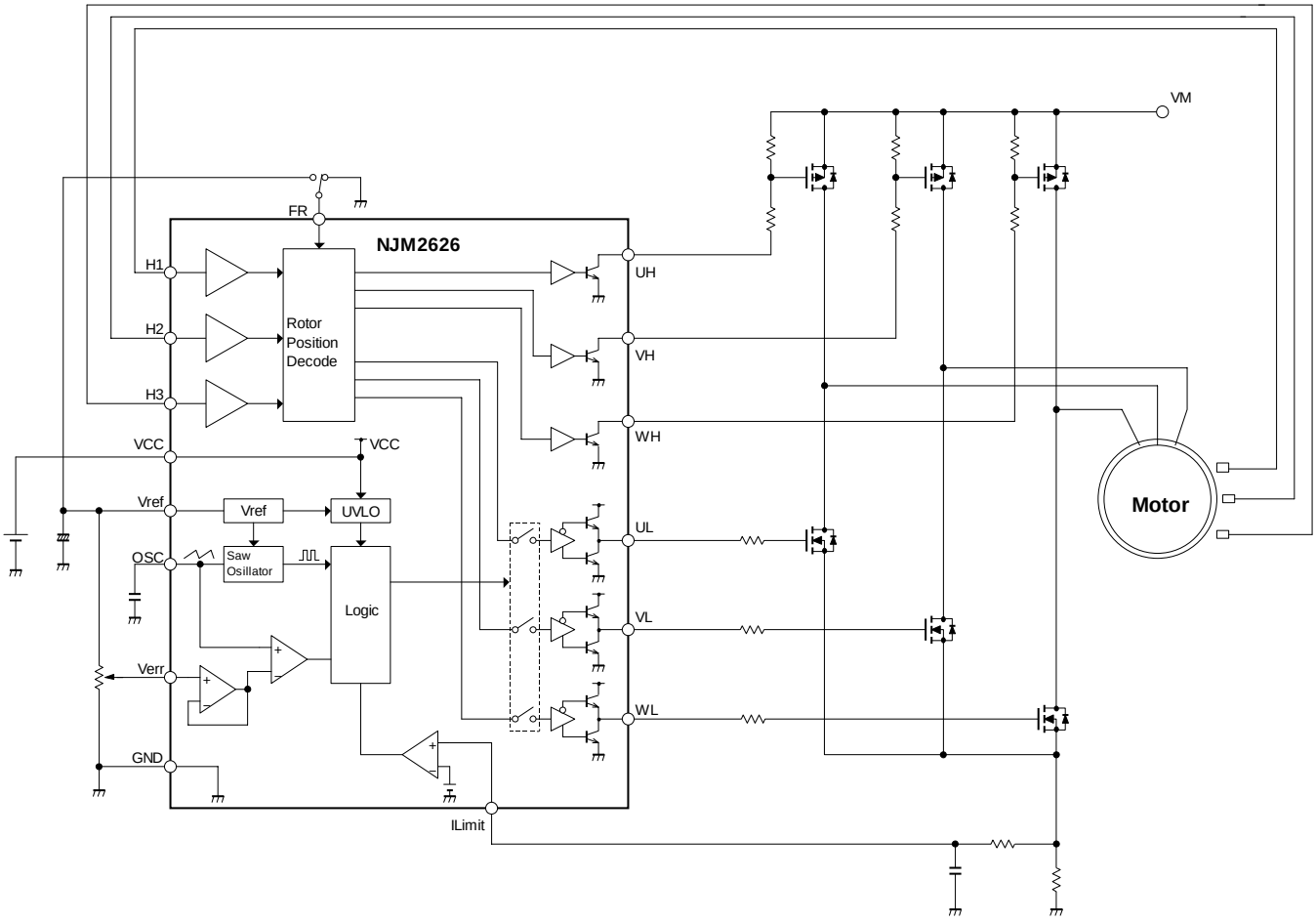
The device has totem-pole pre-drivers for external power MOS transistors and therefore can make the target output motor driver by using suitable power elements.

Further more the device has PWM control ,forward-reverse rotation and current limiting function.

2. Application Circuit

The application shown in below circuit is designed for an open loop motor speed control system that the upper power switch are P-Channel power MOSFET while the lower switches are N-Channel power MOSFET.

MOSFET drive (Upper:Pch ,Lower:Nch),Lower side PWM
Operating Vcc:12V, supply Vm:12V



3. Terminal Functions

(3-1) UH, VH, WH

It consists of Sink-type transistor and controls the upper P-Channel power MOSFET.
The upper side GATE bias current is generated with connected Inverting transistor and resistor.
Regarding design case at Vgs=10V, Isink=20mA about the GATE bias voltage of P-Channel power MOSFET.

$$Rgl + Rg2 = \frac{12V}{I\sin k} = \frac{12}{0.02} = 6oo\Omega$$

$$Vgs = Rgl \times I\sin k = 500 \times 0.02 = 10V$$

The values of Rg1 and Rg2 should be 500Ω, 100Ω.

(3-2) UL, VL, WL

It consists of totem-pole pre-driver and control the lower N-Channel power MOSFET. It is possible to make motor speed control by PWM control. Series GATE resistor Rg3 will damp any high frequency oscillations caused by the MOSFET input capacitance and any series wiring induction in the gate-source circuit.

(3-3) H1, H2, H3

It is the signal input terminal of the Hall IC that is the sensor of rotor magnetic pole position of the motor.
The internal circuit decodes these 3 magnetic position signals to120-degree energization logics
About the relation of H1~H3 (the Hall device input) to UH~WH or UL~WL (that controls ON-OFF of 3-phase MOSFET Bridge), please refer to the below.

The relation between Hall inputs and commutation logic outputs is as follows.

Commutation logic truth table											
Hall Inputs						Outputs					
F/R=L			F/R=H								
H1	H2	H3	H1	H2	H3	UH	VH	WH	UL	VL	WL
H	L	H	L	H	L	X	L	X	H	L	L
H	L	L	L	H	H	X	X	L	H	L	L
H	H	L	L	L	H	X	X	L	L	H	L
L	H	L	H	L	H	L	X	X	L	H	L
L	H	H	H	L	L	L	X	X	L	L	H
L	L	H	H	H	L	X	L	X	L	L	H
L	L	L	L	L	L	X	X	X	L	L	L
H	H	H	H	H	H	X	X	X	L	L	L

The information of the timing chart is shown in attached (5-1)

(3-4) F/R

It is the motor rotation direction input terminal and is controllable by setting the terminal to "H" or "L." A rotation direction change must be made after motor stopped completely.

In such case, switching elements will generate a vertical arm short circuit and it may cause destruction of the switching devices.

However, if PWM is closed before and after a rotation direction change (Verr<0.35V), a rotation direction can be performed safely.

In order to improve the noise resistance, it employs hysteresis input circuit.

The range of input voltage: 0v~Vref

The relation between F/R input and the motor rotation direction is as follows.

F/R Input and Motor Rotation	
F/R	Direction
L	U⇒V⇒W
H	U⇒W⇒V

(3-5) I_{LIMIT}

It is the motor current detection terminal. It allows the control of the torque limiter function, the startup with the soft-start and the current when the motor is constrained. The motor current is converted to a voltage by inserting a ground-referenced sense resistor Rs in series with the three lower MOSFETs. The voltage developed across the sense resistor is monitored by I_{LIMIT} terminal, and compared to the internal Sense Voltage(V_{th}).

If the current sense is exceeded, the comparator sets the over-current latch and terminates the PWM output.

Over-current detection is reset for every cycle of the internal Oscillator.

The value for over-current detection is:

$$I = \frac{\mathrm{Vth}}{\mathrm{Rs}}$$

When an over-current detection function is not well detected by the noise etc., the addition of the RC filter will eliminate current-limit instability by the leading edges spike on the current waveform.

(3-6) Vref

It is the output terminal of internal reference voltage. This terminal please inserts capacitor between GND for stabilization. (We recommend capacitor value is 1μF.)

(3-7) Verr

It is the motor speed control terminal.
The range of input voltage : 0V~Vref
Control approach for Output duty is

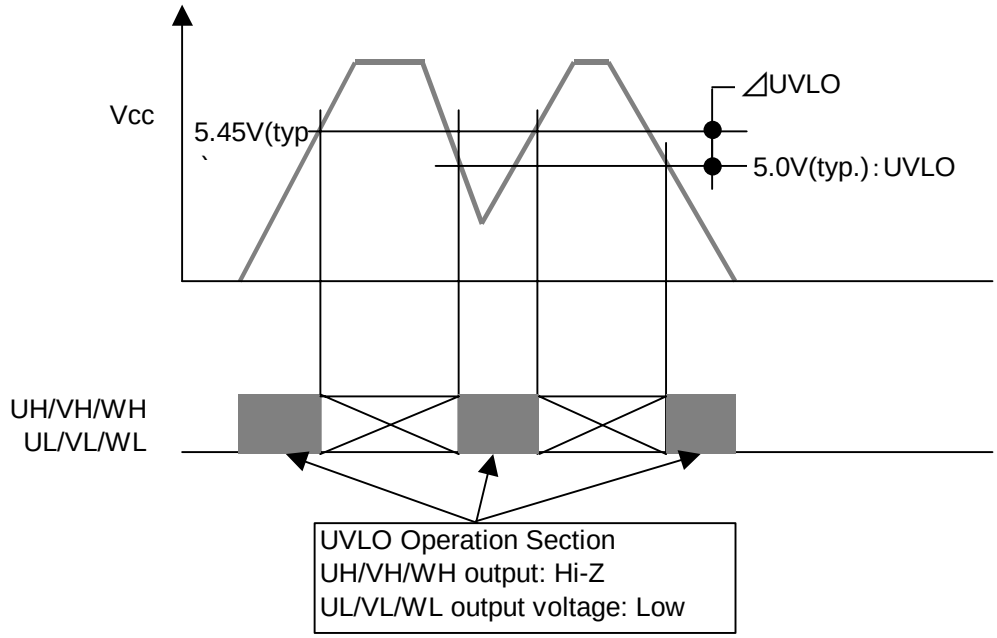
- Analogue voltage control
  Input voltage is compared with internal triangular wave voltage.
  Verr input voltage: less or equal 0.9V (typ.), duty 0%
  : greater and or equal 2.8V(typ.), duty 100%
  or
- Pulse voltage control
  Verr input voltage: 0.35V (max.), PWM 0%
  : 3.5V (min), PWM 100%

(3-8) OSC

By connecting a capacitor to this terminal, the internal Oscillation frequency is decided.
Frequency is set to about 25kHz when capacitor value is 1000pF. If frequency is low, the switching sound from a motor will occur, and if high, the switching loss of a Power element will increase.
We recommend selection with a frequency of 20 to 30kHz.

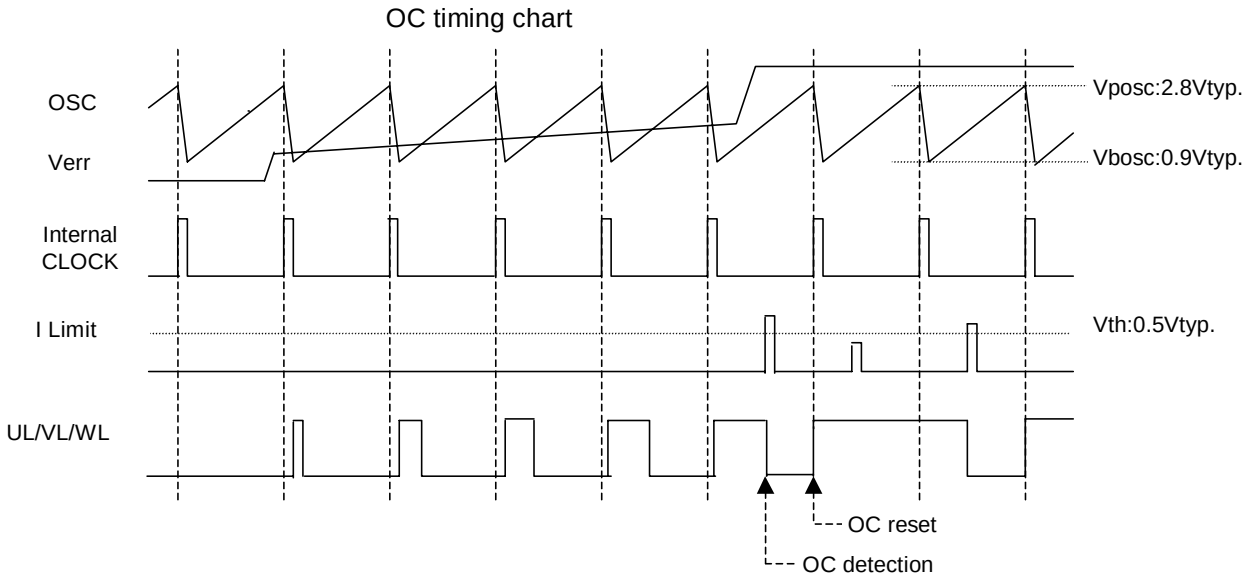
4. Protection circuit
(4-1)UVLO

UVLO timing chart



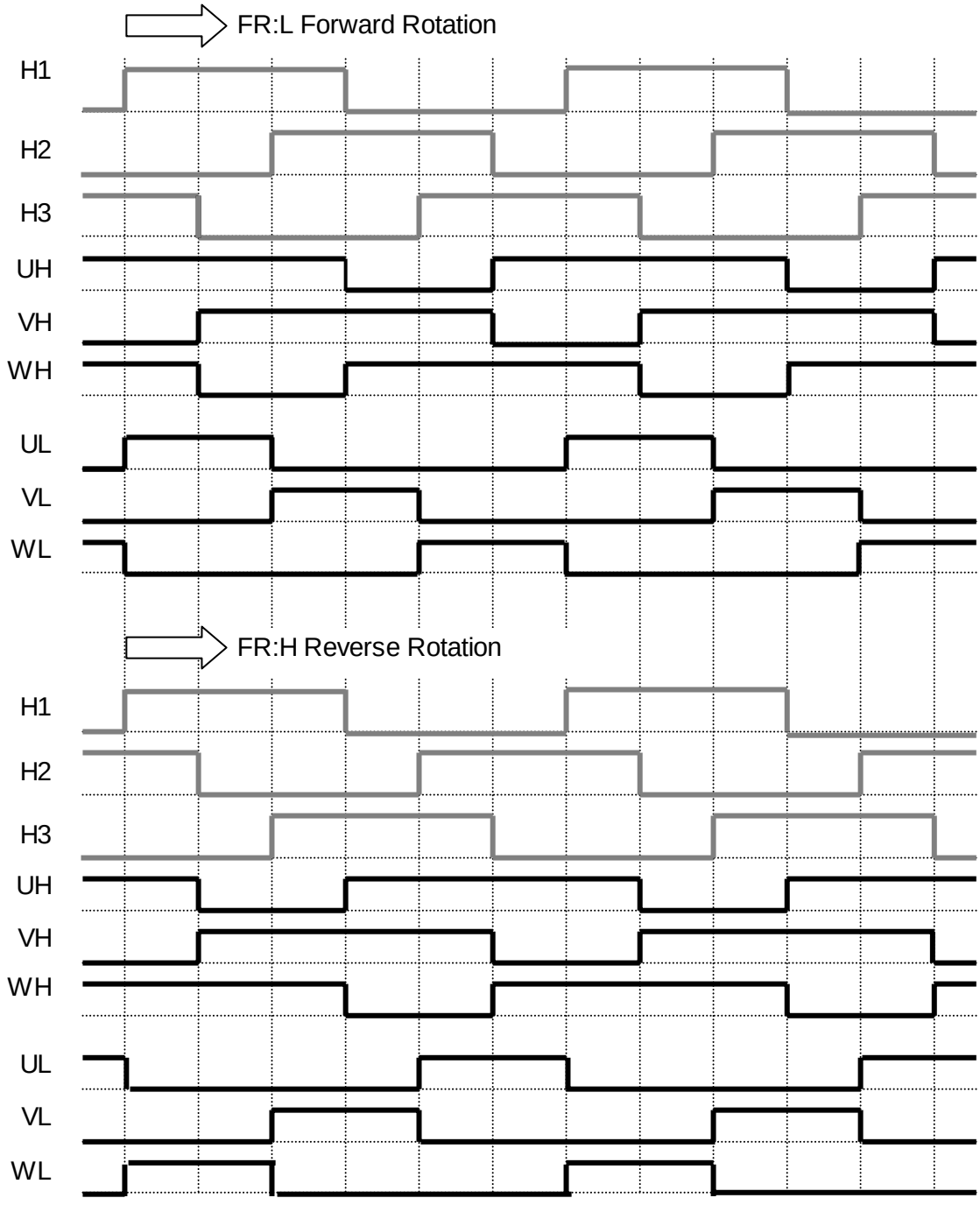
(4-2) Overcurrent detecting circuit

OC timing chart



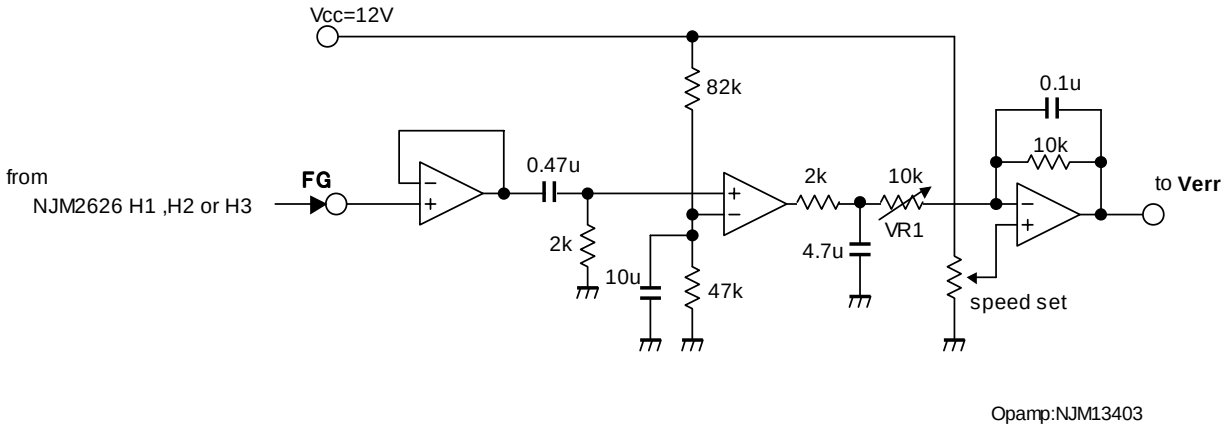
5. Appendix

(5-1) The timing chart of Hall input and pre-driver output

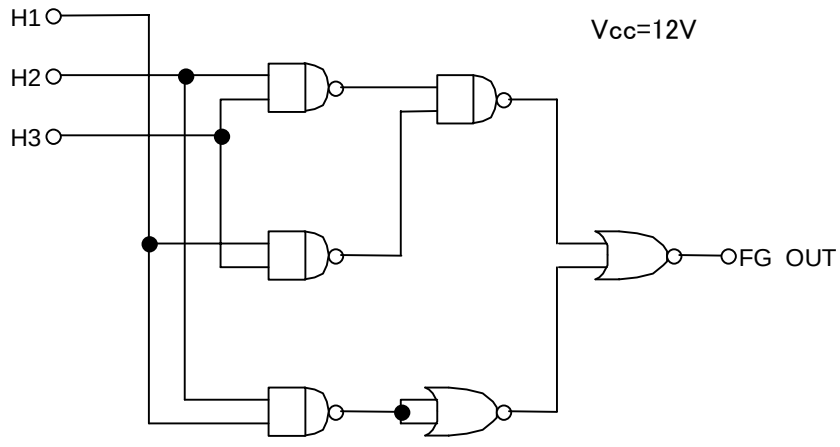


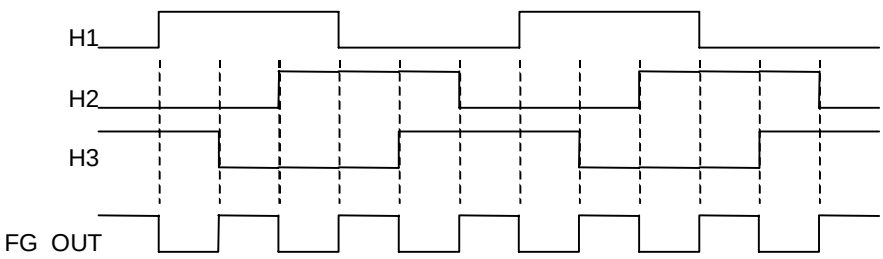
(5-2)Closed Loop speed control circuit

Speed control circuit is shown as following figure. This circuit consists of input buffer, Level shifter and Speed control amplifier. Motor speed can be changed by “speed set” VR. VR1 is trimmer for final stage gain for stability. NJM13403 is quad single supply general-purpose operational amplifier. The typical values of the other parts are shown in figure.

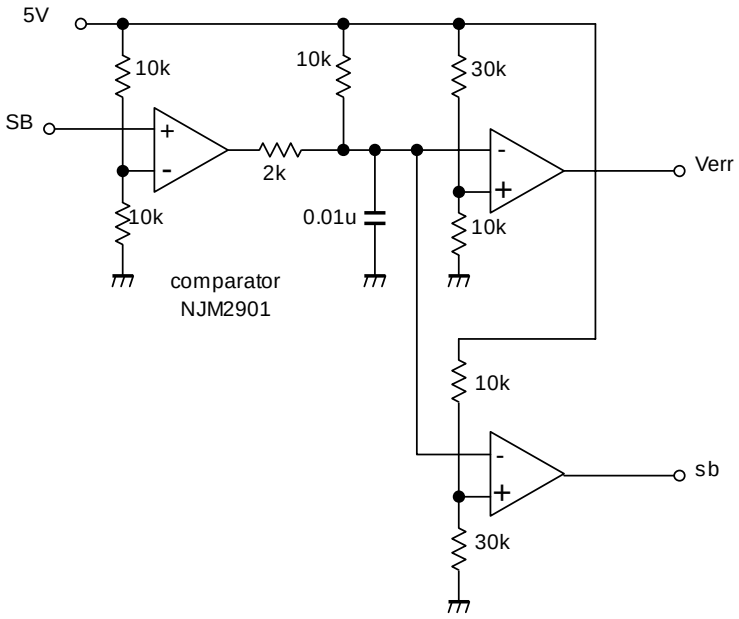


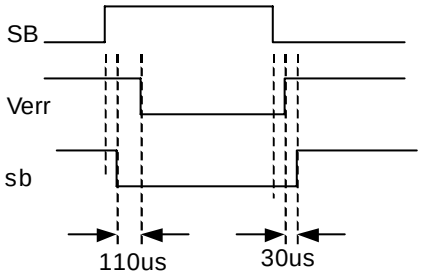
An example circuit of 3 multiple FG_OUT using H1,H2 and H3 is shown below.

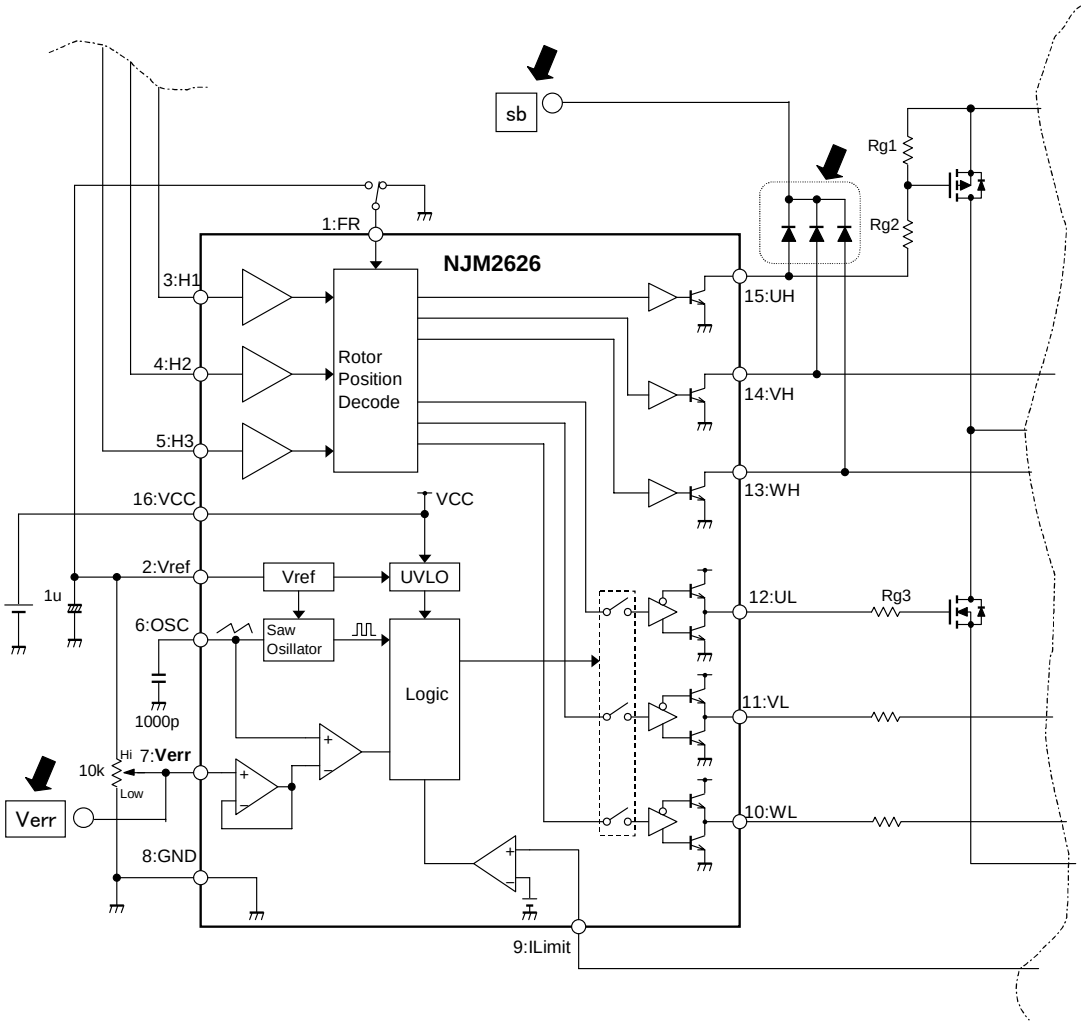




(5-3)Example of a short brake circuit







(5-4) 24V power supply

In the case of using 24V power supply

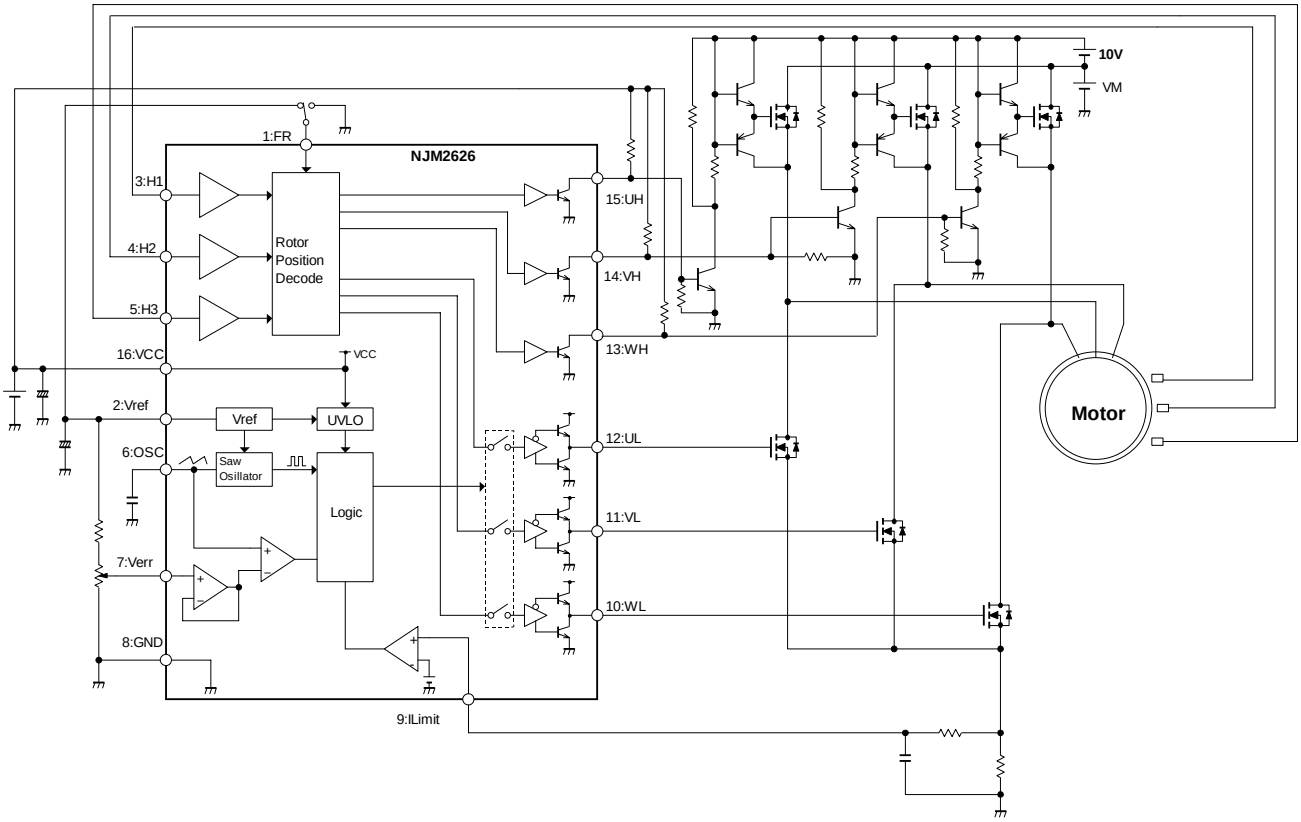
The gate bias resistance of Pch-MOSFET of Upper arm device is designed based on (3-1).

About the gate voltage of Nch-MOSFET of Lower arm device, in consideration of rating of the gate source of Nch-MOSFET, terminals (UL~WL) are redundant circuit, output voltage 20V(max.), Vcc=26V.

(5-5) Upper arm device: Nch-MOSFET

Example of the Circuit construction of external 3-Phase Bridge device (Nch-MOSFET)

It needs 10V power supply for Nch-MOSFET gate driver in addition to power supply for motor (VM).



(5-6) f_{osc} vs. OSC-Capacitor