DN0005
Design note

DESIGNS from our LABS

A three phase induction motor drive using a V/F control

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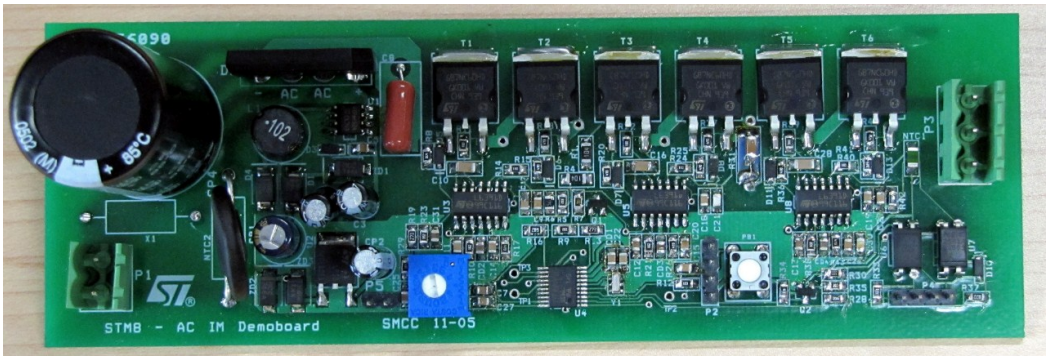
Main components	
STM8S	Mainstream 8-bit MCU with Advanced Timer
L6391	High-voltage high and low side driver

Specification

- Speed control with acceleration and deceleration limit
- Over current protection
- Over voltage protection
- Over temperature protection on power IGBT
- Operating voltage (AC mains input) 90 – 130V
- Motor current up to 1A RMS

Circuit description

For loads where the load curve is well known, such as a fan, a simple V/F drive can provide good efficiency and reasonable speed control without the need for any speed feedback. In such an application, the actual rotation speed is the commanded speed less the slip. This is the same operating mode as if a motor were connected directly to the mains, but we have the added advantage of being able to control the drive frequency and therefore we have a low cost and easily implemented speed control. The original application of this board was a small fan used in a residential heating system.



The example software generates a three phase sine drive for the motor in voltage mode. The software uses a simple V/F algorithm where the amplitude of the applied sine wave is increased proportional to the drive frequency over the operating range. In the example software, the desired speed is set using potentiometer R32 that is read by one of the analog inputs on the microcontroller.

The V/F constant can be estimated from the motor rating. For example, if the motor is rated at 120V for 60 Hz operation, the starting point for selecting the V/F constant is simply 120V/60Hz. For most applications this will be the appropriate value. The acceleration and deceleration limit can be set empirically as appropriate for the application. For the board, the most important parameter is to select a deceleration limit so that when decelerating with the load, the high voltage power supply is not forced above the over voltage trip point. The V/F constant, the acceleration rate and the deceleration rate are all set using #DEFINE statements in the header so they can easily be set for the motor.

The circuit implements the V/F control using the advanced timer of the 8-bit microcontroller, the STM8S103F3, to generate the three phase PWM signals with dead time to drive the power bridge. The power stage is a three phase bridge using discrete IGBTs, T1-T6 and half bridge gate driver ICs, U3, U5 and U8.

The power supply for the controller and gate drivers are derived from the high voltage supply using a VIPer12, U1, in a buck configuration. It regulates 15 V for the gate drivers and supplies a linear regulator, U2, that regulates 5V for the microcontroller and other associated circuitry.

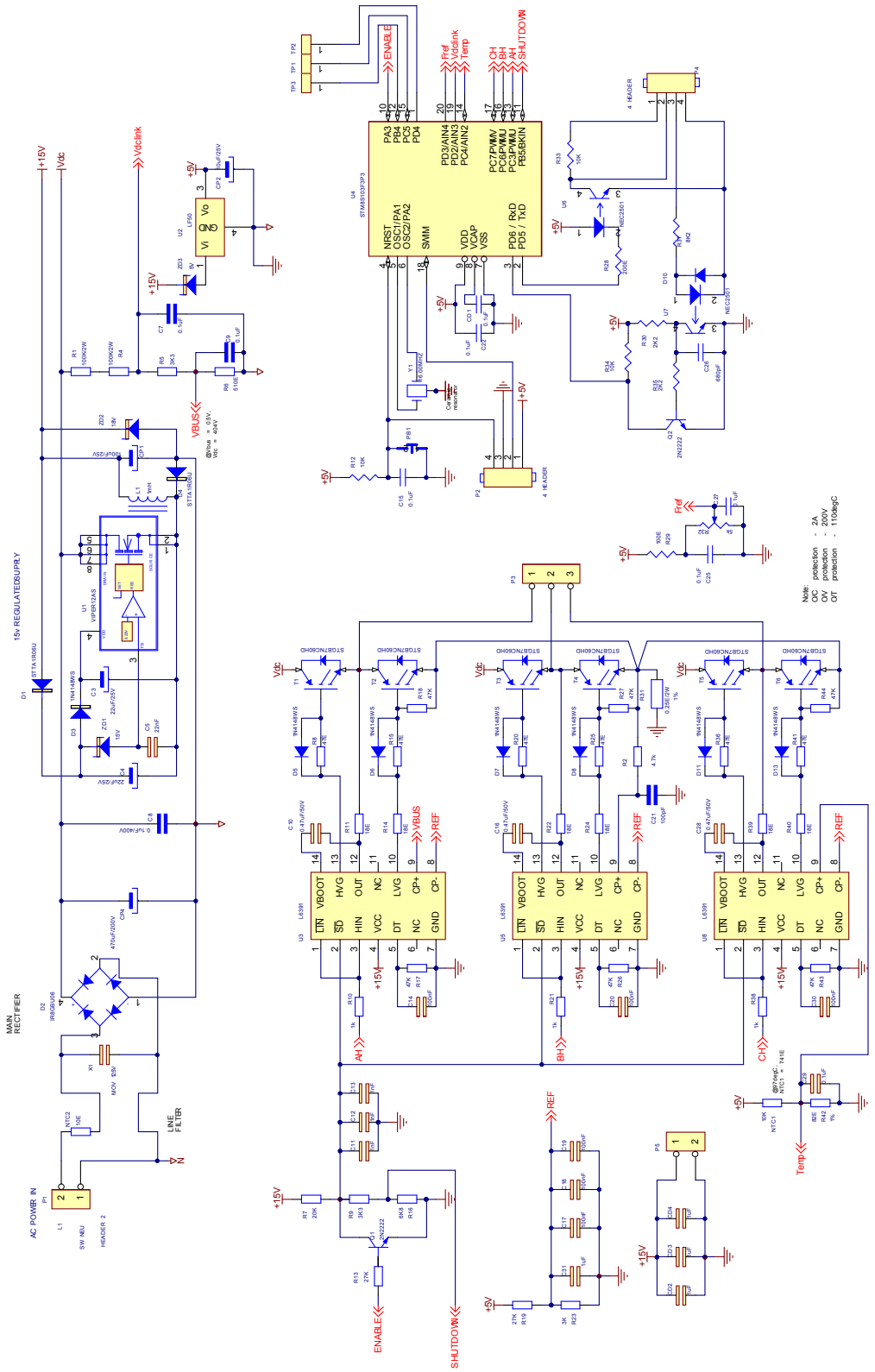
Over current protection, over voltage protection and over temperature protection are implemented using the internal comparators in the L6391 gate driver IC. One input of each comparator input is biased at 0.5V by R19 and R23. The other inputs are connected to sense the voltage across the current sense resistor, R31, the temperature feedback from the thermistor, NCT1, and the bus voltage from the lower resistor, R6, of the voltage divider. If any of these three voltages exceed the 0.5V reference, the comparator will activate the smart shutdown on one of the L6391 and pull the SD pin low. Since all three of the SD pins are connected together, all of the bridge drivers will be turned off. As configured, the board will detect a fault for a motor current over 2A, a high voltage supply voltage over 200V, or a temperature on the NTC over 110^{o}C. The trip point for any of the three can be adjusted by changing the values of resistors on the board. The microcontroller can sense that a fault has occurred by looking for a falling edge on the SD pin and take action appropriate to shut down when a fault occurs.

P1 is power in from the AC mains. (120V, 60 Hz).

P2 is the SWIM programming connection for the STM8S103.

P3 is the motor terminal connection.

Figure 1. Circuit diagram



Variations

The board includes an isolated serial (UART) interface that could be used to send on/off and/or speed commands to the board. This is not implemented in the example software.

Support material

Related design support material
STSW-DRIVE001, 3-phase VF example source code for DN0005
Documentation
Datasheet: STM8S103F3, Mainstream Access line 8-bit MCU
Datasheet: L6391, High-voltage high and low side driver
Datasheet: VIPer12A, Fixed frequency off line converter

Revision history

Date	Version	Changes
30-May-12	1	Initial release
24-Feb-14	2	Revised schematic

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