High current drive using 4 X NJM3770A

The absolute max current provided from New JRC's stepper motor drivers is 1.8 A (NJM3770A). Sometimes higher-current drive capability is needed. A solution which can give up to 3 A total current/phase is described in this chapter. This is accomplished by using a stepper motor with two separate windings for each phase. Each winding is controlled by a NJM3770A and the drivers in one phase are driven in parallel. This increases the total current drive capability in each phase to approximately 3 A. Any of New JRC's stepper motor drivers including the dual drivers can be used similarly.

Basic design

This design (see figure 3) consists of four NJM3770A in a standard configuration (see the datasheet) and a NJM3517 as a step sequence generator. This application can perform full and half step.

For V_{ref}, either the 5 V supply (V_{cc}) or a separately generated reference voltage is used. (A separately generated V_{ref} is usually more accurate). Using R_s=0.33 Ω and V_r=5.0 V results in a motor current of approx. 1200 mA for each driver which gives 2.4 A in each phase (100% level). The motor current can be changed either by changing the V_r and/or the R_s.

To achieve modified half stepping the circuit in figure 1 is included instead of the transistors and resistors within the dotted boundary in figure 3. The added logic circuit uses the I0, I1 inputs to switch between the 100% and 60% current levels.

These two basic paralleling circuits may work well in certain well defined situations. High frequent interference may occur which will cause audible noise from the motor. This interferent noise is a result of the unsynchronized constant current switching in the driver circuits. The motor acts as a nonlinear mixer and all kinds of frequencies may occur. Therefore the motor choice is important when using this unsynchronized design. Unsynchronized switching will also load the supply with high current transients.

Synchronization

Synchronization of the current switching can be used to reduce and in some cases eliminate noise and to put a smoother load on the supply. The synchronization can be done in different ways. In this application a master/slave sync. can not be used since one phase will be completely off when using half stepping. An external oscillator will control all four drive circuits. (see figure 2). In Ericsson's dual stepper motor drivers, the oscillator is still running when the motor current is disabled (via the Dis input or by bringing V_{ref} to zero), making it possible to use a master/slave configuration.

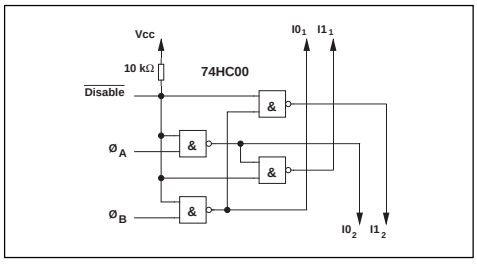

Figure 1. Logic circuit which, when added to design in figure 3, allows it to perform modified-half-step driving.

Table 1. Value of components used in Figure 2

Symbol	Value
R_1	68 kΩ
R_2, R_3	1 kΩ
R_4, R_5	100 Ω
R_6, R_7, R_8, R_9	56 kΩ
C_1,C_2, C_3, C_4 C_5, C_6, C_7	820 pF
P_1	50kΩ trim
IC_1	4093
Q_1, Q_2, Q_3, Q_4	BC547 or equivalent
D_1, D_2	IN4148 or equivalent

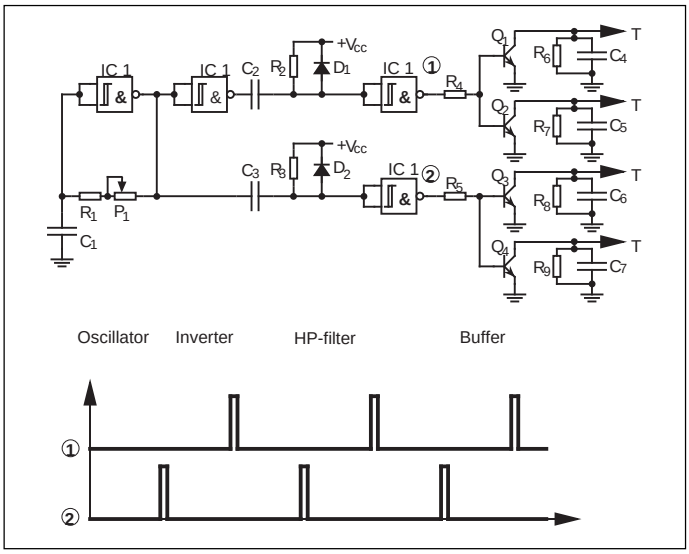

Figure 2. Oscillator circuitry used to synchronize current switching in the design in figure 3 and it's output signals.

The driver circuits are synchronized in pairs to get a “smooth” load on the supply. That is, the two drivers in one phase switch in parallel and the two motor phases are 180° out of phase. It is also possible to sync one driver in each phase in parallel and the other two drivers 180° out of phase. (See the Synchronization application note).

The external oscillator tested in this application is shown in figure 3. A 4093 CMOS Schmitt trigger NAND-gate and some external components form an oscillator with two outputs. The outputs are 180° out of phase and by HF-filtering and Schmitt trigger buffers short positive pulses are generated(see figure 3).

The T inputs of the NJM3770A are controlled via a standard NPN transistor. See the Synchronization application note for information about how the NJM3770A is controlled via the T inputs. The resistor and capacitor at the T-input are still needed to suppress interference.

Conclusion

The interference between the current switching and cause of this the noise from the motor is drastically reduced. The supply current is smooth without any transients.

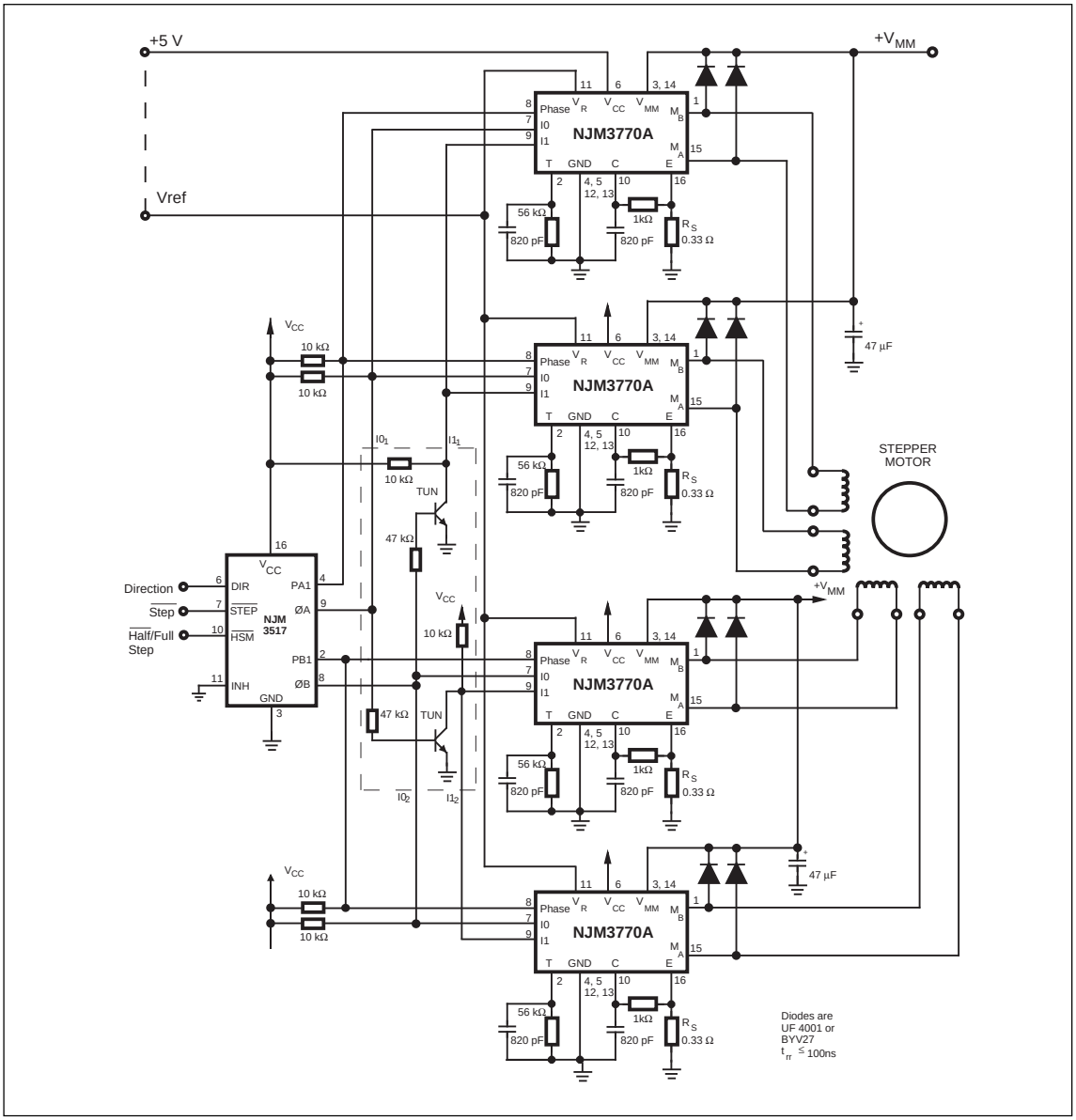

Figure 3. High-current design (2.5 A/Phase) using four NJM3770A.

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