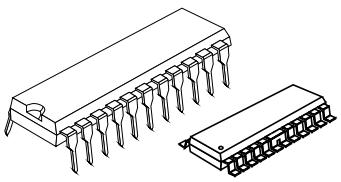
DUAL STEPPER MOTOR DRIVER

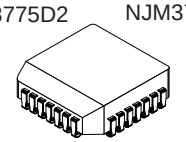
■ GENERAL DESCRIPTION

The NJM3775 is a switch-mode (chopper), constant-current driver with two channels: one for each winding of a two-phase stepper motor. NJM3775 is equipped with a Disable input to simplify half-stepping operation. The NJM3775 contains a clock oscillator, which is common for both driver channels, a set of comparators and flip-flops implementing the switching control, and two output H-bridges, including recirculation diodes. Voltage supply requirements are + 5 V for logic and + 10 to + 45 V for the motor. Maximum output current is 750mA per channel.

■ PACKAGE OUTLINE



NJM3775D2 NJM3775E3



NJM3775FM2

■ FEATURES

- Dual chopper driver
- 750 mA continuous output current per channel
- Digital filter on chip eliminates external filtering components
- Packages DIP22 / PLCC28 / EMP24(batwing)

■ BLOCK DIAGRAM

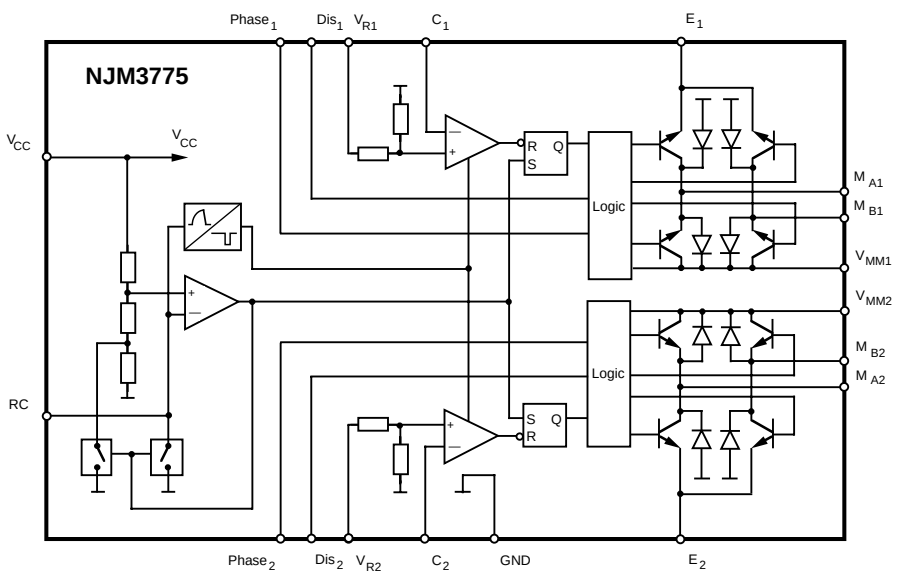


Figure 1. Block diagram

■ PIN CONFIGURATIONS

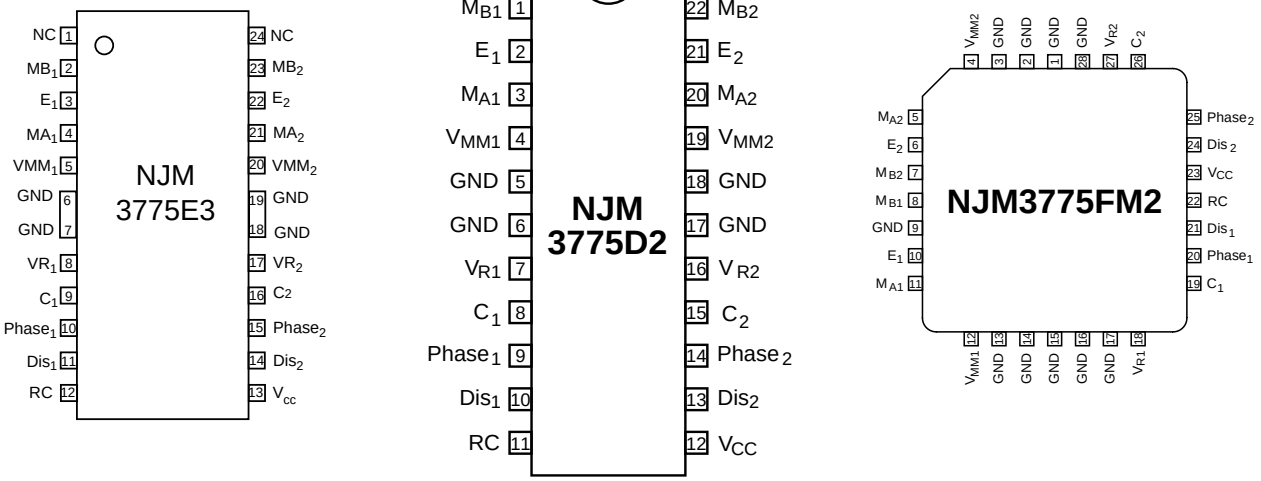


Figure 2. Pin configurations

■ PIN DESCRIPTION

EMP	DIP	PLCC	Symbol	Description
2	1	[8]	M_{B1}	Motor output B, channel 1. Motor current flows from M_{A1} to M_{B1} when $Phase_1$ is HIGH.
3	2	[10]	E_1	Common emitter, channel 1. This pin connects to a sensing resistor R_S to ground.
4	3	[11]	M_{A1}	Motor output A, channel 1. Motor current flows from M_{A1} to M_{B1} when $Phase_1$ is HIGH.
5	4	[12]	V_{MM1}	Motor supply voltage, channel 1, +10 to +40 V. V_{MM1} and V_{MM2} should be connected together.
6,7	5, 6,	[1-3, 9,	GND	Ground and negative supply. Note: these pins are used thermally for heat-sinking.
18,19	17, 18	13-17, 28]		Make sure that all ground pins are soldered onto a suitably large copper ground plane for efficient heat sinking.
8	7	[18]	V_{R1}	Reference voltage, channel 1. Controls the comparator threshold voltage and hence the output current.
9	8	[19]	C_1	Comparator input channel 1. This input senses the instantaneous voltage across the sensing resistor, filtered by the internal digital filter or an optional external RC network.
10	9	[20]	$Phase_1$	Controls the direction of motor current at outputs M_{A1} and M_{B1}. Motor current flows from M_{A1} to M_{B1} when $Phase_1$ is HIGH.
11	10	[21]	Dis_1	Disable input for channel 1. When HIGH, all four output transistors are turned off, which results in a rapidly decreasing output current to zero.
12	11	[22]	RC	Clock oscillator RC pin. Connect a 12 kohm resistor to V_{CC} and a 4 700 pF capacitor to ground to obtain the nominal switching frequency of 23.0 kHz and a digital filter blanking time of 1.0µs.
13	12	[23]	V_{CC}	Logic voltage supply, nominally +5 V.
14	13	[24]	Dis_2	Disable input for channel 2. When HIGH, all four output transistors are turned off, which results in a rapidly decreasing output current to zero.
15	14	[25]	$Phase_2$	Controls the direction of motor current at outputs M_{A2} and M_{B2}. Motor current flows from M_{A2} to M_{B2} when $Phase_2$ is HIGH.
16	15	[26]	C_2	Comparator input channel 2. This input senses the instantaneous voltage across the sensing resistor, filtered by the internal digital filter or an optional external RC network.
17	16	[27]	V_{R2}	Reference voltage, channel 2. Controls the comparator threshold voltage and hence the output current.
20	19	[4]	V_{MM2}	Motor supply voltage, channel 2, +10 to +40 V. V_{MM1} and V_{MM2} should be connected together.
21	20	[5]	M_{A2}	Motor output A, channel 2. Motor current flows from M_{A2} to M_{B2} when $Phase_2$ is HIGH.
22	21	[6]	E_2	Common emitter, channel 2. This pin connects to a sensing resistor R_S to ground.
23	22	[7]	M_{B2}	Motor output B, channel 2. Motor current flows from M_{A2} to M_{B2} when $Phase_2$ is HIGH.

■ FUNCTIONAL DESCRIPTION

Each channel of the NJM3775 consists of the following sections: an output H-bridge with four transistors and four recirculation diodes, capable of driving up to 750 mA continuous current to the motor winding, a logic section that controls the output transistors, an S-R flip-flop, and a com- parator. The clock-oscillator is common to both channels.

Constant current control is achieved by switching the output current to the windings. This is done by sensing the peak current through the winding via a current-sensing resistor R_S, effectively connected in series with the motor winding. As the current increases, a voltage develops across the sensing resistor, which is fed back to the comparator. At the predetermined level, defined by the voltage at the reference input V_R, the comparator resets the flip-flop, which turns off the upper output transistor. The turn-off of one channel is independent of the other channel. The current decreases until the clock oscillator triggers the flip-flops of both channels simultaneously, which turns on the output transistors again, and the cycle is repeated.

To prevent erroneous switching due to switching transients at turn-on, the NJM3775 includes a digital filter. The clock oscillator provides a blanking pulse which is used for digital filtering of the voltage transient across the current sensing resistor during turn-on.

The current paths during turn-on, turn-off and phase shift are shown in figure 3.

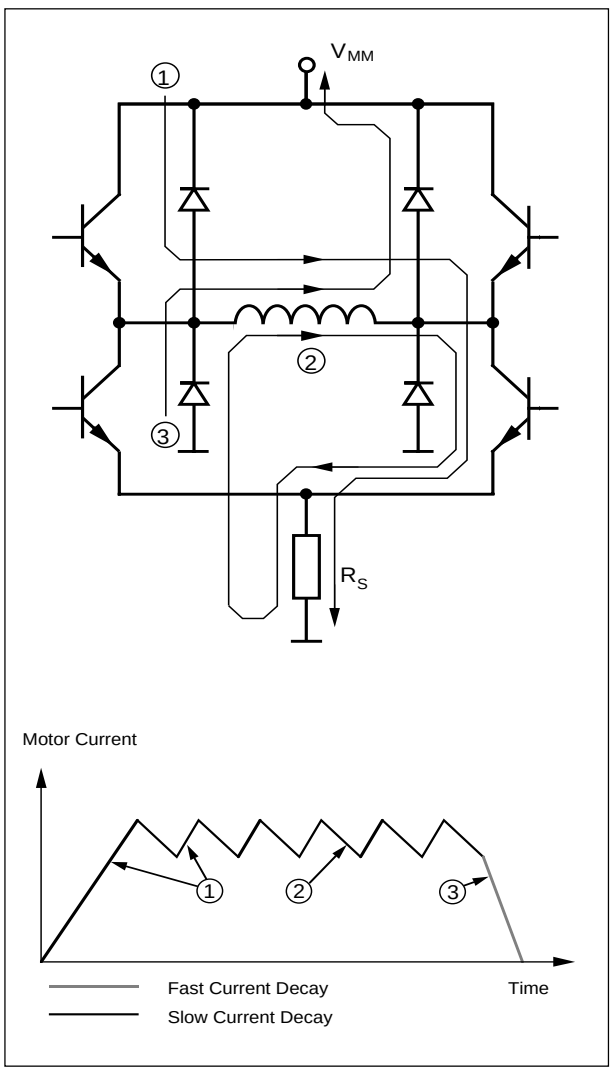


Figure 3. Output stage with current paths during turn-on, turn-off and phase shift.

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Pin No. (DIP)	Symbol	Min	Max	Unit
Voltage					
Logic supply	12	V_{CC}	0	7	V
Motor supply	4, 19	V_{MM}	0	45	V
Logic inputs	9, 10, 13, 14	V_I	-0.3	6	V
Analog inputs	7, 8, 15, 16	V_A	-0.3	V_{CC}	V
Current					
Motor output current	1, 3, 20, 22	I_M	-850	+850	mA
Logic inputs	9, 10, 13, 14	I_I	-10	-	mA
Analog inputs	7, 8, 15, 16	I_A	-10	-	mA
Temperature					
Operating junction temperature		T_j	-40	+150	°C
Storage temperature		T_{stg}	-55	+150	°C
Power Dissipation (Package Data)					
Power dissipation at T_{GND} = +25°C, DIP and PLCC package		P_D	-	5	W
Power dissipation at T_{GND} = +125°C, DIP package		P_D	-	2.2	W
Power dissipation at T_{GND} = +125°C, PLCC package		P_D	-	2.6	W

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Logic supply voltage	V_{CC}	4.75	5	5.25	V
Motor supply voltage	V_{MM}	10	-	40	V
Output emitter voltage	V_E	-	-	1.0	V
Motor output current	I_M	-750	-	+750	mA
Operating junction temperature	T_j	-20	-	+125	°C
Rise and fall time logic inputs	t_r, t_f	-	-	2	ms
Oscillator timing resistor	R_T	2	12	20	kohm

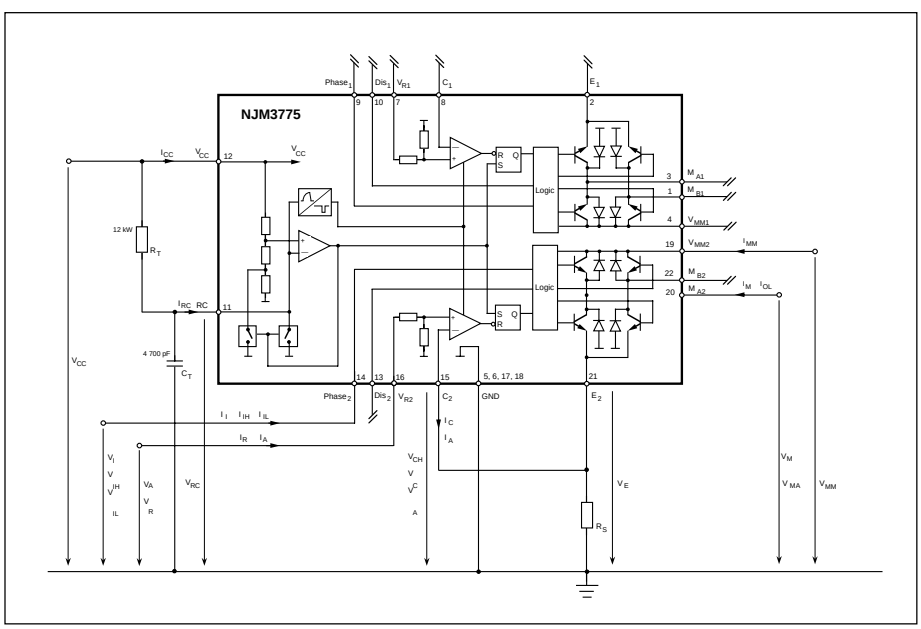


Figure 4. Definition of symbols

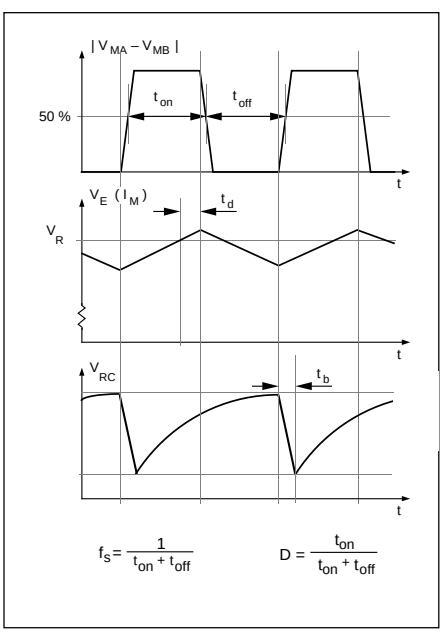


Figure 5. Definition of terms

■ ELECTRICAL CHARACTERISTICS

Electrical characteristics over recommended operating conditions, unless otherwise noted. - 20°C ≤ T_j ≤ + 125°C.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
General						
Supply current	I_{CC}	Note 4.	-	55	70	mA
Supply current	I_{CC}	Dis_1= Dis_2= HIGH.	-	7	10	mA
Total power dissipation	P_D	V_{MM}= 24 V, I_{M1}= I_{M2}= 500 mA. Notes 2, 3, 4.	-	2.0	2.3	W
Total power dissipation	P_D	V_{MM}= 24 V, I_{M1}= 700 mA, I_{M2}= 0 mA. Notes 2, 3, 4.	-	1.7	2.0	W
Thermal shutdown junction temperature			-	160	-	°C
Turn-off delay	t_d	T_A = +25°C, $dV_C/dt \geq 50$ mV/µs, I_M = 100 mA. Note 3.	-	1.1	2.0	µs
Logic Inputs						
Logic HIGH input voltage	V_{IH}		2.0	-	-	V
Logic LOW input voltage	V_{IL}		-	-	0.6	V
Logic HIGH input current	I_{IH}	V_I = 2.4 V	-	-	20	µA
Logic LOW input current	I_{IL}	V_I = 0.4 V	-0.2	-0.1	-	mA
Analog Inputs						
Threshold voltage	V_{CH}	V_R=5 V	480	500	520	mV
Input current	I_A	V_R= 5 V	-	500	-	µA
$\|V_{C1}—V_{C2}\|$ mismatch	V_{Cdiff}		-	1	-	mV
Motor Outputs						
Lower transistor saturation voltage		I_M = 500 mA	-	0.4	0.8	V
Lower transistor leakage current		V_{MM}=41 V,T_A = +25°C. Dis_1= Dis_2= HIGH.	-	-	100	µA
Lower diode forward voltage drop		I_M = 500 mA	-	1.1	1.3	V
Upper transistor saturation voltage		I_M = 500 mA.	-	1.1	1.4	V
Upper transistor leakage current		V_{MM}=41 V,T_A = +25°C. Dis_1= Dis_2= HIGH.	-	-	100	µA
Upper diode forward voltage drop		I_M = 500 mA.	-	1.1	1.4	V
Chopper Oscillator						
Chopping frequency	f_s	C_T = 4 700 pF, R_T = 12 kohm	21.5	23.0	24.5	kHz
Digital filter blanking time	t_b	C_T = 4 700 pF. Note 3.	-	1.0	-	µs

■ THERMAL CHARACTERISTICS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Thermal resistance	Rth_{J-GND}	DIP package.	-	11	-	°C/W
	Rth_{J-A}	DIP package. Note 2.	-	40	-	°C/W
	Rth_{J-GND}	PLCC package.	-	9	-	°C/W
	Rth_{J-A}	PLCC package. Note 2.	-	35	-	°C/W
	Rth_{J-GND}	EMP package	-	13	-	°C/W
	Rth_{J-A}	EMP package	-	42	-	°C/W

Notes
1. All voltages are with respect to ground. Currents are positive into, negative out of specified terminal.
2. All ground pins soldered onto a 20 cm^2 PCB copper area with free air convection, T_A = + 25° C.
3. Not covered by final test program.
4. Switching duty cycle D = 30 %, f_s = 23.0 kHz.

■ APPLICATIONS INFORMATION

Current control

The regulated output current level to the motor winding is determined by the voltage at the reference input and the value of the sensing resistor, R_S. The peak current through the sensing resistor (and the motor winding) can be expressed as:

$I_{M,peak} = 0.1 \cdot V_R / R_S$ [A]

With a recommended value of 0.5 ohm for the sensing resistor R_S, a 2.5 V reference voltage will produce an output current of approximately 500 mA. R_S should be selected for maximum motor current. Be sure not to exceed the absolute maximum output current which is 850 mA. Chopping frequency, winding inductance and supply voltage also affect the current, but to much less extent.

For accurate current regulation,
the sensing resistor should be a 0.5 -1.0 W precision resistor, i. e. less than 1% tolerance and low temperature - coefficient.

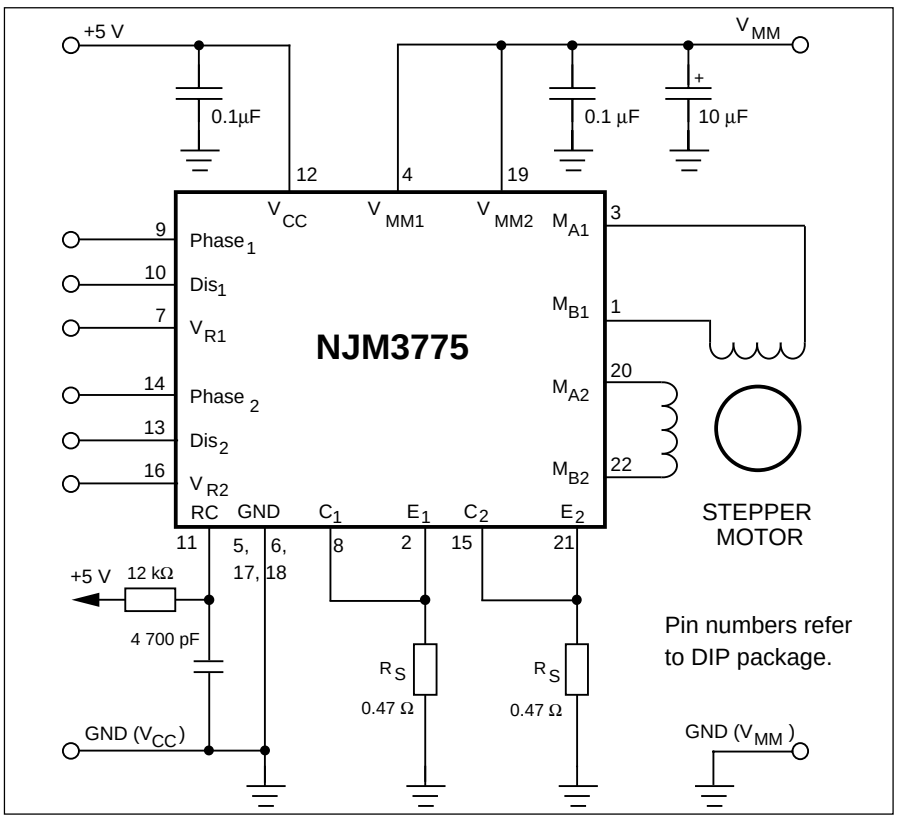


Figure 6. Typical stepper motor driver application with NJM3775.

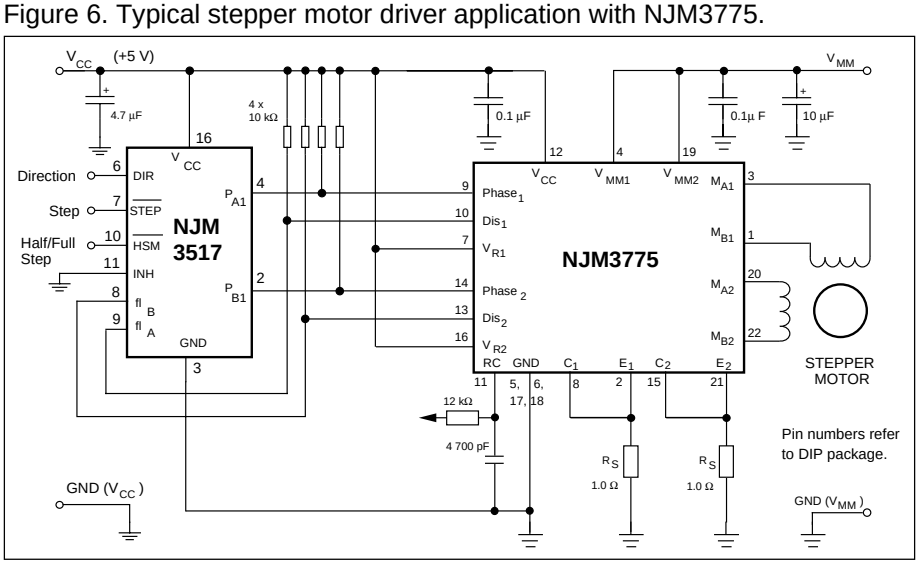


Figure 7. Half stepping system where NJM3517 is used as controller circuit in order to generate the necessary sequence to the NJM3775.