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NTE1885 Integrated Circuit Module, 4 Phase Stepping Motor Driver, 1.75A

Features:

- Low heat generation due to constant current chopper system.
- Functions of pause action and power down.
- Able to be used in any stepping motor of hybrid typ, P.M. type, V.R. type.
- Inverter buffer provides direct drive, for 4 phase dual excitation.
- Built in sensing power resistors for load current.
- Protection elements for fly-back voltage are included.

Absolute Maximum Ratings: ($T_A = +25^\circ\text{C}$ unless otherwise specified)

Supply Voltage, V_{CC} (Quiescent)	50V
Phase Peak Current, I_{OH}	2.1A
Operating Case Temperature, T_C	+105°C
Junction Temperature, T_j	+150°C
Storage Temperature Range, T_{stg}	-40° to +125°C

Recommended Operating Conditions: ($T_A = +25^\circ\text{C}$ Unless othrwise specified)

Supply Voltage Range, V_{CC1}	22V to 45V
Phase Peak Current, I_{OH}	1.5A

Operating Characteristics: ($T_A = +25^\circ\text{C}$, $V_{CC1} = 36\text{V}$, $V_{CC2} = 5\text{V}$ Unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Diode Forward Voltage	V_{df-1}	$I_f = 0.3\text{A}$	–	1.5	1.8	V
	V_{df-2}	$I_f = 0.5\text{A}$	–	1.2	1.6	V
Output Saturation Voltage	V_{sat-1}	$R_L = 12\Omega$, $V_{in} = \text{GND}$, $V_{CC1} = 22\text{V}$	–	1.2	1.6	V
	V_{sat-2}	$R_L = 21\Omega$, $V_{in} = \text{GND}$, $V_{CC1} = 36\text{V}$	–	2.3	3.0	V
Output Current	I_{O-1}		0.98	1.05	1.12	A
OSC Frequency	f		24 (Fixed OSC)			kHz
Thermal Resistance (Note 1)	θ_{j-c}	TR1, TR6	–	8.0	–	°C/W
		TR2, TR3, TR4, TR5	–	13.5	–	

Note 1. From Junction of each transistor or diode to substrate

Description of Operation:

Constant Current Chopper Drive

- a) When the phase drive input is activated, the motor winding current increases. At a predetermined current (the rated current of the motor), the applied voltage of the winding begins to be switched ON–OFF to maintain a constant current.

This is the constant–current chopper drive by PWM offering a higher efficiency (30% under a certain condition) than a constant–voltage drive, but causing relatively large noise due to the switching operation. The PWM method consists of self–excitation and separate excitation methods. For the separate excitation, an oscillator is required, as PWM is externally conducted. The self excitation method has a simpler circuit, not requiring an oscillator, but using the resistance and inductance of the motor winding instead.

- b) When a voltage several times larger than the rated voltage is applied to the motor, a change in the winding currents occurs. The time when the currents reach 63.2% of the rated current (I_O) shows a higher–speed response with regard to the rise of the winding current and acts as a time constant for the R–L series network with the rated applied voltage.
- c) Without a constant current circuit, over current will ramp up to a constant value, so that a constant–current chopper drive is needed. The chopping is conducted below the constant value, so that the winding resistance and the rated current must satisfy the following equation:

$$I_O < \frac{V_{CC} - V_{sat}}{R}$$

Where R : Winding resistance per a phase of the motor + R_{E1}
 V_{sat} : $V_{sat-1} + V_{sat-2}$

With an increase in winding inductance, the flyback energy is increased and, when transistors for each–phase drive are OFF, the power loss is increased. Considering b) and c), the following motor is recommended:

Motor specification (4–phase unipolar stepping motor)
Rated current: $1.0 \pm 0.5A$ /phase
Winding resistance: 10Ω /phase
Inductance: $1 \sim 10mH$ /phase

Chopper Operation (Note: TR's are internal transistors used for reference purposes; D's are internal protection diodes; and L's represent the motor windings)

The operation for a unipolar 2–phase excitation a of 4–phase stepping motor is described as:

When a High–Level input and a Low–Level input are applied to Pin5 (phase A) and Pin6 (phase A) respectively, TR2 is turned ON. Since one terminal of 1/2 IC1 (comparator) is at GND potential, the comparator output (point A becomes High), turning ON TR7. This also causes TR1 to be turned ON and the current in the winding increases as shown by the equation:

$$i = \frac{V_{CC} - V(sat)}{R} (1 - e^{-t/\tau})$$

Where τ : = L/R time constant
L: Winding inductance per phase
R: Winding resistance per phase plus emitter resistance, etc.

also V_{sat} : = $V_{sat-1} + V_{sat-2}$
 V_{sat1} : $V_{CE(sat)}$ of chopper transistors (TR1, 6)
 V_{sat2} : $V_{CE(sat)}$ of phase–drive transistors (TR2, 3, 4, 5) and V_d (Diodes, internal)

