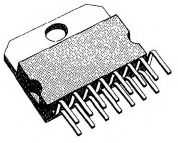
SGS-THOMSON
MICROELECTRONICS

UAB4718
UAF4718

STEPPER MOTOR DRIVE CIRCUIT

- HALF AND FULL STEP MODES
- BIPOLAR DRIVE OF STEPPER MOTOR FOR MAXIMUM MOTOR PERFORMANCE
- BUILT-IN PROTECTION DIODES
- WIDE RANGE OF CURRENT CONTROL : UP TO 1500 mA
- WIDE VOLTAGE RANGE : 10 TO 55 V
- DESIGNED FOR UNSTABILIZED MOTOR SUPPLY VOLTAGE
- CURRENT LEVELS CONTROLLED BY AN EXTERNAL VOLTAGE REFERENCE
- THERMAL OVERLOAD PROTECTION



MULTIWATT 15

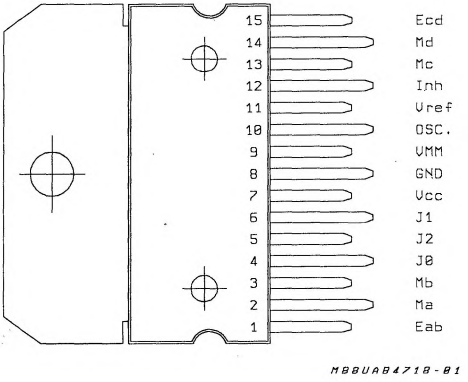
ORDER CODES :
UAB 4718SP (0 to 70 °C)
UAF 4718SP (– 40 to + 85 °C)

DESCRIPTION

The UAB/UAF 4718 provides direct interface between a logical unit and the two windings of a bipolar stepper motor.

It ensures switch-mode current regulation up to 1.5 A with 55 V supply voltage.

PIN CONNECTION



Pin Number	Name	Function	
1 2 3	Eab Ma Mb	Current Sensing Resistor Output Ma Output Mb	H-Bridge a-b
4 5 6	JO J2 J1	Decoder Inputs	Logic Inputs
7 8 9	V_{CC} GND V_{MM}	Logic Supply Voltage Ground Power Supply Voltage	Supply Voltages
10	Osc	Oscillator	
11	V_{ref}	Reference Voltage	
12	I_{nh}	Inhibition	Logic Input
13 14 15	Mc Md Ecd	Output Mc Output Md Current Sensing Resistor	H-Bridge c-d

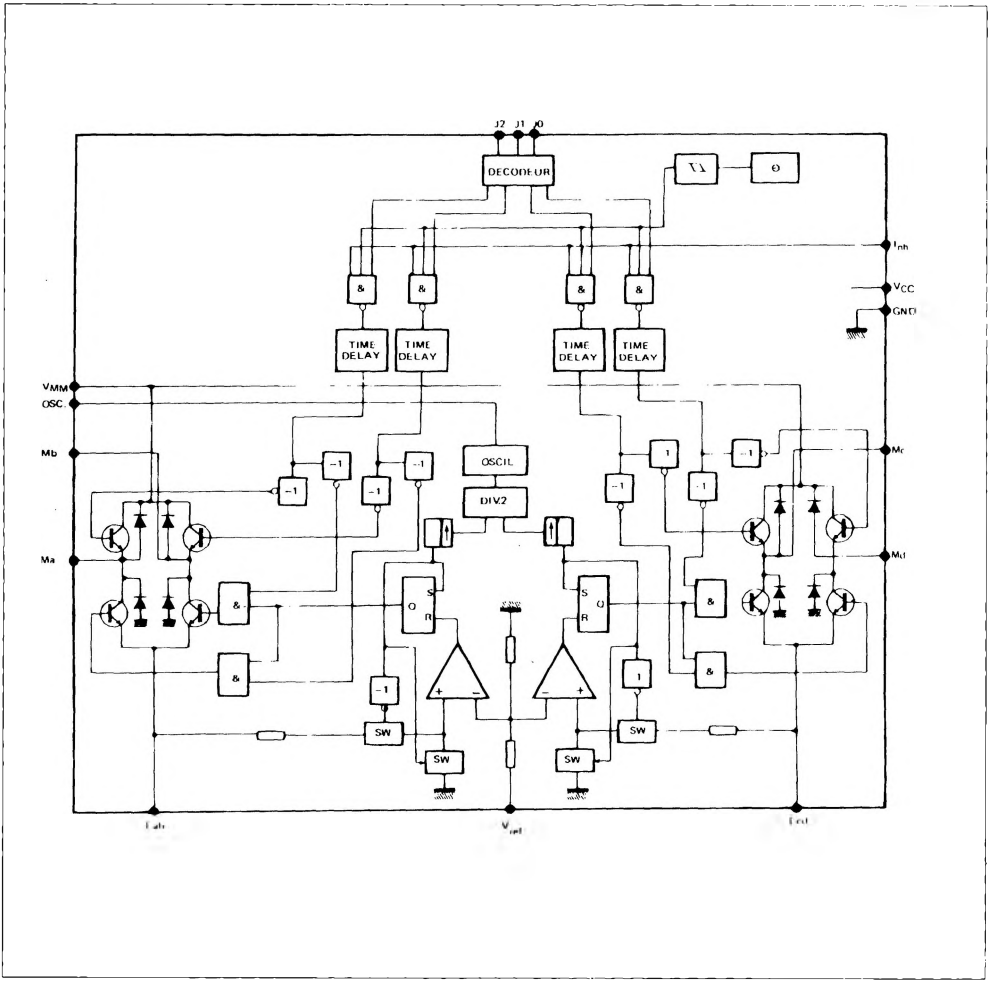
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Value	Unit
V_{CC} V_{MM}	Supply Voltage		10 60	V
V_{ref}	Reference Voltage		15	V
V_{IN}	Logic Input Voltage		– 0.3 to V_{CC} + 0.3	V
I_O	Output Current		± 1.5	A
T_j	Maximum Juction Temperature		+ 150	°C
T_{amb}	Operating Ambient Temperature Range	UAB4718 UAF4718	0 to + 70 – 40 to + 85	°C
T_{stg}	Storage Temperature Range		– 55 to 150	°C

THERMAL DATA

$R_{th\ (j\text{-}c)}$	Maximum Junction-case Thermal Resistance	Max	3	C/W
$R_{th\ (j\text{-}a)}$	Maximum Junction-ambient Thermal Resistance	Max	40	C/W

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS V_{CC} = 5 V ± 10 %, V_{MM} = 10 V to 55 V, T_j = – 40 °C to 125 °C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current		15		mA
$I_{mm\ off}$	Motor Supply Current (all drivers OFF)			100	µA
I_{off}	Output Leakage Current (V_{MM} = 60 V, I_{nh} = 0)			100	µA
V_{IH}	High Level Input Voltage. Logic Input	$2V_{CC}/3$			µA
V_{IL}	Low Level Input Voltage. Logic Input			$V_{CC}/3$	µA
I_{IH}	High Level Input Current. Logic Input (V_I = 3.5 V)			1	µA
I_{IL}	Low Level Input Current. Logic Input (V_I = 0.8 V)	– 1			µA
V_C^+	Comparator's Threshold Voltage (V_{ref} = 5 V)		500		mV
I_R	Reference Input Current (V_{ref} = 5 V)		0.2		mA
V_{sat}	Source Diode Transistor Pair (T_{amb} = 25 °C) Saturation Voltage I_M = 0.7 A I_M = 1.4 A		 1.1 1.6		 V V
V_F	Diode Forward Voltage I_F = 0.7 A I_F = 1.4 A		1.25 1.65		V V
I_{sub}	Substract Leakage Current I_F =1.4 A				mA
V_{sat}	Sink Diode Transistor Pair (T_{amb} = 25 °C) Saturation Voltage I_M = 0.7 A I_M = 1.4 A		 1.08 1.5		 V V
V_F	Diode Forward Voltage I_F = 0.7 A I_F = 2.4 A		1.55 2.1		V V
P	Total Power Dissipation (T_{amb} = 25 °C) (I_M = 0.7 A ; 2 phases On ; T = 16 µS ; V_{MM} = 34 V)		3.6		W
T	Switching Period (case = 1.8 nF)		39		µs
t_d	Turn-off Delay		0.9		µs
$T_{ON\ (min)}$			25		µs
T_j	Thermal Protection Operation		170		°C
ΔT_j	Hysteresis on Thermal Protection		30		°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC} V_{MM}	Supply Voltage	4.5 10	5 –	5.5 55	V
V_{ref}	Reference Voltage	0	–	10	V
I_O	Output Current				A
	No Heatsink One Phase On	–	–	0.7	
	Two Phase On	–	–	0.4	
	10 °C/W Heatsink One Phase On	–	–	1.5	
	Two Phase On	–	–	0.9	

FUNCTIONAL DESCRIPTION

The circuit is organised around two H-bridges. Each one has is switched current regulation, synchronized by a common oscillator.

LOGIC

The logic inputs J2, J1 and J0 define the different sequences of a hald or full step mode excitation of the modor.

Step	J2	J1
0	0	0
1	0	1
2	1	0
3	1	1

JO = 0 : Two phases-on drive

JO = 1 : One phase-on drive

FULL-STEP ROTATION

The reference voltage used for the current regulation varies from 0 to 10 V. Owe to its high impedance input, it can be driven by any DAC. For the simplest applications, it can be connected directly to V_{CC}.

Step	J2	J1	J0
0	0	0	0
5	0	0	1
1	0	1	0
1.5	0	1	1
2	1	0	0
2.5	1	0	1
3	1	1	0
3.5	1	1	1

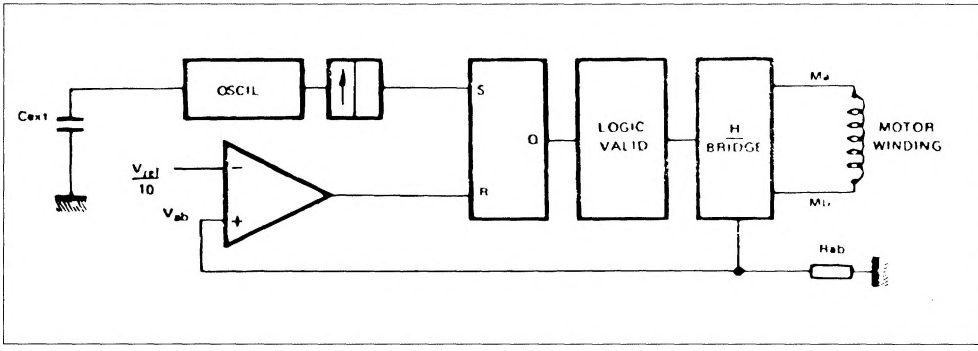
HALF-STEP ROTATION

These 3 Bits are decoded into 4 Bits (one per half H-bridge). An inhibition signal (INH) low activ and an integrated thermal protection can switch off the two output stages simultaneously.

The four logic inputs (INH, J2, J1 and J0) are CMOS compatible.

CURRENT REGULATION

Figure 1.

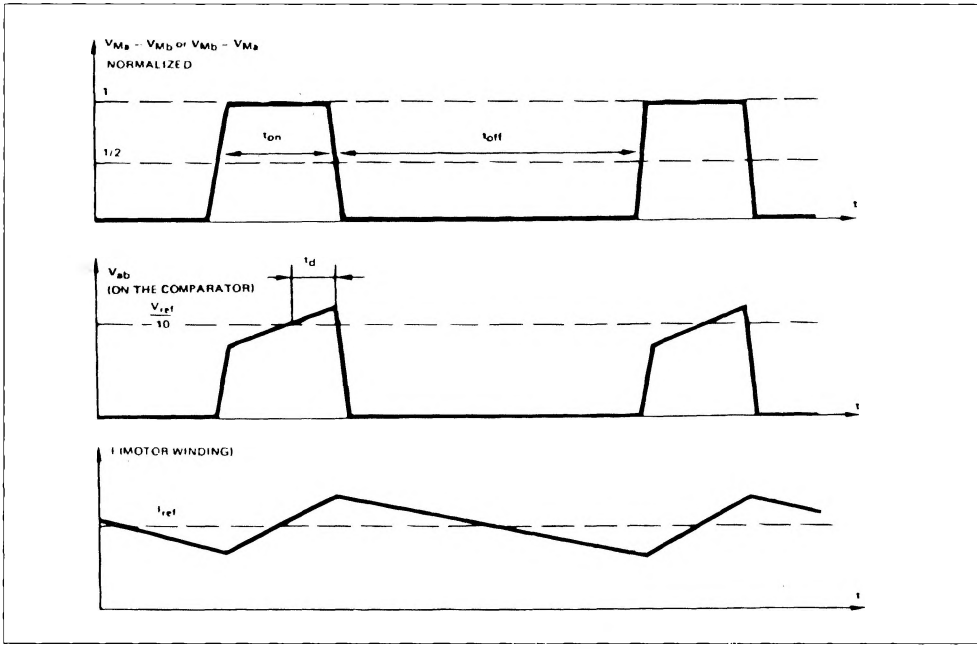


For each H-bridge, a comparator defines the current flowing in the winding by comparison between a reference voltage (defined by the external voltage Vref) and the voltage across the current sensing resistor Rab. The moto current flows through the sensing resistor Rab. When the current has increased so that the voltage across Rab becomes higher than the reference voltage, the comparator output goes high. This output, acting on the Reset input of the RS flip-flop turns of the H-bridge. Then after the next rising edge of the oscillator signal the current flows agains in the sensing resistor Rab.

$$Iout = \frac{V_{ref}}{10\ Rab}$$

WAVEFORMS

Figure 2.



t_d : delay time of comparator + logic + H-bridge,

t_{off} : delay time between ($V_{ab} < \frac{V_{ref}}{10}$) and the next rising edge of the oscillator.

$t_{on} + t_{off} = T$, T = oscillator period, $V'ref = \frac{Vref}{10}$

TIMING DIAGRAM

The oscillator frequency applied on S input is typically 60 KHz (with an external capacitor equal to 1 nF). This frequency can be adapted to the characteristics of the motor by a different value of Cext.

This switching frequency is $f\ (KHz) \# \frac{70}{C\ (nF)}$

THE COMPARATORS

The two comparators ar of PMOS type. The high input impedance of such a comparator allows the integration of an RC-filter which avoids errors on parasitic voltages.

To prevent current spikes from friggering the comparator when the sink stage is switched on, a MOS switch short-circuits the comparator input to ground during these current spikes.

OUTPUT STAGES

The two H-bridges are identical. Each output stage contains four Darlington transistor and four diodes, connected in an H-bridge. The two sinking transistors are used to switch the power supplied to the motor winding, thus driving a constant current through the winding.

It should be noted, however, that it is not permitted to short-circuit the outputs.

OPERATION OF ONE H-BRIDGE

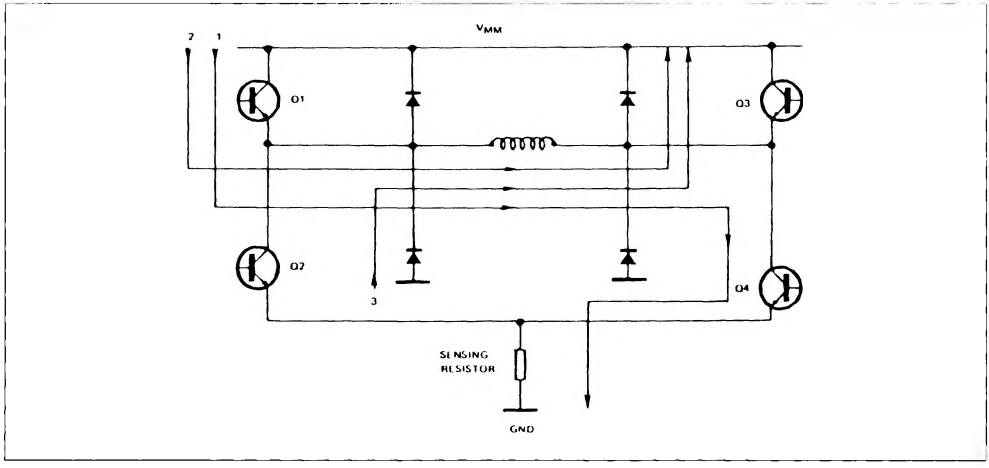
To energize the motor winding, the current flows from the power supply Vmm to the ground through the source transistor, the motor winding and the sink transistor (arrow n. 1) until the voltage drop in the current sensing resistor exceeds the reference voltage of the comparator. Then the RS flip-flop is reset and its output turns off the sink transistor. The current flows through the source transistor, the motor winding and the free wheeling diode (arrow n. 2).

Then, the rising edge of the oscillator signal sets the RS flip-flop and turns on the sink transistor.

To reverse the current in the winding, a fast current decay solution is used (arrow n. 3).

When the output stage is switched off by the inhinition input or by the thermal protection, the fast current decay solution is used too.

Figure 3



LOGIC INPUTS

There are four logic inputs

. J_2, J_1, J_0 select the current direction in the bridges

. Inh disables both bridges.

Table 1: Logic Inputs Operation.

Inh	J2	J1	J0	Bridge ab	Bridge cd
0	X	X	X	0	0
1	0	0	0	I	-I
1	0	0	1	I	0
1	0	1	0	I	I
1	0	1	1	0	I
1	1	0	0	-I	I
1	1	0	0	-I	0
1	1	1	1	-I	-I
1	1	1	0	0	-I

X : Irrelevant
I : Current from Ma to Mb
or from Mc to Md
I : Current from Mb to Ma
or from Md to Mc.

THERMAL OVERLOAD PROTECTION

If internal dissipation becomes too high (typically Tj > 170 °C), the two output stages are disabled. After a decrease of the junction temperature (typically 30 °C), the outputs are again enabled.

TYPICAL APPLICATION

EXAMPLE OF APPLICATION

A complete application can be built with only one UA.4718 and three external components (2 resistors and 1 capacitor). On the figure below, I_O A per output, the switching frequency is 35 KHz.

Figure 4.