NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

UNIVERSAL MOTOR CONTROL

Graduation Project
EE – 400

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First I want to thank to my advisor Özgür Cemal Özerdem. Under his guidance , I successfull overcome many difficulties and learn a lot about Universal Motor Control. In each discussion , he explained my question patiently , and I felt my quick progress from his advise . He always helps me a lot either in my study or my life , I asked him many questions in Electronics he always answered my quesiton quickly and in detail.

Finally , I want to thank my family especially my parents , Without their endless support and love for me , I would never achieve my current position , I wish my mother lives happlit always , and my father in the heaven be proud of me.

ABSTRACT

This document gives all the information needed to operate the Evaluation Board (how to connect it, how it works). In order to modify specific information and parameters at design level, please refer to the three following Application Notes:

- How to Reduce 3rd Harmonics with ST6200C Motor Control Software
- ST6200 Universal Motor Drive Software
- Low-Cost Power Supply for Home Appliances

INTRODUCTION

The UMC01EVAL Evaluation Board is designed for a very low-cost phase control system based on the 8-bit ST62T00C microcontroller. It can be used to control a universal motor powered by a 230 V / 50 Hz mains supply. This type of motor is widely used in home appliances such as: vacuum cleaners, washing machines, power tools and kitchen appliances. In addition to performing a phase angle control algorithm, the board offers many features such as soft start control and 3rd harmonics reduction.

Universal motors produce a strong 3rd harmonic current. When the TRIAC conduction is not in full-wave mode, the actual motor current contains high amplitude 3rd harmonics which may not comply with the 3rd harmonics limits of Standard IEC61000-3-2. The UMC01EVAL Evaluation Board introduces an innovative cost-saving solution for reducing 3rd harmonics.

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1. CLASSIFICATIONS CONTROL SYSTEMS

1.1 Block Diagram

Figure 1 shows the block diagram of the UMC01EVAL Evaluation Board.

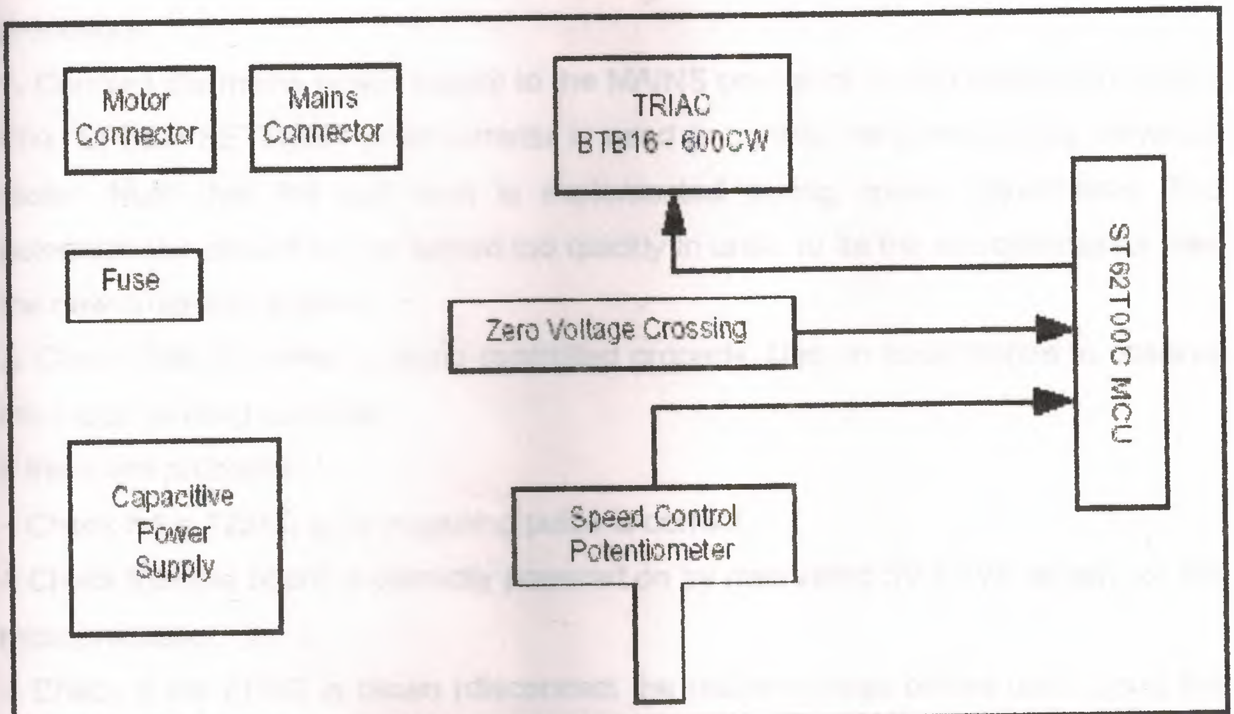


Figure 1 . Universal Motor Control Evaluation Board Block Diagram

1.2 List Of Contents

The following items are supplied in the package:

– One Universal Motor Control Evaluation Board (ref.: UMC01EVAL) (including the ST62T00C MCU programmed with the software described in Application Note AN1449)

– A small Sintech Universal Motor (100 W)

– RC Oscillator Phase Angle Control Software programmed in the ST62T00C microcontroller

– 3rd Harmonics Reduction Software for 1.5 kW vacuum cleaner application– A User Manual (this document)

1.3 Getting Started

By following this step-by-step procedure, you can use the UMC01EVAL Evaluation Board to first run the provided Sintech universal motor. Later, you can use the board to run your own AC universal motor. To operate the board correctly, use the following procedure:

1. Connect the mains power supply to the MAINS connector on the Evaluation Board. The "SPEED SETTING" potentiometer is used to control the speed of the universal motor. Note that the soft start is implemented during speed adjustments. The potentiometer should not be turned too quickly in order to let the microprocessor take the new order into account.

2. Check that the motor is being controlled properly. Use an oscilloscope to observe the motor winding currents.

If there are problems:

– Check if the TRIAC gate triggering pulse is correct.

– Check that the board is correctly powered on by measuring 5V power supply for the microprocessor.

– Check if the FUSE is blown (disconnect the mains voltage before unplugging the fuse).

– Reset the MCU by unplugging the mains voltage and waiting for VDD to drop below 0.7V. Then apply the mains voltage and try again to see if the board works.

3. Running with the provided SINTECH Universal Motor in Open Loop Mode When using the provided SINTECH universal motor in open loop mode, the motor speed is changed by using the phase angle control through a TRIAC. Check that the programmed triggering pulse of the TRIAC gates is compatible with the motor to be controlled (see Section 3.2). When your motor is runing in open loop mode, the shunt resistor R1 is not necessary and must be replaced by a jumper.

In low cost sensorless speed regulation mode, resistor R1 is used to measure the peak motor current. To run the motor in close loop mode, please refer to the following application note:

– AN416: Sensorless Motor Drive with the ST62 MCU + TRIAC The ST6200C MCU can detect the voltage zero crossing, after which it can calculate the phase angle, make the triggering pulse delay and trigger the TRIAC.

Before changing the motor control parameters, please refer to Application Note AN1449.

4. Running with your own Standard Universal Motor in Open Loop Mode When using your own universal motor in open loop mode, your motor parameters should be checked, i.e. the phase lag between motor current and input voltage. The triggering pulse width should be checked as well.

5. 3rd Harmonics Reduction Software

When using 3rd harmonics reduction software with a 1500 W vacuum cleaner, replace shunt resistor R1 with a jumper before starting the motor.

6. If you changed the software in the above steps, don't forget to program the Option Byte setting as follows in you MCU:

D1 = 1 (Hardware Watchdog Activation)

D6 = 1 (RC network oscillator selection)

D8 = 1 (LVD reset activation)

2 . FUNCTIONAL DESCRIPTION

2.1 Performance

The UMC01EVAL board is designed to meet the following requirements:

Low cost: Capacitive or resistive power supply is used to reduce the system cost as well as the size. Simple voltage zero crossing detection circuit is provided via a current limiting resistor. A crystal oscillator or external resonator are not used. External RESET circuitry is NOT required.

IEC61000-3-2 Standards: Using the dedicated software (vacuum.st6 file), the board complies with the 3rd harmonics limits specified in standard IEC61000 Generic: This board may also used in a wide variety of applications: i.e. light dimmer, power control, universal motor control and thermostat control.

2 . 2 Main Features

2 . 2 . 1 Phase Angle Control

The speed can be set using the potentiometer mounted on the board. To generate the correct phase angle, the voltage zero crossing signal must be detected. On this board, we use two current limiting resistors to perform voltage zero crossing. The voltage at this port is clamped to 0V and +5V by internal clamping diodes. The microprocessor is able to calculate the phase angle and trigger the TRIAC. It will adjust the voltage applied to the motor.

2 . 2 . 2 Soft Start

When you start the motor, the motor speed and the Back-EMF are initially set to zero. The mains voltage is applied directly to the motor winding. Since the resistance of the motor winding is very small, it will generate very high inrush current which is 10 to 15 times the nominal current. Using soft start software, the voltage applied to the motor winding ramps up step by step. Therefore, the inrush current at start up will be reduced accordingly. You can modify the ramping up steps and slope by using the software.

2 . 2 . 3 3rd Harmonic Limitations

At reduced speeds, universal motors produce very high levels of 3rd harmonics in phase angle mode. The strongest 3rd harmonics are produced when the conduction angle is approximately 90 degrees (refer to Table 1).

Table 1. 1500W Vacuum Cleaner Harmonic Currents
(measured at a fixed load using the symmetrical phase angle control method)

Power	Delay Time	Harmonic Order & Harmonic Currents (A)			
P (W)	t (ms)	3	5	7	9
250	6.9	1.918	0.92	0.275	0.2
320	6.5	2.122	0.931	0.322	0.213
535	5.75	2.474	0.92	0.453	0.175
590	5.55	2.513	0.923	0.478	0.156
780	5.0	2.601	0.883	0.502	0.127
900	4.5	2.576	0.859	0.44	0.162
1000	4.2	2.515	0.834	0.357	0.196
1050	4.0	2.448	0.82	0.306	0.194
1090	3.75	2.406	0.806	0.27	0.188
1130	3.6	2.331	0.793	0.232	0.182
1200	3.5	2.193	0.743	0.188	0.142
1300	3.0	1.892	0.612	0.196	0.06
1400	2.25	1.386	0.33	0.2	0.116
1450	1.6	1.11	0.138	0.13	0.111
1480	0.3	0.77	0.107	0.022	0.01
Harmonic Current Limit (A)		2.30	1.14	0.77	0.4

Table 2. 1500W Vacuum Cleaner Harmonic Currents
(measured at a fixed load using the asymmetrical phase angle control method)

Power	Delay Time		Harmonic Order & Harmonic Currents (A)			
P (Watt)	t_1 (ms)	t_2 (ms)	3	5	7	9
535W	6.90	5.48	2.22	0.634	0.281	0.041
580W	6.90	5.13	2.170	0.532	0.280	0.072
700W	6.85	4.74	2.115	0.451	0.251	0.157
780W	6.85	4.36	1.974	0.437	0.241	0.185
940W	6.13	3.75	1.799	0.371	0.182	0.174
1000W	6.04	3.37	1.595	0.364	0.219	0.105
1050W	6.08	2.91	1.362	0.389	0.234	0.049
1100W	5.19	2.90	1.658	0.204	0.245	0.084
1150W	5.20	2.47	1.349	0.121	0.293	0.052
Harmonic Current Limit (A)			**2.30**	**1.14**	**0.77**	**0.4**

In order to suppress 3rd harmonic current in the power line, an innovative, cost-saving solution is used. This control method is based on the modulation of the phase angle delay times and is easily implemented using the ST62T00C microcontroller software. The test results shown in Table 2 prove the efficiency of this solution.

In Table 1, the figures in bold exceed harmonic current limit specifications.

2 . 3 Hardware Features

2 . 3 . 1 ST62T00C Microcontroller

The MCU used in the UMC01EVAL board is the ST62T00C. This is a basic ST6 microcontroller that embeds a large number of features at minimum cost. The peripheral hardware requirements have been reduced to the minimum:

n A crystal oscillator or external resonator is not used. Indeed, the internal resonator of the ST62T00C is used to generate the clock.

External RESET circuitry is not required due to the internal circuit of the ST62T00C.

When programming the MCU EPROM, you have to set the following three options:

D1: Hardware Watchdog Activation (as it is not software enabled)

D6: RC network oscillator selection

D8: Low Voltage Detection option (in order to reset the MCU when the board is plugged to the mains supply). The ST62T00C memory program space is 1024 bytes. The size of the implemented software is 618 bytes. In order to test longer programs, ST62X01C (with 2K bytes of program memory) can also be installed instead of the ST62X00C in the DIL16 socket.

2 . 3 . 2 Capacitive Power Supply

In order to reduce the board price as much as possible, a capacitive power supply is used instead of a transformer-based supply. This supply can only source an average current lower than 10 mA. For higher currents, capacitor C1 (cf. Annex 1) can be replaced with one having a higher value. A special characteristic of this power supply is that it is a "negative" supply where the Vdd terminal is linked to Neutral. That means that the Vss voltage is 5V below the Neutral value. The TRIAC can be triggered by a negative current (i.e. sourced from the gate).

For more information, please refer to the following application note:

n AN1476: Low Cost Power Supply for Home Appliances

2 . 3 . 3 TRIAC Drive

A BTB16-600CW device is used on the UMC01EVAL Evaluation Board. It is the most economical AC power switch for operating directly on the 110V/230V mains. It is directly driven by the MCU. The triggering pulse is short in order to minimize the power supply size. The Snubberless TRIAC is driven in quadrants QII and QIII using 60 mA gate current provided by three parallel I/O ports of the ST6200C. This pulse is long enough to ensure that the TRIAC is latched at the end of the pulse. Pulse length can be modified by software if another TRIAC or motor is used. The BTB16-600CW is a Snubberless TRIAC. It is used to turn off inductive loads without requiring a snubber circuit, therefore saving the cost and space of extra components. It is able to drive a 1600 W vacuum cleaner connected to a 230V mains supply. Table 3 sums up the characteristics of TRIAC and MCU performances with various sensitivities. It also gives the gate current we suggest to control correctly the TRIAC for a minimum ambient temperature of 0°C, with the power supply implemented on our board.

Table 3. TRIAC and MCU Sensitivity Characteristics

MCU Output Capability	TRIAC Type	Sensitivity (Igt)	Suggested Gate Current	Connection
ST622X ST621X ST620X I_{OL} = 20 mA	T & TW Series	I_{GT} = 5 mA	I_G = 10 mA	1 I/O Port
	S & SW Series	I_{GT} = 10 mA	I_G = 20 mA	1 I/O Port
	C Series	I_{GT} = 25 mA	I_G = 40 mA	2 I/O Ports in Parallel
	CW Series	I_{GT} = 35 mA	I_G = 60 mA	3 I/O Ports in Parallel
	B & BW Series	I_{GT} = 50 mA	I_G = 80 mA	4 I/O Ports in Parallel

3 . USING THE UMC01EVAL EVALUATION BOARD

3 . 1 Symmetrical Phase Angle Control Pulse

Figure 2 shows how the gate current pulses are defined for a universal motor. The calculation of phase angle time is explained in Application Note AN1449. Since the universal motor is an induction motor running on an inductive load, there is the risk of misfiring the TRIAC for one or several half cycles if a different power factor is applied. So you should check that the programmed angle is compatible with your own motor. If not, please refer to AN1449 for instruction on how to change these values.

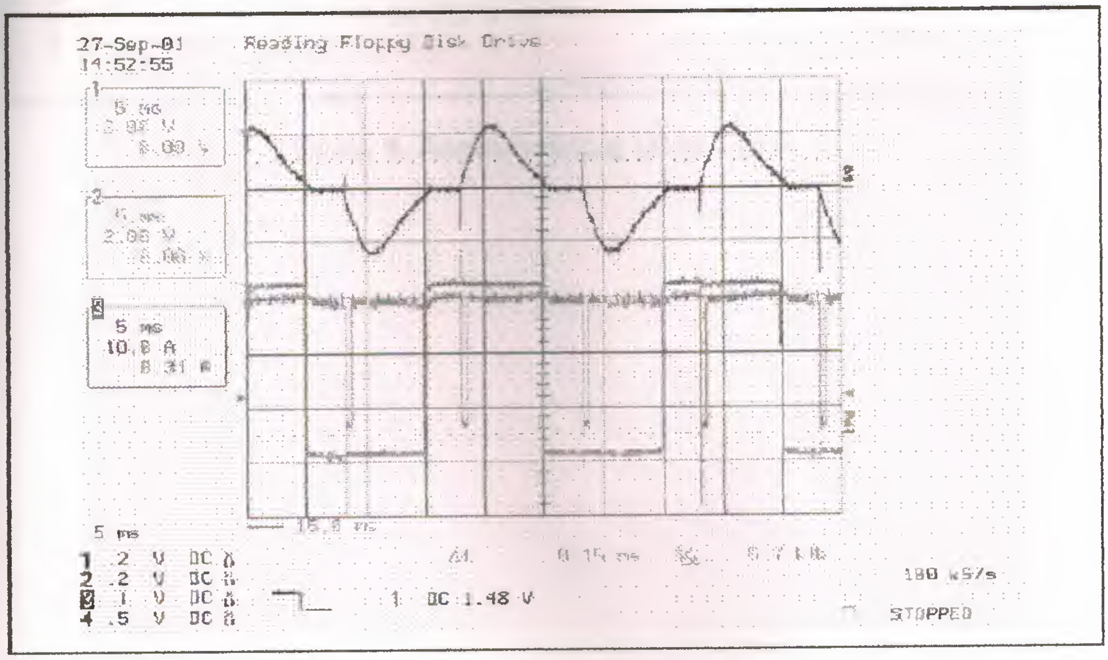


Figure 2. Gate Current Pulse

3 . 2 Asymmetrical Gate Pulse

Figure 3 shows how the gate pulses are generated in asymmetrical control mode. In this mode, the phase angle is specifically modulated in order to suppress 3rd harmonic current in the power line.

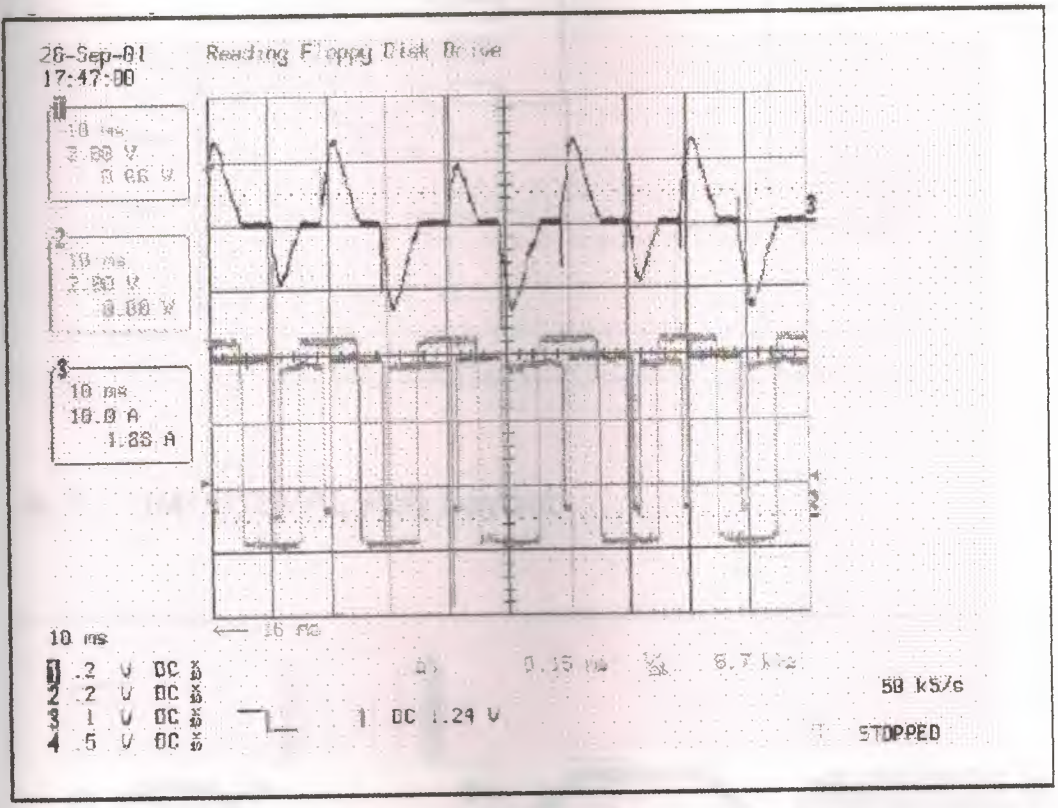
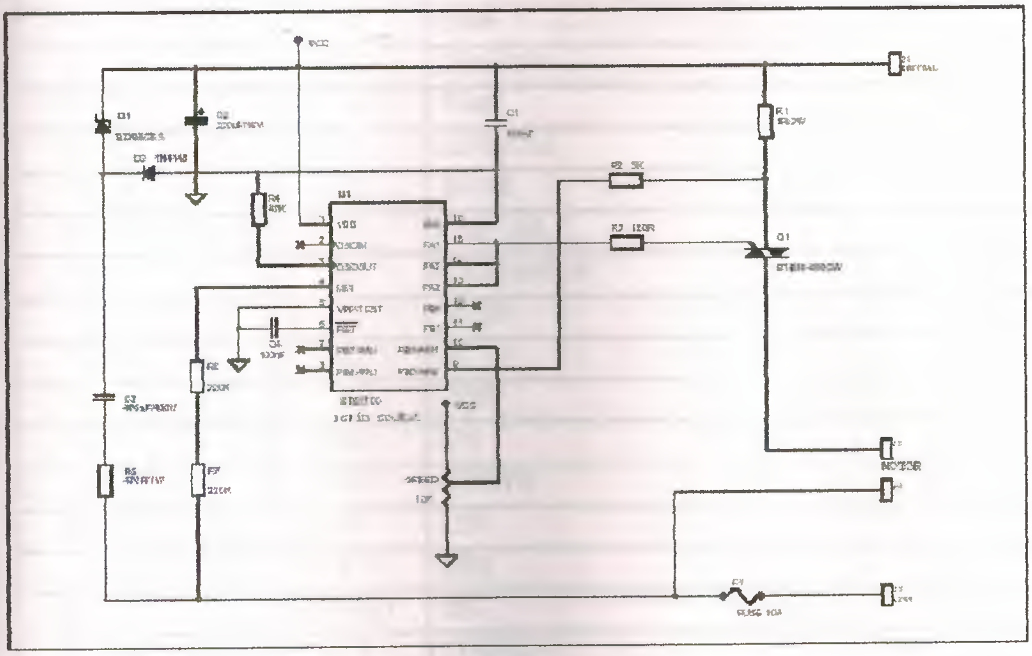
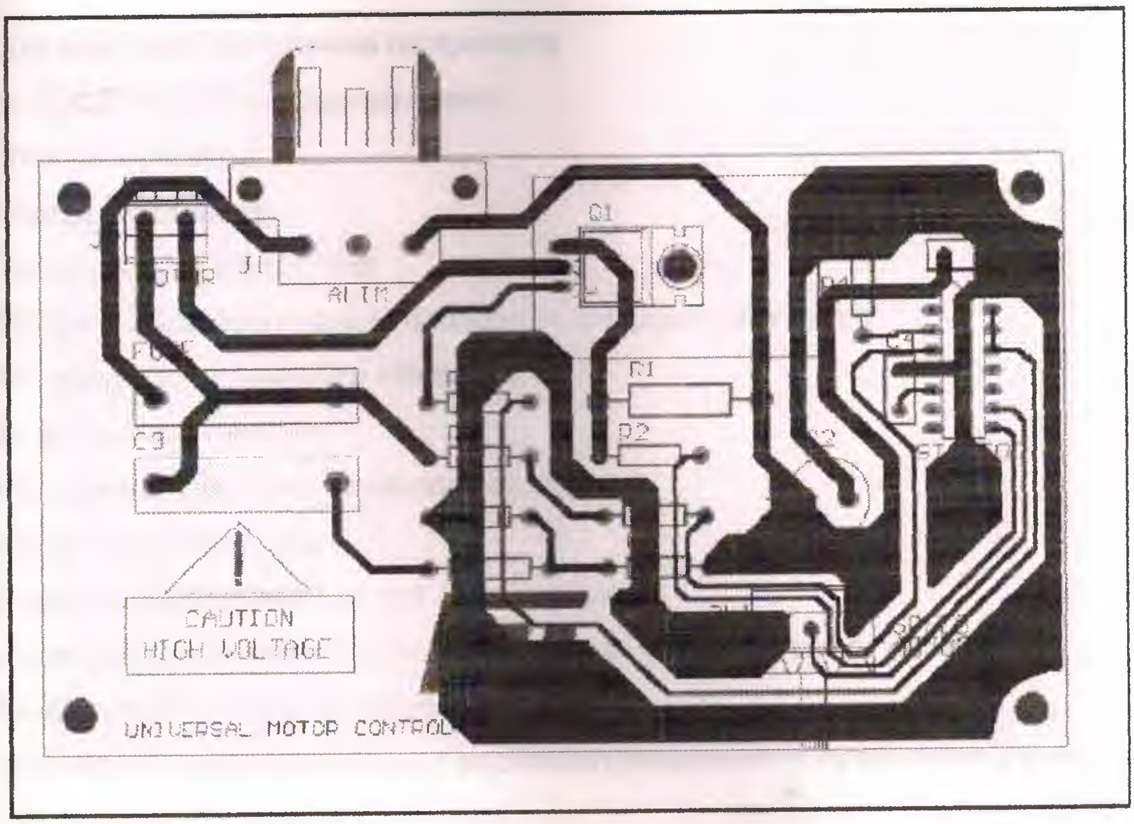


Figure 3. Asymmetrical Gate Pulse

4 - UMC01EVAL SCHEMATIC DIAGRAM



4 .1 . UMC01EVAL Pcb Layout



4 . 2 . Bill Of Materials

Item	Quantity	Reference	Reference
1	1	C1	100nF
2	1	C2	220uF/16V
3	1	C4	100nF
4	1	D1	BZX85C5.6
5	1	D2	1N4148
6	1	F1	FUSE 10A
7	1	Q1	BTB16-600CW
8	1	R1	1R/2W
9	1	R2	3K
10	1	R3	150R
11	1	R4	47K
12	1	R5	470R/1W
13	2	R6	220K
		R7	220K
14	1	SPEED	10K
15	1	U1	ST62T00

4 . 3 . Speed Regulator For Universal Motors Features& Benefits

Low cost - minimal external components

In PDIL8, PSOP8 or Chip-on-board

50/60Hz operation

Robust digital design:

Offering stable triac control

Eliminating variations due to changes in analogue parameters

No aging and temperature influences

True PI speed regulator

No external calibration or adjustment required

Low power consumption

Suited for driving resistive and inductive loads

Pulse input to measure the motor speed with a low cost coil or a hall sensor

Motor current sensing for power limitation

Adaptable to specific motor and application requirements by mask programming

4 . 4 . Applications

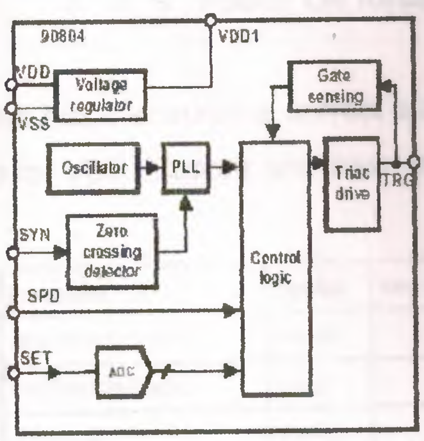
Universal motor control applications that require true speed regulation, such as used in blenders, mixers, kitchen appliances, drills, etc

4 . 4 . 1 . Description

The MLX90804 is a power control IC for controlling the speed of AC motors by means of a triac. The speed setting is done by applying a ratiometric voltage at pin SET (usually by means of a potentiometer). This speed setting is compared with the pulse rate at the SPD input. The input is compatible with inductive and magnetic detectors. The calculation of the required phase angle is done with a PI regulator, which is fully digital.

A soft start function is implemented to eliminate high current peaks at startup. Also available are an overload and overspeed protection. The build in Frequency Locked Loop compensates for variations in the mains frequency giving a stable frequency independent trigger control. Several parameters can be adjusted by mask programming: minimum and maximum speed, soft start delay, gain settings of the PI regulator, ...

4 . 4 . 2 . Functional Diagram



4 . 4 . 3 . MLX90804 Electrical Specifications

DC Operating Parameters TA = 0oC to 85oC

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Ambient temperature	Tamb		0		85	°C
Maximum chip temperature	Tch				150	°C
Thermal resistance	Rth	PDIP8 package		110		°C/W
Maximum allowed source supply current	IDD4m	Drivers off, all the current flows in the chip			10	mA

4 . 4 . 4 . Power Supply

The 90804 supply pin (VDD1) must be connected by external series resistors and a rectifier diode to the AC line. An internal zener function limits the voltage at VDD1 to approximately 16V. For proper operation a decoupling capacitor must be connected between VDD1 and VSS.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Voltage applied at the supply pin	VDD1	IDD1 = 5mA	14	16	18	V
Internal 5V supply	VDD		4.6	5.0	5.4	V
Current consumption	IDD1	VDD1 = 14V		0.7		mA
For external circuitry	VEXT	IEXT = 8mA	4.5	5		V

4 . 4 . 5 . Power On Reset

This block ensures a correct start of the digital part. The reset signal (DPORB) goes up for VDD>Vdporh and down for VDD<Vdporl.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
High level threshold	Vdporh			2.5		V
Low level threshold	Vdporl			2.0		V
Hysteresis	Vdphyst			0.5		V

4 . 4 . 6 . Analog Power-On Reset

This block tracks the voltage applied at VDD1. The triac firing is permitted if VDD1 > Vaporh and is stopped when VDD1<Vaporl.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
High level threshold	Vaporh			13		V
Low level threshold	Vaporl			10		V
Hysteresis	Vaphyst		2	3	4	V

4 . 4 . 7. Zero Crossing Detector

This detector contains two comparators with hysteresis. The first comparator has reference at VDD1. The reference of the second one is VDD1-1V. Both outputs ZC1 and ZC2 are HIGH during positive half wave of the mains and LOW during negative half wave of the mains.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
High level threshold 1	Vzc1h	Referenced to VDD1		0.5		V
Low level threshold 1	Vzc1l	Referenced to VDD1		-0.5		V
High level threshold 2	Vzc2h	Referenced to VDD1		-1.5		V
Low level threshold 2	Vzc2l	Referenced to VDD1		-2.5		V

4 . 4 . 8 . Speed Measurement

The chip has an input SPD to measure the motor speed. It is possible to connect a low cost inductor (between SPD and VSS) or a hall sensor with digital output. . The type of sensor can be defined by mask option. In case of the use of a coil the input levels are defined in the table below. In case of the use of a hall sensor, the levels are cmos compatible.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
High comparator level	SPDHI			80		mV
Low comparator level	SPDLO			-80		mV

4 . 4 . 9. Ignition Driver

This driver operates as a current generator to fire the triac.

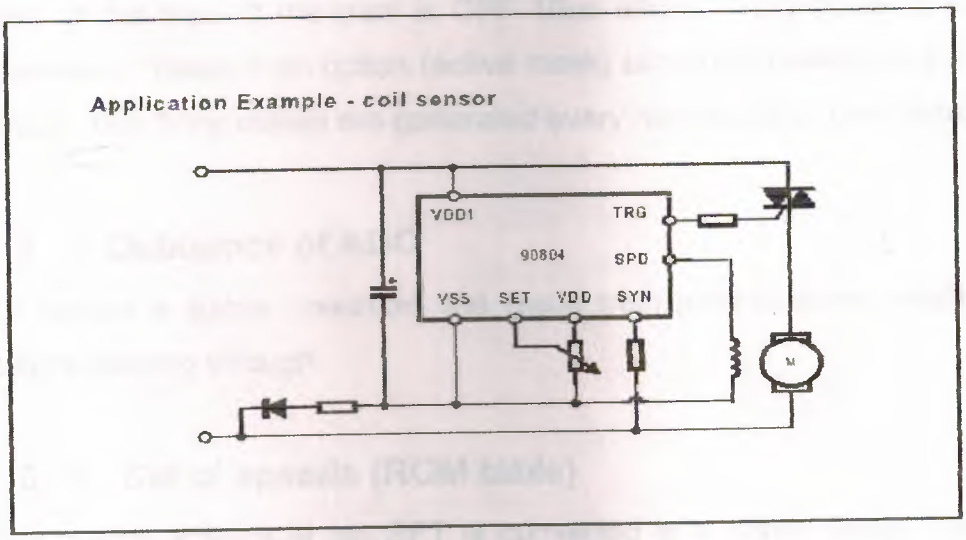
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Triac gate current	ITRG	VDD1 > Vaporh	30	60	90	mA

4 . 4 . 10 . Adc

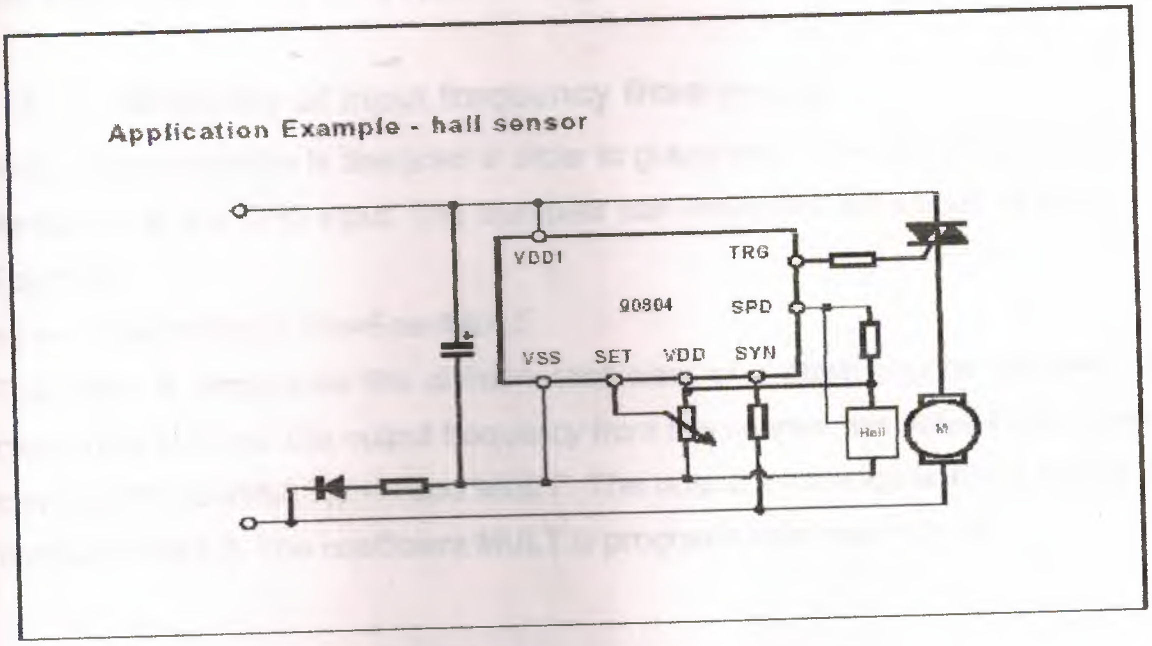
This is a 4-bit ADC.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Resolution				4		bits
Reference voltage	Vref			VDD		

4 . 4 . 11 – Example – Coil Sensor



4 . 4 . 11 – Example Hall Sensor



5 . DIGITAL FEATURES IGNITION DETECTOR

This block tracks if the triac is ON after each firing pulse. It senses the voltage at the gate of the triac. If the triac is OFF 10us after a firing pulse, a new pulse will be generated. There is an option (active mask) allowing to eliminate the ignition detector circuit. Two firing pulses are generated every half period to fire the triac, instead.

5 . 1 Debounce of ADC

To assure a stable operation, the result from potentiometer reading is debounced before passing through.

5 . 2 . Set of speeds (ROM table)

The analog voltage at pin SET is converted to a digital value. This digital value is addressing a value in the ROM table. This value defines the required speed and has a resolution of 10 bits. The definition of the speed settings is totally free: it does not need to be linear, nor continuously, and different ROM adresses can have the same speed. An example can be found in the table: this is an application where the SET input voltage is defined with a rotating knob which has only 6 positions. Switch position 1 corresponds to a very low speed (1700 rpm) and covers position 0 to 3 of the AD converter. Switch position 2, corresponding to ADC position 4 and 5 has zero speed. For switch position 3 to 6 the speed setting is increasing.

5 . 3 . Multiplier of input frequency from sensor

A frequency multiplier is designed in order to guarantee accurate measuring of the low frequency at the SPD input. The multiplier has measured the period of Fspd =>N = Tspd*Fm;

where Tspd =1/Fspd; Fm=Fosc/MULT.

The value N determines the division coefficient of a down counter (divider), which clock input is Fosc. The output frequency from this counter has value Fout = Fosc/N = osc/(Tspd*(Fosc/MULT)) = Fspd*MULT. The output frequency is Fspd multiplied by coefficient MULT. The coefficient MULT is programmable from 1 to 256.

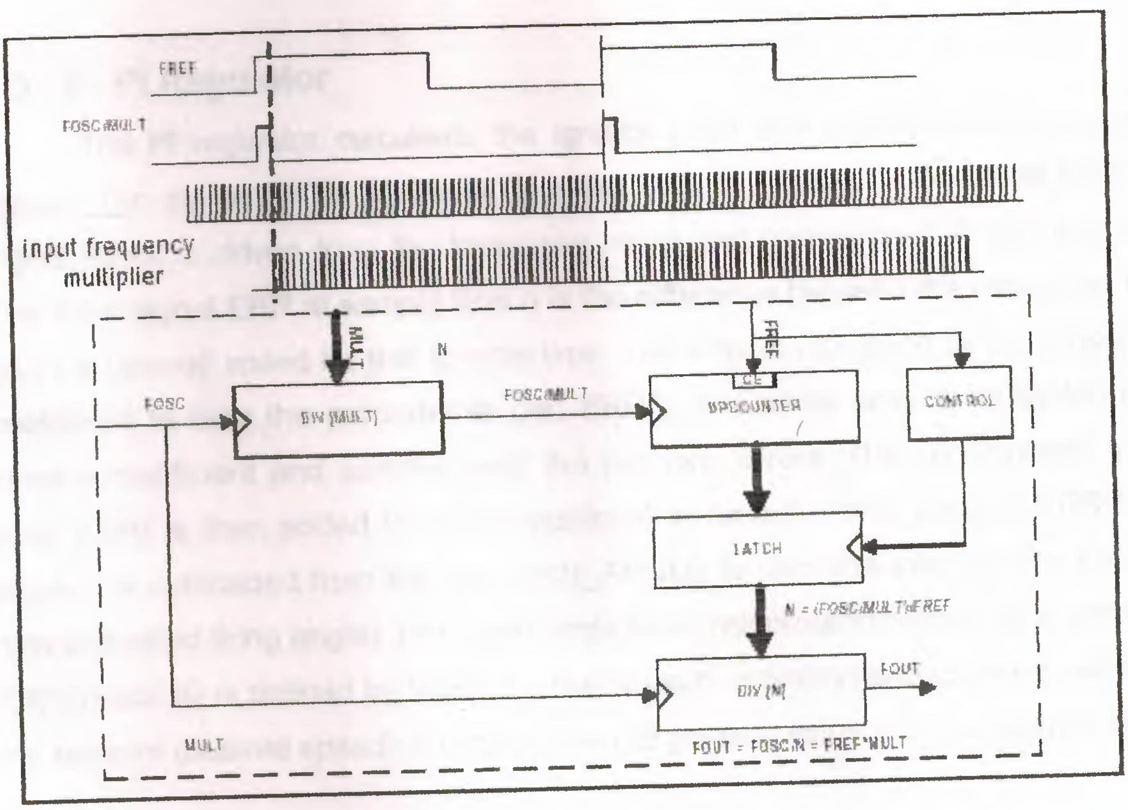
5 . 4 . Frequency meter

The frequency meter is implemented as a simple counter .This counter is cleared at the beginning of every mains period (20ms) .During the mains period the output frequency from the frequency multiplier (Fout = Fref*Mult) is applied at the clock input of this counter. At the end of the mains period the value of the counter is stored in a latch. This stored value is p ro por t i on a l to Fspd and equals Tmains*Fspd*MULT. The frequency can be measured during a full or during half a period of the mains. If option FP = 1 the frequency is measured over a full mains period. If option FP = 0 the frequency is measured for a half mains period.

5 . 5 . Soft Start

The soft start is initiated after a proper power on reset sequence. The startup sequence can be influenced by several options. The initial phase angle applied to the triac is defined as (MIN[9:0] - LD[9:0]), where MIN[9:0] is the minimum allowed firing angle, and LD[9:0] is the value initially stored in the integrator. The phase angle remains unchanged for a duration defined by the startup time SFT[1:0]. After that time the PI regulator is enabled with a Kp factor defined by PX[3:1]. As long as the measured speed is smaller then the start speed (defined by SPE[1:0]), the error signal at the input of the PI regulator is kept at zero. If PX[3] = 0, the Kp factor is fixed all the time. If PX[3] = 1, the Kp factor changes at the moment the measured speed gets higher than

SWITCH position	POT settings	SPEED [rpm]
1	0	1700
	1	1700
	2	1700
	3	1700
2	4	0
	5	0
3	6	2000
	7	2000
4	8	3500
	9	3500
5	10	7200
	11	7200
6	12	12200
	13	12200
	14	12200
	15	12200



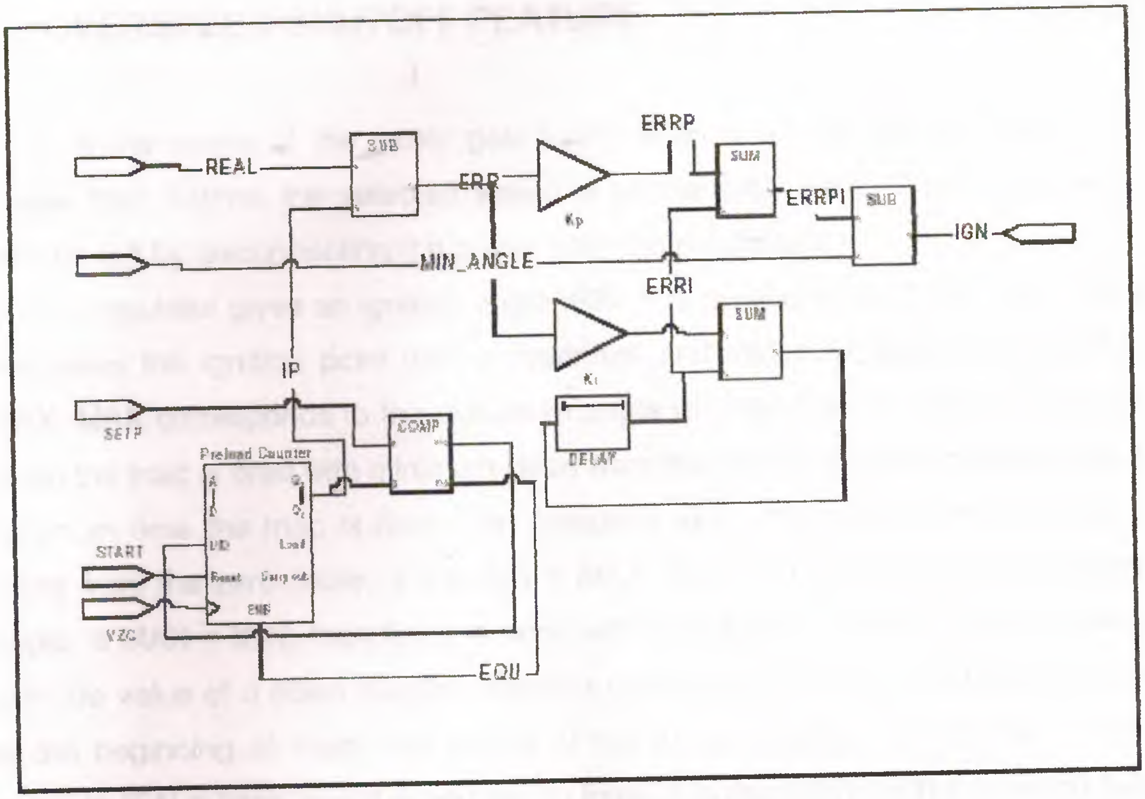
PX3	PX2	PX1	Kp
0	0	0	8
0	0	1	4
0	1	0	2
0	1	1	1
1	0	0	1 -> 4
1	0	1	2 -> 4
1	1	0	1 -> 2
1	1	1	4 -> 8

SFT1	SFT0	Duration in half periods
0	0	0
0	1	7
1	0	15
1	1	31

the start speed, which is defined by SPE[1:0]. At the same moment the SETP integrator (see PI regulator) is enabled and preloaded with the value of the measured speed.

5 . 6 . Pi Regulator

The PI regulator calculates the ignition point that corresponds to a selected speed. The signal SETP is driven from the sets of speeds in the ROM table. The signal REAL is driven from the frequency meter and corresponds to the real speed. The error signal ERR at sample time n is the difference between the measured speed and the desired speed for this sample time. The error is multiplied by the proportional coefficient to form the proportional part ERRP. The same error is multiplied by the integral coefficient and summed with the previous errors. The accumulated integral error ERRI is then added to the proportional to form the final product ERRPI. This product is subtracted from the fixed MIN_ANGLE to form the triac ignition point (the new estimated firing angle) The coefficients are mask programmable: Kp is defined by PX[3:1] and Ki is defined by SSE[1:0]. For smooth operation and to avoid overshoots, the setpoint (desired speed) is ramped from its present value to the a desired value



5 . 7 . Speed Set Ramping

The SETP integrator is built around a 8 bit counter and guarantees a smooth transition when changing the speed setting. There is a comparator between SETP and IP. If SETP changes then the comparator enables the IP-counter until IP gets equal to SETP. The clock, which defines the rate of change, can be defined for up and down counting independently, and equals Fclkip= 102.3KHz/(128*(UPR[4:0]+1)) in case of counting up. Since the value for the desired speed is 10 bit wide, and the counter only 8, the setpoint ramp speed from the table is effectively multiplied by 4.

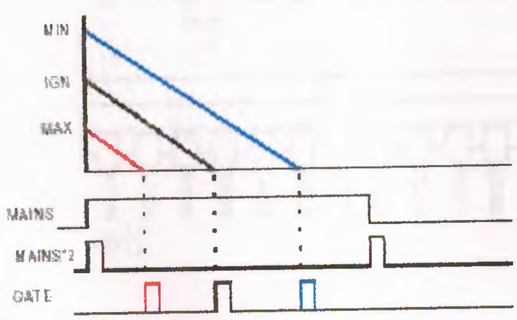
A frequency locked loop circuit is implemented to obtain a master frequency (approximately 100KHz) from a free running on-chip oscillator. Both FLL and frequency multiplier have the same functional blocks, but the FLL uses the AC line frequency as his reference. 625 ms after starting the motor (i.e. selecting a speed setting different from 0 rpm) the following function will be enabled: if the speed of the motor gets lower then a programmable value SLIM for longer then 320 ms, the motor speed is permanently set to 0 rpm. As a consequence the first possible timeout to recognize a blocked motor after start will be approximately 1 sec. This state can only be left by disconnecting the power from the electronic circuit.

6 . OVERSPEED SHUTOFF FEATURE

If the speed of the motor gets higher then a programmable value SLIMA for longer than 320ms, the selected speed is permanently set to 0 rpm. This state can only be left by disconnecting the power from the electronics.

The PI regulator gives an ignition angle IGN. The resolution is 10 us. The firing circuit compares the ignition point with a maximum and minimum allowed angle MIN and MAX. MAX corresponds to the maximum angle with the triac on (fired). This happens when the triac is fired with minimum delay from the zero cross. MIN corresponds to the minimum time the triac is fired. This happens when the triac is fired with maximum delay from the zero cross. If the IGN < MAX ,then IGN = MAX, thus firing with max angle. If MAX < IGN, then firing is done with IGN angle. The IGN value is compared with the value of a down counter, which is clocked by DCLK = 100kHz and is cleared at the beginning of every half period of the AC line. When this counter value gets equal to IGN a firing circuit produces an ignition pulse GATE with a duration selected with option DUTS[1:0]. After each firing pulse the ignition detector is activated. This will check whether the triac is fired correctly and thus no additional firing pulses are required. If there is no current flowing in the triac additional pulses will be generated.

6 . 1 . Example



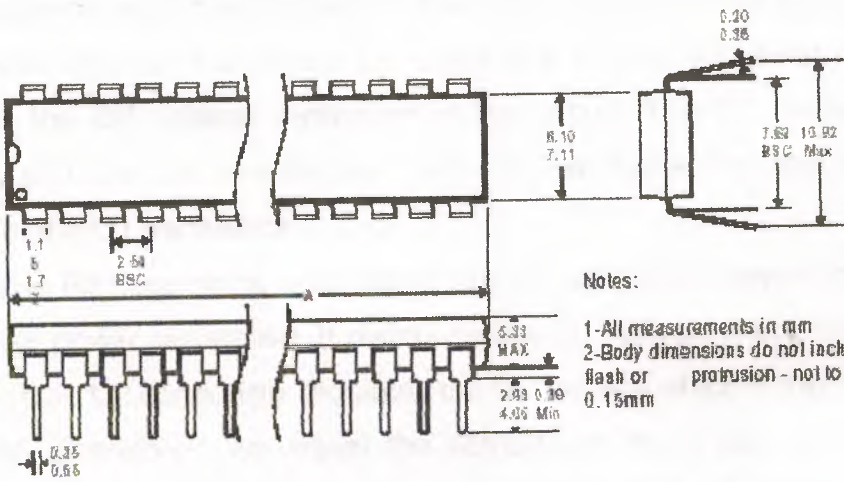
DUTS1	DUTS0	Duration in us
0	0	320
0	1	80
1	0	40
1	1	20

6 . 2 . Pinout

Standard package is 8-pin dual inline package. (Known as DIP-8, PDIP-8, DIL-8 and PDIL-8)

Pin	Name	Type	Description
1	SET	Input	Speed setting input
2	SPD	Input	Speed measurement
3	TEST	Input	Test pin
4	SYN	Input	Zero cross input
5	TRG	Output	Triac driver output
6	VSS	Supply	Ground
7	VDD1	Supply	Supply, high level
8	VDD	Output	Reference voltage

6 . 3 . MLX90804 Physical Characteristics



Notes:

1-All measurements in mm
2-Body dimensions do not include mold flash or protrusion - not to exceed 0.15mm

Dimension		8 Leads	14 Leads	16 Leads	18 Leads	20 Leads	24 Leads
A	Min Max	9.02 10.16	18.67 19.69	18.67 19.69	22.35 23.37	24.89 25.92	31.24 32.51

7 . CONCLUSION

The guidelines provided in this document have been given to help you use the UMC01EVAI Evaluation Board properly. This Evaluation Board is designed for controlling universal motors, but it can also be used for a wide variety of applications such as light dimmers, thermostats and heating systems.

The main thing to check is that your loads, especially the inductive load, correspond to the programmed data (maximum speed, triggering pulse width, etc.). Then, after certain adjustments to your software (and using the EPROM version of ST6200 MCU), you are able to perform tests using your own universal motor. With this evaluation board, you can take your own measurements and see how much the 3rd harmonic current is reduced by using this method. Fully detailed information about programming is given in Application Notes AN1448 and AN1449.

In this circuit , when the S1 switch is turned off , it gives us the necessary power to move 240V AC machine.In other words when we adjust the coming voltage we automatically adjust our motor's devir D1 diyod turns AC voltage to DC voltage which is necessary to work the elements in this circuit we obtain the amount of voltage which is required by our transistors by using the R2and R1 resistance.C1 conductors provides the DC voltage regulation in the circuit. The Q1 transistor is transmitted through 470 ahm R4 resistance. Therefore, we make the flow of voltage from the emitter of the Q1 transisstor.

The R5 resistance here keeps our Q2 transistor always in the circuit. R6-R5 works like power resistance. It distributesthe DC voltage which comes from D2 diyod to the circuit. C2 condenser regulates the DC voltage which is formedby C2 condenser D2 diyot. Therefore , we adjust the cathode-anode of our motor by increasing or decreasing the cathode anode voltage resistance. The main elements which provides this are R1 and R2 resistances. The aim of the R9 resistance is to act like an insurance . it protects the circuit against short circuit or detects