FUDAN MICROELECTRONICS

复旦微电子

FM2822 DIMMING BALLAST CONTROL IC AND FLUORESCENT LAMP

Specification

May. 2008

1. Product Overview

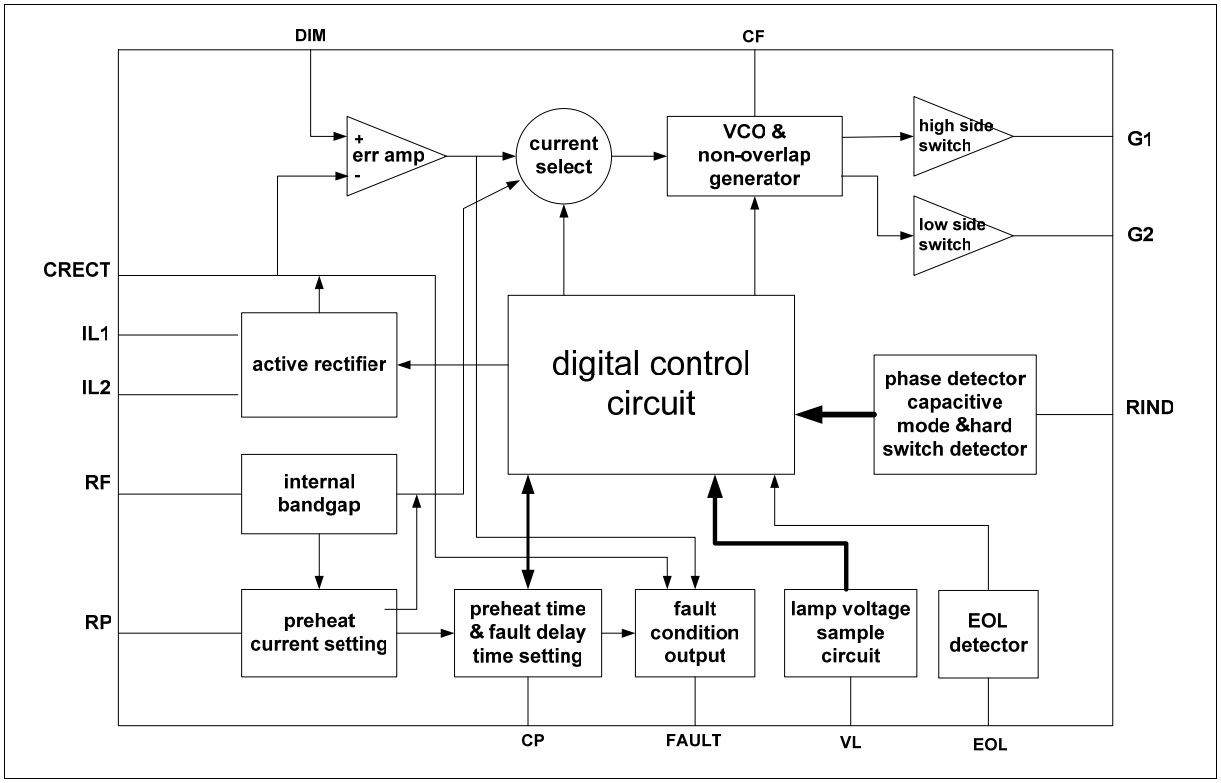
1.1. Description

FM2822 is a dimming ballast control IC. It contains half bridge driver; voltage controlled oscillation circuit (VCO); phase detection and protection circuit; dim circuit; and control logic unit. It works in close loop state, with wide dim range and high stability. Its special features can decrease the number of external components and greatly increase design flexibility.

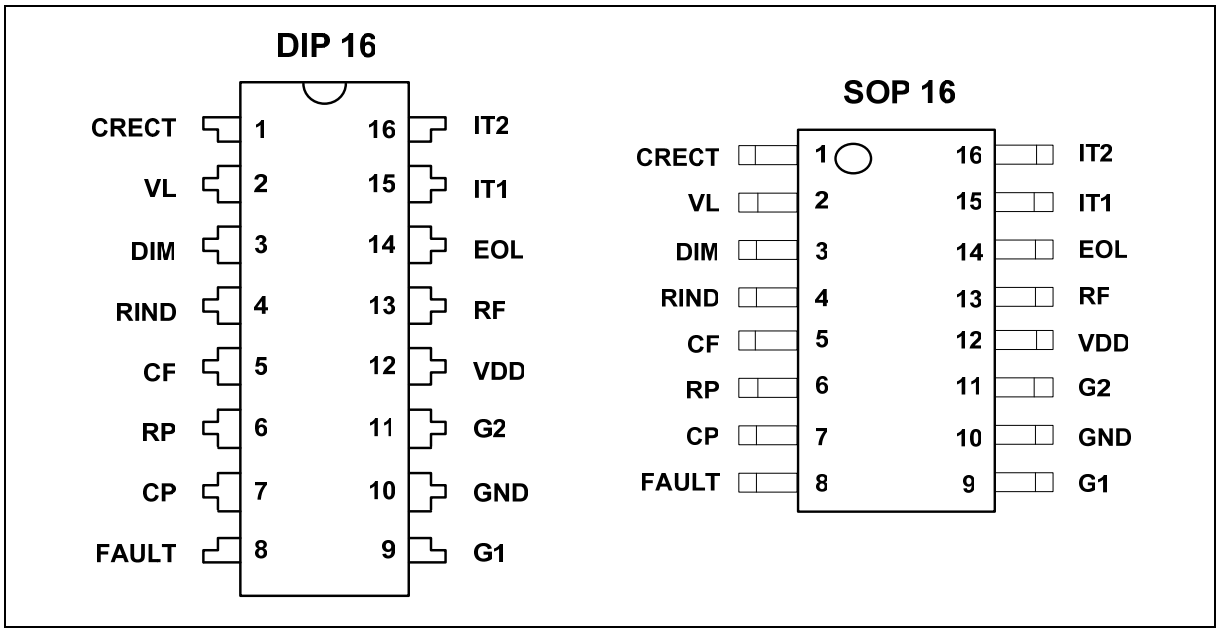
1.2. Features

- **Dim range 1%~100%**
- **Closed-loop lamp current control**
- **Internal active rectifier**
- **Dim range without flicker**
- **Adjustable preheat time and ignite time**
- **Half-bridge convert circuit with capacitive protection**
- **Phase detection and avoid Hard Switch**
- **Over voltage protect**
- **End of live (EOL) protection**
- **Suitable for different lamp types**
- **Package: DIP16, SOP16**

1.3. Block Diagram



1.4. Pin Configuration



1.5. Pin Function

Pin	Symbol	Function
1	CRECT	Lamp power filtering capacitor
2	VL	Sensing of averaged lamp voltage
3	DIM	Dimming level control
4	RIND	Inductor current monitoring input
5	CF	Capacitor for setting VCO frequency
6	RP	Preheat current setting Resistor
7	CP	Preheat and ignition scan timing capacitor
8	FAULT	abnormal state output
9	G1	Gate of high-side switch
10	GND	Ground
11	G2	Gate of low-side switch
12	VDD	Supply for ground level control and drive
13	RF	Reference resistor
14	EOL	End of life circuit monitor input
15	IT1	Differential input for sensing lamp current
16	IT2	Differential input for sensing lamp current

1.6. Pin Specification

Pin	Symbol	Specification
1	CRECT	The CRECT pin sources a current that represents the lamp power into an external capacitor and resistor network, Crect and Rect. The capacitor is used for filtering of the high frequency ripple in the representation of the lamp power, derived from the product of the lamp current and the lamp voltage at multiplier circuit. It also stabilizes the lamp control feedback loop. The resistor is used to set the gain of the multiplier circuit.
2	VL	VL pin serves the dual purpose of detecting an over voltage condition during ignition, removal, or failure of the lamp, and sensing the lamp voltage for power regulation during the normal running phase. It forms the input to three current comparators and the multiplier function. VL is sampled by the comparators. As soon as the input currents exceeds a current level of IVLstop (110μA for the design value of Rref), the stop timer is activated. If at the end of the Tstop period the IVLstop is exceeded, the circuit is switched into the standby state, with G1 off and G2 on. The circuit remains in the standby state when the VL input current drops below IVLstop, until the complete circuit is powered down below Vdoff and back up to above Vdon. If the input current exceeds a level of IVLpanic (corresponding to Vpanic), then the circuit is switched into standby state immediately. After ignition the VL pin forms a current input to one side of the multiplier function. The current into VL should be a well filtered DC signal with a maximum value (corresponding to the maximum lamp voltage in the dimming state)
3	DIM	Brightness setting signal input .The valid signal range is 0---4vdc .When the DIM signal is greater than 4V, it is clamped and kept at 4V level. When the DIM signal is lower than 0.3V, it is also clamped and kept at 0.3V. The 4V and 0.3V level respectively means the full brightness and full dim status. DIM input is high impedance.
4	RIND	Current phase detector of the inverter, two comparators are provided at this pin for FWD control of the oscillator and also used for capacitive mode protection.
5	CF	An external capacitor is connected to the CF pin. The CF capacitor is precharged to Vreg during the start-up state (VDDA, VDDD).
6	RP	An external resistor is connected to the RP pin to set the preheat current. During preheat period, the voltage on this pin remain at 4V. After preheat the voltage sweep down to 0V at certain rate.
7	CP	An external capacitor Cp is connected to pin Cp, which serves two purposes. First, it is used to set the preheat timing: During preheat a small current is used to charge Cp, and the voltage on CP increase gradually from 0V to 4V. When the voltage reaches 4V, preheat timing is over. A 5 time bigger current is applied to discharge the capacitor, then the voltage sweep down gradually, and so does the switch frequency. At certen point the lamp will be ignited. This

Pin	Symbol	Specification
		period of time is called ignition time. At the end of ignition the voltage at Cp is set to zero. Secondly, the Cp pin is used to set the stop timing duration when the open circuit lamp voltage exceeds the Vstop level or capacitive mode during the ignition phase. The stop timing duration is equal to 1/2 of the preheat time. This function only becomes active at the instant the ignition sweeps ends, however it remains active continuously after that.
8	FAULT	This is output pin. So long as the circuit is not in the normal ignition phase, this pin output high level voltage with driver capability. It can be used conveniently to control or protect the circuit
9/11	G1、G2	These pins are connected to the gates of T1 and T2 respectively to drive the MOSFETs. There is a fixed non-overlap time between these two signals.
10	GND	Signal and power ground.
12	VDD	The supply current for the FM2822 is supplied via this pin. It provides a zener function, with a peak transient capability to limit the voltage during standby to Vdclamp. The average current may increase proportional with the frequency. An under-voltage lockout function prevents oscillation until the voltage at VDD exceeds Vdon, and stops oscillation if the supply drops below Vdoff.
13	RF	An external resistor Rref is connected to the RF pin. This resistor converts the reference voltage at the RF pin into a reference current. The reference voltage at this point is Vref. A value of Rref of 30k will be referred to as the design value of Rref. In this text the nominal value of Rref will always be between 20k and 40k.
14	EOL	This pin provides End Of Life protection. If the voltage applied on this pin is out of the range –1V and 1V, circuit will go into EOL protection. This pin can be grounded if this function is not used.
15/16	IT1、IT2	Pins IT1 and IT2 form the inputs to a bipolar differential current amplifier. The differential input current at the pins IT1 and IT2 is converted into a fully rectified output current which is fed to one input of the multiplier function. The magnitude of the output current is approximately equal to the absolute value of the differential input current. Pins IT1 and IT2 act as current sources such that at any time one of the inputs will be supplying a minimum current equal to Ilbias and the other pin will be supplying a current equal to Ilbias + Ildiff. The input pins must be connected through matched resistors Rli, to the terminals of the voltage source which represents the lamp current. The external resistor network tied to pins LI1 and LI2 should be designed such that the rectifier normally operates with a peak differential input current near the maximum allowed level, IDLmax, but does not exceeds it. This will minimize errors at low current levels and avoid amplifier saturation at high current level. Recommended values for Rli are in the range between 1k and 4k. The value of ILDmax is 800μA.

2. Status Description

Closed-loop negative feedback:

Compared dimming signal DIM and feedback signal CRECT, the internal error amplifier brings the error current and send it to voltage controlled oscillator. The square wave on G1, G2 respectively drive high and low side MOS of half-bridge converter which works at the certain oscillation frequency , the inductance of main-loop circuit correspondence the impedance which decides the lamp current.

Dimming controlled DIM is high –impedance voltage input, the valid voltage range is 0VDC~4VDC, the voltage is clamped on 0.25VDC~4VDC internally, this means average power range is 2%~100%, if adds some proper compensation, the range is well widened from 1% to 100%. The clamp on 0.25VDC guarantees the lamp to be igniting correctly in lowest lightness.

Preheat and Ignition:

Upstanding Preheat and Ignition function can extend the life of the fluorescent lamp. The preheat time is decided by external capacitor on CP. After voltage on CP is charged from 0V to 4V, that's the end of preheat time. The resistor on RP decides the preheat frequency, so we can set the preheat frequency by changing the resistor.

After preheat, voltage on RP sweeps down from 4V to 0 V, the falling speed is concerned with capacitor on CP, when the frequency sweeps down approaching to resonance frequency of LC, the high voltage will ignite lamp. The lowest sweeping frequency is concerned with resistor on RREF and capacitor on CF.

Abnormal protection:

FM2822 provides perfect protection such as over voltage protection, capacitive protection and EOL protection.

If the operating frequency approaches to resonance frequency, it brings a high voltage and the converter will be failed for excessive heat. FM2822 provides over voltage protection and can avoid this. VL is used as lamp voltage test, if current of VL is over 120μA, the capacitor connects to CP is charged by the current over two times of preheat charge current and delayed to 0.5s, when the voltage of CP reaches 4V, if over voltage is still occurred, the system will enter into STANDBY to protect converter, otherwise CP discharged gradually and system is still in normal. If system is in badly over voltage state (current of VL is more than 240μA), the system enters into STANDBBY directly. Restart condition is that voltage of VDD falls below 8V and then rises above 11V.

If the converter is in capacitive mode, the dissipation on MOS is large and the converter will be failed for excessive heat. FM2822 provides capacitive protection. When the current phase of main-loop circuit leads to voltage phase, system is in capacitive mode, this is checked by RIND and it will enter into STANDBY. Restart condition is that voltage of VDD fails below 8V and then rises above 11V.

EOL protection is means when lamp occurs rectification effect, the system must stop oscillating, and otherwise the extreme heat o filament will melt away the glass of lamp and lead the fire. FM2822 not only provides EOL protection, but also provides more flexible test method. There are +1V, -1V build-in window comparators at EOL when input voltage of EOL is over rang, the valid signal is sent to control logical and start delay protection, at the end of delay, if the signal is still valid, the system will enter STANDBY.

3. Characteristics

3.1. Absolute Maximum Rating

Parameter	Symbol	Min.	Max.	Unit
Supply voltage	V_{DD}	0	15	V
Supply voltage clamp current	I_{DD}		3	mA
VDIM Input voltage	V_{DIM}	0	5	V
VL input current	I_{VL}	0	1	mA
RIND input voltage	V_{IPT}	-5	5	V
Operating temperature	T_{OPR}	-25	+120	℃
Storage temperature	T_{STO}	-55	+150	℃

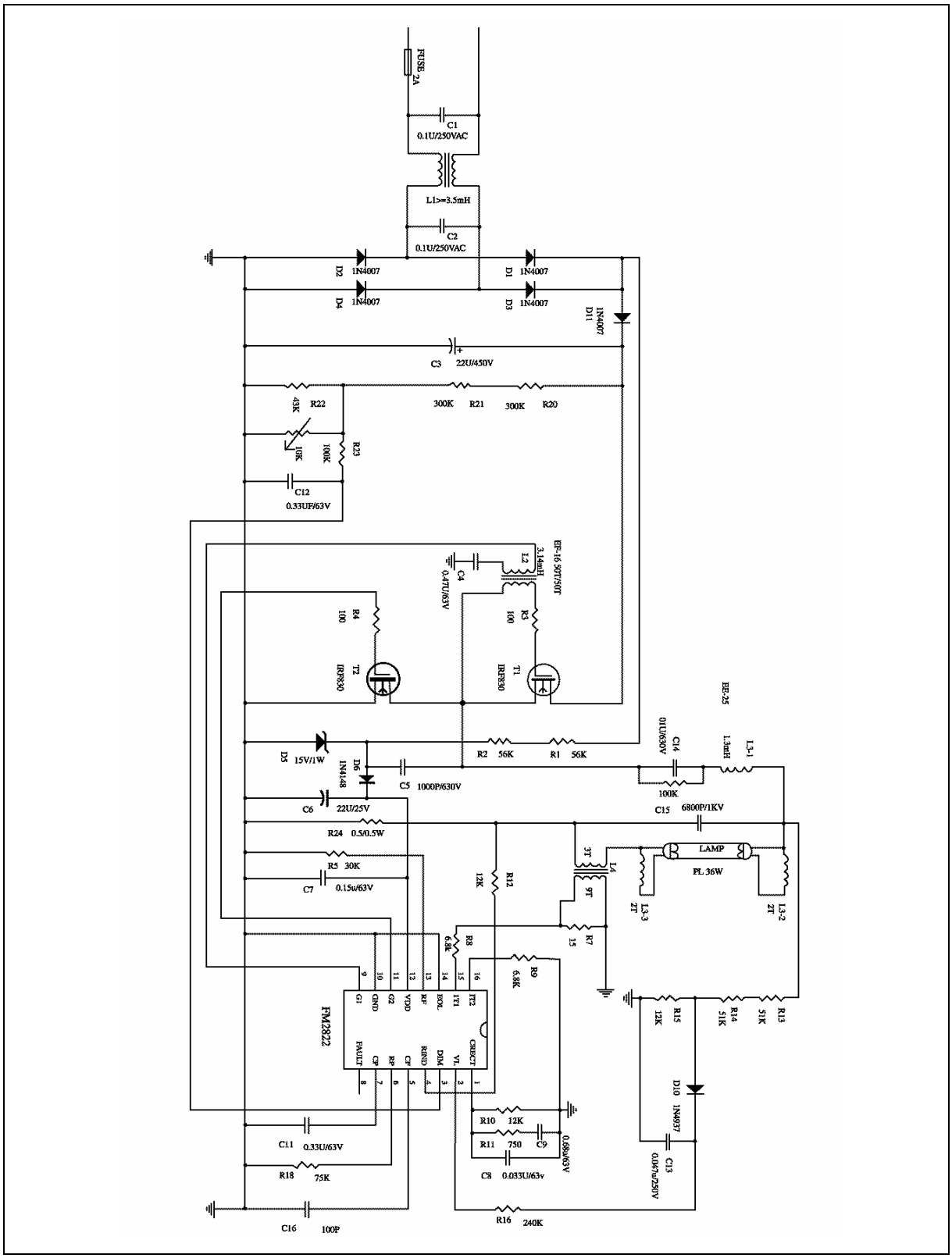
3.2. Electrical Characteristics

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Start-up state						
Supply turn-on Voltage		Vdon	10.0	11.0	12.0	V
Supply lockout Voltage		Vdoff	7.1	8.1	9.1	V
Supply lockout hysteresis		Vdhys		3.0		V
Startup current	VDD=11V	Istart		1.2	1.6	mA
Supply voltage clamp	Id=3mA	Vdclmp	15.6	16.2	16.8	V
Reference section						
Voltage at RF pin	VDD=11V	VRF	2.4	2.5	2.6	V
Voltage at RP pin	VDD=11V	VRP	3.8	4.0	4.2	V
Oscillator section						
High VCO threshold		Vcfh	3.8	4.0	4.2	V
Low VCO threshold		Vcfl	0.8	1.0	1.2	V
Non-overlap time		Tnon	1.1	1.3	1.5	μS
Preheat and stop timing section						
CP high threshold		Vcph	3.8	4.0	4.2	V
CP low threshold		Vcpl	0.4	0.5	0.6	V
CP charging current 1	preheat state	Ipre	1.2	1.3	1.4	μA

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
CP charging current 2	Abnormal condition	Ifault	2.4	2.6	2.8	μA
CP discharge current		Idis	6.0	6.5	7.0	μA
Preheat time	CP=0.33uF	Tpre		1.0		S
Ignition time	CP=0.33uF	Tigni		0.2		S
Time ratio of preheat/ ignition				5:1		
Ignition time over Signal		Vpro		0.5		V
Protection section (The circuit is enabled after the first time CP voltage drop below Vpro)						
Overvoltage protection						
Clamp level	Closed-loop state	Ichg	75	80	85	μA
Stop threshold level		Istop	110	120	130	μA
Max level		Ipanic	220	240	260	μA
Capacitive modes						
RIND high threshold	Closed-loop state	Vrindh	45	50	55	mV
RIND high threshold		Vrindl	-55	-50	-45	mV
Lamp life (EOL) detection section						
EOL high threshold	Closed-loop state	Veolh	0.9	1.0	1.1	V
EOL low threshold		Veoll	-0.9	-1.0	-1.1	V
Driver section (G1 G2)						
Sink current	Closed-loop state VDD=13V	Isink	550	600	650	mA
Source current		Isource	400	400	450	mA
On voltage		Vgh	12.3	12.5	12.7	V
Off voltage		Vgl		0.5	0.7	V
Dimming control section						
Dim voltage range		Vdim		0~4		V
Dim internal clamp				0.25~4		V
Max CRECT output current		Icrectmax		800		μA
CRECT output offset current		Icrectoff	-3	3	0	μA
LI1/LI2 bias current		ILbias	75	85	95	μA
Tran conductance error amplifier		gm	0.6	0.75	0.9	μA/mV

4. Application Circuits

Suitable for: 220V/50Hz T8/36W

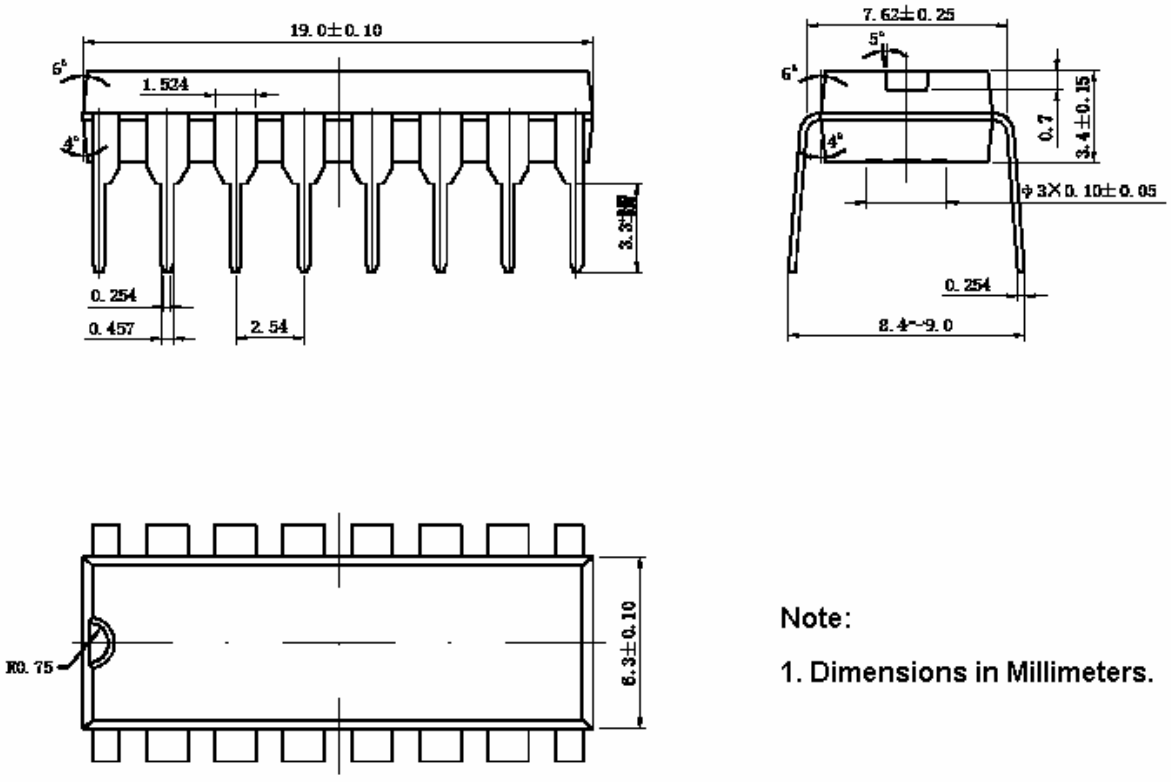


5. Ordering Information

Ordering Code	Package	Operation Temperature
FM2822-PD	PDIP16	Industrial Temperature - 25°C ~ + 120°C
FM2822-SO	SOP16	

6. Package Dimensions

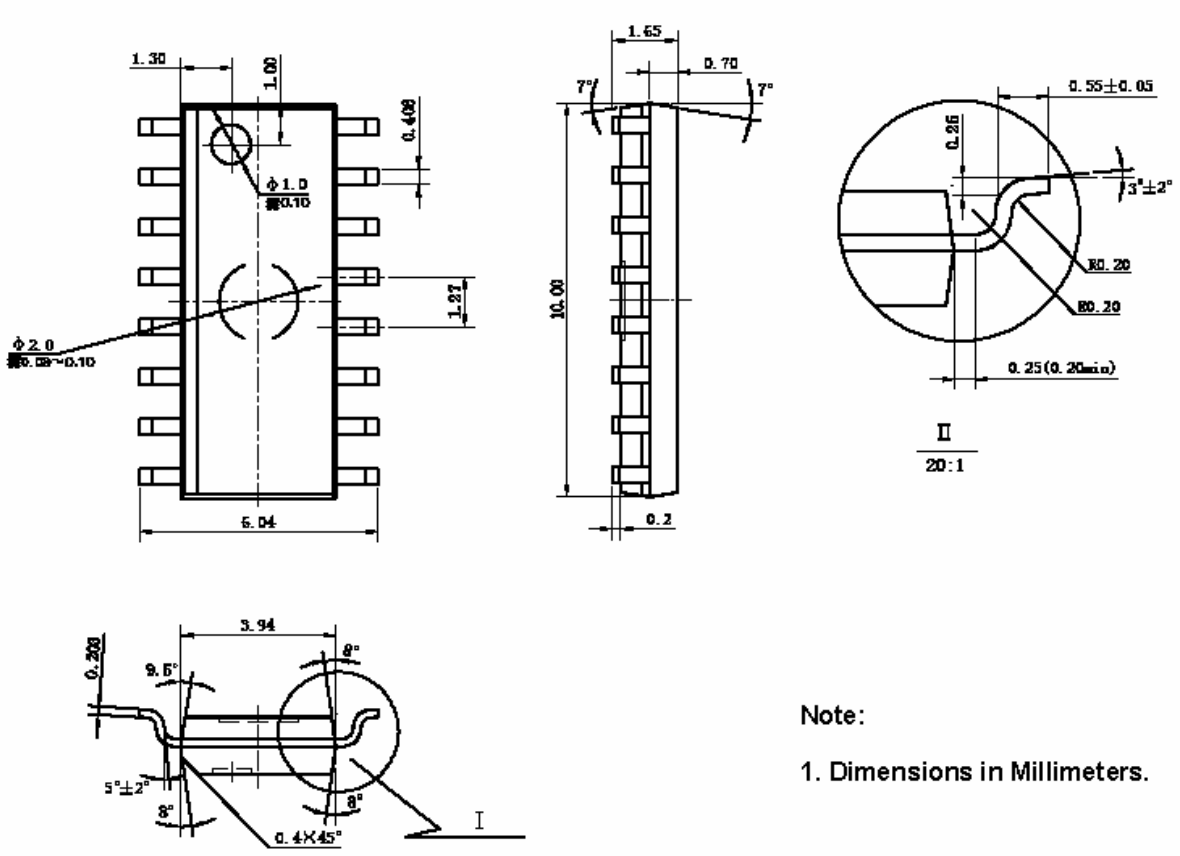
DIP16



Note:

1. Dimensions in Millimeters.

SOP16



Note:

1. Dimensions in Millimeters.

Revision History

Version	Publication date	Pages	Paragraph or Illustration	Revise Description
1.0	Oct. 2007	16		Initial Release.
1.1	May. 2008	16	Sales and service	Updated the address of HK office.

Sales and Service

Shanghai Fudan Microelectronics Co., Ltd.
Address: Bldg No. 4, 127 Guotai Rd,
Shanghai City China.
Postcode: 200433
Tel: (86-21) 6565 5050
Fax: (86-21) 6565 9115

Shanghai Fudan Microelectronics (HK) Co., Ltd.
Address: Unit 506, 5/F., East Ocean Centre, 98 Granville Road,
Tsimshatsui East, Kowloon, Hong Kong
Tel: (852) 2116 3288 2116 3338
Fax: (852) 2116 0882

Beijing Office
Address: Room.1208, Bldg C,
Zhongguancun Science and Technology Development Edifice,
34 zhongguancun Street (South),
Haidian District, Beijing City, China.
Tel: (86-10) 6212 0682 6213 9558
Fax: (86-10) 6212 0681

Shenzhen Office
Address: Room.1301, Century Bldg, Shengtingyuan Hotel, Huaqiang Rd (North),
Shenzhen City, China.
Postcode: 518028
Tel: (86-755) 8335 3211 8335 6511
Fax: (86-755) 8335 9011

Web Site: http://www.fmsh.com/