



**MOTOROLA**

# Liquid Crystal Display and Backlight Integrated Controller

The MC34270 and MC34271 are low power dual switching voltage regulators, specifically designed for handheld and laptop applications, to provide several regulated output voltages using a minimum of external parts. Two uncommitted switching regulators feature a very low standby bias current of 5.0  $\mu\text{A}$ , and an operating current of 7.0 mA capable of supplying output currents in excess of 200 mA.

Both devices have three additional features. The first is an ELD Output that can be used to drive a backlight or a liquid crystal display. The ELD output frequency is the clock divided by 256. The second feature allows four additional output bias voltages, in specific proportions to  $V_B$ , one of the switching regulated output voltages. It allows use of mixed logic circuitry and provides a voltage bias for N-Channel load control MOSFETs™. The third feature is an Enable input that allows a logic level signal to turn-“off” or turn-“on” both switching regulators.

Due to the low bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

## MC34270 and MC34271 Features:

- Low Standby Bias Current of 5.0  $\mu\text{A}$
- Uncommitted Switching Regulators Allow Both Positive and Negative Supply Voltages
- Logic Enable Allows Microprocessor Control of All Outputs
- Synchronizable to External Clock
- Mode Commandable for ELD and LCD Interface
- Frequency Synchronizable
- Auxiliary Output Bias Voltages Enable Load Control via N-Channel FETs

MOSFET is a trademark of Motorola, Inc.

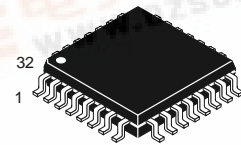
## MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

Rating	Symbol	Value	Unit
Input Voltage	$V_{DD}$	16	Vdc
Power Dissipation and Thermal Characteristics			
Maximum Power Dissipation	$P_D$	1.43	W
Case 873			
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	100	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	60	$^\circ\text{C}/\text{W}$
Output #1 and #2 Switch Current	$I_{SL}$ & $I_{SB}$	500	mA
Output #1 and #2 “Off”-State Voltage	$V_{SL}$	60	Vdc
Feedback Enable MOSFETs “Off”-State Voltage	$V_{LF}$	20	Vdc
Operating Junction Temperature	$T_J$	125	$^\circ\text{C}$
Operating Ambient Temperature	$T_A$	0 to +70	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-55 to +150	$^\circ\text{C}$

**MC34270**  
**MC34271**

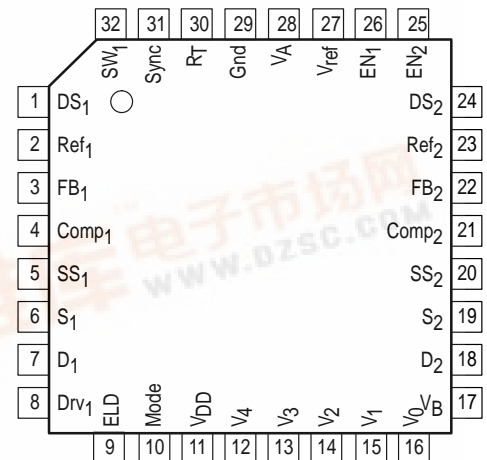
## LIQUID CRYSTAL DISPLAY AND BACKLIGHT INTEGRATED CONTROLLER

SEMICONDUCTOR  
TECHNICAL DATA



FB SUFFIX  
PLASTIC PACKAGE  
CASE 873

## PIN CONNECTIONS



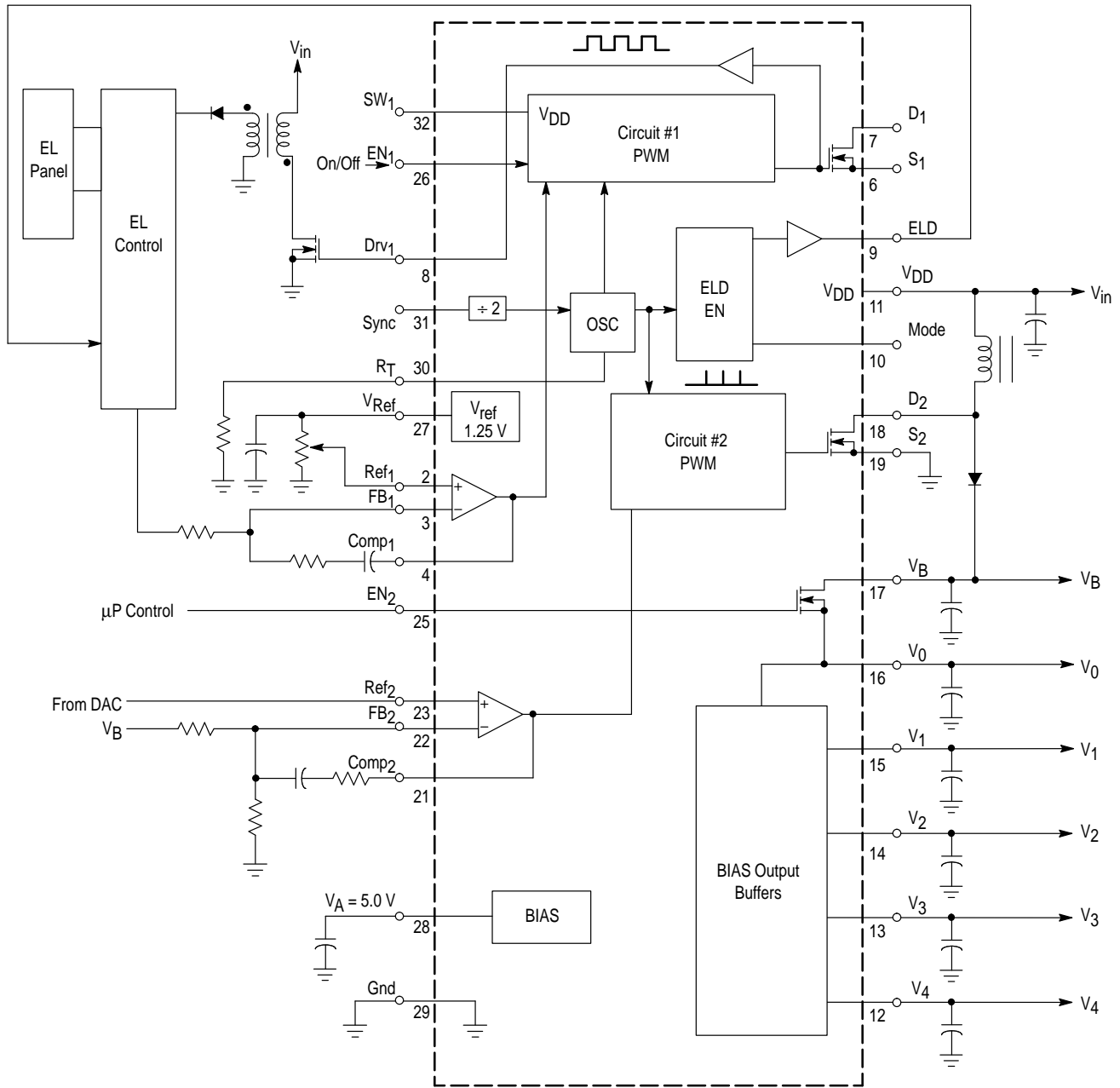
## ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC34270FB	$T_A = 0^\circ$ to $+70^\circ\text{C}$	QFP-32
MC34271FB		QFP-32



# MC34270 MC34271

## Representative Block Diagram



This device contains 350 active transistors.

## MC34270 MC34271

**ELECTRICAL CHARACTERISTICS** ( $V_{DD} = 6.0$  V, for typical values  $T_A = \text{Low to High}$  [Note 1], for min/max values  $T_A$  is the operating ambient temperature range that applies, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>REFERENCE SECTION</b>					
Reference Voltage ( $T_J = 25^\circ\text{C}$ )	$V_{ref}$	1.225	1.250	1.275	V
Line Regulation ( $V_{DD} = 5.0$ V to 12.5 V)	Reg <sub>line</sub>	–	2.0	10	mV
Load Regulation ( $I_O = 0$ to 120 $\mu\text{A}$ )	Reg <sub>load</sub>	–	2.0	10	mV
Total Variation (Line, Load and Temperature)	$V_{ref}$	1.215	–	1.285	V

### ERROR AMPLIFIERS

Input Offset Voltage ( $V_{CM} = 1.25$ V)	$V_{IO}$	–	1.0	10	mV
Input Bias Current ( $V_{CM} = 1.25$ V)	$I_{IB}$	–	120	600	nA
Open Loop Voltage Gain ( $V_{CM} = 1.25$ V, $V_{COMP} = 2.0$ V)	$A_{VOL}$	80	100	–	dB
Output Voltage Swing High State ( $I_{OH} = -100$ $\mu\text{A}$ ) Low State ( $I_{OL} = 100$ $\mu\text{A}$ )	$V_{eOH}$ $V_{eOL}$	$V_A - 1.5$ 0	4.0 –	5.5 1.0	V

### BIAS VOLTAGE

Voltage ( $V_{DD} = 5.0$ V to 12.5 V, $I_O = 0$ )	$V_A$	4.6	5.0	5.4	V
---	-------	-----	-----	-----	---

### OSCILLATOR AND PWM SECTIONS

Total Frequency Variation Over Line and Temperature $V_{DD} = 5.0$ V to 10 V, $T_A = 0^\circ$ to $70^\circ\text{C}$ , $R_T = 169$ k	$f_{OSC}$	90	115	140	kHz
Duty Cycle at Each Output Maximum Minimum	$DC_{max}$ $DC_{min}$	92 –	95 –	– 0	%
Sync Input Input Resistance ( $V_{sync} = 3.5$ V) Minimum Sync Pulse Width	$R_{sync}$ $T_p$	25 –	50 1.0	100 –	$k\Omega$ $\mu\text{s}$

### OUTPUT MOSFETS

Output Voltage – “On”-State ( $I_{sink} = 200$ mA)	$V_{OL}$	–	150	250	mV
Output Current – “Off”-State ( $V_{OH} = 40$ V)	$I_{OH}$	–	0.1	1.0	$\mu\text{A}$
Rise and Fall Times	$t_r, t_f$	–	50	–	ns

### EL DISCHARGE OUTPUT (ELD) AND DRV<sub>1</sub>

Output Voltage – “On”-State ( $I_{sink} = 100$ $\mu\text{A}$ )	$V_{OL}$	–	30	100	mV
Output Voltage – “On”-State ( $I_{sink} = 50$ mA)	$V_{OL}$	–	2.0	2.5	V
Output Voltage – “Off”-State ( $I_{source} = -100$ $\mu\text{A}$ )	$V_{OH}$	$V_{DD} - 0.5$	5.9	–	V
Output Voltage – “Off”-State ( $I_{source} = -50$ mA)	$V_{OH}$	$V_{DD} - 3.5$	3.3	–	V

### FEEDBACK ENABLE SWITCHES (DS<sub>1</sub>, DS<sub>2</sub>)

Output Voltage – “Low”-State ( $I_{sink} = 1.0$ mA)	$V_{feOL}$	–	10	100	mV
Output Current – “Off”-State ( $V_{OH} = 12.5$ V)	$I_{feOH}$	–	0.6	1.0	$\mu\text{A}$

### SWITCHED $V_{DD}$ OUTPUT (SW<sub>1</sub>)

Output Voltage Switch “On” ( $EN_1 = 1$ , $I_{source} = 100$ $\mu\text{A}$ ) Switch “Off” ( $EN_1 = 0$ , $I_{sink} = 100$ $\mu\text{A}$ )	$V_{swOH}$ $V_{swOL}$	5.5 0	5.9 0.1	6.0 0.2	V
---	--------------------------	----------	------------	------------	---

### AUXILIARY VOLTAGE OUTPUTS

$V_0$ Enable Switch “On”-Resistance: $V_B$ to $V_0$	$R_{ds}$	0	2.0	10	$\Omega$
“Off”-State Leakage Current ( $V_B = 10$ V)	$I_{lkg}$	0	0.1	2.0	$\mu\text{A}$
$V_0$ Voltage ( $V_B = 30$ V, $I_{source} = 0$ mA)	$V_0$	29.5	29.9	30	V
$V_0$ Resistance ( $I_{source} = 4.0$ mA)	$R_0$	20	40	60	$\Omega$

**NOTE:** 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

## MC34270 MC34271

**ELECTRICAL CHARACTERISTICS (continued)** ( $V_{DD} = 6.0\text{ V}$ , for typical values  $T_A = \text{Low to High}$  [Note 1], for min/max values  $T_A$  is the operating ambient temperature range that applies, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>AUXILIARY VOLTAGE OUTPUTS</b>					
$V_1, V_2, V_3, V_4$ Outputs					
1- $V_1/V_0$ Ratio: MC34270		0.0565	0.0580	0.0595	
MC34271		0.0500	0.0520	0.0535	
1- $V_2/V_0$ Ratio: MC34270		0.1135	0.1160	0.1185	
MC34271		0.1010	0.1035	0.1065	
$V_3/V_0$ Ratio: MC34270		0.1135	0.1160	0.1185	
MC34271		0.1010	0.1035	0.1065	
$V_4/V_0$ Ratio: MC34270		0.0565	0.0580	0.0595	
MC34271		0.0500	0.0520	0.0535	
Output Resistance ( $I_{\text{source}} = 4.0\text{ mA}$ )	$R_O$	20	40	60	$\Omega$
Output Short Circuit Current	$I_{\text{ss}}$	5.0	10	20	mA

### LOGIC INPUTS (EN<sub>1</sub>, EN<sub>2</sub>, MODE)

Input Low State	$V_{IL}$	0	–	0.8	V
Input High State	$V_{IH}$	2.0	–	6.0	V
Input Impedance	$R_{in}$	25	50	100	k $\Omega$

### SOFT START CONTROL (SS<sub>1</sub>, SS<sub>2</sub>)

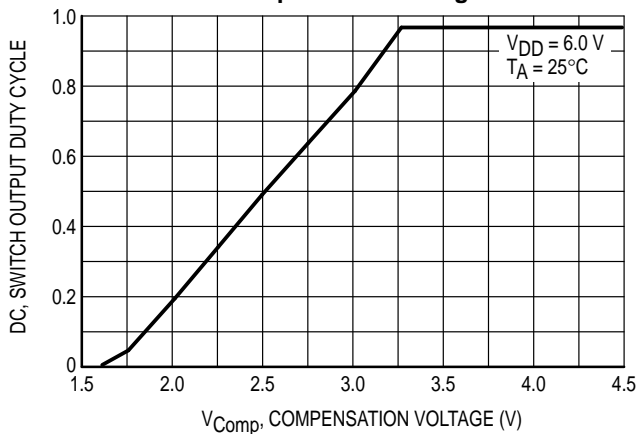
Charge Current (Capacitor Voltage = 1.0 V to 4.0 V)	$I_{\text{chg}}$	0.5	1.0	2.5	$\mu\text{A}$
Discharge Current (Capacitor Voltage = 1.0 V)	$I_{\text{dschg}}$	250	650	–	$\mu\text{A}$

### TOTAL SUPPLY CURRENT

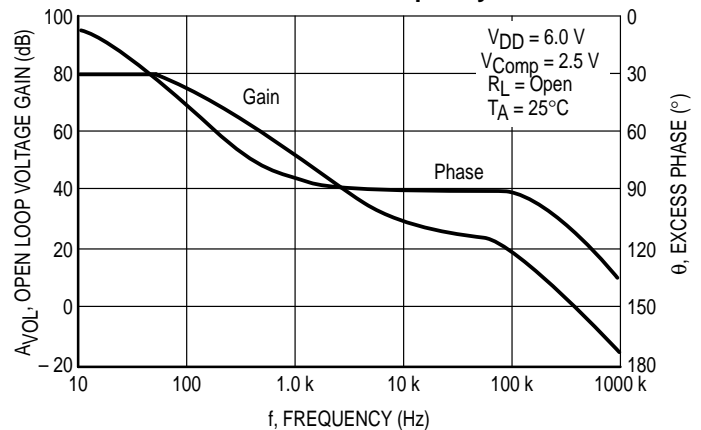
$V_{DD}$ Current Standby Mode (EN <sub>1</sub> = EN <sub>2</sub> = 0)	$V_{DD} = 6.0\text{ V}$ $V_{DD} = 16\text{ V}$	$I_{CC}$	–	2.0 3.0	5.0 15	$\mu\text{A}$
$V_{DD}$ Current Backlight "On" (EN <sub>1</sub> = 1; EN <sub>2</sub> = 0)		$I_{CC}$	–	0.7	3.0	mA
$V_{DD}$ Current LCD "On" (No Inductor) (EN <sub>1</sub> = 0; EN <sub>2</sub> = 1)		$I_{CC}$	–	0.9	2.0	mA
$V_B$ Current ( $V_0 = 35\text{ V}$ )		$I_O$	–	1.2	3.0	mA

**NOTE:** 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

**Figure 1. Switch Output Duty Cycle versus Compensation Voltage**

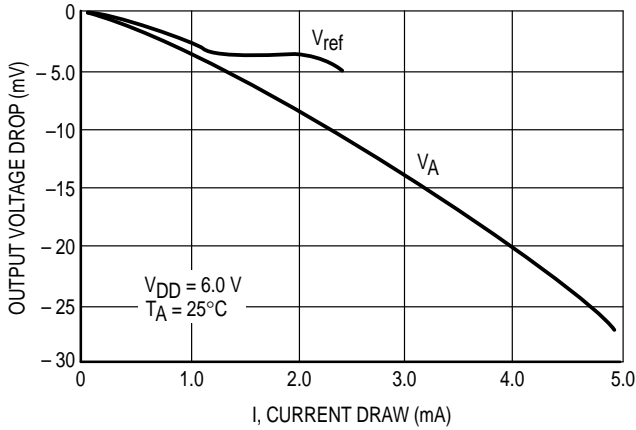


**Figure 2. Error Amp Open Loop Gain and Phase versus Frequency**

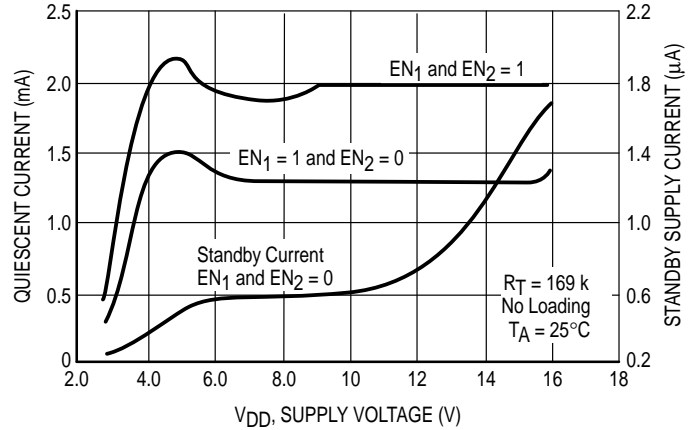


# MC34270 MC34271

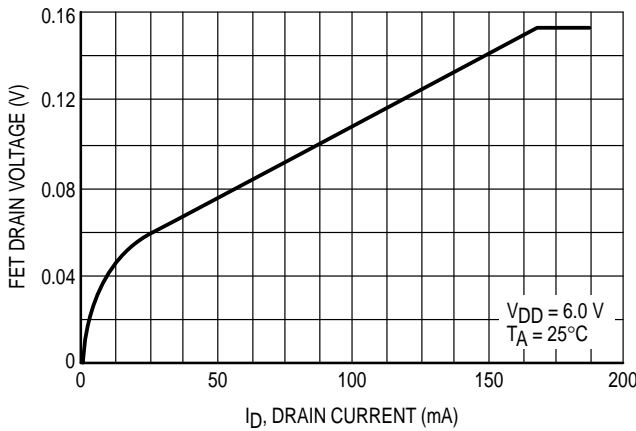
**Figure 3. Reference Voltage Change versus Reference Current**



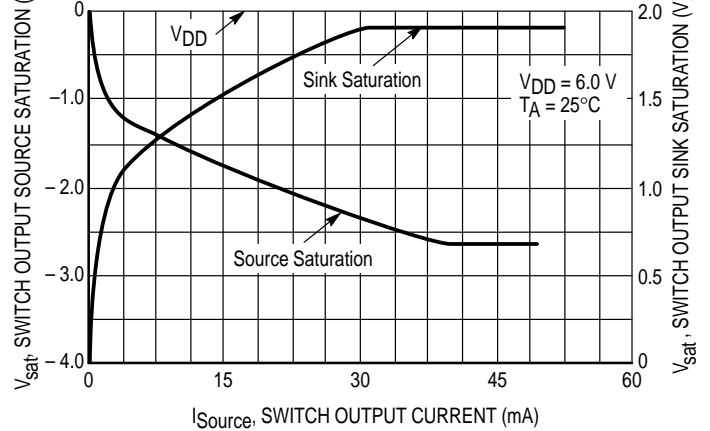
**Figure 4. Quiescent Current versus Supply Voltage**



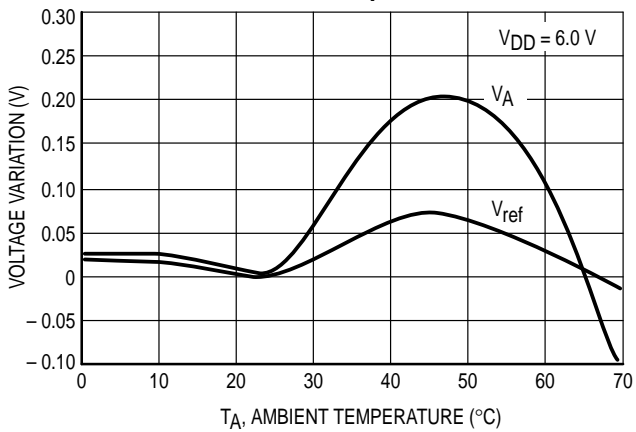
**Figure 5. FET Drain Voltage versus Sink Current**



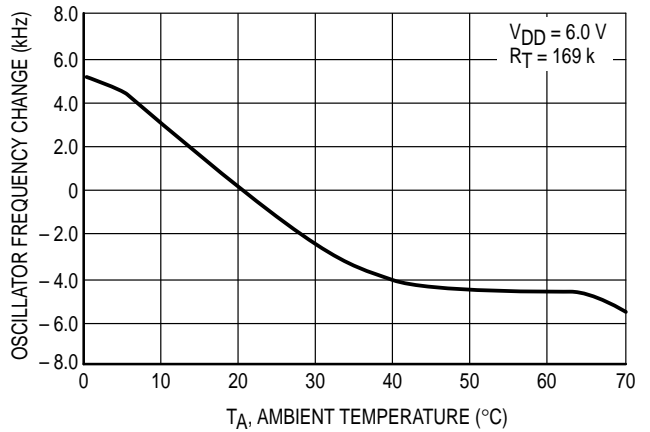
**Figure 6. ELD and DRV<sub>1</sub> Switch Output Source and Sink Saturation versus Current**



**Figure 7.  $V_{ref}$  and  $V_A$  Variation versus Temperature**



**Figure 8. Oscillator Frequency Variation versus Temperature**



## MC34270 MC34271

Figure 9. Frequency versus Timing

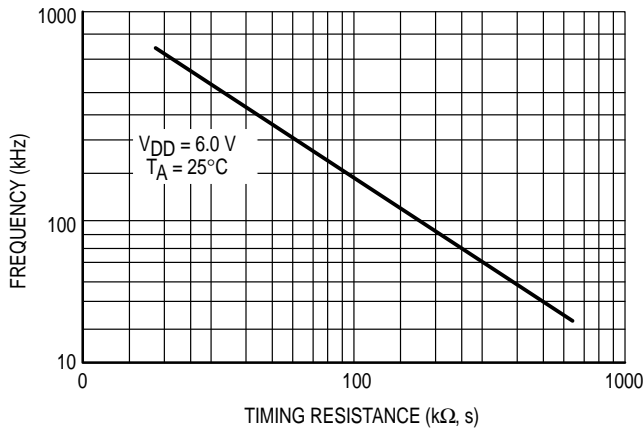
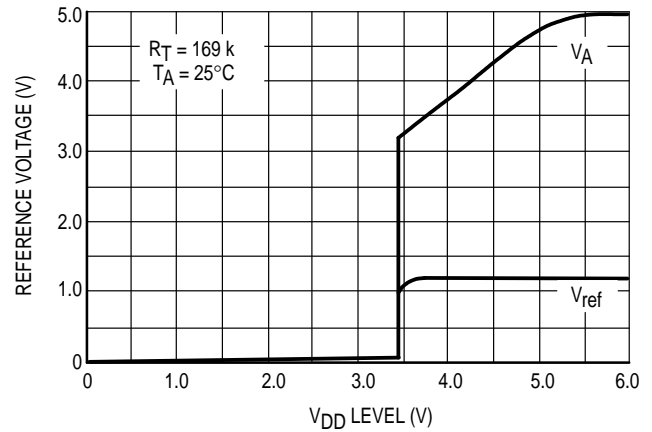


Figure 10.  $V_A$ ,  $V_{ref}$  versus  $V_{DD}$



### OPERATING DESCRIPTION

The MC34270 and MC34271 series are monolithic, fixed frequency power switching regulators specifically designed for dc to dc converter and battery powered applications. These devices operate as fixed frequency, voltage mode regulators containing all the active functions required to directly implement step-up, step-down and voltage inverting converters with a minimum number of external components. Potential markets include battery powered, handheld, automotive, computer, industrial and cost sensitive consumer products. A description of each section is given below with the representative block diagram shown in Figure 9.

#### Oscillator

The oscillator frequency is programmed by resistor  $R_T$ . The charge to discharge ratio is controlled to yield a 95% maximum duty cycle at the switch outputs. During the fall time of the internal sawtooth waveform, the oscillator generates an internal blanking pulse that holds the inverting input of the AND gates high, disabling the output switching MOSFETs. The internal sawtooth waveform has a nominal peak voltage of 3.3 V and a valley voltage of 1.7 V.

#### Pulse Width Modulators

Both pulse width modulators consist of a comparator with the oscillator ramp voltage applied to the noninverting input, while the error amplifier output is applied to the inverting input. A third input to the comparator has a 0.5 mA typical current source that can be used to implement soft start. Output switch conduction is initiated when the ramp waveform is discharged to the valley voltage. As the ramp voltage increases to a voltage that exceeds the error amplifier output, the latch resets, terminating output MOSFET conduction for the duration of the oscillator ramp. This PWM/latch combination prevents multiple output pulses during a given oscillator cycle.

Each PWM circuit is enabled by a logic input. When disabled, the entire block is turned off, drawing only leakage current from the power source. Shared circuits, like the

reference and oscillator, can be activated by either  $EN_1$  or  $EN_2$ .

Circuit #1 has an ELD output which may be used to drive an LCD or backlight. Its output frequency is the oscillator frequency divided by 1024.

#### Error Amplifiers and Reference

Each error amplifier is provided with access to both inverting and noninverting inputs, and the output. The Error Amplifiers' Common Mode Input Range is 0 to 2.5 V. The amplifiers have a minimum dc voltage gain of 60 dB. The 1.25 V reference has an accuracy of  $\pm 4.0\%$  at room temperature.

External loop compensation is required for converter stability. A simple low-pass filter is formed by connecting a resistive divider from the output to the error amplifier inverting input, and a series resistor-capacitor from the error amplifier output also to the inverting input. The step down converter is easiest to compensate for stability. The step-up and voltage inverting configurations, when operated as continuous conduction boost or flyback converters, are more difficult to compensate, and may require a lower loop design bandwidth.

#### MOSFET Switch Outputs

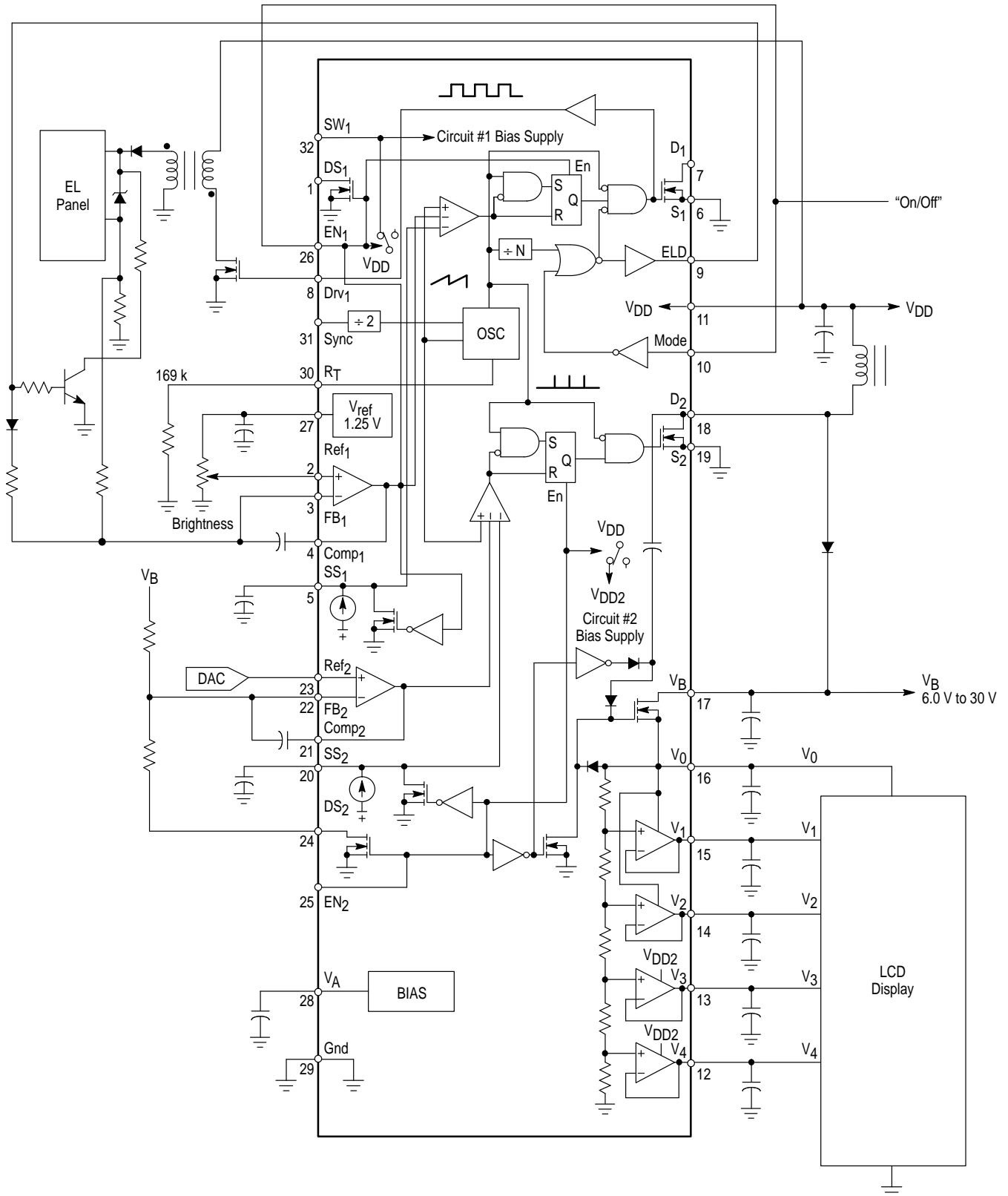
The output MOSFETs are designed to switch a maximum of 60 V, with a peak drain current capability of 500 mA. In circuit #1 an additional  $DRV_1$  output is provided for interfacing with an external MOSFET. The gates of the MOSFETs are held low when the circuit is disabled.

#### Auxiliary Output Voltages

Output voltages  $V_0$  through  $V_4$  are provided for use as references or bias voltages.  $V_0$  is the circuit #2 output voltage, when an internal FET switch is activated. The other auxiliary output voltages are proportional to  $V_B$ . The amplifiers for  $V_1$  and  $V_2$  are powered from  $V_0$ , while the amplifiers for  $V_3$  and  $V_4$  are powered from  $V_{DD}$ .

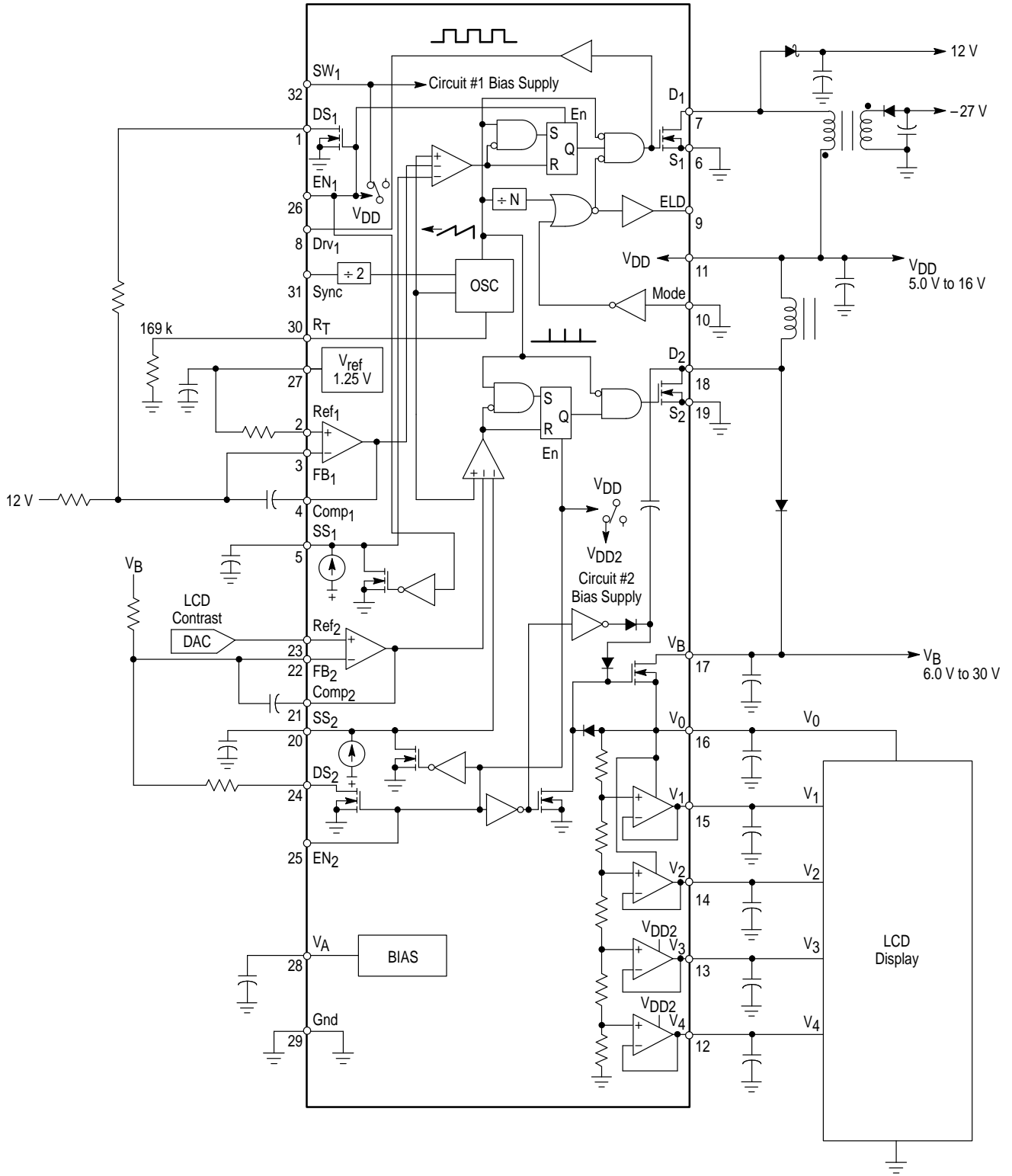
# MC34270 MC34271

Figure 11. Representative Block Diagram Electroluminescent Backlight Configuration



# MC34270 MC34271

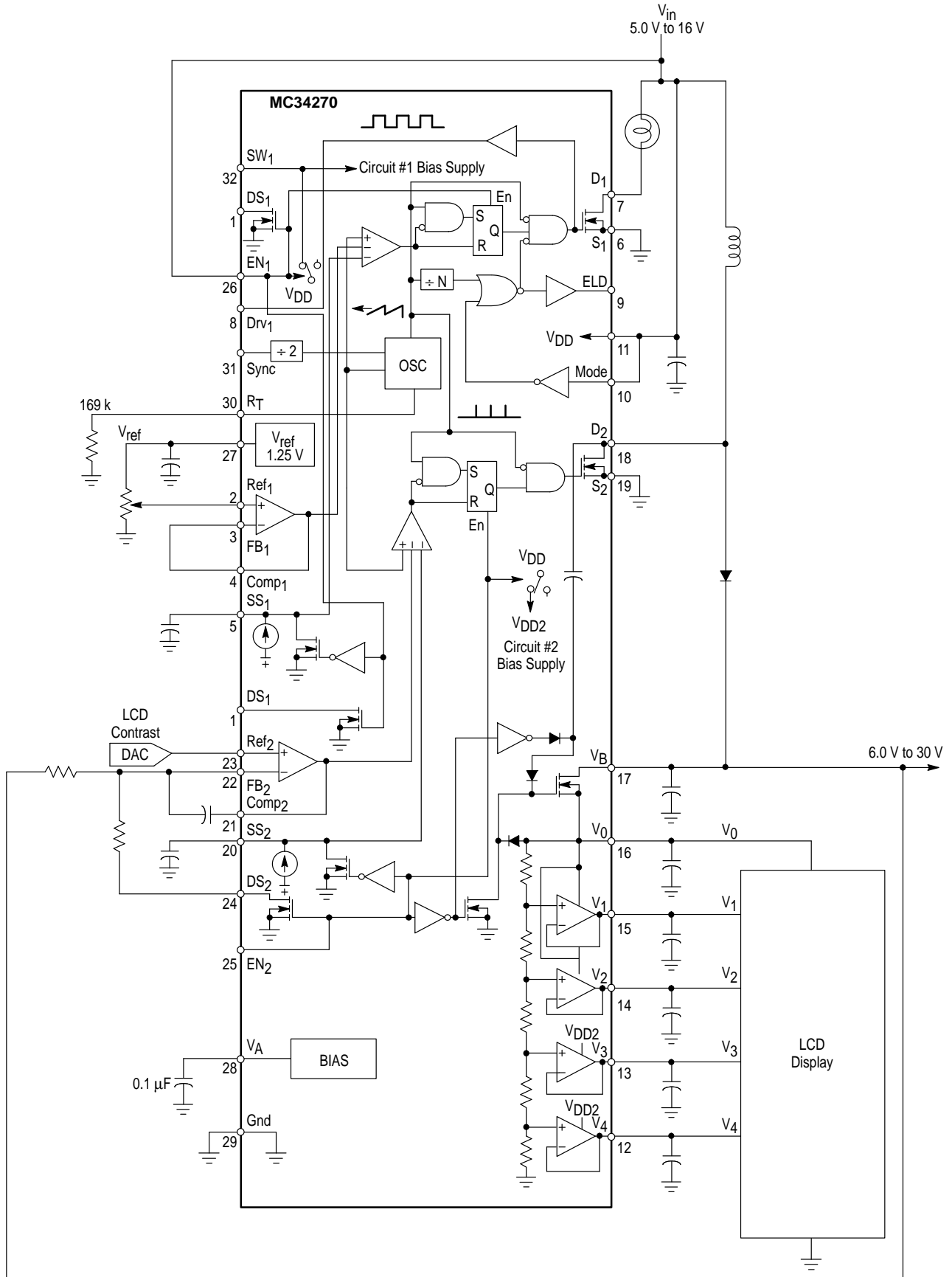
Figure 12. Auxiliary Supply Configuration





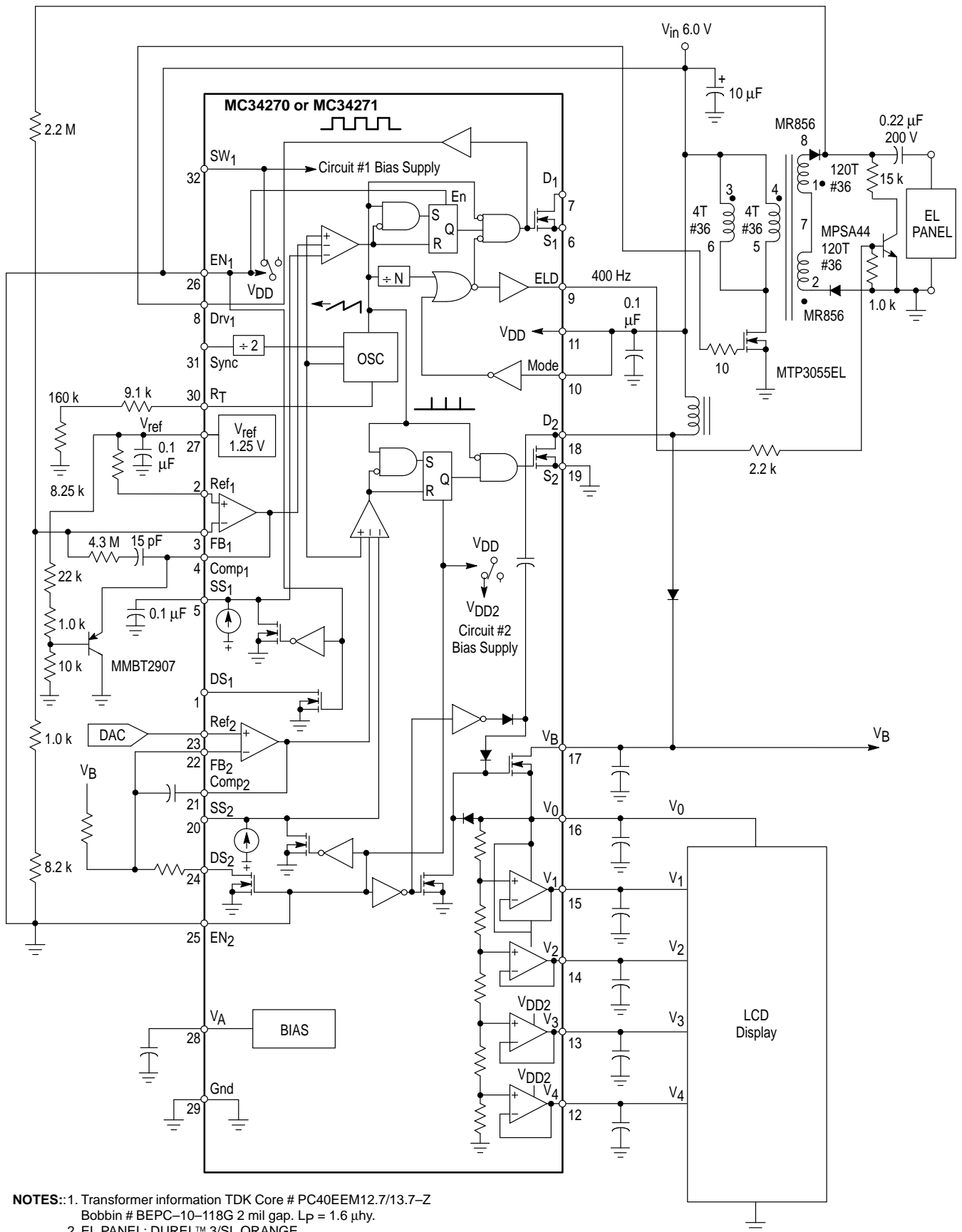
# MC34270 MC34271

Figure 13. MC34270 Incandescent Backlight Configuration



# MC34270 MC34271

Figure 14. EL PANEL Drive Circuit

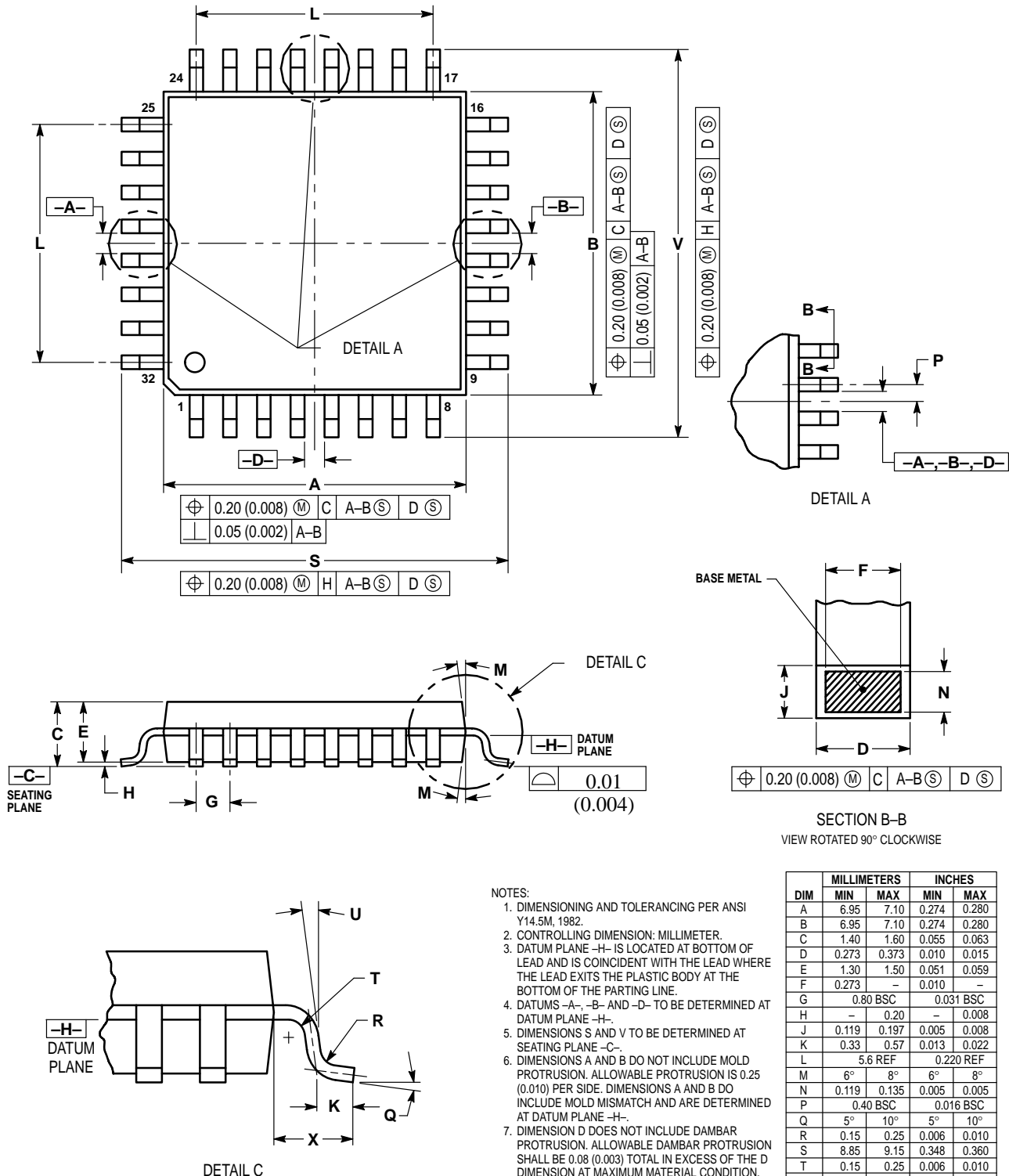


**NOTES:** 1. Transformer information TDK Core # PC40EEM12.7/13.7-Z  
 Bobbin # BEPC-10-118G 2 mil gap. Lp = 1.6 µhy.  
 2. EL PANEL: DUREL™ 3/SL ORANGE

# MC34270 MC34271

## OUTLINE DIMENSIONS

FB SUFFIX  
PLASTIC PACKAGE  
CASE 873-01




### NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- DATUM PLANE -H- IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
- DATUMS -A-, -B- AND -D- TO BE DETERMINED AT DATUM PLANE -H-.
- DIMENSIONS S AND V TO BE DETERMINED AT SEATING PLANE -C-.
- DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 (0.010) PER SIDE. DIMENSIONS A AND B DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
- DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.95	7.10	0.274	0.280
B	6.95	7.10	0.274	0.280
C	1.40	1.60	0.055	0.063
D	0.273	0.373	0.010	0.015
E	1.30	1.50	0.051	0.059
F	0.273	-	0.010	-
G	0.80 BSC		0.031 BSC	
H	-	0.20	-	0.008
J	0.119	0.197	0.005	0.008
K	0.33	0.57	0.013	0.022
L	5.6 REF		0.220 REF	
M	6°	8°	6°	8°
N	0.119	0.135	0.005	0.005
P	0.40 BSC		0.016 BSC	
Q	5°	10°	5°	10°
R	0.15	0.25	0.006	0.010
S	8.85	9.15	0.348	0.360
T	0.15	0.25	0.006	0.010
U	5°	11°	5°	11°
V	8.85	9.15	0.348	0.360
X	1.0 REF		0.039 REF	

## MC34270 MC34271

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

**How to reach us:**

**USA/EUROPE/Locations Not Listed:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

**MFAX:** RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609  
**INTERNET:** <http://Design-NET.com>

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,  
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

**ASIA/PACIFIC:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298



MOTOROLA