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May 1997

ML4823

High Frequency Power Supply Controller

GENERAL DESCRIPTION

The ML4823 High Frequency PWM Controller is an IC controller optimized for use in Switch Mode Power Supply designs running at frequencies to 1MHz. Propagation delays are minimal through the comparators and logic for reliable high frequency operation while slew rate and bandwidth are maximized on the error amplifier. This controller is designed for single-ended applications using voltage or current mode and provides for input voltage feed forward.

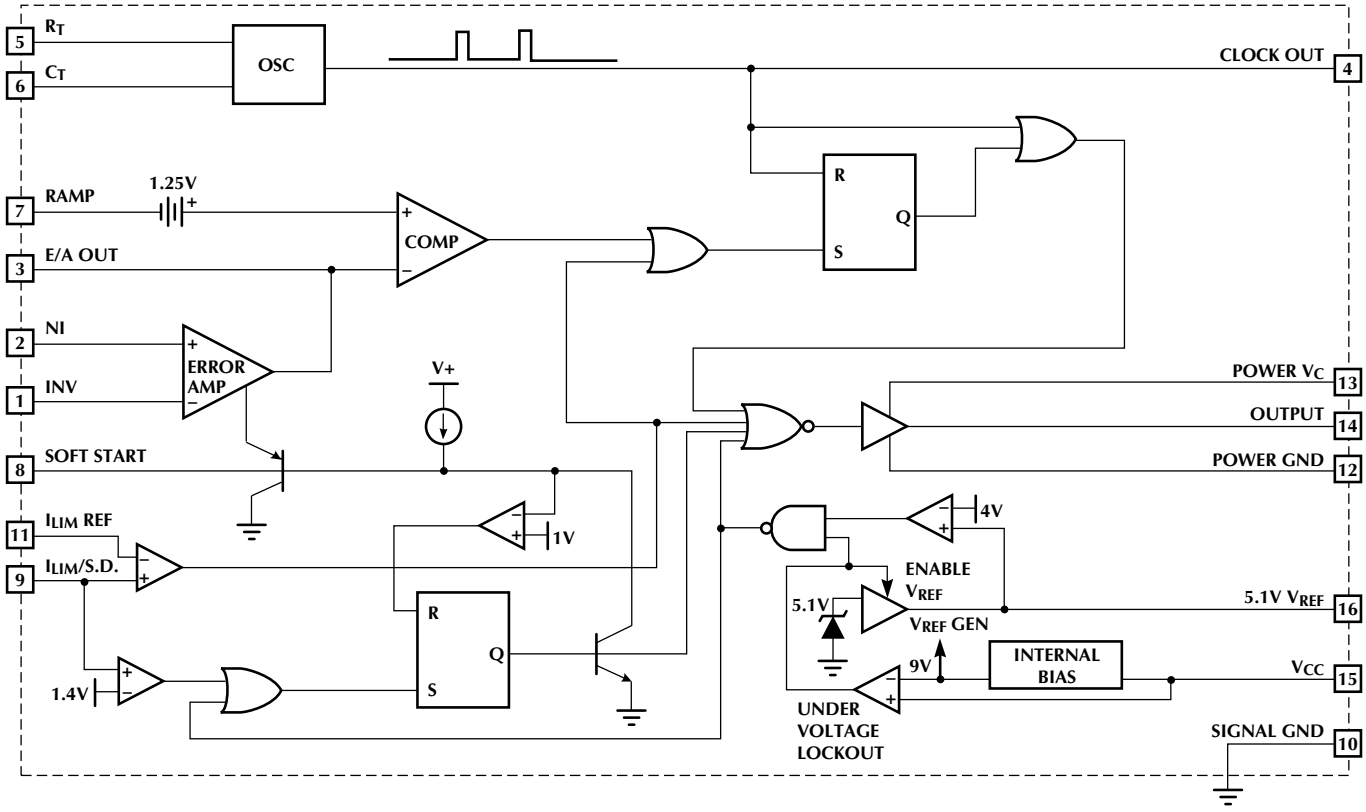
A 1V threshold current limit comparator provides cycle-by-cycle current limit and exceeding a 1.4V threshold initiates a soft-start cycle. The soft start pin doubles as a maximum duty cycle clamp. All logic is fully latched to provide jitter-free operation and prevent multiple pulsing. An under-voltage lockout circuit with 800mV of hysteresis assures low startup current and drives the outputs low during fault conditions.

This controller is an improved second source for the UC3823 controller; however, the ML4823 includes features not found on the 3823. These features are set in italics.

FEATURES

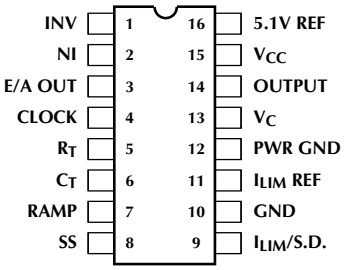
- Practical operation at switching frequencies to 1.0MHz
- High current (2A peak) totem pole output
- Wide bandwidth error amplifier
- Fully latched logic with double pulse suppression
- Pulse-by-pulse current limiting
- Soft start and max. duty cycle control
- Under voltage lockout with hysteresis
- 5.1V trimmed bandgap reference
- Low start-up current (1.1mA)
- Pin compatible improved replacement for UC3823
- Fast shut down path from current limit to output
- Soft start latch ensures full soft start cycle
- Outputs pull low for undervoltage lockout

BLOCK DIAGRAM (Pin Configuration Shown for 16-Pin Version)



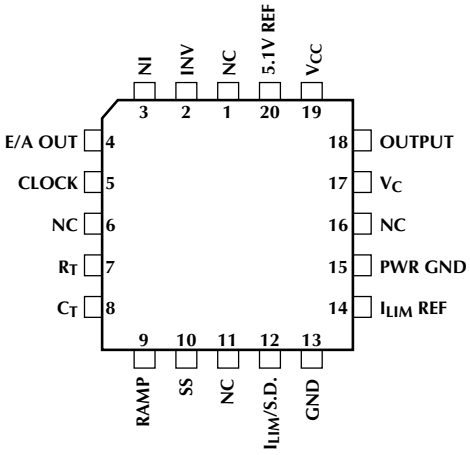
PIN CONFIGURATION

ML4823
16-PIN DIP (P16)
16-PIN SOIC (S16W)



TOP VIEW

ML4823
20-PIN PLCC (Q20)



TOP VIEW

PIN DESCRIPTION (Pin Numbers in Parentheses are for PLCC Version)

PIN	NAME	FUNCTION
1 (2)	INV	Inverting input to error amp.
2 (3)	NI	Non-inverting input to error amp.
3 (4)	E/A OUT	Output of error amplifier and input to main comparator.
4 (5)	CLOCK	Oscillator output.
5 (7)	R_T	Timing resistor for oscillator — sets charging current for oscillator timing capacitor (pin 6).
6 (8)	C_T	Timing capacitor for oscillator.
7 (9)	RAMP	Non-inverting input to main comparator. Connected to C_T for Voltage mode operation or to current sense resistor for current mode.
8 (10)	SS	Normally connected to soft start capacitor.
9 (12)	I_{LIM}/S.D.	Current limit sense pin. Normally connected to current sense resistor.
10 (13)	GND	Analog signal ground.
11 (14)	I_{LIM} REF	Reference input for cycle-by-cycle current limit comparator.
12 (15)	PWR GND	Return for the high current totem pole output.
13 (17)	V_C	Positive supply for the high current totem pole output.
14 (18)	OUT B	High current totem pole output.
15 (19)	V_{CC}	Positive supply for the IC.
16 (20)	5.1V REF	Buffered output for the 5.1V voltage reference.

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

Supply Voltage (V_C, V_{CC}) 30V
OUTPUT Current, Source or Sink
  DC 0.5A
  Pulse (0.5µs) 2.0A
Analog Inputs
  (INV, NI, RAMP, SS, I_{LIM}) ..... GND –0.3V to 6V
CLOCK OUTPUT Current ..... –5mA
F/A OUT Current 5mA
SOFT START Sink Current 20mA
R_T Charging Current ..... –5mA

Junction Temperature ..... 125°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering 10 sec.) ..... 260°C
Thermal Resistance (θ_{JA})
  Plastic DIP ..... 80°C/W
  Plastic SOIC ..... 105°C/W
  Plastic Chip Carrier (PLCC) ..... 78°C/W

OPERATING CONDITIONS

Temperature Range
  ML4823C ..... 0°C to 70°C
  ML4823I ..... –40°C to 85°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, R_T = 3.65kΩ, C_T = 1000pF, T_A = Operating Temperature Range, V_{CC} = 15V. (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
OSCILLATOR					
Initial Accuracy	T_J = 25°C,	360	400	440	kHz
Voltage Stability	10V ≤ V_{CC} ≤ 30V,		0.2	2	%
Temperature Stability			5		%
Total Variation	Line, temp.	340		460	kHz
Clock Out High		3.9	4.5		V
Clock Out Low			2.3	2.9	V
Ramp Peak		2.6	2.8	3.0	V
Ramp Valley		0.7	1.0	1.25	V
Ramp Valley to Peak		1.6	1.8	2.0	V
REFERENCE					
Output Voltage	T_J = 25°C, I_O = 1mA	5.025	5.10	5.175	V
Line Regulation	10V ≤ V_{CC} ≤ 30V		2	20	mV
Load Regulation	1mA ≤ I_O ≤ 10mA		5	20	mV
Temperature Stability	–40°C ≤ T_J ≤ 150°C,		0.2	0.4	%
Total Variation	Line, load, temp.	4.975		5.225	V
Output Noise Voltage	10Hz to 10kHz		50		µV
Long Term Stability	T_J = 125°C, 1000 hrs,		5	25	mV
Short Circuit Current	V_{REF} = 0V	–15	–50	–100	mA
ERROR AMPLIFIER					
Input Offset Voltage				±30	mV
Input Bias Current			0.6	3	µA
Input Offset Current			0.1	1	µA
Open Loop Gain	1 ≤ V_O ≤ 4V	50	95		dB

ELECTRICAL CHARACTERISTICS (Continued)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
ERROR AMPLIFIER (Continued)					
CMRR	$1.5 \le V_{CC} \le 5.5V$	50	80		dB
PSRR	$10 \le V_{CC} \le 30V$	70	100		dB
Output Sink Current	$V_{E/A\ OUT}$ = 1V	1	2.5		mA
Output Source Current	$V_{E/A\ OUT}$ = 4V	–0.5	–1.3		mA
Output High Voltage	$I_{E/A\ OUT}$ = –0.5mA	4.0	4.7	5.0	V
Output Low Voltage	$I_{E/A\ OUT}$ = 1mA	0	0.5	1.0	V
Unity Gain Bandwidth		3	5.5		MHz
Slew Rate		6	12		V/µs
PWM COMPARATOR					
RAMP Bias Current	V_{RAMP} = 0V		–1	–5	µA
Duty Cycle Range		0		80	%
E/A OUT Zero DC Threshold	V_{RAMP} = 0V	1.1	1.25		V
Delay to Output			50	80	ns
SOFT START					
Charge Current	$V_{SOFT\ START}$ = 0.5V	3	9	20	µA
Discharge Current	$V_{SOFT\ START}$ = 1V	1			mA
CURRENT LIMIT/SHUTDOWN					
I_{LIM} Bias Current	$0V \le I_{LIM} \le 4V$			±10	µA
Current Limit Offset	I_{LIM} REF = 1.1V	0		15	mV
I_{LIM} REF Common Mode Range		1.0		1.25	V
Shutdown Threshold		1.25	1.40	1.55	V
Delay to Output			50	80	ns
OUTPUT					
Output Low Level	I_{OUT} = 20mA		0.25	0.40	V
	I_{OUT} = 200mA		1.2	2.2	V
Output High Level	I_{OUT} = –20mA	12.8	13.5		V
	I_{OUT} = –200mA	12.0	13.0		V
Collector Leakage	V_C = 30V		100	500	µA
Rise/Fall Time	C_L = 1000pF		30	60	ns
UNDER VOLTAGE LOCKOUT					
Start Threshold		8.8	9.2	9.7	V
UVLO Hysteresis		0.4	0.8	1.2	V
SUPPLY					
Start Up Current	V_{CC} = 8V		1.1	2.5	mA
I_{CC}	INV, RANP, I_{LIM} = 0V NI = 1V		22	33	mA

Note 1: Limits are guaranteed by 100% testing, sampling, or correlation with worst-case test conditions.

FUNCTIONAL DESCRIPTION

OSCILLATOR

The ML4823 oscillator charges the external capacitor (C_T) with a current (I_{SET}) equal to $3/R_{SET}$. When the capacitor voltage reaches the upper threshold (Ramp Peak), the comparator changes state and the capacitor discharges to the lower threshold (Ramp Valley) through Q1. While the capacitor is discharging, Q2 provides a high pulse.

The oscillator period can be described by the following relationship:

$$T_{OSC} = T_{RAMP} + T_{DEADTIME}$$

where: $T_{RAMP} = C$ (Ramp Valley to Peak)/I_{SET}

and: $T_{DEADTIME} = C$ (Ramp Valley to Peak)/I_{Q1}

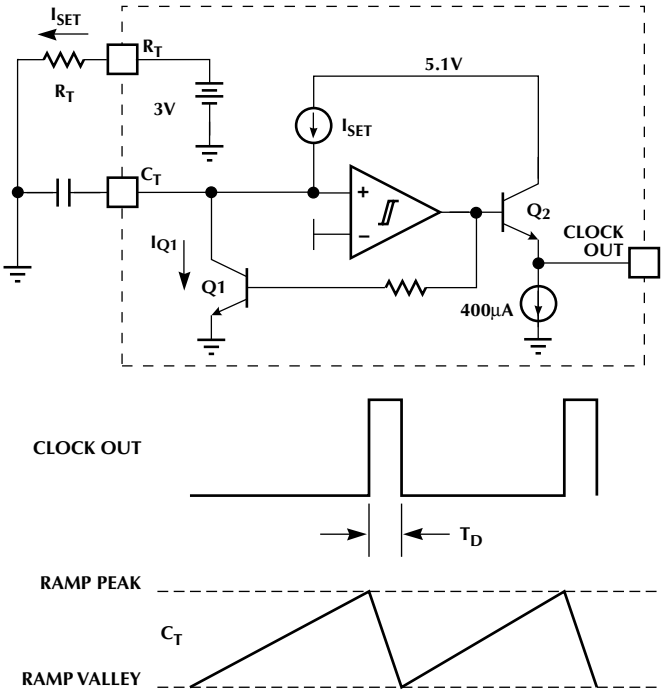


Figure 1. Oscillator Block Diagram

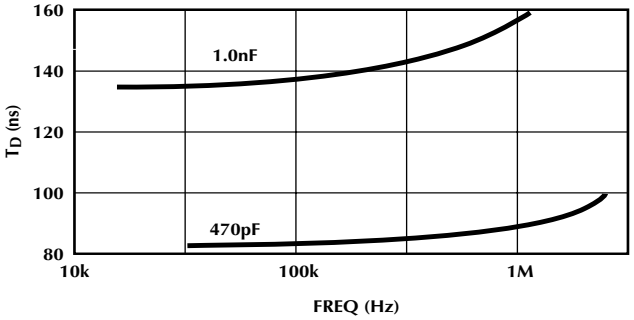


Figure 3. Oscillator Deadtime vs Frequency

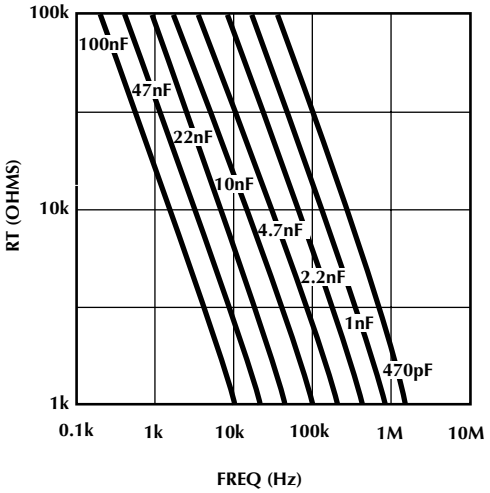


Figure 2. Oscillator Timing Resistance vs Frequency

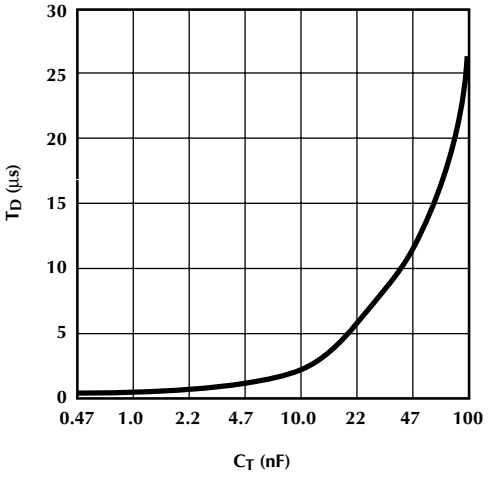


Figure 4. Oscillator Deadtime vs C_T (3kÝ - R_T - 100kÝ)

ERROR AMPLIFIER

The ML4823 error amplifier is a 5.5MHz bandwidth 12V/µs slew rate op-amp with provision for limiting the positive output voltage swing (Output Inhibit line) for ease in implementing the soft start function.

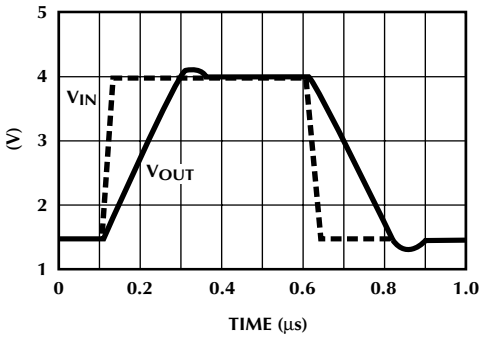


Figure 5. Unity Gain Slew Rate

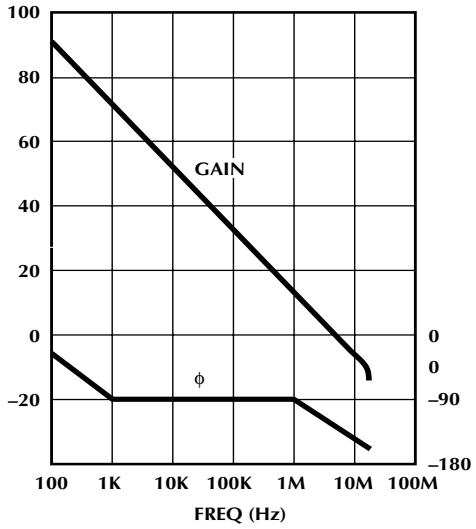


Figure 6. Open Loop Frequency Response

OUTPUT DRIVER STAGE

The ML4823 Output Driver is a 2A peak output high speed totem pole circuit designed to quickly switch the gates of capacitive loads, such as power MOSFET transistors.

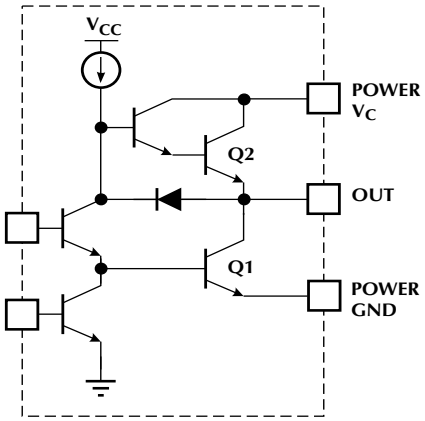


Figure 7. Simplified Schematic

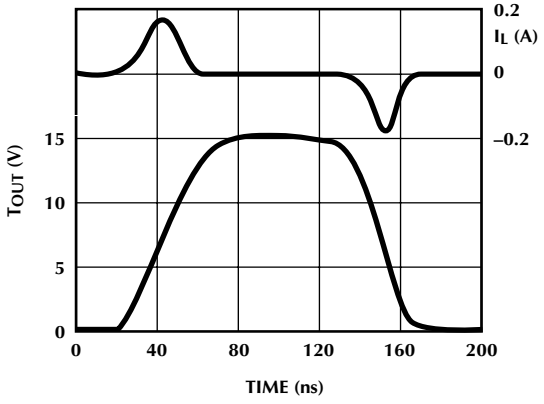


Figure 9. Rise/Fall Time (C_L = 1000pF)

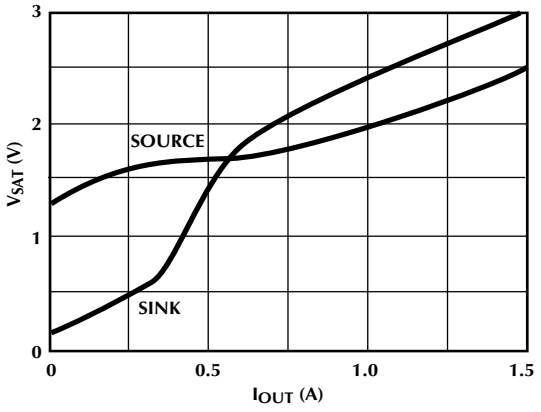


Figure 8. Saturation Curves

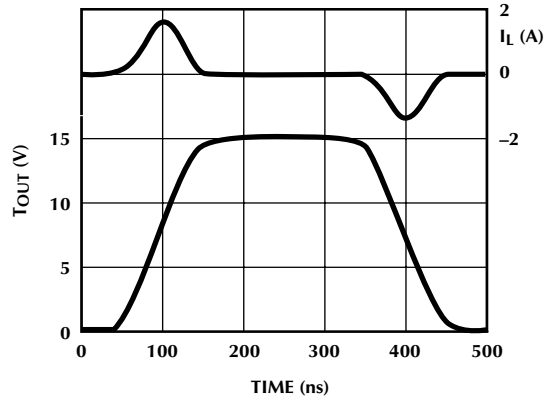


Figure 10 Rise/Fall Time (C_L = 10,000pF)

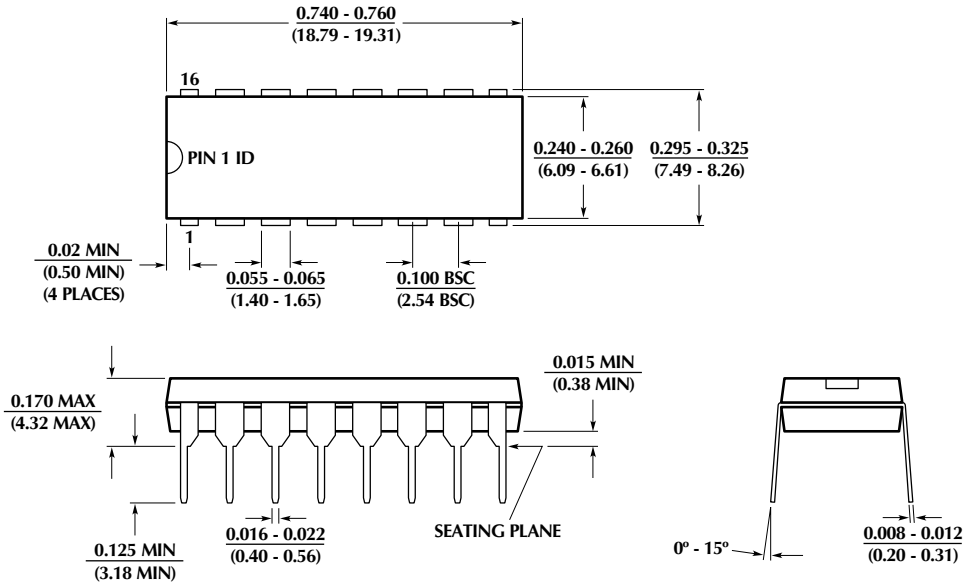
SOFT START AND CURRENT LIMIT

The ML4823 employs two current limits. When the voltage at I_{LIM}/SD exceeds the I_{LIM} REF threshold on I_{LIM} REF, the outputs are immediately shut off and the cycle is terminated for the remainder of the oscillator period by resetting the RS flip flop.

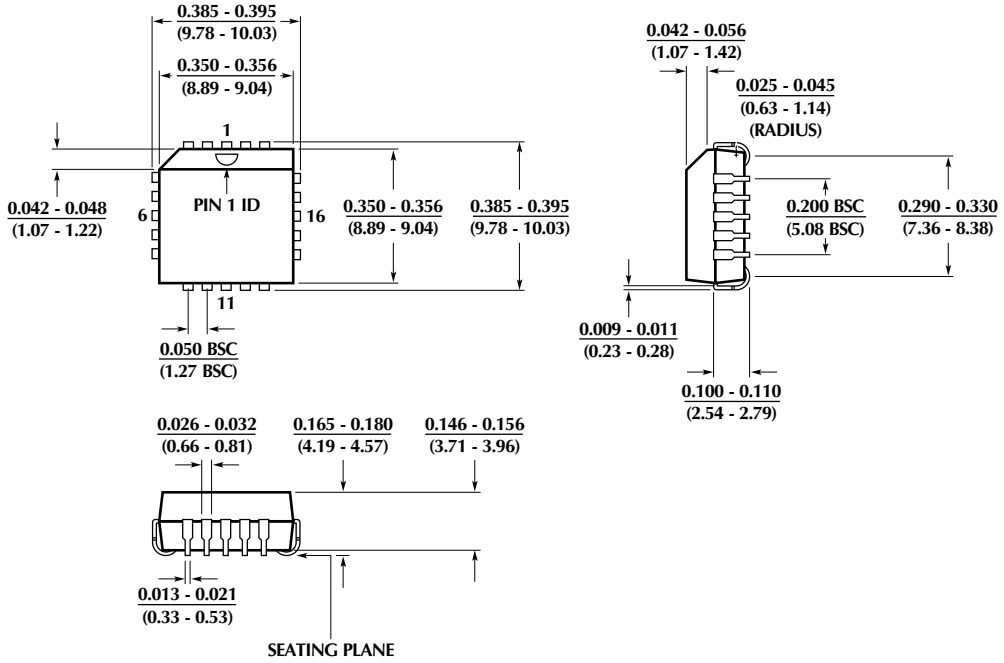
If the output current is rising quickly (usually due to transformer saturation) such that the voltage on pin 9 reaches 1.4V before the outputs have turned off, a soft start cycle is initiated. The soft start capacitor is discharged and outputs are held "off" until the voltage at SS reaches 1V, ensuring a complete soft start cycle. The duty cycle on start up is limited by limiting the output voltage of the error amplifier voltage to the voltage at the SS pin.

PHYSICAL DIMENSIONS inches (millimeters)

Package: P16
16-Pin PDIP

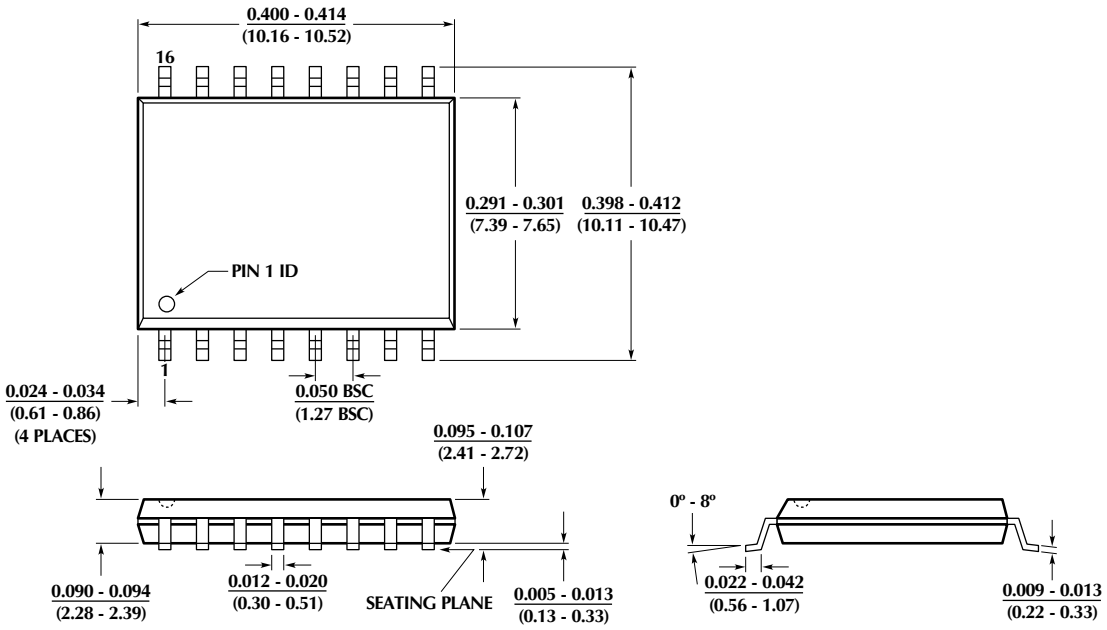


Package: Q20
20-Pin PLCC



PHYSICAL DIMENSIONS inches (millimeters)

Package: S16W
16-Pin Wide SOIC



ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE
ML4823CP	0°C to 70°C	16-Pin PDIP (P16)
ML4823CQ	0°C to 70°C	20-Pin PLCC (Q20)
ML4823CS	0°C to 70°C	20-Pin Wide SOIC (S16W)
ML4823IQ	–40°C to 85°C	16-Pin PDIP (P16)
ML4823IS	–40°C to 85°C	20-Pin PLCC (Q20)
ML4823MJ	–40°C to 85°C	16-Pin Wide SOIC (S16W)

ML4823

High Frequency Power Supply Controller

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Features

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- Wide bandwidth error amplifier
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- Soft start and max. duty cycle control
- Under voltage lockout with hysteresis
- 5.1V trimmed bandgap reference
- Low start-up current (1.1mA)
- Pin compatible improved replacement for UC3823
- Fast shut down path from current limit to output
- Soft start latch ensures full soft start cycle
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Product status/pricing/packaging

Product	Product status	Pricing*	Package type	Leads	Package marking	Packing method
ML4823ISX	Full Production	$3.56	SOIC-Wide	16	$Y&Z&2&T ML4823IS	TAPE REEL
ML4823IP	Full Production	$2.51	DIP	16	$Y&Z&4&T ML4823IP	RAIL
ML4823CS	Full Production	$2.34	SOIC-Wide	16	$Y&Z&2&T ML4823CS	RAIL
ML4823IS	Full Production	$3.49	SOIC-Wide	16	$Y&Z&2&T ML4823IS	RAIL
ML4823CSX	Full Production	$2.41	SOIC-Wide	16	$Y&Z&2&T ML4823CS	TAPE REEL
ML4823CP	Full Production	$2.21	DIP	16	$Y&Z&4&T ML4823CP	RAIL

* 1,000 piece Budgetary Pricing

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Application notes

AB-28: AB-28 Power Conversion for the Data Communications Market
(333 K) Jul 19, 2002

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