MICREL

The Infinite Bandwidth Company™

General Description

The MIC38HC4x family are fixed frequency current-mode PWM controllers with 1A drive current capability. Micrel's BiCMOS devices are pin-compatible with 384x bipolar devices. Their high output drive, with fast rise and fall times, combined with low startup current make it an ideal PWM controller where high efficiency is required.

Undervoltage lockout circuitry allows the '42 and '44 versions to start up at 14.5V and operate down to 9V, and the '43 and '45 versions start at 8.4V with operation down to 7.6V. All versions operate up to 20V.

When compared to bipolar UC384x devices operating from a 15V supply, start-up current has been reduced to 50µA typical and operating current has been reduced to 4.0 mA typical. Decreased output rise and fall times drive larger MOSFETs, and rail-to-rail output capability increases efficiency, especially at lower supply voltages. The MIC38HC4x also features a trimmed oscillator discharge current and bandgap reference.

MIC38HC4x-1 is available in 14-pin plastic DIP and SOIC packages. 8-pin devices feature small size, while 14-pin devices separate the analog and power connections for improved performance and power dissipation.

Features

- Fast 20ns output rise and 15ns output fall times
- −40°C to +85°C temperature range
    exceeds UC284x specifications
- High-performance, low-power BiCMOS Process
- Ultralow start-up current (50µA typical)
- Low operating current (4mA typical)
- High output drive (1A peak current, HC version)
- CMOS outputs with rail-to-rail swing
- Current-mode operation up to 500kHz
- Trimmed 5V bandgap reference
- Pin-for-pin compatible with UC3842/3843/3844/3845(A)
- Trimmed oscillator discharge current
- UVLO with hysteresis
- Low cross-conduction currents

Applications

- Current-mode, off-line, switched-mode power supplies
- Current-mode, dc-to-dc converters.
- Step-down "buck" regulators
- Step-up "boost" regulators
- Flyback, isolated regulators
- Forward converters
- Synchronous FET converters

Functional Diagram
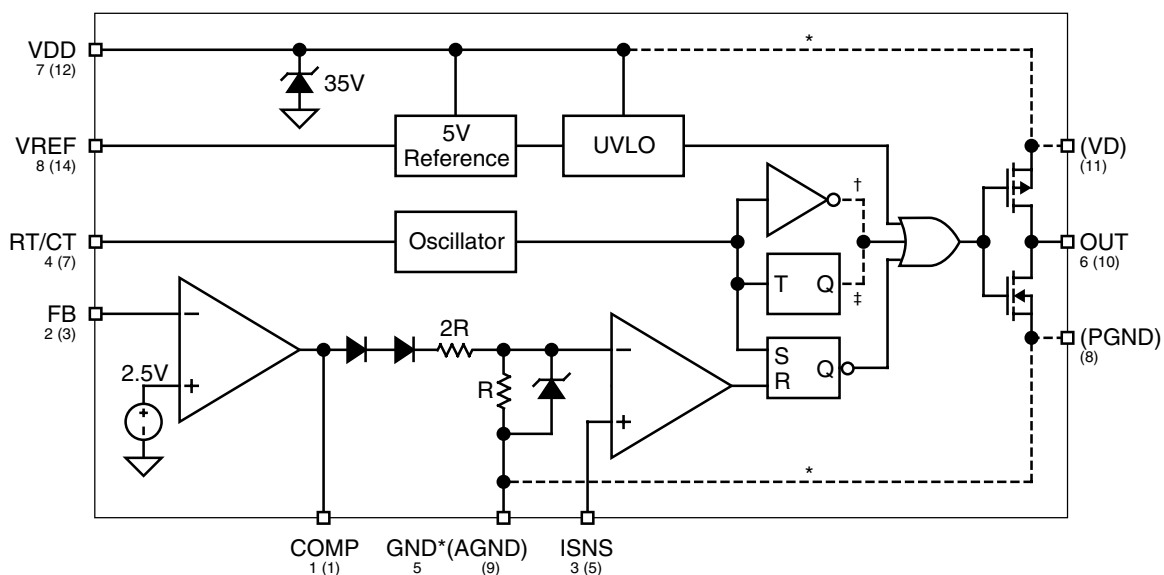
( ) pins are on MIC38HC4x-1 (14-lead) versions only
* MIC38HC4x (8-lead) versions only
† MIC38HC42, MIC38HC43 (96% max. duty cycle) versions only
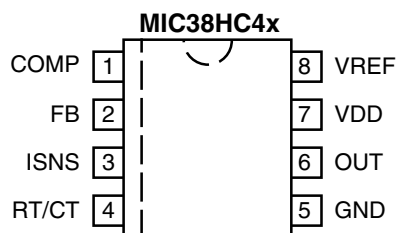‡ MIC38HC44, MIC38HC45 (50% max. duty cycle) versions only

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Ordering Information

Part Number	Temperature Range	Package
MIC38HC42BN	–40°C to +85°C	8-pin Plastic DIP
MIC38HC43BN	–40°C to +85°C	8-pin Plastic DIP
MIC38HC44BN	–40°C to +85°C	8-pin Plastic DIP
MIC38HC45BN	–40°C to +85°C	8-pin Plastic DIP
MIC38HC42-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38HC43-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38HC44-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38HC45-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38HC42BM	–40°C to +85°C	8-pin SOIC
MIC38HC43BM	–40°C to +85°C	8-pin SOIC
MIC38HC44BM	–40°C to +85°C	8-pin SOIC
MIC38HC45BM	–40°C to +85°C	8-pin SOIC
MIC38HC42-1BM	–40°C to +85°C	14-pin SOIC
MIC38HC43-1BM	–40°C to +85°C	14-pin SOIC
MIC38HC44-1BM	–40°C to +85°C	14-pin SOIC
MIC38HC45-1BM	–40°C to +85°C	14-pin SOIC

Selection Guide

	UVLO Thresholds	
Duty Cycle	Startup 8.4V Minimum Operating 7.6V	Startup 14.5V Minimum Operating 9V
0% to 96%	MIC38HC43	MIC38HC42
0% to 50%	MIC38HC45	MIC38HC44

Pin Configuration

MIC38HC4x-1

COMP	1		14	VREF
NC	2		13	NC
FB	3		12	VDD
NC	4		11	VD
ISNS	5		10	OUT
NC	6		9	AGND
RT/CT	7		8	PGND

MIC38HC4x

COMP	1		8	VREF
FB	2		7	VDD
ISNS	3		6	OUT
RT/CT	4		5	GND

8-Pin DIP (N)
8-Lead SOIC (M)
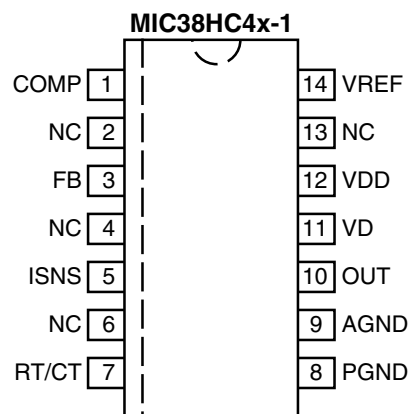
14-Pin DIP (-1BN)
14-Lead SOIC (-1BM)

Pin Description

Pin Number N, M, MM	Pin Number -1BN, -1BM	Pin Name	Pin Function
1	1	COMP	Compensation: Connect external compensation network to modify the error amplifier output.
	2	NC	Not internally connected.
2	3	FB	Feedback (Input): Error amplifier input. Feedback is 2.5V at desired output voltage.
	4	NC	Not internally connected.
3	5	ISNS	Current Sense (Input): Current sense comparator input. Connect to current sensing resistor or current transformer.
	6	NC	Not internally connected.
4	7	RT/CT	Timing Resistor/Timing Capacitor: Connect external RC network to select switching frequency.
5		GND	Ground: Combined analog and power ground.
	8	PGND	Power Ground: N-channel driver transistor ground.
	9	AGND	Analog Ground: Controller circuitry ground.
6	10	OUT	Power Output: Totem-pole output.
	11	VD	Power Supply (Input): P-channel driver transistor supply input. Return to power ground (PGND).
7	12	VDD	Analog Supply (Input): Controller circuitry supply input. Return to analog ground (AGND).
	13	NC	Not internally connected.
8	14	VREF	5V Reference (Output): Connect external RC network.

Absolute Maximum Ratings

Zener Current (V$_{DD}$) 30mA

**Operation at ≥18V may require
special precautions (Note 6).**

Supply Voltage (V$_{DD}$), **Note 6** 20V
Switch Supply Voltage (V$_D$) 20V
Current Sense Voltage (V$_{ISNS}$) ....–0.3V to 5.5V
Feedback Voltage (V$_{FB}$) ....–0.3V to 5.5V
Output Current, 38HC42/3/4/5 (I$_{OUT}$) 1A

Operating Junction Temperature (T$_J$) ....150°C
Package Thermal Resistance
  8-Pin Plastic DIP (θ$_{JA}$) ....125°C/W
  8-Pin MM8™ (θ$_{JA}$) ....250°C/W
  8-Pin SOIC (θ$_{JA}$) ....170°C/W
  14-Pin Plastic DIP (θ$_{JA}$) ....90°C/W
  14-Pin SOIC (θ$_{JA}$) ....145°C/W
Storage Temperature (T$_A$) ....–65°C to +150°C

Electrical Characteristics

V$_{DD}$ = 15V, **Note 4**; R$_T$ = 9.09kΩ; C$_T$ = 3.3nF; –40°C ≤ T$_A$ ≤ 85°C; unless noted

Parameter	Test Conditions	Min	Typ	Max	Units
Reference Section					
Output Voltage	T$_A$ = 25°C, I$_O$ = 1mA	4.90	5.00	5.10	V
Line Regulation	12V ≤ V$_{DD}$ ≤ 18V, I$_O$ = 5µA, **Note 6**		2	20	mV
Load Regulation	1 ≤ I$_O$ ≤ 20mA		1	25	mV
Temp. Stability	**Note 1**		0.2		mV/°C
Total Output Variation	Line, Load, Temp., **Note 1**	4.82		5.18	V
Output Noise Voltage	10Hz ≤ f ≤ 10kHz, T$_A$ = 25°C, **Note 1**		50		µV
Long Term Stability	T$_A$ = 125°C, 1000 hrs., **Note 1**		5	25	mV
Output Short Circuit		–30	–80	–180	mA
Oscillator Section					
Initial Accuracy	T$_A$ = 25°C, **Note 5**	49	52	55	kHz
Voltage Stability	12 ≤ V$_{DD}$ ≤ 18V, **Note 6**		0.2	1.0	%
Temp. Stability	T$_{MIN}$ ≤ T$_A$ ≤ T$_{MAX}$, **Note 1**		0.04		%/°C
Clock Ramp	T$_A$ = 25°C, V$_{RT/CT}$ = 2V	7.7	8.4	9.0	mA
Reset Current	T$_A$ = T$_{MIN}$ to T$_{MAX}$	7.2	8.4	9.5	mA
Amplitude	V$_{RT/CT}$ peak to peak		1.9		Vp-p
Error Amp Section					
Input Voltage	V$_{COMP}$ = 2.5V	2.42	2.50	2.58	V
Input Bias Current	V$_{FB}$ = 5.0V		–0.1	–2	µA
A$_{VOL}$	2 ≤ V$_O$ ≤ 4V	65	90		dB
Unity Gain Bandwidth	**Note 1**	0.7	1.0		MHz
PSRR	12 ≤ V$_{DD}$ ≤ 18V	60			dB
Output Sink Current	V$_{FB}$ = 2.7V, V$_{COMP}$ = 1.1V	2	14		mA
Output Source Current	V$_{FB}$ = 2.3V, V$_{COMP}$ = 5V	–0.5	–1		mA
V$_{OUT}$ High	V$_{FB}$ = 2.3V, R$_L$ = 15k to ground	5	6.8		V
V$_{OUT}$ Low	V$_{FB}$ = 2.7V, R$_L$ = 15k to V$_{REF}$		0.1	1.1	V

Parameter	Test Conditions	Min	Typ	Max	Units
Current Sense					
Gain	**Notes 2, 3**	2.85	3.0	3.15	V/V
MaximumThreshold	V_{COMP} = 5V, **Note 2**	0.9	1	1.1	V
PSRR	$12 \leq V_{DD} \leq 18V$, **Note 2**		70		dB
Input Bias Current			−0.1	−2	μA
Delay to Output			120	250	ns
Output					
$R_{DS(ON)}$ 'HC' High $R_{DS(ON)}$ 'HC' Low	I_{SOURCE} = 200mA I_{SINK} = 200mA		10 5.5		Ω Ω
Rise Time	T_A = 25°C, C_L = 1nF		20	50	ns
Fall Time	T_A = 25°C, C_L = 1nF		15	40	ns
Undervoltage Lockout					
Start Threshold	MIC38HC42/4	13.5	14.5	15.5	V
	MIC38HC43/5	7.8	8.4	9.0	V
Minimum Operating Voltage	MIC38HC42/4	8	9	10	V
	MIC38HC43/5	7.0	7.6	8.2	V
Pulse Width Modulator					
Maximum Duty Cycle	MIC38HC42/3	94	96		%
	MIC38HC44/5	46	50		%
Minimum Duty Cycle				0	%
Total Standby Current					
Start-Up Current	V_{DD} = 13V, 38HC42/44 V_{DD} = 7.5V, 38HC43/45		50	200	μA
Operating Supply Current	$V_{FB} = V_{ISNS}$ = 0V		4.0	6.0	mA
Zener Voltage (V_{DD})	I_{DD} = 25mA, **Note 6**	30	37		V

Note 1: These parameters, although guaranteed, are not 100% tested in production.
Note 2: Parameter measured at trip point of latch with V_{EA} = 0.
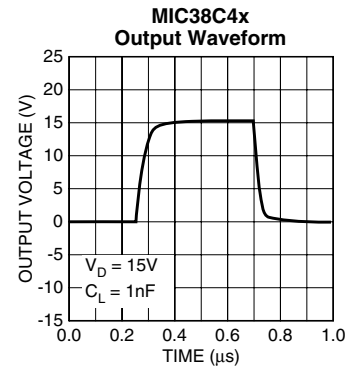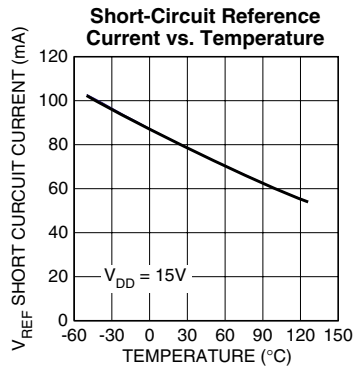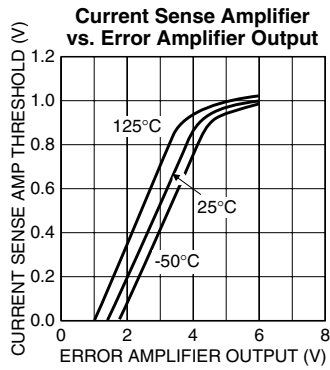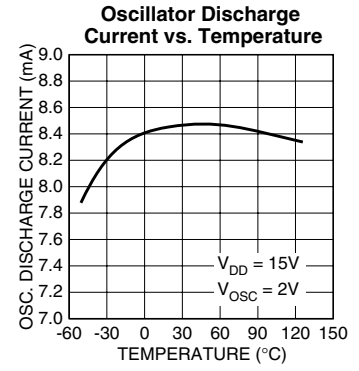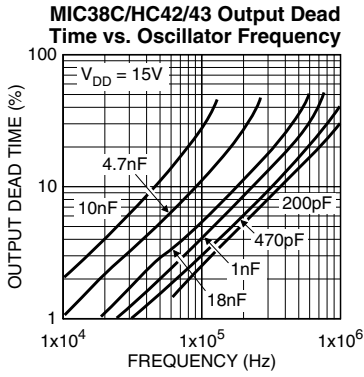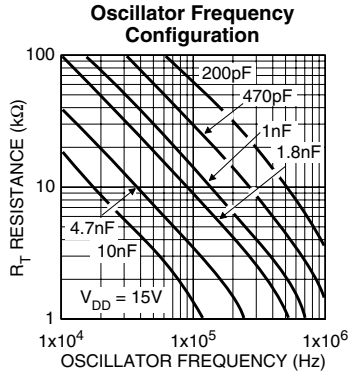**Note 3:** Gain defined as:

$$A = \frac{\Delta V_{PIN1}}{V_{TH}(I_{SNS})}; \quad 0 \leq V_{TH}(I_{SNS}) \leq 0.8V$$

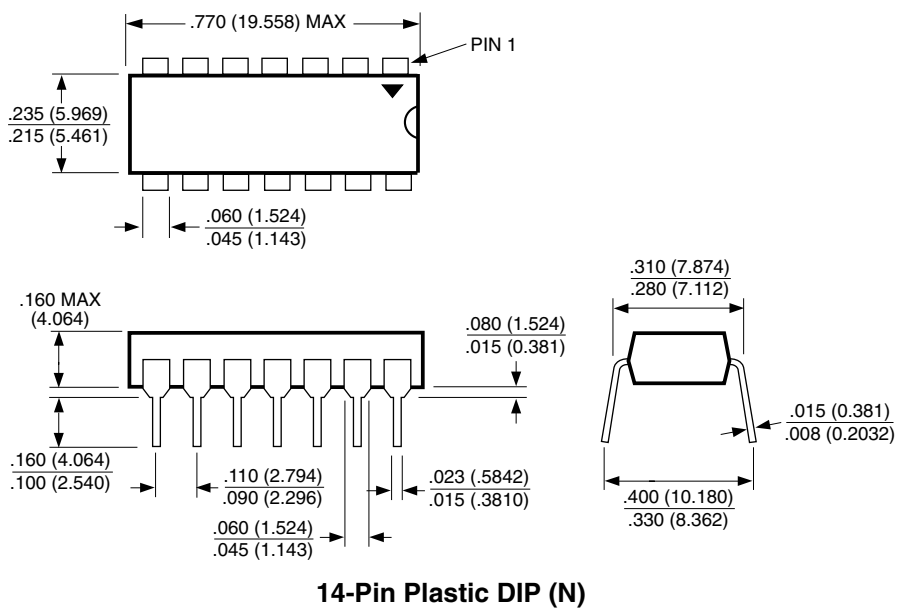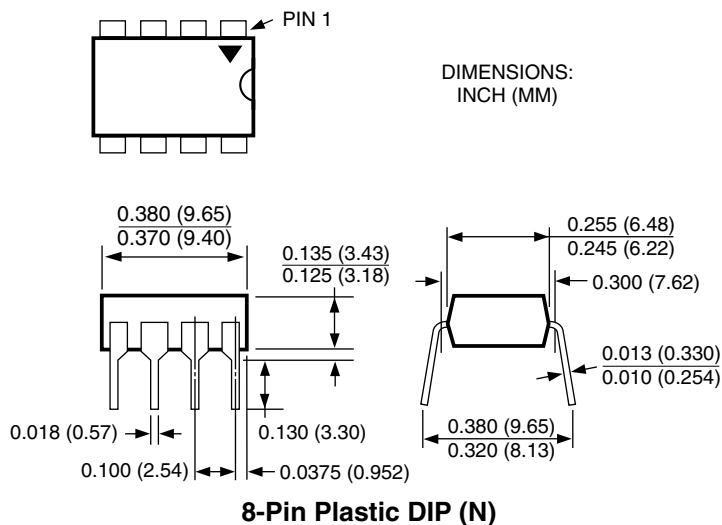**Note 4:** Adjust V_{DD} above the start threshold before setting at 15V.
Note 5: Output frequency equals oscillator frequency for the MIC38HC42 and MIC38HC43. Output frequency for the MIC38HC44, and MIC38HC45 equals one half the oscillator frequency.
Note 6: On 8-pin version, 20V is maximum input on pin 7, as this is also the supply pin for the output stage. On 14-pin version, 40V is maximum for pin 12 and 20V maximum for pin 11.

Typical Characteristics

Oscillator Frequency Configuration

MIC38C/HC42/43 Output Dead Time vs. Oscillator Frequency

Oscillator Discharge Current vs. Temperature

Current Sense Amplifier vs. Error Amplifier Output

Short-Circuit Reference Current vs. Temperature

MIC38C4x Output Waveform

Package Information

DIMENSIONS:
INCH (MM)

PIN 1

0.380 (9.65)
0.370 (9.40)

0.135 (3.43)
0.125 (3.18)

0.255 (6.48)
0.245 (6.22)

0.300 (7.62)

0.013 (0.330)
0.010 (0.254)

0.018 (0.57)

0.130 (3.30)

0.100 (2.54)

0.0375 (0.952)

0.380 (9.65)
0.320 (8.13)

8-Pin Plastic DIP (N)

.770 (19.558) MAX

PIN 1

.235 (5.969)
.215 (5.461)

.060 (1.524)
.045 (1.143)

.310 (7.874)
.280 (7.112)

.160 MAX
(4.064)

.080 (1.524)
.015 (0.381)

.015 (0.381)
.008 (0.2032)

.160 (4.064)
.100 (2.540)

.110 (2.794)
.090 (2.296)

.023 (.5842)
.015 (.3810)

.400 (10.180)
.330 (8.362)

.060 (1.524)
.045 (1.143)

14-Pin Plastic DIP (N)

0.026 (0.65)
MAX

0.157 (3.99)
0.150 (3.81)

PIN 1

DIMENSIONS:
INCHES (MM)

0.020 (0.51)
0.013 (0.33)

0.050 (1.27)
TYP

0.0098 (0.249)
0.0040 (0.102)

45°

0.010 (0.25)
0.007 (0.18)

0.197 (5.0)
0.189 (4.8)

SEATING
PLANE

0°–8°

0.050 (1.27)
0.016 (0.40)

0.064 (1.63)
0.045 (1.14)

0.244 (6.20)
0.228 (5.79)

8-Pin SOIC (M)

PIN 1

0.154 (3.90)

DIMENSIONS:
INCHES (MM)

0.026 (0.65)
MAX

0.050 (1.27)
TYP

0.016 (0.40)
TYP

0.006 (0.15)

0.193 (4.90)

45°

3°–6°

0.344 (8.75)
0.337 (8.55)

SEATING
PLANE

0.244 (6.20)
0.228 (5.80)

0.057 (1.45)
0.049 (1.25)

14-Pin SOIC (M)