# MIC38HC42/3/4/5

## BiCMOS 1A Current-Mode PWM Controllers

## 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.

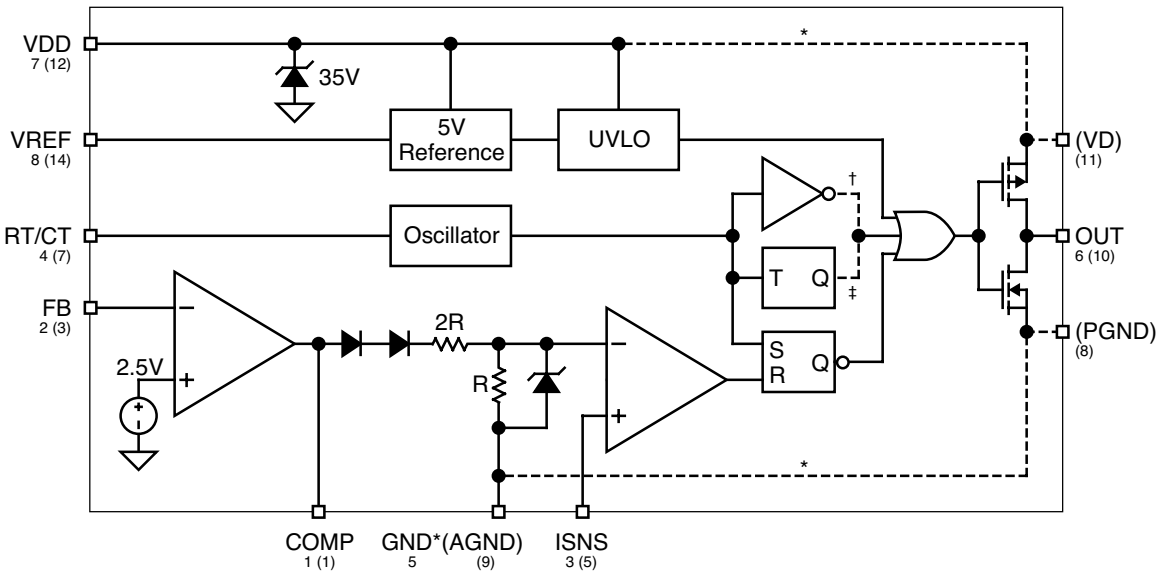
## Features

- 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

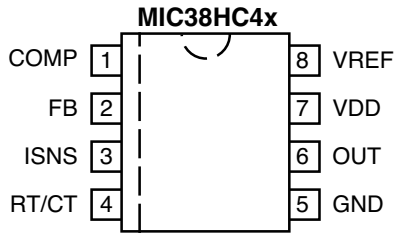
## Ordering Information

| Part Number | | Junction Temp. Range | Package |
|---|---|---|---|
| **Standard** | **Pb-Free** | | |
| MIC38HC42BN | MIC38HC42YN | –40°C to +85°C | 8-pin Plastic DIP |
| MIC38HC43BN | MIC38HC43YN | –40°C to +85°C | 8-pin Plastic DIP |
| MIC38HC44BN | MIC38HC44YN | –40°C to +85°C | 8-pin Plastic DIP |
| MIC38HC45BN | MIC38HC45YN | –40°C to +85°C | 8-pin Plastic DIP |
| MIC38HC42-1BN | Contact Factory | –40°C to +85°C | 14-pin Plastic DIP |
| MIC38HC43-1BN | Contact Factory | –40°C to +85°C | 14-pin Plastic DIP |
| MIC38HC44-1BN | Contact Factory | –40°C to +85°C | 14-pin Plastic DIP |
| MIC38HC45-1BN | Contact Factory | –40°C to +85°C | 14-pin Plastic DIP |
| MIC38HC42BM | MIC38HC42YM | –40°C to +85°C | 8-pin SOIC |
| MIC38HC43BM | MIC38HC43YM | –40°C to +85°C | 8-pin SOIC |
| MIC38HC44BM | MIC38HC44YM | –40°C to +85°C | 8-pin SOIC |
| MIC38HC45BM | MIC38HC45YM | –40°C to +85°C | 8-pin SOIC |
| MIC38HC42-1BM | MIC38HC42-1YM | –40°C to +85°C | 14-pin SOIC |
| MIC38HC43-1BM | MIC38HC43-1YM | –40°C to +85°C | 14-pin SOIC |
| MIC38HC44-1BM | MIC38HC44-1YM | –40°C to +85°C | 14-pin SOIC |
| MIC38HC45-1BM | MIC38HC45-1YM | –40°C to +85°C | 14-pin SOIC |

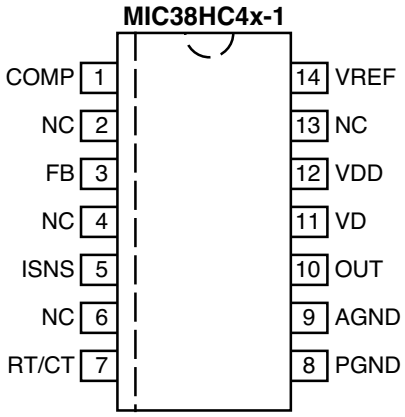
## Selection Guide

| | UVLO Thresholds | |
|---|---|---|
| **Duty Cycle** | Startup 8.4V<br>Minimum Operating 7.6V | Startup 14.5V<br>Minimum Operating 9V |
| 0% to 96% | MIC38HC43 | MIC38HC42 |
| 0% to 50% | MIC38HC45 | MIC38HC44 |

## Pin Configuration




**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 ($\theta_{JA}$) ..... 125°C/W
8-Pin MM8™ ($\theta_{JA}$) ..... 250°C/W
8-Pin SOIC ($\theta_{JA}$) ..... 170°C/W
14-Pin Plastic DIP ($\theta_{JA}$) ..... 90°C/W
14-Pin SOIC ($\theta_{JA}$) ..... 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 ≤ $V_{DD}$ ≤ 18V, **Note 2** | | 70 | | dB |
| Input Bias Current | | | –0.1 | –2 | μA |
| Delay to Output | | | 120 | 250 | ns |
| **Output** | | | | | |
| $R_{DS(ON)}$ 'HC' High<br>$R_{DS(ON)}$ 'HC' Low | $I_{SOURCE}$ = 200mA<br>$I_{SINK}$ = 200mA | | 10<br>5.5 | | Ω<br>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<br>$V_{DD}$ = 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 |

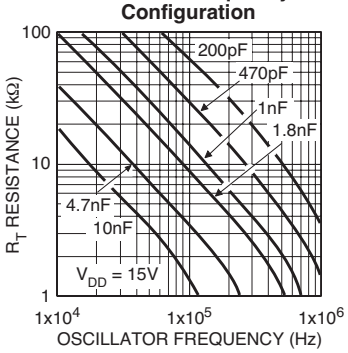
**Note 1:** These parameters, although guaranteed, are not 100% tested in production.
**Note 2:** Parameter measured at trip point of latch with $V_{EA}$ = 0.
**Note 3:** Gain defined as:

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

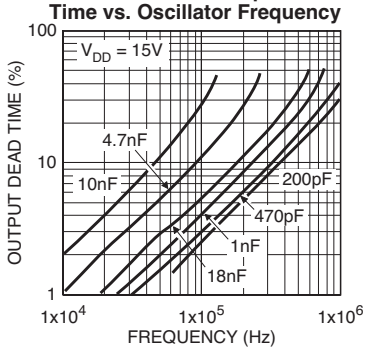
**Note 4:** Adjust $V_{DD}$ above the start threshold before setting at 15V.
**Note 5:** Output frequency equals oscillator frequency for the MIC38HC42 and MIC38HC43. Output frequency for the MIC38HC44, and MIC38HC45 equals one half the oscillator frequency.
**Note 6:** On 8-pin version, 20V is maximum 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

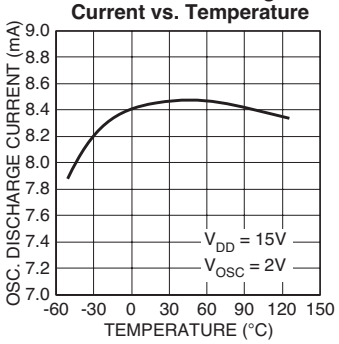
**Oscillator Frequency Configuration**



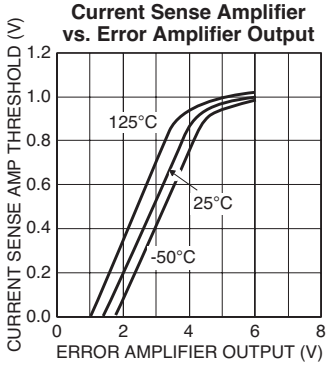

**MIC38C/HC42/43 Output Dead Time vs. Oscillator Frequency**



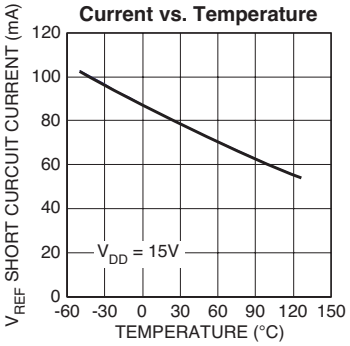

**Oscillator Discharge Current vs. Temperature**



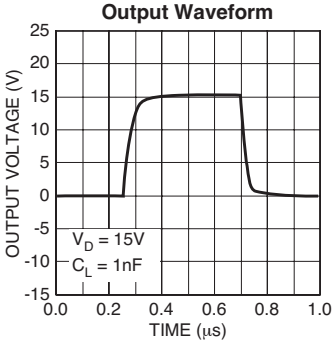

**Current Sense Amplifier vs. Error Amplifier Output**



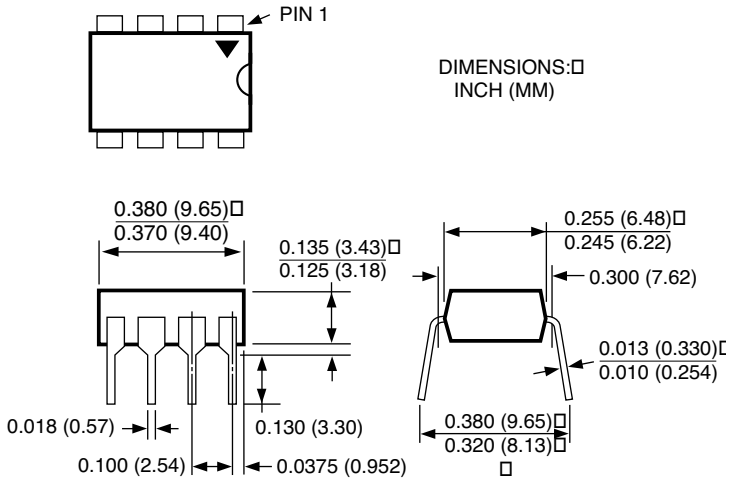

**Short-Circuit Reference Current vs. Temperature**



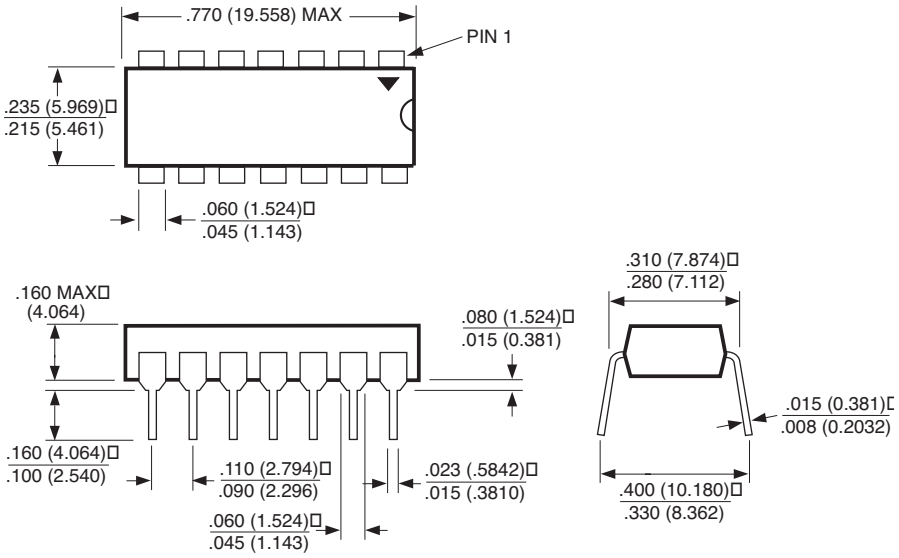

**MIC38C4x Output Waveform**



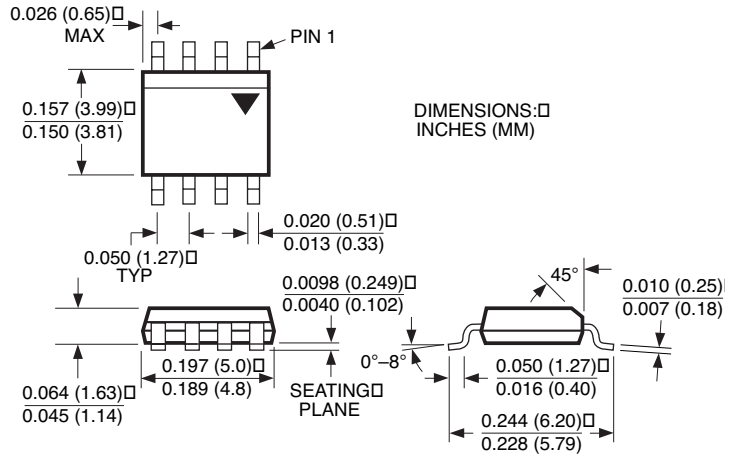
## Package Information



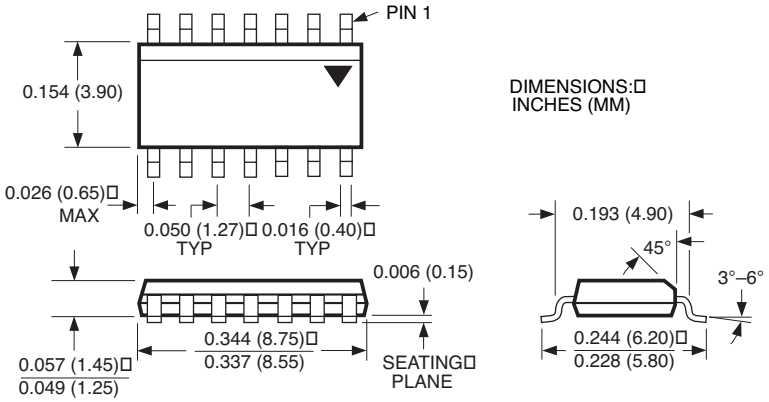

**8-Pin Plastic DIP (N)**




**14-Pin Plastic DIP (N)**




**8-Pin SOIC (M)**




**14-Pin SOIC (M)**

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