MIC18C42/MIC18HC42 Family

BiCMOS Current Mode Switching Regulator

Preliminary Information

General Description

The MIC18C42 family of devices are fixed frequency, high performance current mode PWM controllers. Although fully pin compatible with the bipolar 3842 family of controllers, the BiCMOS MIC18C42 family features key improvements that optimize performance to meet the need of today's SMPS designs. Start-up current has been reduced to 75µA typical. Operating currents also have been reduced to 4.0 mA typical with a 15V supply. Decreases in rise/fall times of the output drivers allows the use of larger FETs resulting in efficiency improvements.

These features, along with trimmed oscillator discharge current and bandgap reference, makes the MIC18C42/18HC42 family ideally suited for SMPS applications where low power loss, increased accuracy and stability, and reduced component count are essential.

Available in both 8 pin and 14 pin packages, the MIC18C42/18HC42 family offers the designer the choice between small package size and the increased performance and efficiency that comes with the separate grounding scheme available in a larger package.

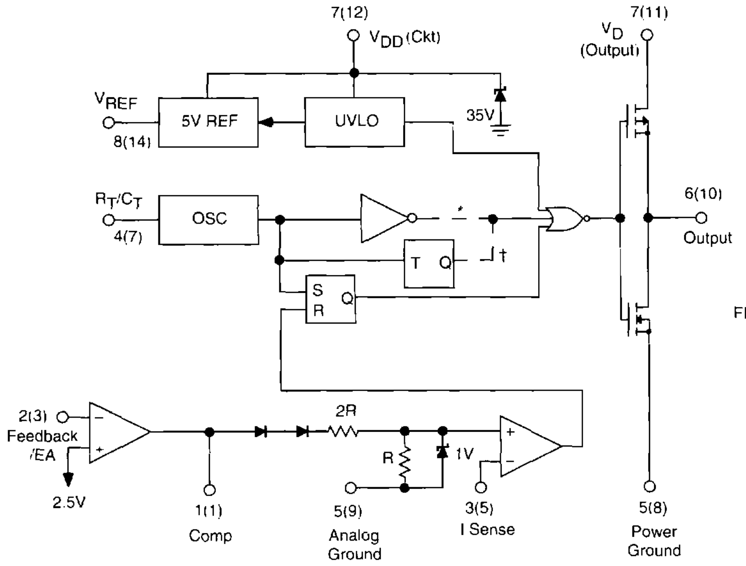
Features

- Fast output rise/fall times:
  40nS rise/30nS fall for the MIC38C42
  20nS rise/15 nS fall for the MIC38HC42
- High performance, low power BiCMOS Process
- Ultra low start-up current (75µA typical)
- Low operating current (4mA typical)
- High output drive (1A peak current, HC version)
- Current mode operation ≥500kHz
- Trimmed 5V bandgap reference
- Plug-in compatible with UC3842/3843/3844/3845(A)
- Trimmed oscillator discharge current
- UVLO with hysteresis
- CMOS outputs with rail-to-rail swing
- Low cross-conduction currents

Applications

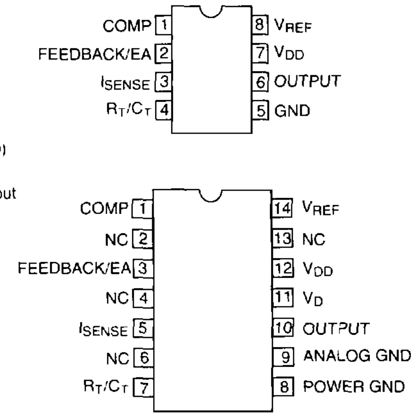
- Current mode off-line SMPS systems.
- Current mode DC to DC converters.

Functional Diagram



* MICx8C42, 43 / MICx8HC42, 43
† MICx8C44, 45 / MICx8HC44, 45

Pin Configurations



Ordering Information

Part Number	Temperature Range	Package
MIC18C42AJ	–55°C to +125°C	8-pin CerDIP
MIC18C43AJ	–55°C to +125°C	8-pin CerDIP
MIC18C44AJ	–55°C to +125°C	8-pin CerDIP
MIC18C45AJ	–55°C to +125°C	8-pin CerDIP
MIC18C42-1AJ	–55°C to +125°C	14-pin CerDIP
MIC18C43-1AJ	–55°C to +125°C	14-pin CerDIP
MIC18C44-1AJ	–55°C to +125°C	14-pin CerDIP
MIC18C45-1AJ	–55°C to +125°C	14-pin CerDIP
MIC38C42BJ	–40°C to +85°C	8-pin CerDIP
MIC38C43BJ	–40°C to +85°C	8-pin CerDIP
MIC38C44BJ	–40°C to +85°C	8-pin CerDIP
MIC38C45BJ	–40°C to +85°C	8-pin CerDIP
MIC38C42-1BJ	–40°C to +85°C	14-pin CerDIP
MIC38C43-1BJ	–40°C to +85°C	14-pin CerDIP
MIC38C44-1BJ	–40°C to +85°C	14-pin CerDIP
MIC38C45-1BJ	–40°C to +85°C	14-pin CerDIP
MIC38C42BN	–40°C to +85°C	8-pin Plastic DIP
MIC38C43BN	–40°C to +85°C	8-pin Plastic DIP
MIC38C44BN	–40°C to +85°C	8-pin Plastic DIP
MIC38C45BN	–40°C to +85°C	8-pin Plastic DIP
MIC38C42-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38C43-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38C44-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38C45-1BN	–40°C to +85°C	14-pin Plastic DIP
MIC38C42BM	–40°C to +85°C	8-pin SOIC
MIC38C43BM	–40°C to +85°C	8-pin SOIC
MIC38C44BM	–40°C to +85°C	8-pin SOIC
MIC38C45BM	–40°C to +85°C	8-pin SOIC
MIC38C42-1BM	–40°C to +85°C	14-pin SOIC
MIC38C43-1BM	–40°C to +85°C	14-pin SOIC
MIC38C44-1BM	–40°C to +85°C	14-pin SOIC
MIC38C45-1BM	–40°C to +85°C	14-pin SOIC

Part Number	Temperature Range	Package
MIC18HC42AJ	–55°C to +125°C	8-pin CerDIP
MIC18HC43AJ	–55°C to +125°C	8-pin CerDIP
MIC18HC44AJ	–55°C to +125°C	8-pin CerDIP
MIC18HC45AJ	–55°C to +125°C	8-pin CerDIP
MIC18HC42-1AJ	–55°C to +125°C	14-pin CerDIP
MIC18HC43-1AJ	–55°C to +125°C	14-pin CerDIP
MIC18HC44-1AJ	–55°C to +125°C	14-pin CerDIP
MIC18HC45-1AJ	–55°C to +125°C	14-pin CerDIP
MIC38HC42BJ	–40°C to +85°C	8-pin CerDIP
MIC38HC43BJ	–40°C to +85°C	8-pin CerDIP
MIC38HC44BJ	–40°C to +85°C	8-pin CerDIP
MIC38HC45BJ	–40°C to +85°C	8-pin CerDIP
MIC38HC42-1BJ	–40°C to +85°C	14-pin CerDIP
MIC38HC43-1BJ	–40°C to +85°C	14-pin CerDIP
MIC38HC44-1BJ	–40°C to +85°C	14-pin CerDIP
MIC38HC45-1BJ	–40°C to +85°C	14-pin CerDIP
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

Absoulte Maximum Ratings

Zener Current 30mA

V_{DD} (8-pin) 18V

V_D (14-pin) 18V

Output Current (18C42/43/44/45, 38HC42/43/44/45) 0.5A

Output Current (18HC42/43/44/45, 38HC42/43/44/45) 1A

I_{SENSE}, FEEDBACK –0.3V to 5.5V

Ambient Temperature Range (T_A)

38C42/43/44/45, 38HC42/43/44/45 –40°C to +85°C

18C42/43/44/45, 18HC42/43/44/45 –55°C to +125°C

T_J Operating Temperature 150°C

Storage Temperature –65°C to 150°C

	UVLO Thresholds	
Duty Cycle	7.6V/8.4V	9V/14.5V
0 to 99%	MIC18C43/HC43 MIC38C43/HC43	MIC18C42/HC42 MIC38C42/HC42
0 to 50%	MIC18C45/HC45 MIC38C45/HC45	MIC18C44/HC44 MIC38C44/HC44

MIC18C/38C, 18HC/38HC	14 pin	8 pin
θ_{JA} (Plastic DIP)	90°C/W	100°C/W
θ_{JA} (Ceramic DIP)	110°C/W	125°C/W
θ_{JA} (SOIC)	145°C/W	170°C/W

Electrical Characteristics

Unless otherwise stated, these specifications apply for
$-55 \le T_A \le 125°C$ for MIC18C42/43/44/45, 18HC42/43/44/45
$-40 \le T_A \le 85°C$ for MIC38C42/43/44/45, 38HC42/43/44/45
V_{CC} = 15V (Note 4); R_T 10 kΩ; C_T = 3.3nF

		MIC18C42/43/44/45 MIC18HC42/43/44/45			MIC38C42/43/44/45 MIC38HC42/43/44/45			
Parameter	**Test Conditions**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Units**
Reference Section								
Output Voltage	T_A = 25°C, I_O = 1mA	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation	$12 \le V_{DD} \le 18V$, I_O = 5 µA (Note 6)		2	20		2	20	mV
Load Regulation	$1 \le I_O \le 20$ mA		1	25		1	25	mV
Temp. Stability	(Note 1)		0.2			0.2		mV/°C
Total Output Variation	Line, Load, Temp. (Note 1)	4.9		5.1	4.82		5.18	V
Output Noise Voltage	10Hz ≤ f ≤ 10kHz, T_A = 25°C (Note 1)		50			50		µV
Long Term Stability	*T_A = 125 °C, 1000 Hrs. (Note 1)*		*5*	*25*		*5*	*25*	*mV*
Output Short Circuit		–30	–80	–180	–30	–80	–180	mA
Oscillator Section								
Initial Accuracy	T_A = 25°C (Note 5)	49	52	55	49	52	55	kHz
Voltage Stability	$12 \le V_{DD} \le 18V$ (Note 6)		0.2	1.0		0.2	1.0	%
Temp. Stability	$T_{MIN} \le T_A \le T_{MAX}$ (Note 1)		0.04			0.04		%/°C
Clock Ramp Reset Current	T_A = 25°C, $V_{RT\,CT}$ = 2V $T_A = T_{MIN}$ to T_{MAX}	8.1 7.5	8.4 8.4	8.7 9.3	8.1 7.5	8.4 8.4	8.7 9.3	mA mA
Amplitude	$V_{RT \cdot CT}$ peak to peak		1.9			1.9		Vp–p
Error Amp Section								
Input Voltage	V_{COMP} = 2.5V	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current	$V_{FEEDBACK}$ = 5.0V		–0.1	–1		–0.1	–2	µA
A_{VOL}	$2 \le V_O \le 4V$	65	90		65	90		dB
Unity Gain Bandwidth	(Note 1)	0.7	1.0		0.7	1.0		MHz
PSRR	$12 \le V_{DD} \le 18V$	60			60			dB
Output Sink Current	$V_{FEEDBACK}$ = 2.7V, V_{COMP} = 1.1V	2	14		2	14		mA
Output Source Current	$V_{FEEDBACK}$ = 2.3V, V_{COMP} = 5V	–0.5	–0.75		–0.5	–0.75		mA
V_{OUT} High	$V_{FEEDBACK}$ = 2.3V, R_L = 15k to ground	5	6.8		5	6.8		V
V_{OUT} Low	$V_{FEEDBACK}$ = 2.7V, R_L = 15k to V_{REF}		0.1	1.1		0.1	1.1	V
Current Sense								
Gain	(Notes 2 & 3)	2.85	3.0	3.15	2.85	3.0	3.15	V/V
MaximumThreshold	V_{COMP} = 5V (Note 2)	0.9	1	1.1	0.9	1	1.1	V
PSRR	$12 \le V_{DD} \le 18V$ (Note 2)		70			70		dB
Input Bias Current			–0.1	–1		–0.1	–2	µA
Delay to Output			150	250		150	250	nS

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		MIC18C42/43/44/45 MIC18HC42/43/44/45			MIC38C42/43/44/45 MIC38HC42/43/44/45			
Parameter	**Test Conditions**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Units**
Output Section								
$R_{DS(ON)}$ 'C' High	I_{SOURCE} = 200 mA		20			20		Ω
$R_{DS(ON)}$ 'C' Low	I_{SINK} = 200 mA		11			11		Ω
$R_{DS(ON)}$ 'HC' High	I_{SOURCE} = 200 mA		10			10		Ω
$R_{DS(ON)}$ 'HC' Low	I_{SINK} = 200 mA		5.5			5.5		Ω
Rise Time: 'C' version	T_A = 25°C, C_L = 1 nF		40	80		40	80	nS
Fall Time: 'C' version	T_A = 25°C, C_L = 1 nF		30	60		30	60	nS
Rise Time: 'HC' version	T_A = 25°C, C_L = 1 nF		20	50		20	50	nS
Fall Time: 'HC' version	T_A = 25°C, C_L = 1 nF		15	40		15	40	nS
Under-Voltage Lockout								
Start Threshold	38C42/4, 18C42/4, 38HC42/4, 18HC42/4	13.5	14.5	15.5	13.5	14.5	15.5	V
	38C43/5, 18C43/5, 38HC43/5, 18HC43/5	7.8	8.4	9.0	7.8	8.4	9.0	V
Min. Operating Voltage	38C42/4, 18C42/4, 38C42/4, 18HC42/4	8	9	10	8	9	10	V
	38C43/5, 38C43/5, 38HC43/5, 38HC43/5	7.0	7.6	8.2	7.0	7.6	8.2	V
PWM Section								
Maximum Duty Cycle	38C42/3, 18C42/3, 38HC42/3, 18HC42/3	94	96		94	96		%
	38C44/5, 18C44/5, 38HC44/5, 18HC44/5	46	50		46	50		%
Minimum Duty Cycle				0			0	%
Total Standby Current								
Start-Up Current	V_{DD} = 13V for x8C42/44, x8HC42/44 V_{DD} = 7.5V for x8C43/45, x8HC43/45		75	150		75	200	µA
Operating Supply Current	$V_{FEEDBACK} = V_{I\,SENSE}$ = 0V		4.0	6.0		4.0	6.0	mA
Zener Voltage (V_{DD})	I_{DD} = 25mA (Note 6)	30	37		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:

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

Note 4: Adjust V_{DD} above the start threshold before setting at 15V.
Note 5: Output frequency equals oscillator frequency for the X8C42 and X8C43. Output frequency for the 38C44, 18C44 and 38C45, 18C45 equals one half the oscillator frequency.
Note 6: On 8-pin version, 18 volts 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 18V maximum for pin 11.

Application Information

The Advantage of Micrel's 38C4x/38HC4x

Designed to be completely compatible with the popular 384xA series current-mode PWM controllers, Micrel's BiCMOS process now provides the power supply engineer with several enhanced features making the 38C4x/38HC4x attractive for new as well as existing designs.

Start-up current has been reduced to an ultra-low 75µA (typical) allowing higher value bootstrap resistors to be used. Resistor wattage values can be reduced which saves PC board space.

Operating current has been reduced by more than half over the bipolar converter (4mA typical). Reduced current provides a cooler running part and reduces the amount of capacitance required to hold up the V_{DD} pin while the power supply starts. This reduced capacitance, coupled with the high valued bootstrap resistor, reduces the restarting frequency the power supply experiences during output overloads*. This feature increases the reliability of the supply to sustain abnormal conditions.

The most powerful enhancement offered by this converter is its rail-to-rail output drive stage. A complementary CMOS

Applications Information (continued)

pair makes up this stage making it an ideal choice for direct drive of conventional power MOSFET designs. The low $R_{DS(ON)}$ values together with the high I_{peak} capabilities allow the designer to drive MOSFETs with input capacitance of greater than 1000pF. In fact, the value of output capacity which can be handled is determined only by the rise/fall time requirements which are directly proportional to the output capacity and the power dissipation of the IC. Useful designs can now approach switching frequencies of 1MHz as long as these two criteria are kept in mind.

Care should be taken when designing high frequency converters to avoid capacitive and inductive coupling of the switching waveform into high impedance circuitry such as the error amplifier, oscillator, and current sense amplifier. Avoid long PC traces and component lead lengths. Locate oscillator and compensation circuitry near the IC. Use high frequency decoupling capacitors on V_{REF} and, if necessary, on V_{DD}. Return high di/dt currents directly to the source and use large area ground planes where possible.

500kHz MIC38C42 25W Buck DC-DC Converter

Upon application of at least 26 volts to the input, C5 is charged through R2 until the voltage V_{DD} is greater than the under-voltage-lockout of the MIC38C42. Output switching then begins with the turn on of Q1 via the gate drive transformer T1, charging the output filter capacitor C3 through L1.

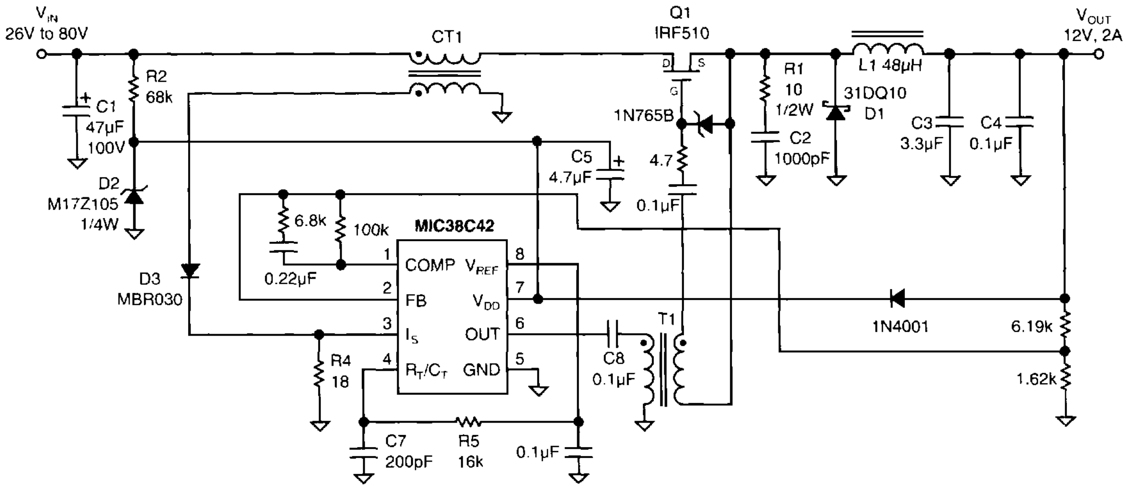
Current sense transformer CT1 implements current mode operation and cycle-by-cycle current limiting. This scheme eliminates the need for an inefficient sense resistor and the resulting level shift needed to reference the voltage to input ground.

Using a 100V Schottky for the catch diode D1 puts a lower V_F in the main current path and results in higher circuit efficiency than could be accomplished using an ultra-fast-recovery diode. The R1 and C2 combination suppresses parasitic oscillations from D1.

Using a high value inductance for L1 and a low ESR capacitor for C3 permits using a small capacitance for C3 while producing minimal output ripple. This inductance value also improves circuit efficiency by reducing the flux swing in L1.

Magnetic components were carefully chosen for minimal losses at 500kHz and contribute significantly to higher efficiency. CT1 and T1 are wound on Magnetics, Inc. P type material toroids. L1 is wound on a Siemens N49 EFD core.

*The power supply will restart whenever the output load increases beyond the design maximum. This reduces the voltage to the V_{DD} pin until it shuts the IC off. The bootstrap resistor then recharges the V_{DD} capacitor and the power supply operates again until V_{DD} falls. This cycle continues at a rate determined by the bootstrap resistor and V_{DD} capacitor.



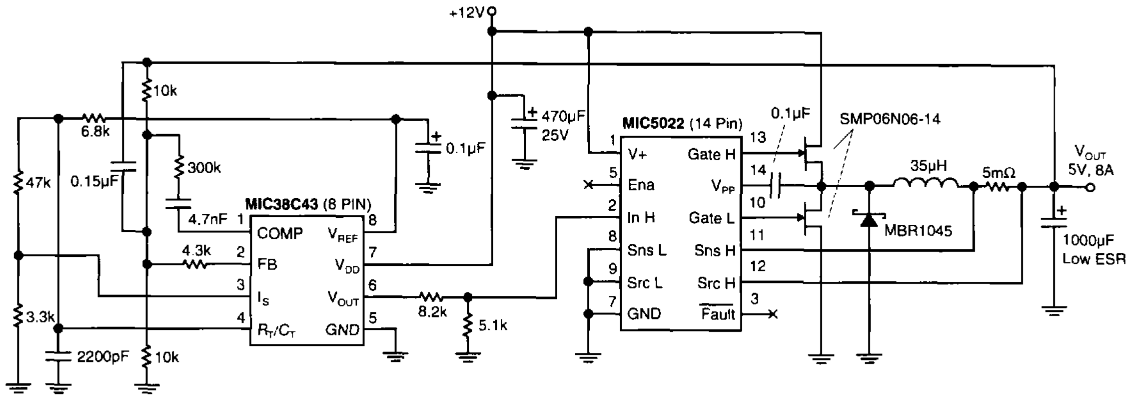
500kHz 25W Buck DC-DC Converter

Test	Conditions	Results
Line Regulation	V_{IN} = 26V to 80V, I_O = 2A	0.5%
Load Regulation	V_{IN} = 48V, I_O = 0.2A to 2A	0.6%
Efficiency	V_{IN} = 48V, I_O = 2A	90%
Output Ripple	V_{IN} = 48V, I_O = 2A (20 MHz BW)	100mV

Symbol	Transformer/Inductor Part Number
CT1	ETS 92420
T1	ETS 92418
L1	ETS 92421

Note: Magnetic components are available from Energy Transformation Systems, Inc., tel. (415) 324-4949.

Applications Information (continued)



100kHz High Efficiency Synchronous Buck Rectifier