

DESCRIPTION

The SG1844/45 family of control ICs provides all the necessary features to implement off-line fixed frequency, current-mode switching power supplies with a minimum number of external components. Current-mode architecture demonstrates improved line regulation, improved load regulation, pulse-by-pulse current limiting and inherent protection of the power supply output switch.

The bandgap reference is trimmed to $\pm 1\%$ over temperature. Oscillator discharge current is trimmed to less than $\pm 10\%$. The SG1844/45 has under-voltage lockout, current-limiting circuitry

and start-up current of less than 1mA.

The totem-pole output is optimized to drive the gate of a power MOSFET. The output is low in the off state to provide direct interface to an N-channel device.

Both operate up to a maximum duty cycle range of zero to $< 50\%$ due to an internal toggle flip-flop which blanks the output off every other clock cycle.

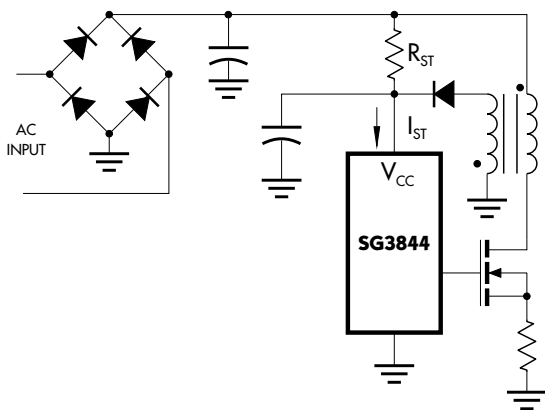
The SG1844/45 is specified for operation over the full military ambient temperature range of -55°C to 125°C . The SG2844/45 is specified for the industrial range of -25°C to 85°C , and the SG3844/45 is designed for the commercial range of 0°C to 70°C .

KEY FEATURES

- OPTIMIZED FOR OFF-LINE CONTROL
- LOW START-UP CURRENT ($< 1\text{mA}$)
- AUTOMATIC FEED FORWARD COMPENSATION
- TRIMMED OSCILLATOR DISCHARGE CURRENT
- PULSE-BY-PULSE CURRENT LIMITING
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- UNDER-VOLTAGE LOCKOUT WITH 6V HYSTERESIS (SG1844 only)
- DOUBLE PULSE SUPPRESSION
- HIGH-CURRENT TOTEM-POLE OUTPUT
- INTERNALLY TRIMMED BANDGAP REFERENCE
- 500kHz OPERATION
- UNDERVOLTAGE LOCKOUT
 - SG1844 - 16 volts
 - SG1845 - 8.4 volts
- LOW SHOOT-THROUGH CURRENT $< 75\text{mA}$ OVER TEMPERATURE

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF SG3844 IN A FLYBACK CONVERTER



HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

PACKAGE ORDER INFORMATION

| T _A (°C) | M | N | DM | D | Y | J | F | L |
|---------------------|----------------------|-----------------------|-----------------------|------------------------|----------------------|-----------------------|-------------------------|-----------------------|
| | Plastic DIP 8-pin | Plastic DIP 14-pin | Plastic SOIC 8-pin | Plastic SOIC 14-pin | Ceramic DIP 8-pin | Ceramic DIP 14-pin | Cer. Flatpack 10-pin | Ceramic LCC 20-pin |
| 0 to 70 | SG3844M | SG3844N | SG3844DM | SG3844D | SG3844Y | SG3844J | — | — |
| | SG3845M | SG3845N | SG3845DM | SG3845D | SG3845Y | SG3845J | — | — |
| -25 to 85 | SG2844M | SG2844N | SG2844DM | SG2844D | SG2844Y | SG2844J | — | — |
| | SG2845M | SG2845N | SG2845DM | SG2845D | SG2845Y | SG2845J | — | — |
| -55 to 125 | — | — | — | — | SG1844Y | SG1844J | — | SG1844L |
| | — | — | — | — | SG1845Y | SG1845J | — | SG1845L |
| MIL-STD/883 | — | — | — | — | SG1844Y/883B | SG1844J/883B | — | SG1844L/883B |
| | — | — | — | — | SG1845Y/883B | SG1845J/883B | — | SG1845L/883B |
| DESC | — | — | — | — | SG1844Y/DESC | SG1844J/DESC | SG1844F/DESC | SG1844L/DESC |
| | — | — | — | — | SG1845Y/DESC | SG1845J/DESC | SG1845F/DESC | SG1845L/DESC |

Note: All surface-mount packages are available in Tape & Reel.

FOR FURTHER INFORMATION CALL (714) 898-8121

SG1844/SG1845 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Notes 1 & 2)

| | |
|---|-----------------|
| Supply Voltage ($I_{CC} < 30\text{mA}$) | Self Limiting |
| Supply Voltage (Low Impedance Source) | 30V |
| Output Current (Peak) | $\pm 1\text{A}$ |
| Output Current (Continuous) | 350mA |
| Output Energy (Capacitive Load) | 5 μJ |
| Analog Inputs (Pins 2, 3) | -0.3V to +6.3V |
| Error Amp Output Sink Current | 10mA |
| Operating Junction Temperature | |
| Hermetic (J, Y, F, L Packages) | 150°C |
| Plastic (N, M, D, DM Packages) | 150°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (Soldering, 10 Seconds) | 300°C |

Note 1. Exceeding these ratings could cause damage to the device.

Note 2. All voltages are with respect to Pin 5. All currents are positive into the specified terminal.

THERMAL DATA

M PACKAGE:

| | |
|---|--------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 95°C/W |
|---|--------|

N PACKAGE:

| | |
|---|--------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 65°C/W |
|---|--------|

DM PACKAGE:

| | |
|---|---------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 165°C/W |
|---|---------|

D PACKAGE:

| | |
|---|---------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 120°C/W |
|---|---------|

Y PACKAGE:

| | |
|---|---------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 130°C/W |
|---|---------|

J PACKAGE:

| | |
|---|--------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 80°C/W |
|---|--------|

F PACKAGE:

| | |
|--|--------|
| THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC} | 80°C/W |
|--|--------|

| | |
|---|---------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 145°C/W |
|---|---------|

L PACKAGE:

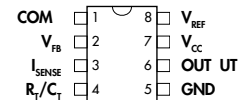
| | |
|--|--------|
| THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC} | 35°C/W |
|--|--------|

| | |
|---|---------|
| THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} | 120°C/W |
|---|---------|

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.

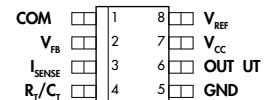
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



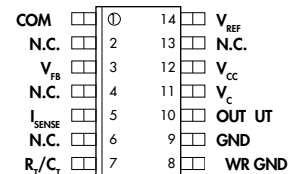
M & Y PACKAGE

(Top View)



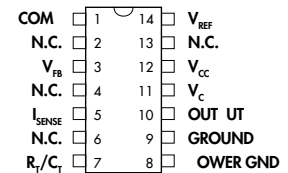
DM PACKAGE

(Top View)



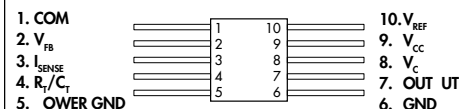
D PACKAGE

(Top View)



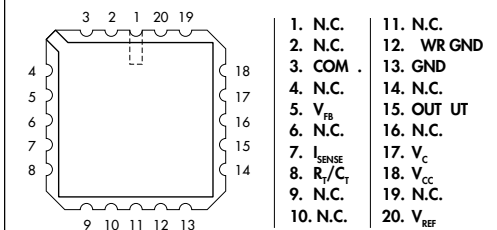
J & N PACKAGE

(Top View)



F PACKAGE

(Top View)



L PACKAGE

(Top View)

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 3)

| Parameter | Symbol | Recommended Operating Conditions | | | Units |
|--------------------------------------|--------|----------------------------------|------|------|-------|
| | | Min. | Typ. | Max. | |
| Supply Voltage Range | | | 30 | | V |
| Output Current (Peak) | | | ±1 | | A |
| Output Current (Continuous) | | | 200 | | mA |
| Analog Inputs (Pin 2, Pin 3) | | 0 | | 2.6 | V |
| Error Amp Output Sink Current | | | 5 | | mA |
| Oscillator Frequency Range | | 0.1 | | 500 | kHz |
| Oscillator Timing Resistor | R_T | 0.52 | | 150 | kΩ |
| Oscillator Timing Capacitor | C_T | 0.1 | | 1.0 | μF |
| Operating Ambient Temperature Range: | | | | | |
| SG1844/45 | | -55 | | 125 | °C |
| SG2844/45 | | -25 | | 85 | °C |
| SG3844/45 | | 0 | | 70 | °C |

Note 3. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG1844/SG1845 with $-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$, SG2844/SG2845 with $-25^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$, SG3844/SG3845 with $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$, $V_{CC} = 15\text{V}$ (Note 7), $R_T = 10\text{k}\Omega$, and $C_T = 3.3\text{nF}$. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

| Parameter | Symbol | Test Conditions | SG1844/45 | | | SG2844/45 | | | SG3844/45 | | | Units |
|---------------------------------|-----------|--|-----------|------|------|-----------|------|------|-----------|------|------|-------|
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Reference Section | | | | | | | | | | | | |
| Output Voltage | | $T_J = 25^{\circ}\text{C}, I_O = 1\text{mA}$ | 4.95 | 5.00 | 5.05 | 4.95 | 5.00 | 5.05 | 4.90 | 5.00 | 5.10 | V |
| Line Regulation | | $12 \leq V_{IN} \leq 25\text{V}$ | | 6 | 20 | | 6 | 20 | | 6 | 20 | mV |
| Load Regulation | | $1 \leq I_O \leq 20\text{mA}$ | | 6 | 25 | | 6 | 25 | | 6 | 25 | mV |
| Temperature Stability (Note 4) | | | | 0.2 | 0.4 | | 0.2 | 0.4 | | 0.2 | 0.4 | mV/°C |
| Total Output Variation (Note 4) | | Line, Load, Temp. | 4.90 | | 5.10 | 4.90 | | 5.10 | 4.82 | | 5.18 | V |
| Output Noise Voltage (Note 4) | V_N | $10\text{Hz} \leq f \leq 10\text{kHz}, T_J = 25^{\circ}\text{C}$ | | 50 | | | 50 | | | 50 | | μV |
| Long Term Stability (Note 4) | | $T_A = 125^{\circ}\text{C}, 1000\text{hrs}$ | | 5 | 25 | | 5 | 25 | | 5 | 25 | mV |
| Output Short Circuit | | | -30 | -100 | -180 | -30 | -100 | -180 | -30 | -100 | -180 | mA |
| Oscillator Section | | | | | | | | | | | | |
| Initial Accuracy (Note 8) | | $T_J = 25^{\circ}\text{C}$ | 47 | 52 | 57 | 47 | 52 | 57 | 47 | 52 | 57 | kHz |
| Voltage Stability | | $12\text{V} \leq V_{CC} \leq 25\text{V}$ | | .02 | 1 | | 0.2 | 1 | | 0.2 | 1 | % |
| Temperature Stability (Note 4) | | $T_{MIN} \leq T_A \leq T_{MAX}$ | | 5 | | | 5 | | | 5 | | % |
| Amplitude | | $V_{RT/CT}$ (Peak to Peak) | | 1.7 | | | 1.7 | | | 1.7 | | V |
| Discharge Current | | $T_J = 25^{\circ}\text{C}$ | 7.8 | 8.3 | 9.1 | 7.5 | 8.4 | 9.3 | 7.5 | 8.4 | 9.3 | mA |
| | | $T_{MIN} \leq T_A \leq T_{MAX}$ | 6.8 | | 9.3 | 7.2 | | 9.5 | 7.2 | | 9.5 | mA |
| Error Amp Section | | | | | | | | | | | | |
| Input Voltage | | $V_{COMP} = 2.5\text{V}$ | 2.45 | 2.50 | 2.55 | 2.45 | 2.50 | 2.55 | 2.42 | 2.50 | 2.58 | V |
| Input Bias Current | | | | -0.3 | -1 | | -0.3 | 1 | | -0.3 | -2 | μA |
| Open Loop Gain | A_{VOL} | $2 \leq V_O \leq 4\text{V}$ | 65 | 90 | | 65 | 90 | | 65 | 90 | | dB |
| Unity Gain Bandwidth (Note 4) | | $T_J = 25^{\circ}\text{C}$ | 0.7 | 1 | | 0.7 | 1 | | 0.7 | 1 | | MHz |
| Power Supply Rejection Ratio | PSRR | $12 \leq V_{CC} \leq 25\text{V}$ | 60 | 70 | | 60 | 70 | | 60 | 70 | | dB |
| Output Sink Current | | $V_{VFB} = 2.7\text{V}, V_{COMP} = 1.1\text{V}$ | 2 | 6 | | 2 | 6 | | 2 | 6 | | mA |
| Output Source Current | | $V_{VFB} = 2.3\text{V}, V_{COMP} = 5\text{V}$ | -0.5 | -0.8 | | -0.5 | -0.8 | | -0.5 | -0.8 | | mA |
| V_{OUT} High | | $V_{VFB} = 2.3\text{V}, R_L = 15\text{K to gnd}$ | 5 | 6 | | 5 | 6 | | 5 | 6 | | V |
| V_{OUT} Low | | $V_{VFB} = 2.7\text{V}, R_L = 15\text{K to } V_{REF}$ | | 0.7 | 1.1 | | 0.7 | 1.1 | | 0.7 | 1.1 | V |

(Electrical Characteristics continue next page.)

SG1844/SG1845 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

ELECTRICAL CHARACTERISTICS (Cont'd.)

| Parameter | Symbol | Test Conditions | SG1844/45 | | | SG2844/45 | | | SG3844/45 | | | Units |
|---------------------------------------|--------|-------------------------------|-----------|------|------|-----------|------|------|-----------|------|------|---------|
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Current Sense Section | | | | | | | | | | | | |
| Gain (Notes 5 & 6) | | | 2.85 | 3 | 3.15 | 2.85 | 3 | 3.15 | 2.85 | 3 | 3.15 | V/V |
| Maximum Input Signal (Note 5) | | $V_{COMP} = 5V$ | 0.9 | 1 | 1.1 | 0.9 | 1 | 1.1 | 0.9 | 1 | 1.1 | V |
| Power Supply Rejection Ratio (Note 5) | PSRR | $12 \leq V_{CC} \leq 25V$ | | 70 | | | 70 | | | 70 | | dB |
| Input Bias Current | | | | -2 | -10 | | -2 | -10 | | -2 | -10 | μA |
| Delay to Output (Note 4) | | | | 150 | 300 | | 150 | 300 | | 150 | 300 | ns |
| Output Section | | | | | | | | | | | | |
| Output Low Level | | $I_{SINK} = 20mA$ | | 0.1 | 0.4 | | 0.1 | 0.4 | | 0.1 | 0.4 | V |
| | | $I_{SINK} = 200mA$ | | 1.5 | 2.2 | | 1.5 | 2.2 | | 1.5 | 2.2 | V |
| Output High Level | | $I_{SOURCE} = 20mA$ | 13 | 13.5 | | 13 | 13.5 | | 13 | 13.5 | | V |
| | | $I_{SOURCE} = 200mA$ | 12 | 13.5 | | 12 | 13.5 | | 12 | 13.5 | | V |
| Rise Time (Note 4) | | $T_J = 25^\circ C, C_L = 1nF$ | | 50 | 150 | | 50 | 150 | | 50 | 150 | ns |
| Fall Time (Note 4) | | $T_J = 25^\circ C, C_L = 1nF$ | | 50 | 150 | | 50 | 150 | | 50 | 150 | ns |
| Under-Voltage Lockout Section | | | | | | | | | | | | |
| Start Threshold | | 1844 | 15 | 16 | 17 | 15 | 16 | 17 | 14.5 | 16 | 17.5 | V |
| | | 1845 | 7.8 | 8.4 | 9.0 | 7.8 | 8.4 | 9.0 | 7.8 | 8.4 | 9.0 | V |
| Min. Operation Voltage After Turn-On | | 1844 | 9 | 10 | 11 | 9 | 10 | 11 | 8.5 | 10 | 11.5 | V |
| | | 1845 | 7.0 | 7.6 | 8.3 | 7.0 | 7.6 | 8.2 | 7.0 | 7.6 | 8.2 | V |
| PWM Section | | | | | | | | | | | | |
| Maximum Duty Cycle | | | 46 | 48 | 50 | 46 | 48 | 50 | 46 | 48 | 50 | % |
| Minimum Duty Cycle | | | | | 0 | | | 0 | | | 0 | % |
| Power Consumption Section | | | | | | | | | | | | |
| Start-Up Current | | | | 0.5 | 1 | | 0.5 | 1 | | 0.5 | 1 | mA |
| Operating Supply Current | | $V_{FB} = V_{ISENSE} = 0V$ | | 11 | 17 | | 11 | 17 | | 11 | 17 | mA |
| V_{CC} Zener Voltage | | $I_{CC} = 25mA$ | | 34 | | | 34 | | | 34 | | V |

Notes: 4. These parameters, although guaranteed, are not 100% tested in production.

5. Parameter measured at trip point of latch with $V_{VFB} = 0$.

6. Gain defined as: $A = \frac{\Delta V_{COMP}}{\Delta V_{ISENSE}}$; $0 \leq V_{ISENSE} \leq 0.8V$.

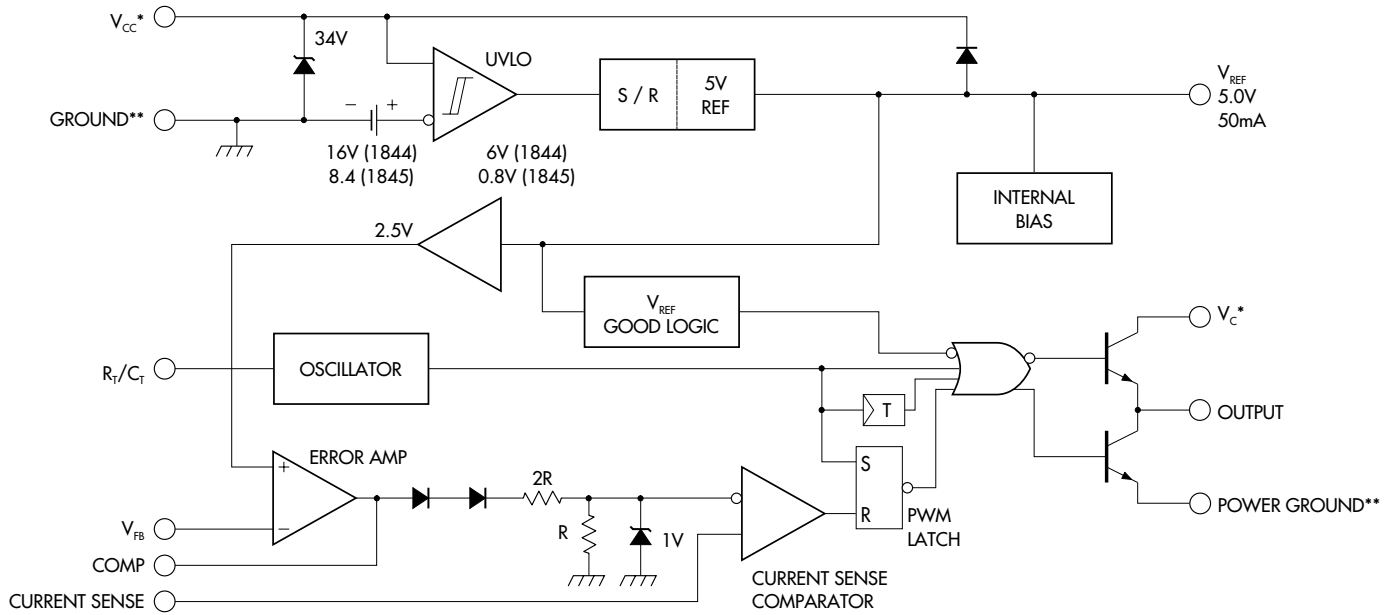
7. Adjust V_{CC} above the start threshold before setting at 15V.

8. Output frequency equals one half of oscillator frequency.

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

BLOCK DIAGRAM



* - V_{cc} and V_c are internally connected for 8-pin packages.

** - POWER GROUND and GROUND are internally connected for 8-pin packages.

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6. START-UP VOLTAGE THRESHOLD vs. TEMPERATURE
7. START-UP VOLTAGE THRESHOLD vs. TEMPERATURE
8. OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE
9. OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT AND TEMPERATURE (SINK TRANSISTOR)
10. CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT
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FIGURE

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16. BIPOLAR TRANSISTOR DRIVE
17. ISOLATED MOSFET DRIVE
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19. EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION
20. OSCILLATOR CONNECTION
21. ERROR AMPLIFIER CONNECTION

CHARACTERISTIC CURVES

FIGURE 1. — DROPOUT VOLTAGE vs. TEMPERATURE

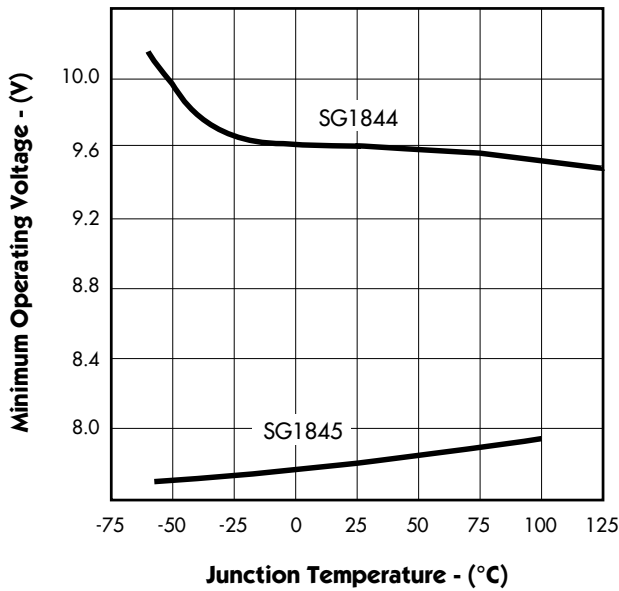


FIGURE 2. — OSCILLATOR TEMPERATURE STABILITY

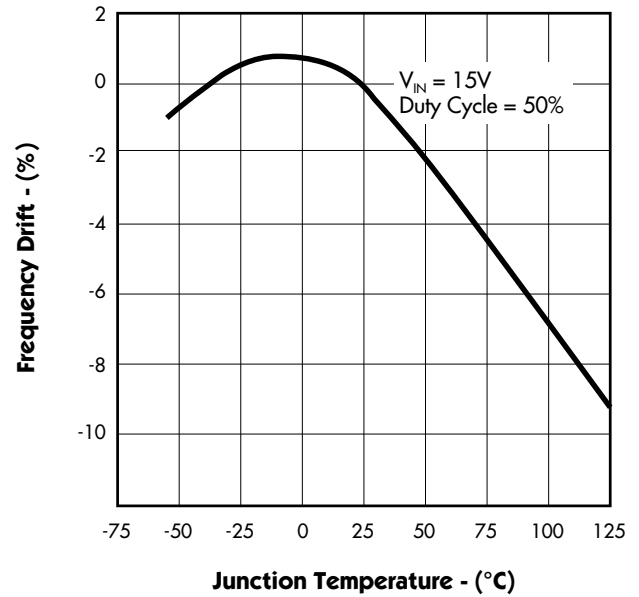


FIGURE 3. — CURRENT SENSE TO OUTPUT DELAY vs. TEMPERATURE

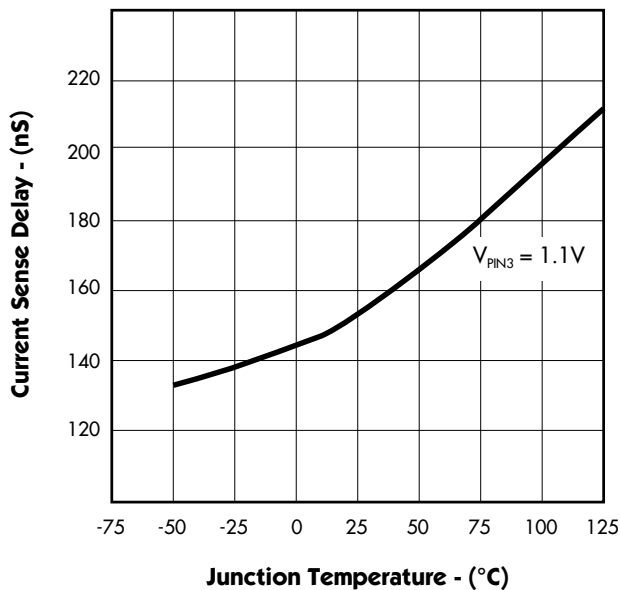
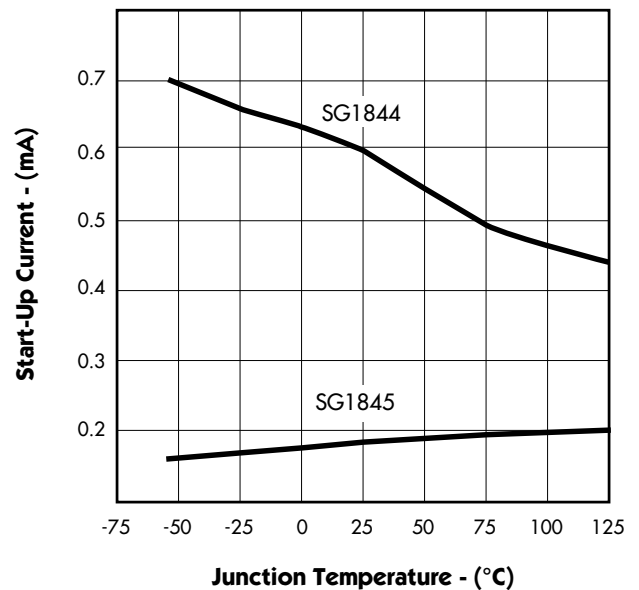


FIGURE 4. — START-UP CURRENT vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 5. — REFERENCE VOLTAGE vs. TEMPERATURE

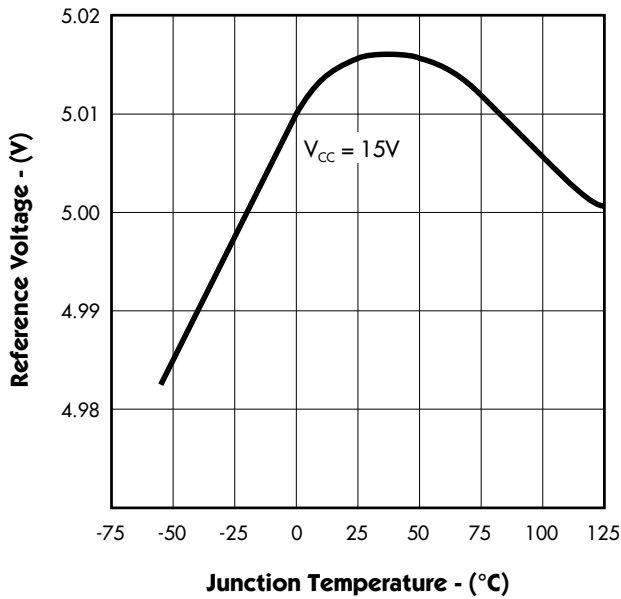


FIGURE 6. — START-UP VOLTAGE THRESHOLD vs. TEMPERATURE

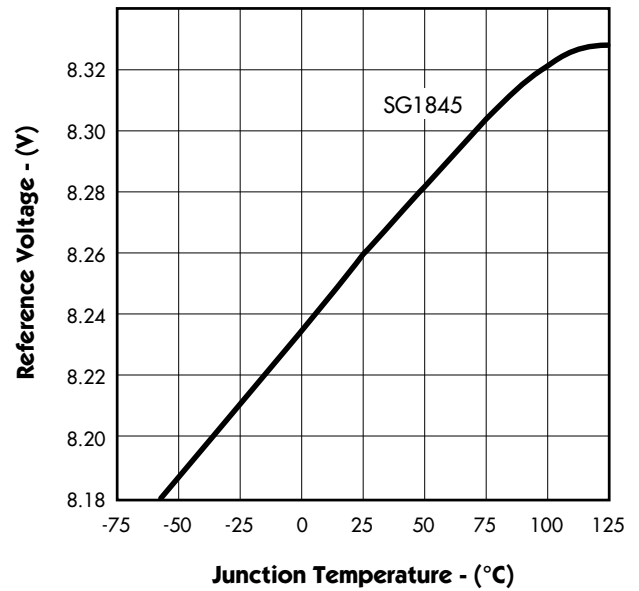


FIGURE 7. — START-UP VOLTAGE THRESHOLD vs. TEMPERATURE

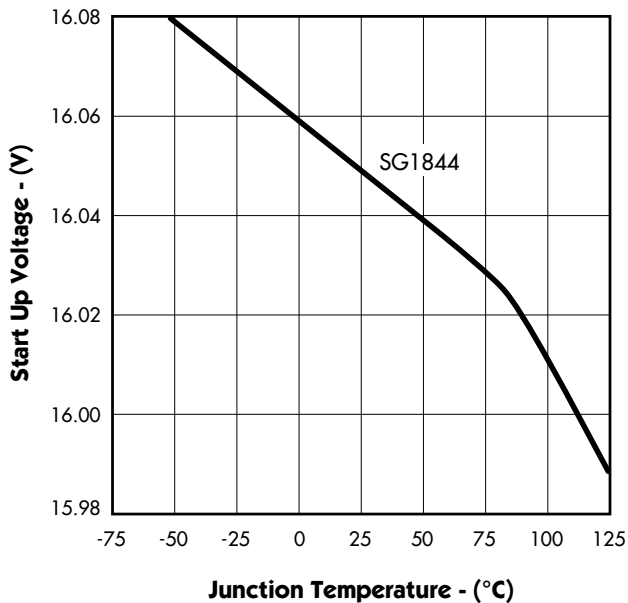
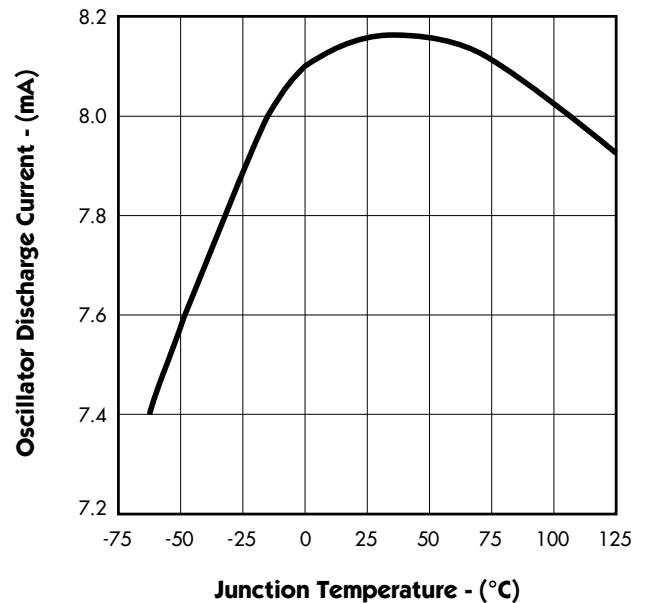


FIGURE 8. — OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE



CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

CHARACTERISTIC CURVES

FIGURE 9. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT & TEMPERATURE

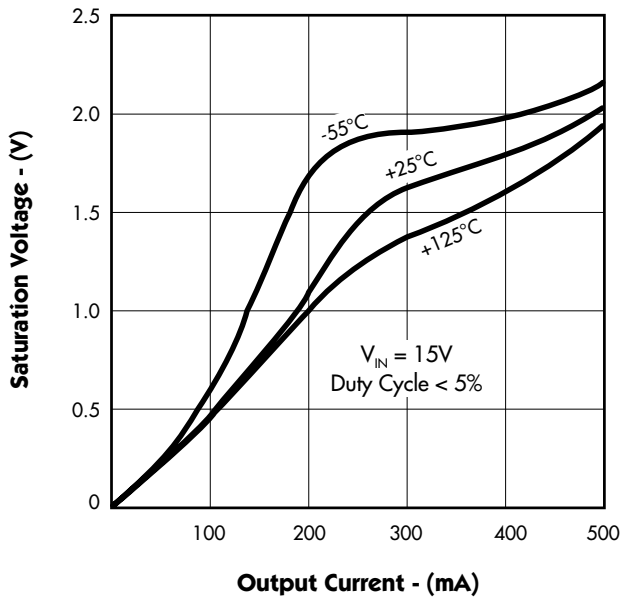


FIGURE 10. — CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT

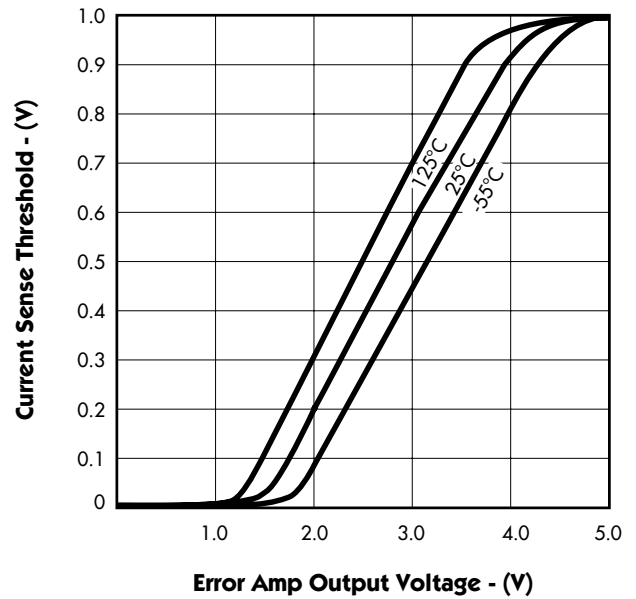
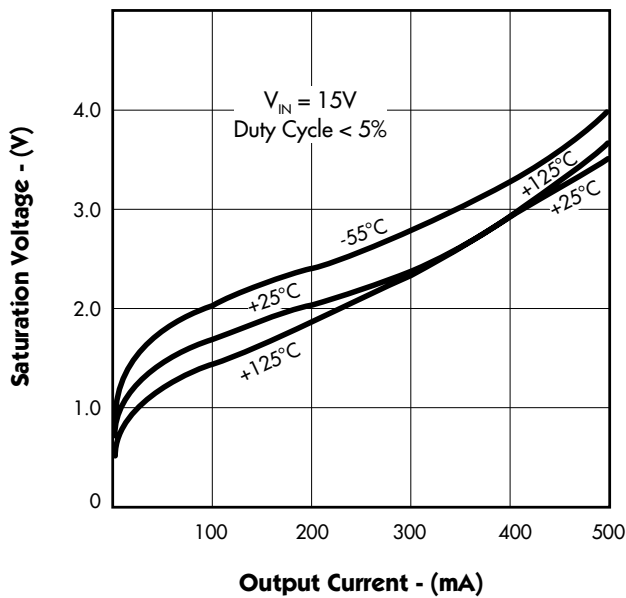


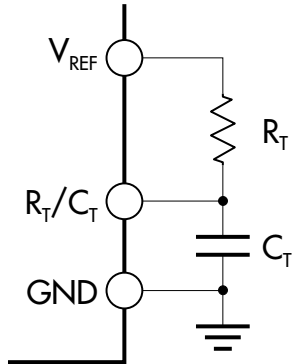
FIGURE 11. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT & TEMPERATURE



APPLICATION INFORMATION

OSCILLATOR

The oscillator of the 1844/45 family of PWM's is programmed by the external timing components (R_T , C_T) as shown in Figure 13.



$$F \approx \frac{1.86}{R_T C_T} \text{ where } R_T \geq 5k\Omega$$

FIGURE 12 — OSCILLATOR TIMING CIRCUIT

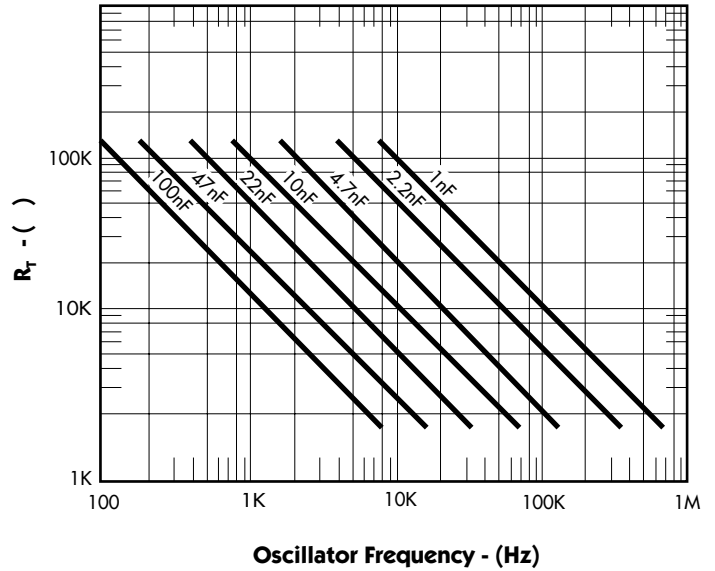


FIGURE 13 — OSCILLATOR FREQUENCY vs. R_T FOR VARIOUS C_T

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

TYPICAL APPLICATION CIRCUITS

Pin numbers referenced are for 8-pin package and pin numbers in parenthesis are for 14-pin package.

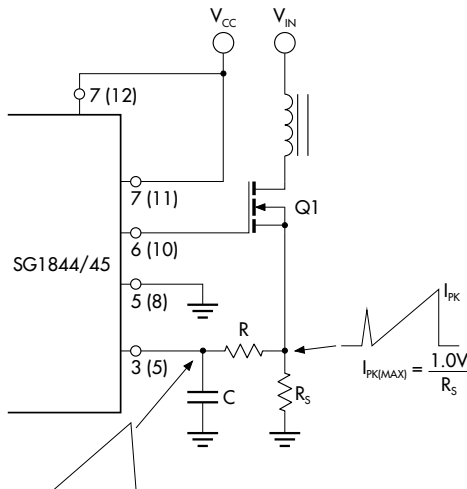


FIGURE 14. — CURRENT SENSE SPIKE SUPPRESSION

The RC low-pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

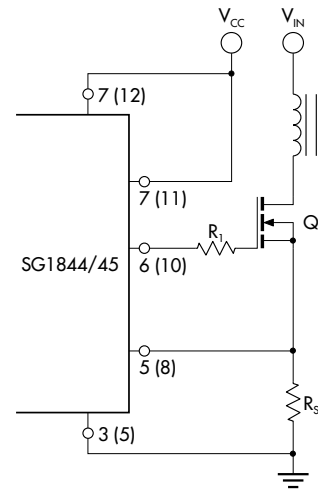


FIGURE 15. — MOSFET PARASITIC OSCILLATIONS

A resistor (R_1) in series with the MOSFET gate reduce overshoot and ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

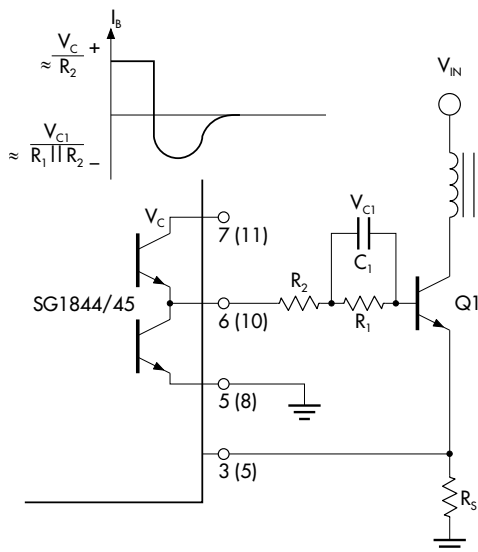
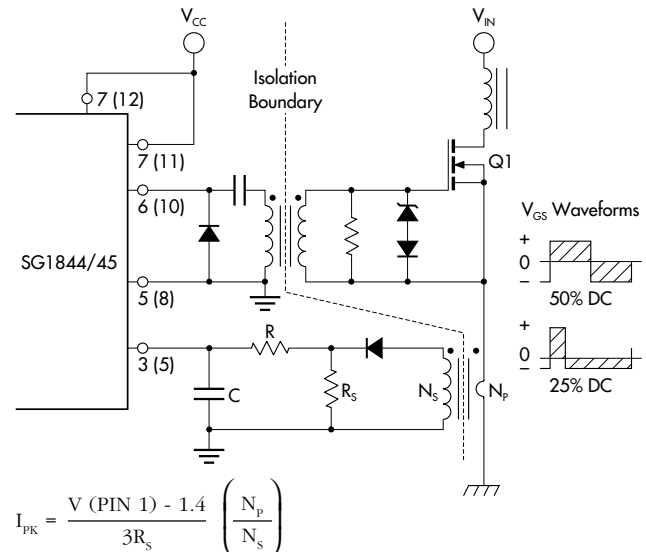


FIGURE 16. — BIPOLAR TRANSISTOR DRIVE

The 1844/45 output stage can provide negative base current to remove base charge of power transistor (Q_1) for faster turn off. This is accomplished by adding a capacitor (C_1) in parallel with a resistor (R_1). The resistor (R_1) is to limit the base current during turn on.

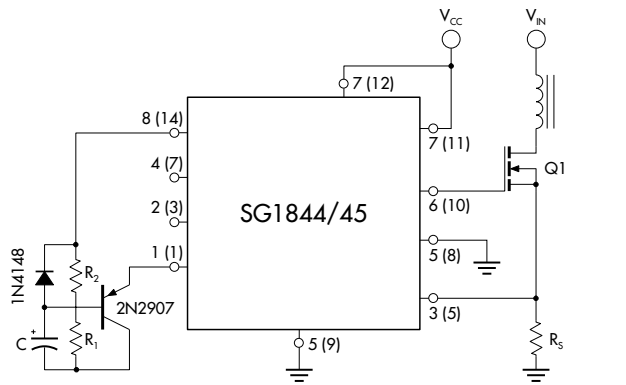


$$I_{PK} = \frac{V(\text{PIN } 1) - 1.4}{3R_s} \left(\frac{N_p}{N_s} \right)$$

FIGURE 17. — ISOLATED MOSFET DRIVE

Current transformers can be used where isolation is required between PWM and Primary ground. A drive transformer is then necessary to interface the PWM output with the MOSFET.

TYPICAL APPLICATION CIRCUITS (continued)



$$I_{PK} = \frac{V_1}{R_s} \quad \text{Where: } 0 \leq V_1 \leq 1.0V$$

$$t_{SOFTSTART} = -\ln 1 \left[-\frac{V_c}{V_2} \right] C \frac{R_1 R_2}{R_1 + R_2}$$

$$\text{and } V_1 = \frac{1.43 - 0.23 \frac{R_1}{R_2}}{1 + \frac{R_1}{R_2}} \quad \text{where: } V_2 = \frac{0.5}{1 + \frac{R_1}{R_2}}$$

FIGURE 18. — ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFTSTART

Softstart and adjustable peak current can be done with the external circuitry shown above.

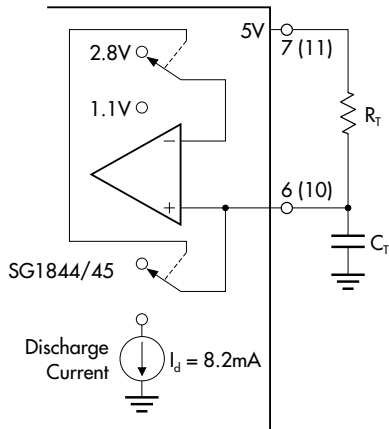
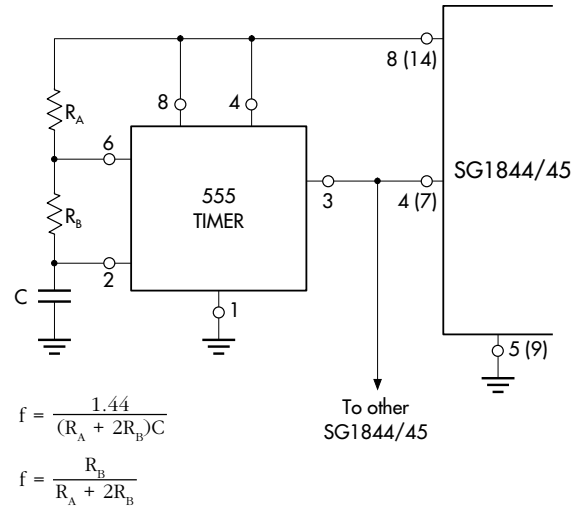


FIGURE 20. — OSCILLATOR CONNECTION

The oscillator is programmed by the values selected for the timing components R_t and C_t . Refer to application information for calculation of the component values.



$$f = \frac{1.44}{(R_A + 2R_B)C}$$

$$f = \frac{R_B}{R_A + 2R_B}$$

FIGURE 19. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION

Precision duty cycle limiting for a duty cycle of $<50\%$, as well as synchronizing several 1844/45's is possible with the above circuitry.

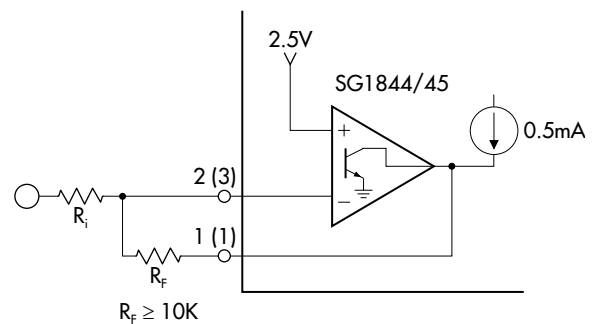


FIGURE 21. — ERROR AMPLIFIER CONNECTION

Error amplifier is capable of sourcing and sinking current up to 0.5mA.