NEC
ELECTRON DEVICE

BIPOLAR ANALOG INTEGRATED CIRCUIT

# μPC1906

# SWITCHING REGULATOR CONTROL CIRCUIT FOR 500 kHz OPERATION

μPC1906 is a control IC for the high performance switching power supply equipped with high speed/high sensitivity protection circuit. There are 3 series of μPC1099, 1905, 1906, as control IC for the high performance switching power supply. The features of μPC1906 are as follows:

① Power supply voltage is as high as 31 V.
→ It is possible to drive the output power MOS FET with high voltage.
② Hysteresis voltage of under voltage lockout circuit is 6.5 V.
→ The ripple allowance of the input capacitor is wide, therefore, the reduction of the same capacitor is possible.
③ Over current latch protection circuit is external reset mode.
→ When over current status occurs, power supply output is shut down. So it is most suitable for high reliability power supply.

## CONTROL IC FAMILY FOR THE HIGH PERFORMANCE SWITCHING POWER SUPPLY

| PART NUMBER | SUPPLY VOLTAGE | START-UP THRESHOLD VOLTAGE | THRESHOLD HYSTERESIS | OVER CURRENT LATCH PROTECTION MODE |
|---|---|---|---|---|
| μPC1099 | 26 V | 11 V | 3 V | Pulse by pulse current limiting |
| μPC1905 | 31 V | 16.5 V | 6.5 V | Pulse by pulse current limiting |
| μPC1906 | 31 V | 16.5 V | 6.5 V | Shut down and lockout |

## FEATURES

- Directly drive power MOS FET (totem pole circuit adopted)
- Over current latch circuit incorporated.
- Over voltage latch circuit incorporated
- Under voltage lockout circuit incorporated
- Remote control circuit incorporated
- Error amplifier incorporated

| PART NUMBER | PACKAGE | QUALITY GRADE |
|---|---|---|
| μPC1906CX | 16 pin plastic DIP (300 mil) | Standard |
| μPC1906GS | 16 pin plastic SOP (300 mil) | |

Please refer to "Quality grade on NEC Semiconductor Devices" (Document number IEI-1209) published by NEC Corporation to know the specification of quality grade on the devices and its recommended applications.

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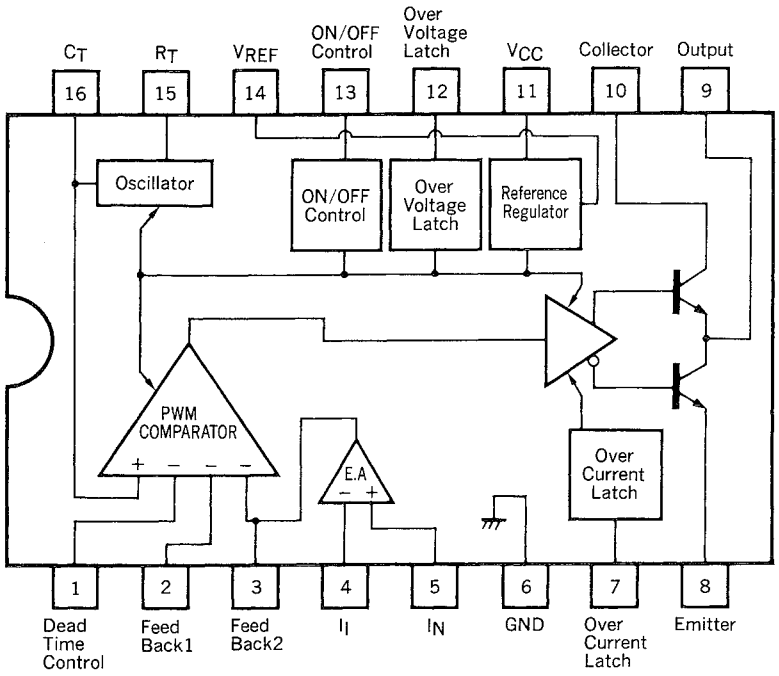
## PIN CONNECTION DIAGRAM (Top View)



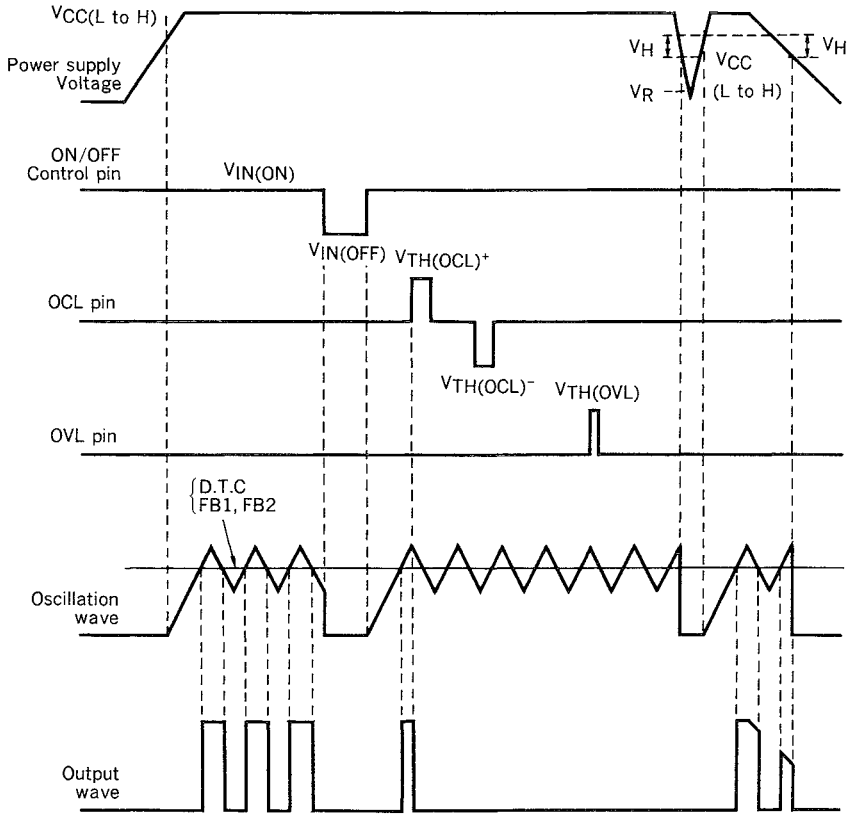
## ABSOLUTE MAXIMUM RATING ($T_a$ = 25 °C)

| PARAMETER | | SYMBOL | RATING | UNIT |
|---|---|---|---|---|
| Supply Voltage | | $V_{CC}$ | 31 | V |
| Output Voltage | | $V_C$ | 31 | V |
| Output Current | | $I_{C(DC)}$ | 100 | mA |
| Peak Output Current | | $I_{C(peak)}$ | 1.2 | A |
| Total Power Dissipation | μPC1906CX | $P_T$ ($T_a$ = 25 °C) | 1 000 | mW |
| | μPC1906GS | $P_T$ ($T_a$ = 25 °C) | 694 | mW |
| Operation Temperature | | $T_{opt}$ | −20 to +85 | °C |
| Storage Temperature | | $T_{stg}$ | −55 to +150 | °C |

## RECOMMENDED OPERATION REQUIREMENTS

| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 12 | 18 | 30 | V |
| Oscillation Frequency | $f_{OSC}$ | 50 | 200 | 500 | kHz |
| Output Load Capacitance | $C_L$ | – | 2 200 | 3 000 | pF |

## OPERATION WAVES



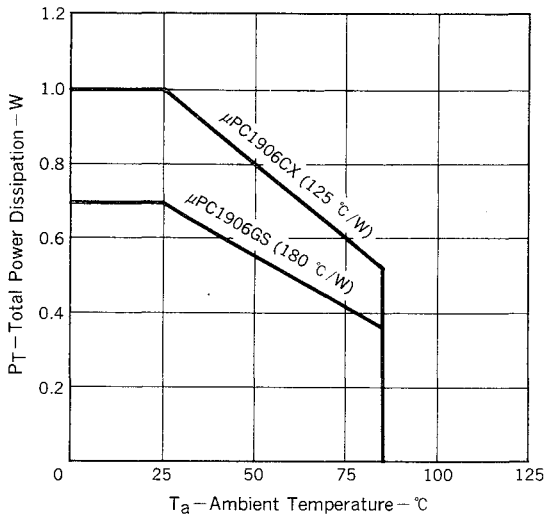
## ELECTRICAL CHARACTERISTICS ($T_a$ = 25 °C, $V_{CC}$ = 18 V, $C_T$ = 470 pF, $R_T$ ≒ 10 kΩ, $f_{OSC}$ = 200 kHz)

| BLOCK | PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNIT | CONDITIONS |
|---|---|---|---|---|---|---|---|
| Total | Standby Current | $I_{CC(SB)}$ | 0.1 | 0.25 | 0.4 | mA | $V_{CC}$ = 15 V, −10 °C ≤ $T_a$ ≤ 85 °C |
| | Circuit Current at OVL Operation Mode | $I_{CC(OVL)}$ | | 10 | | mA | |
| | Circuit Current at Off Mode | $I_{CC(OFF)}$ | | 10 | | mA | |
| | Circuit Current | $I_{CC}$ | | 10 | 15 | mA | $V_{CC}$ = $V_C$ = 24 V, $V_D$ = 2.7 V, no load |
| Under Voltage Lockout Section | Start-Up Threshold Voltage | $V_{CC(L\ to\ H)}$ | 15.5 | 16.5 | 17.5 | V | |
| | Threshold Hysteresis | $V_H$ | 5.5 | 6.5 | 7.5 | V | |
| Reference Voltage Section | Output Voltage | $V_{REF}$ | 4.8 | 5 | 5.2 | V | $I_{REF}$ = 0 |
| | Line Regulation | $REG_{IN}$ | | 4 | 10 | mV | 12 V ≤ $V_{CC}$ ≤ 30 V, $I_{REF}$ = 0 |
| | Load Regulation | $REG_L$ | | 2 | 12 | mV | 0 ≤ $I_{REF}$ ≤ 3 mA |
| | Output Voltage Temperature Coefficient | $V_{REF}/\Delta T$ | | 100 | 700 | μV/°C | $I_{REF}$ = 0, −10 °C ≤ $T_a$ ≤ +85 °C |
| | Short Circuit Current | $I_{O\ short}$ | | 15 | | mA | $V_{REF}$ = 0 |
| PWM Section | Input Bias Current | $I_B$ | | | 10 | μA | |
| | Low Level Threshold Voltage | $V_{TH(L)}$ | | 1.5 | | V | |
| | High Level Threshold Voltage | $V_{TH(H)}$ | | 3.5 | | V | |
| | Dead Time Temperature Coefficient | $\Delta DT/\Delta T$ | | 1 | 5 | % | $V_D$ = 0.54 $V_{REF}$, −10 °C ≤ $T_a$ ≤ +85 °C |
| Oscillator Section | Oscillation Frequency | $f_{OSC}$ | 180 | 200 | 220 | kHz | |
| | Frequency Line Regulation | $\Delta f/\Delta V_{CC}$ | | 0.6 | | % | 12 V ≤ $V_{CC}$ ≤ 30 V |
| | Frequency Temperature Coefficient | $\Delta f/\Delta T$ | | 1 | 5 | % | −10 °C ≤ $T_a$ ≤ +85 °C |
| Output Section | Low Level Output Voltage | $V_{OL}$ | | | 0.5 | V | $I_{SINK}$ = 3 mA, $V_{CC}$ = $V_C$ |
| | High Level Output Voltage | $V_{OH}$ | | $V_{CC}$−1.6 | | V | $I_{SOURCE}$ = 30 mA, $V_{CC}$ = $V_C$ |
| | Output Voltage Rise Time | $t_r$ | | 80 | | ns | $R_L$ = 15 Ω, $C_L$ = 2 200 pF, $V_{CC}$ = $V_C$ |
| | Output Voltage Fall Time | $t_f$ | | 30 | | ns | |
| Remote Control Section | Input Voltage at Output ON | $V_{IN(ON)}$ | 2.3 | 2.5 | 2.7 | V | |
| | Input Voltage at Output OFF | $V_{IN(OFF)}$ | 2.1 | 2.3 | 2.5 | V | |
| | Hysteresis Width | $V_H$ | 0.1 | 0.2 | 0.3 | V | |
| Over Voltage Latch Section | Over Voltage Threshold Voltage | $V_{TH(OVL)}$ | 2.0 | 2.4 | 2.8 | V | −10 °C ≤ $T_a$ ≤ +85 °C |
| | Input Bias Current | $I_{B(OVL)}$ | | | 4 | μA | OVL pin voltage = $V_{TH(OVL)}$ |
| | OVL Reset Voltage | $V_{R(OVL)}$ | | 2 | | V | |
| | Delay to Output | $t_{d(OVL)}$ | | 600 | | ns | |
| Over Current Latch Section | Over Current Threshold Voltage | $V_{TH(OCL)^+}$ | 200 | 220 | 240 | mV | −10 °C ≤ $T_a$ ≤ +85 °C |
| | Over Current Threshold Voltage | $V_{TH(OCL)^-}$ | −230 | −210 | −190 | mV | −10 °C ≤ $T_a$ ≤ +85 °C |
| | OCL Pin Output Current | $I_{B(OCL)}$ | | 250 | | μA | |
| | Delay to Output | $t_{d(OCL)^+}$ | | 120 | | ns | |
| | Delay to Output | $t_{d(OCL)^-}$ | | 190 | | ns | |

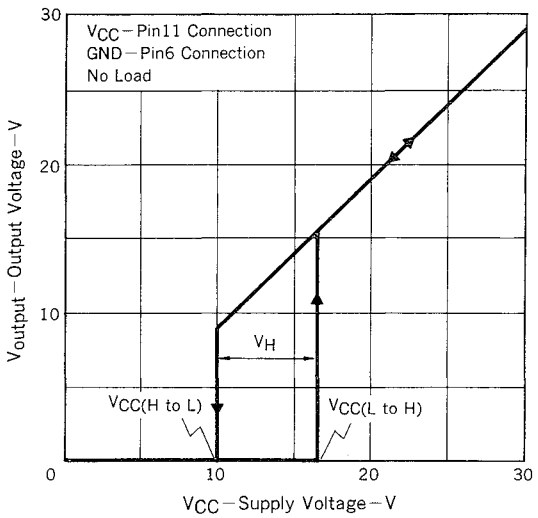
| BLOCK | PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNIT | CONDITIONS |
|---|---|---|---|---|---|---|---|
| Error Amplification Section | Input Bias Current | $I_{B(AMP)}$ | | | 1 | μA | $V_{IN}$ = 2.5 V |
| | Open-Loop Voltage Gain | $A_v$ | 60 | 90 | | dB | $V_{FB}$ = 2.9 V |
| | Unit Gain Bandwidth | $f_{unity}$ | 1 | 1.6 | | MHz | |
| | High Level Output Voltage | $V_{om^+}$ | 3.0 | | | V | |
| | Low Level Output Voltage | $V_{om^-}$ | | | 1.0 | V | |
| | Common Mode Input Voltage Range | $V_{ICM^+}$ | 3 | | | V | 12 V ≤ $V_{CC}$ ≤ 30 V, |
| | Common Mode Input Voltage Range | $V_{ICM^-}$ | | | −0.3 | V | −10 °C ≤ $T_a$ ≤ +85 °C |

## TYPICAL CHARACTERISTICS ($T_a$ = 25 °C)

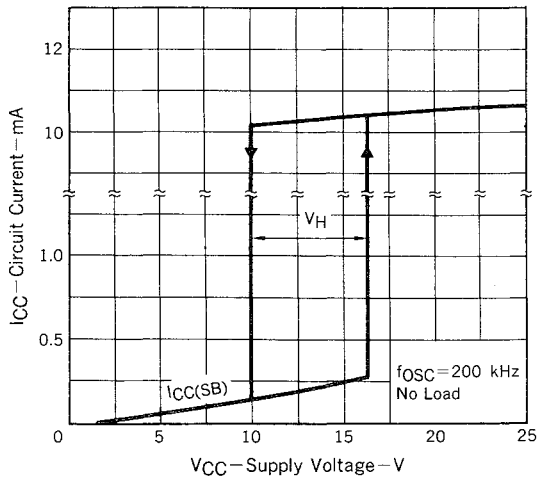
$P_T - T_a$



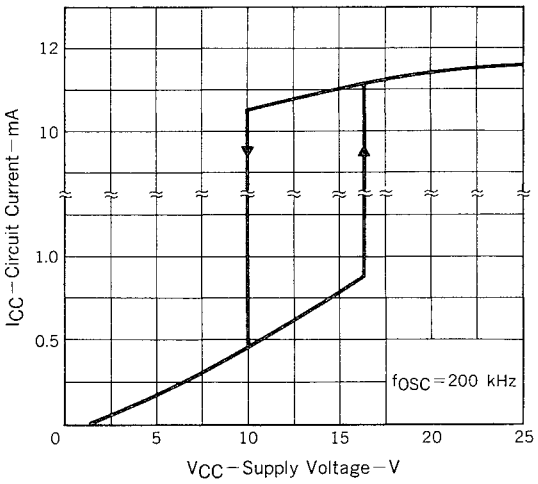

UNDER VOLTAGE LOCKOUT SECTION



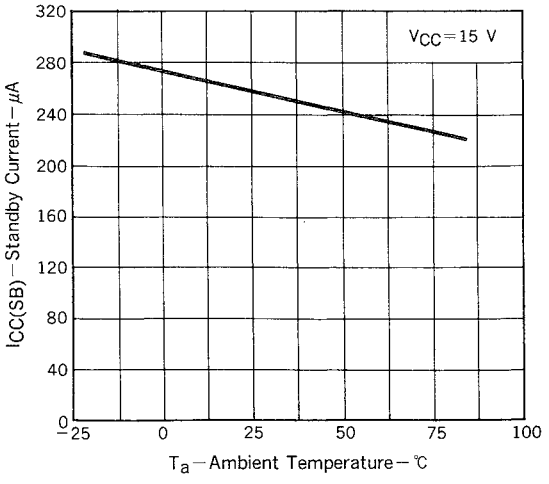

$I_{CC} - V_{CC}$



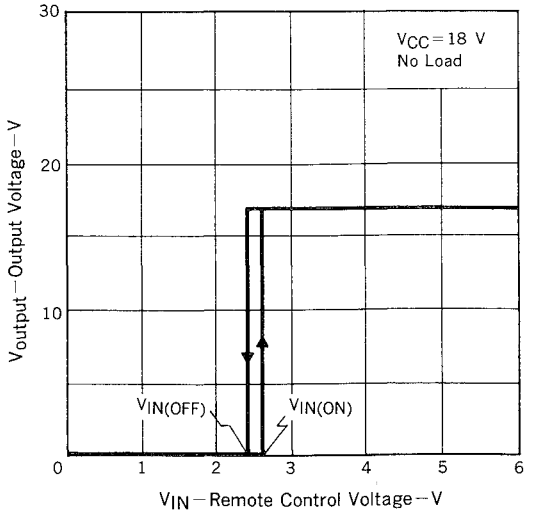

$I_{CC} - V_{CC}$ (OVL, OCL Mode)



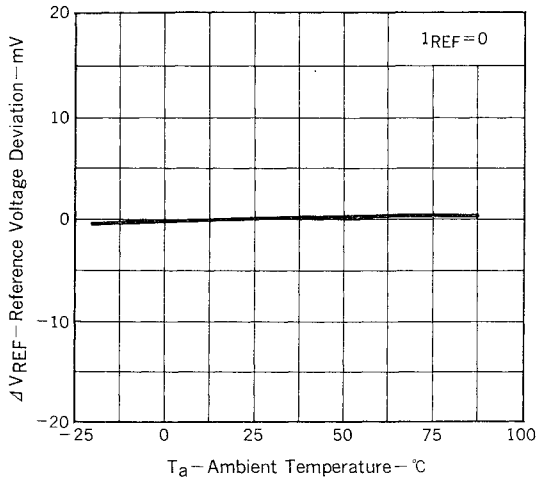

$I_{CC(SB)} - T_a$



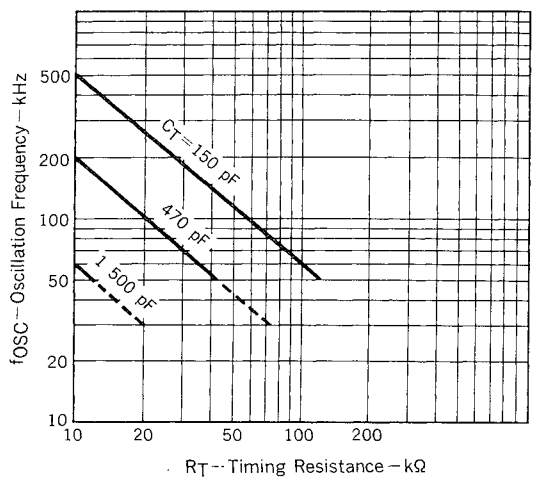

$V_{output} - V_{IN}$



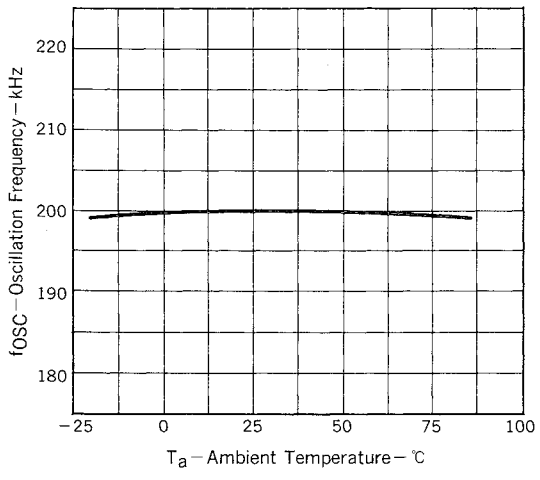
$\Delta V_{REF} - T_a$



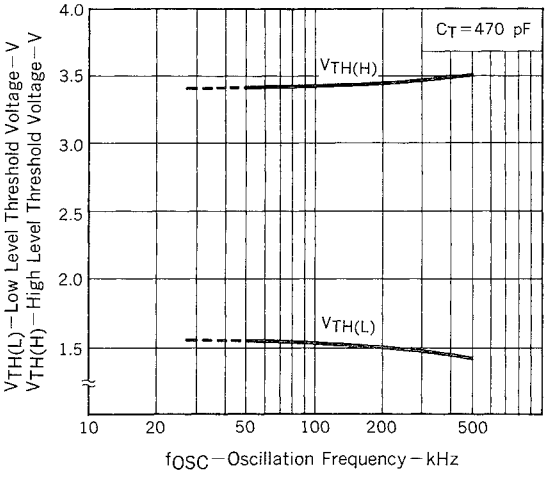

$f_{OSC} - R_T, C_T$



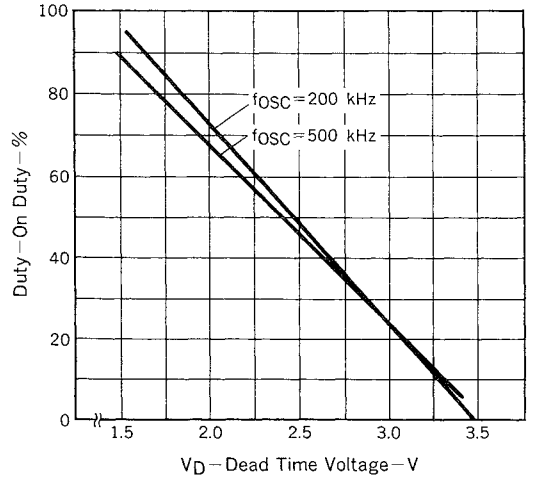

$f_{OSC} - T_a$



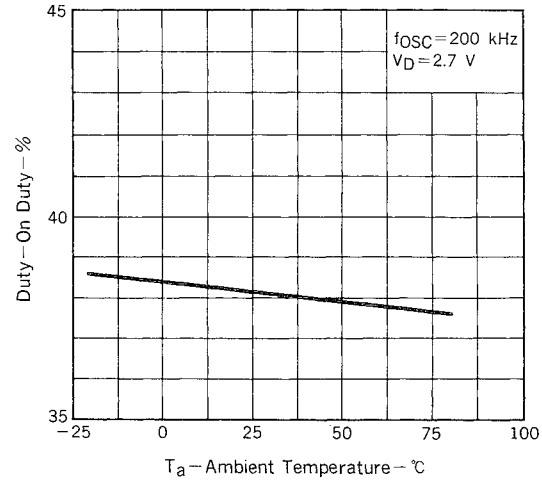

$V_{TH(L)}, V_{TH(H)} - f_{OSC}$



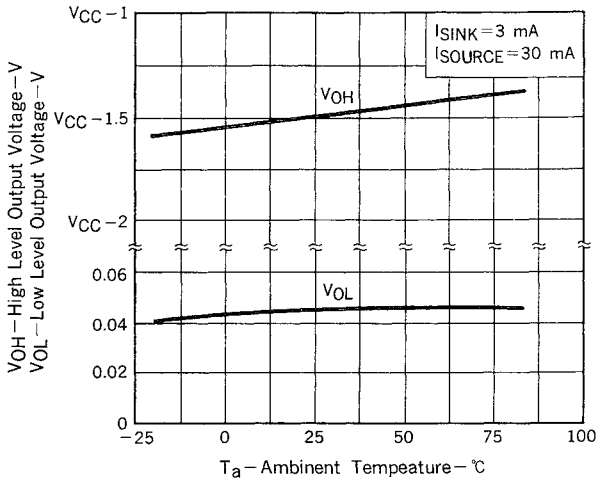

Duty – $V_D$



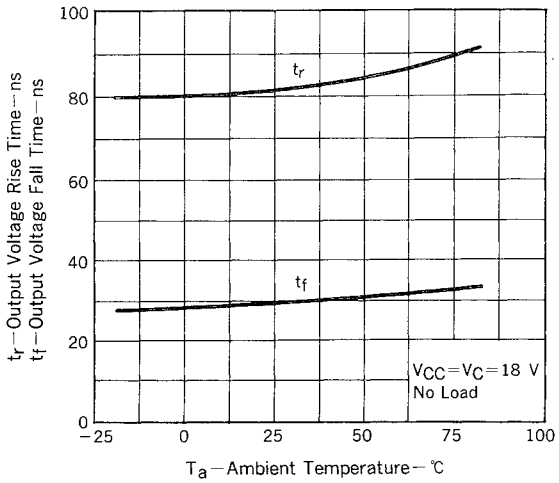

Duty – $T_a$



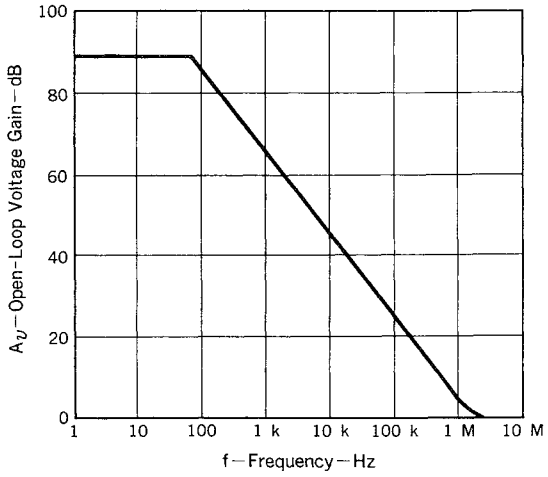
$V_{OL}, V_{OH} - T_a$




$t_r, t_f - T_a$




$A_v - f$




**NOTE:** When under-shoot voltage at pin 9 occur, it must be cramped to prevent from wrong operation. See Fig. 1.

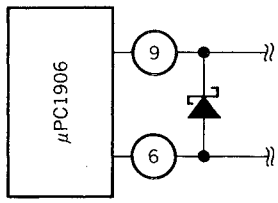
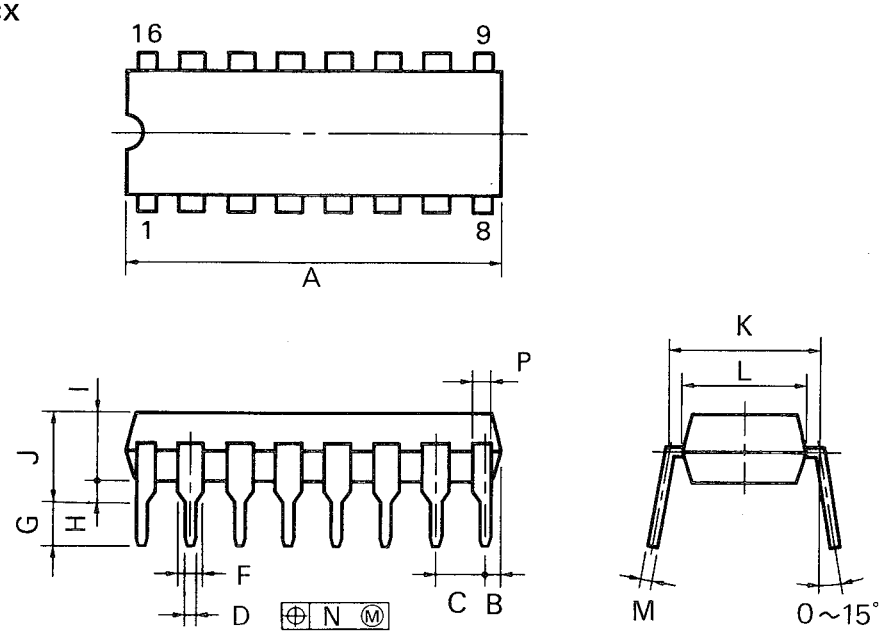



Fig. 1

## 16PIN PLASTIC DIP (300 mil)

μPC1906CX




P16C-100-300B

**NOTES**

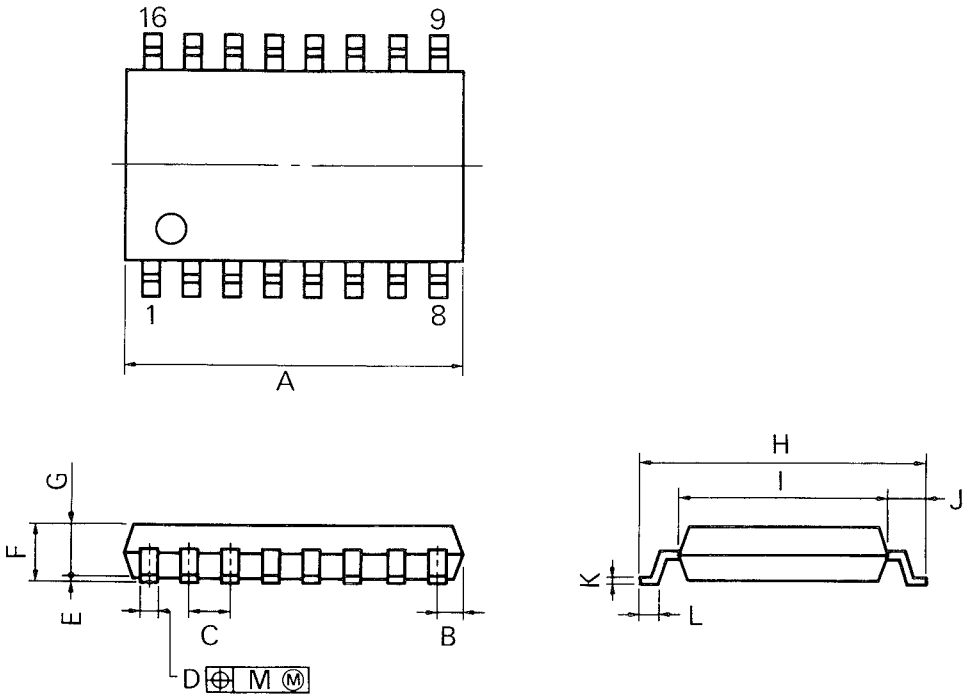
1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

2) Item "K" to center of leads when formed parallel.

| ITEM | MILLIMETERS | INCHES |
|---|---|---|
| A | 20.32 MAX. | 0.800 MAX. |
| B | 1.27 MAX. | 0.050 MAX. |
| C | 2.54 (T.P.) | 0.100 (T.P.) |
| D | $0.50^{\pm 0.10}$ | $0.020^{+0.004}_{-0.005}$ |
| F | 1.1 MIN. | 0.043 MIN. |
| G | $3.5^{\pm 0.3}$ | $0.138^{\pm 0.012}$ |
| H | 0.51 MIN. | 0.020 MIN. |
| I | 4.31 MAX. | 0.170 MAX. |
| J | 5.08 MAX. | 0.200 MAX. |
| K | 7.62 (T.P.) | 0.300 (T.P.) |
| L | 6.5 | 0.256 |
| M | $0.25^{+0.10}_{-0.05}$ | $0.010^{+0.004}_{-0.003}$ |
| N | 0.25 | 0.01 |
| P | 1.1 MIN. | 0.043 MIN. |

## 16PIN PLASTIC SOP (300 mil)

μPC1906GS




P16GM-50-300B-1

**NOTE**

Each lead centerline is located within 0.12 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

| ITEM | MILLIMETERS | INCHES |
|---|---|---|
| A | 10.46 MAX. | 0.412 MAX. |
| B | 0.78 MAX. | 0.031 MAX. |
| C | 1.27 (T.P.) | 0.050 (T.P.) |
| D | $0.40^{+0.10}_{-0.05}$ | $0.016^{+0.004}_{-0.003}$ |
| E | $0.1 \pm 0.1$ | $0.004 \pm 0.004$ |
| F | 1.8 MAX. | 0.071 MAX. |
| G | 1.55 | 0.061 |
| H | $7.7 \pm 0.3$ | $0.303 \pm 0.012$ |
| I | 5.6 | 0.220 |
| J | 1.1 | 0.043 |
| K | $0.20^{+0.10}_{-0.05}$ | $0.008^{+0.004}_{-0.002}$ |
| L | $0.6 \pm 0.2$ | $0.024^{+0.008}_{-0.009}$ |
| M | 0.12 | 0.005 |

[MEMO]