DATA SHEET

NEC

Bipolar Analog Integrated Circuit

μPC1909

SWITCHING REGULATOR CONTROL IC

The μPC1909 is a switching regulator control IC ideal for primary side control of active-clamp type[Note] DC/DC converters. This IC has 2 outputs employing a totem-pole circuit with peak output current 1.2 A, and is capable of directly driving a power MOS-FET. As a result, it has been possible to realize primary side control of an active-clamp type converter on a single chip.

Note It is necessary to obtain license from Vicor Corporation before using the μPC1909 in an active-clamp type circuit.

FEATURES

- 2 on-chip outputs; for Q and $\overline{Q}$
- Capable of directly driving a power MOS-FET
- Drive supply voltage range: 7 V to 24 V
- On-chip remote control circuit
- On-chip pulse-by-pulse overcurrent protection circuit
- On-chip overvoltage latch circuit

ORDERING INFORMATION

Part Number	Package
μPC1909CX	16-pin plastic DIP (300 mils)
μPC1909GS	16-pin plastic SOP (300 mils)

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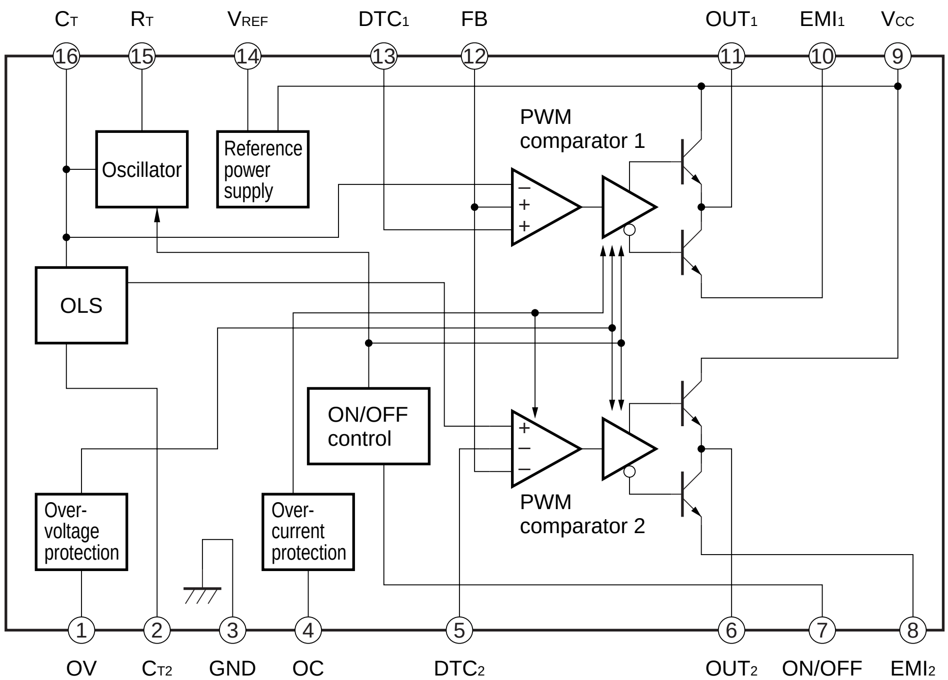
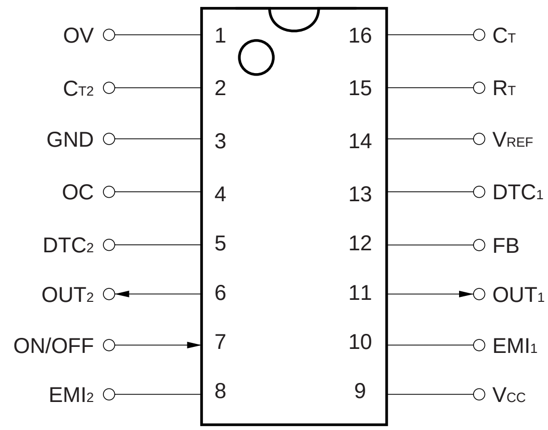
BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)

16-pin plastic DIP (300 mils)
μPC1909CX

16-pin plastic SOP (300 mils)
μPC1909GS



PIN FUNCTION LIST

Pin Number	Pin Name	Function	Pin Number	Pin Name	Function
1	OV	Overvoltage protection	9	V_{CC}	Power supply
2	C_{T2}	OLS shift setting	10	EMI_1	OUT_1 emitter
3	GND	Ground	11	OUT_1	OUT_1 output
4	OC	Overcurrent protection	12	FB	Feedback input
5	DTC_2	OUT_2 dead-time setting	13	DTC_1	OUT_1 dead-time setting
6	OUT_2	OUT_2 output	14	V_{REF}	Reference voltage output
7	ON/OFF	ON/OFF control	15	R_T	Timing resistance
8	EMI_2	OUT_2 emitter	16	C_T	Timing capacitance

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (Unless otherwise specified, T_A = 25°C)

Parameter	Symbol	μPC1909CX	μPC1909GS	Unit
Supply Voltage	V_{CC}	26		V
Output Current (DC, per output)	$I_{C\,(DC)}$	100		mA
Output Current (peak, per output)	$I_{C\,(peak)}$	1.2		A
Total Power Dissipation	P_T	1000	694	mW
Operating Ambient Temperature	T_A	–20 to +85		°C
Operating Junction Temperature	T_J	–20 to +150		°C
Storage Temperature	T_{stg}	–55 to +150		°C

Caution Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

Recommended Operating Conditions

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	V_{CC}	7	10	24	V
Oscillation Frequency	f_{OSC}	50	200	500	kHz
Output Load Capacitance	C_L		2200	3000	pF
Output Load Resistance	R_L	10			kΩ
Operating Junction Temperature	T_J	–20		+100	°C

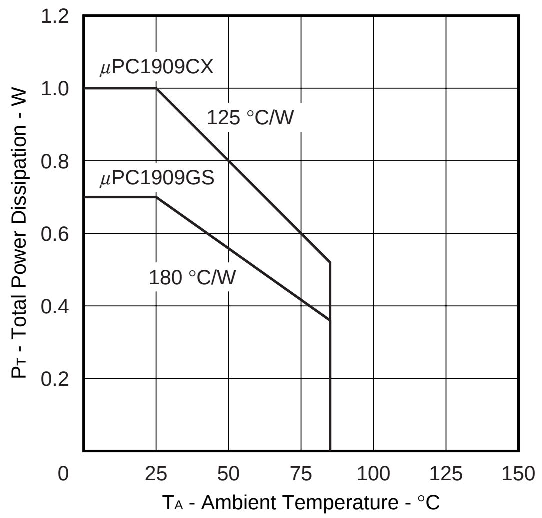
Electrical Characteristics (Unless otherwise specified, T_A = 25°C, V_{CC} = 10 V, R_T = 10 kΩ, fosc = 200 kHz)

Block	Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Total	Standby Current	$I_{CC\ (SB)}$	V_{CC} = 7 V		0.1		mA
	Circuit Current	I_{CC}	Without load	6	12	18	mA
Under-Voltage Lockout Circuit	Start-Up Threshold Voltage	$V_{CC\ (L\ to\ H)}$		8	9	10	V
	Operating Voltage Hysteresis Width	V_H		3	4	5	V
Reference Voltage	Output Voltage	V_{REF}	I_{REF} = 0 A	4.7	4.9	5.1	V
	Line Regulation	REG_{IN}	8 V ≤ V_{CC} ≤ 15 V, I_{REF} = 0 A		1	10	mV
	Load Regulation	REG_L	1 mA ≤ I_{REF} ≤ 4 mA		6	12	mV
	Output Voltage Temperature Coefficient	$\Delta V_{REF}/\Delta T$	–10°C ≤ T_A ≤ +85°C, I_{REF} = 0 A		400	(700)	μV/°C
	Short Circuit Current	$I_{O\ short}$	I_{REF} = 0 A		15		mA
Oscillation	Oscillation Frequency	f_{OSC}		180	200	220	kHz
	Frequency Line Regulation	$\Delta f/\Delta V$	8 V ≤ V_{CC} ≤ 15 V		1		%
	Frequency Temperature Coefficient	$\Delta f/\Delta T$	–10°C ≤ T_A ≤ +85°C		2	(5)	%
PWM Comparator	Input Bias Current	$I_{B\ (COMP1)}$	V_{COMP1} = V_{REF}			10	μA
		$I_{B\ (COMP2)}$	V_{COMP2} = V_{REF}			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 Coeficient	$\Delta DT/\Delta T$	–10°C ≤ T_A ≤ +85°C, V_D = 0.46 V_{REF}		3		%
Output	Low-level Output Voltage	V_{OL}	I_{SINK} = 3 mA			0.5	V
	High-level Output Voltage	V_{OH}	I_{SOURCE} = 30 mA		V_{CC} – 1.6		V
	Rise Time	t_r	R_L = 15 Ω, C_L = 2200 pF		60		ns
	Fall Time	t_f	R_L = 15 Ω, C_L = 2200 pF		40		ns
Remote Control	Input Voltage at Output ON	$V_{IN\ (ON)}$		2.4	2.6	2.8	V
	Input Voltage at Output OFF	$V_{IN\ (OFF)}$		2.2	2.4	2.6	V
	Hysteresis Width	V_H		0.1	0.2	0.3	V
Overcurrent Latch	Overcurrent Threshold Voltage	$V_{TH\ (OC)}$		190	210	230	mV
	Input Bias Current	$I_{B\ (OC)}$	V_{CC} = 0 V		200		μA
	Delay to Output	$t_{d\ (OC)}$			150		ns
Overvoltage Latch	Overvoltage Threshold Voltage	$V_{TH\ (OV)}$		2	2.4	2.8	V
	Input Bias Current	$I_{B\ (OV)}$	V_{OV} = V_{REF}			4	μA
	OVL Reset Voltage	$V_{R\ (OV)}$			2		V
	Delay to Output	$t_{d\ (OV)}$			750		ns

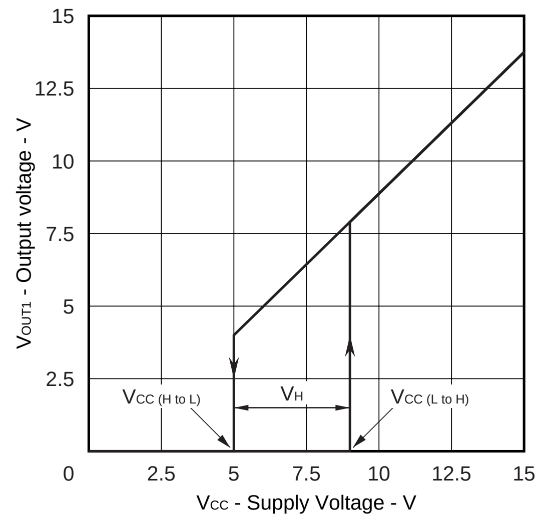
Remark Values in parentheses ( ) represent reference values.

TYPICAL CHARACTERISTICS CURVES (UNLESS OTHERWISE SPECIFIED, T_A = 25°C, V_{CC} = 10 V, REFERENCE VALUES)

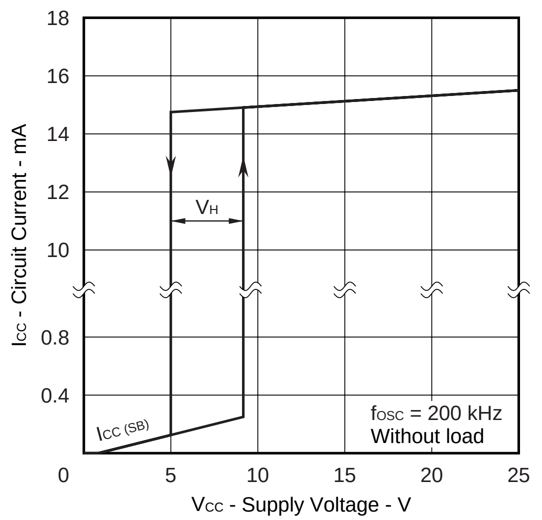
P_T vs. T_A



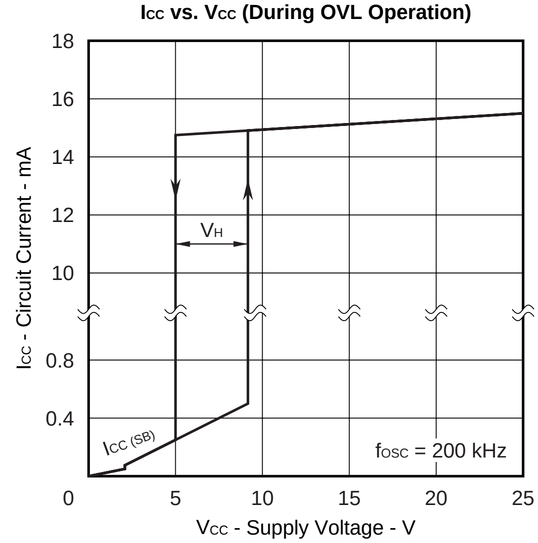
Under-Voltage Lockout Circuit



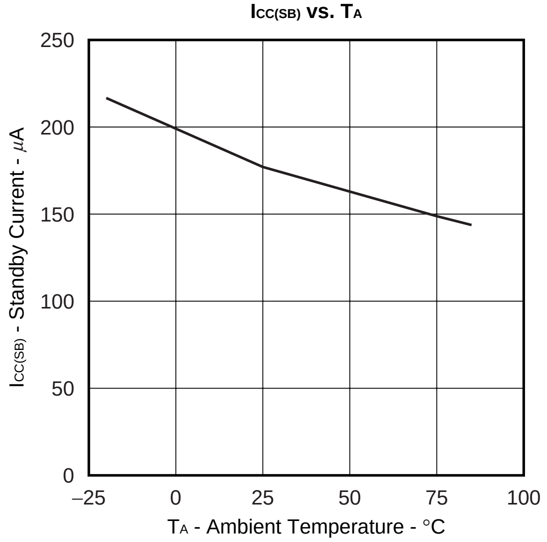
I_{CC} vs. V_{CC}



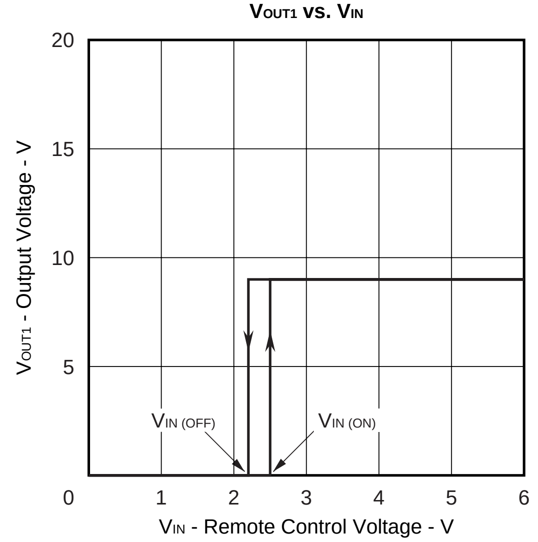
I_{CC} vs. V_{CC} (During OVL Operation)



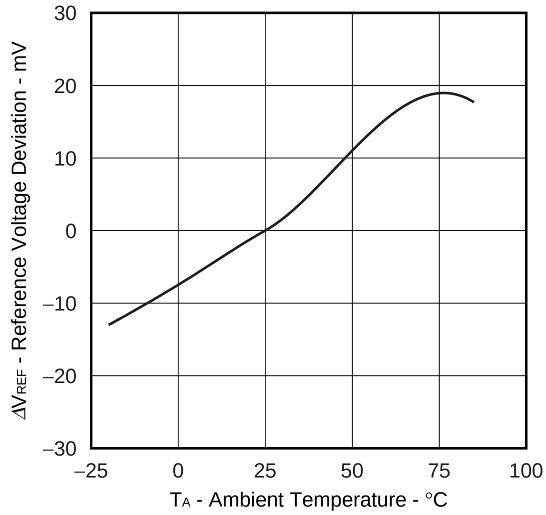
$I_{CC(SB)}$ vs. T_A



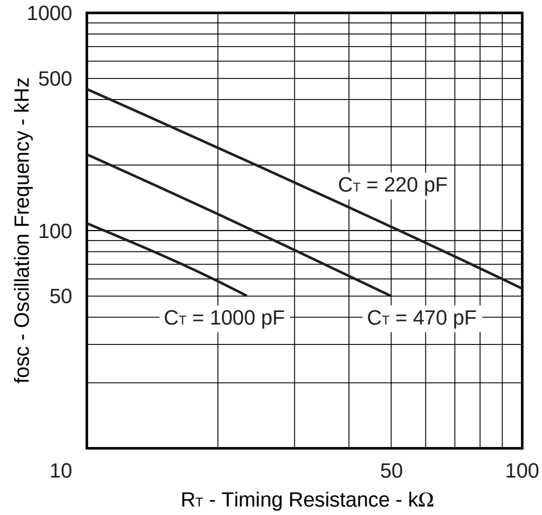
V_{OUT1} vs. V_{IN}



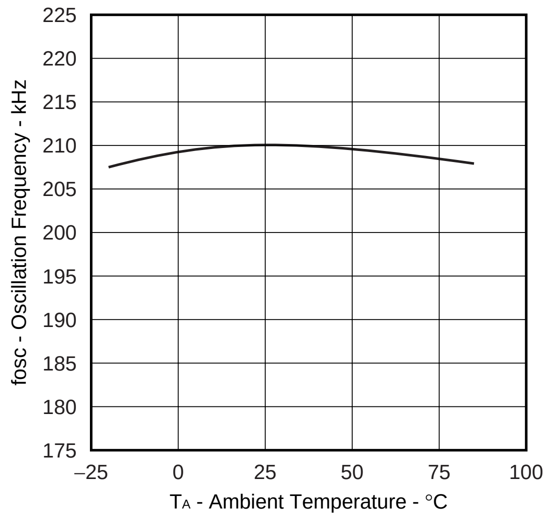
ΔVREF vs. TA



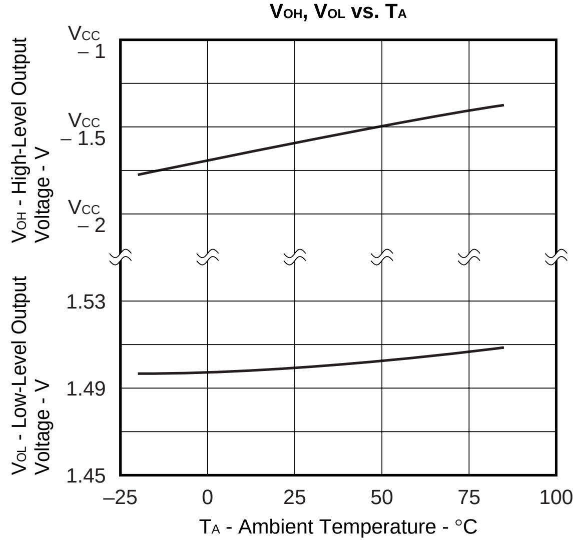
fosc vs. RT, CT



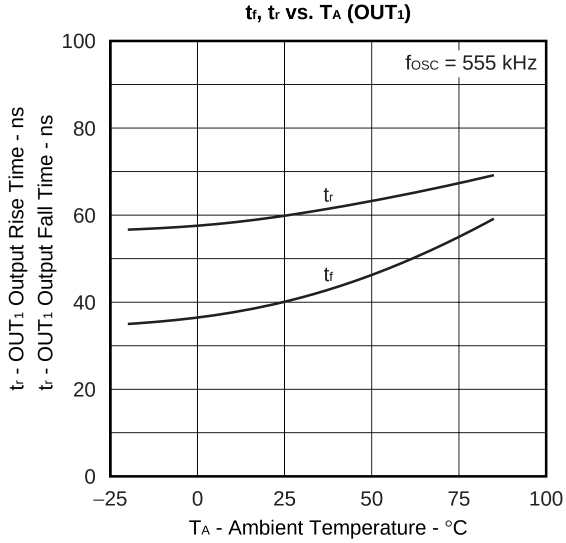
fosc vs. TA



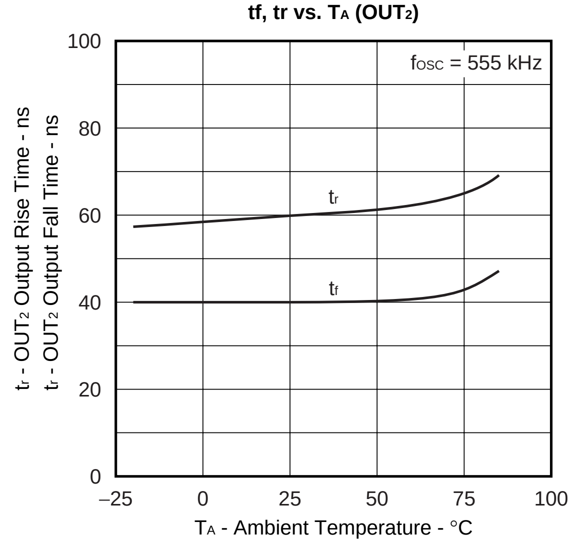
VOH, VOL vs. TA

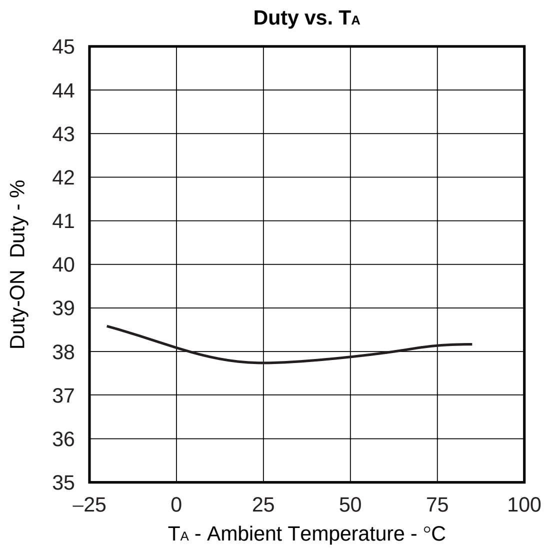


tf, tr vs. TA (OUT1)

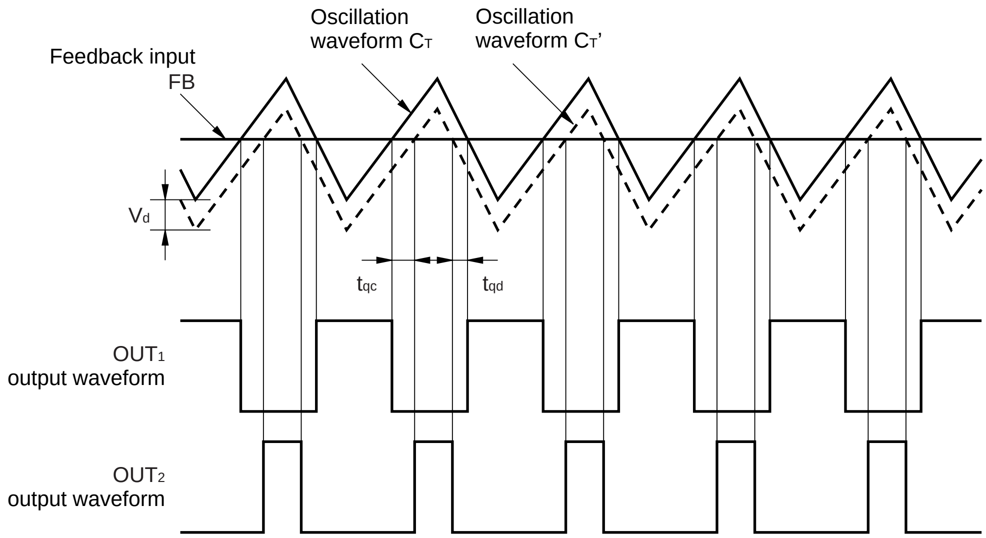


tf, tr vs. TA (OUT2)




Duty vs. TA
Duty-ON Duty - %
45
44
43
42
41
40
39
38
37
36
35
–25
0
25
50
75
100
TA - Ambient Temperature - °C

TIMING CHART



(1) Oscillation waveform (C_T)

This waveform is determined by the external capacitor connected to the C_T pin (pin 16) and the external resistor connected to the R_T pin (pin 15). It is usually a 1.5-V to 3.5-V triangle waveform (the rise and fall times are the same).

(2) Output waveform (OUT_1)

Whichever is the lower of the DTC_1 pin (pin 13) and FB pin (pin 12) voltages is compared with the triangle wave of the C_T pin (pin 16). The OUT_1 pin (pin 11) is high level while the triangle wave is low.

(3) Output waveform (OUT_2)

Whichever is the higher of the DTC_2 pin (pin 5) and FB pin (pin 12) voltages is compared with the level-shifted triangle wave (C_T'). The OUT_2 pin (pin 6) is high level while the level-shifted triangle wave is high.

(4) Triangle wave level shift

The triangle wave that controls OUT_2 is the original triangle wave of the C_T pin (pin 16) shifted to a lower potential via the level shift circuit (OLS). The amount of shift (V_d) can be adjusted using the resistor (R_{CT2}) connected between the C_{T2} pin (pin 2) and the V_{REF} pin.

The relationship between the shift amount (V_d) and the resistance value (kΩ) of the resistor R_{CT2} connected to the C_{T2} pin (pin 2) is as follows.

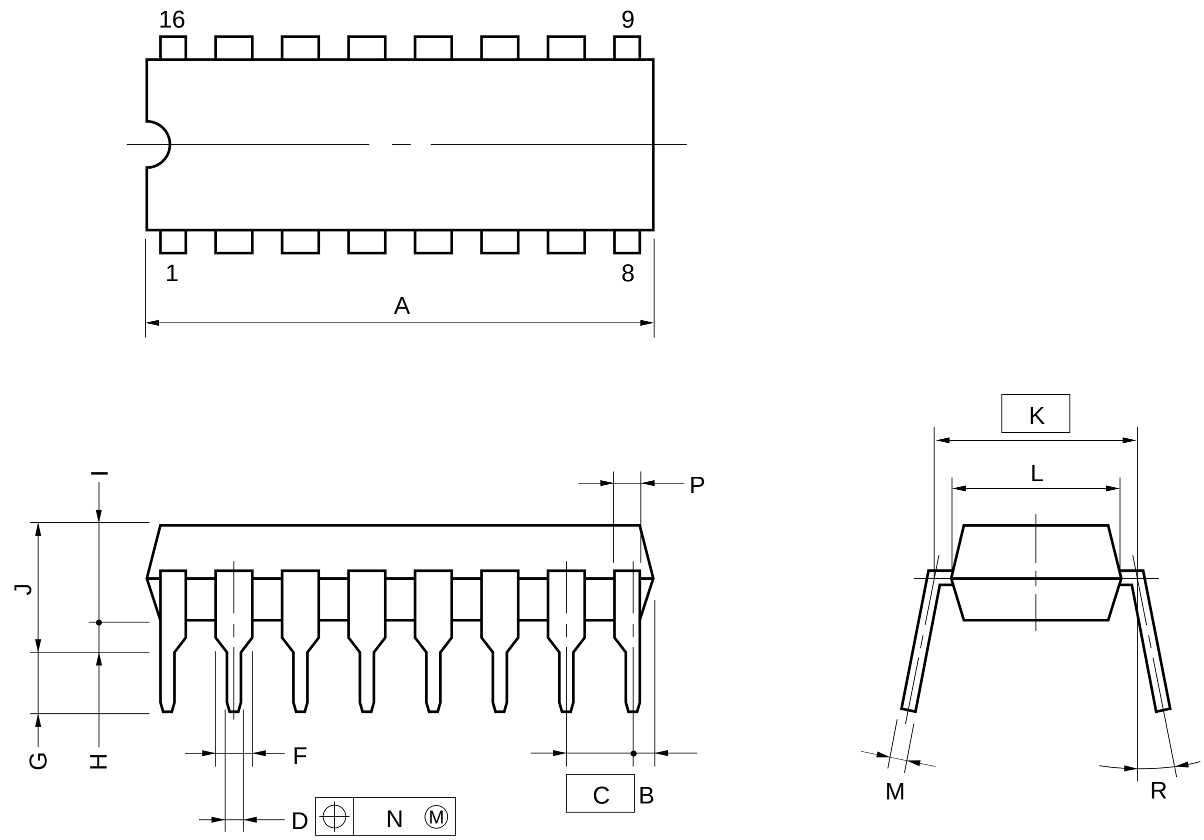
$$V_d = \frac{4.3}{R_{CT2}[k\Omega] + 10} \times 2 \text{ [V]}$$

(5) Dead-time (t_{qc}, t_{qd}) adjustment

The dead time between the fall of OUT_1 and the rise of OUT_2 (t_{qc}) and the dead time between the fall of OUT_2 and the rise of OUT_1 (t_{qd}) is determined by the oscillation frequency and the amount of level shift of the triangle wave. Although usually $t_{qc} = t_{qd}$, if setting these independently, connect a suitable resistor between the C_T pin and the V_{REF} pin, as well as between the C_T pin and GND, and adjust the dead time by making the oscillation waveform asymmetrical.

PACKAGE DRAWINGS

16 PIN PLASTIC DIP (300 mil)



NOTES

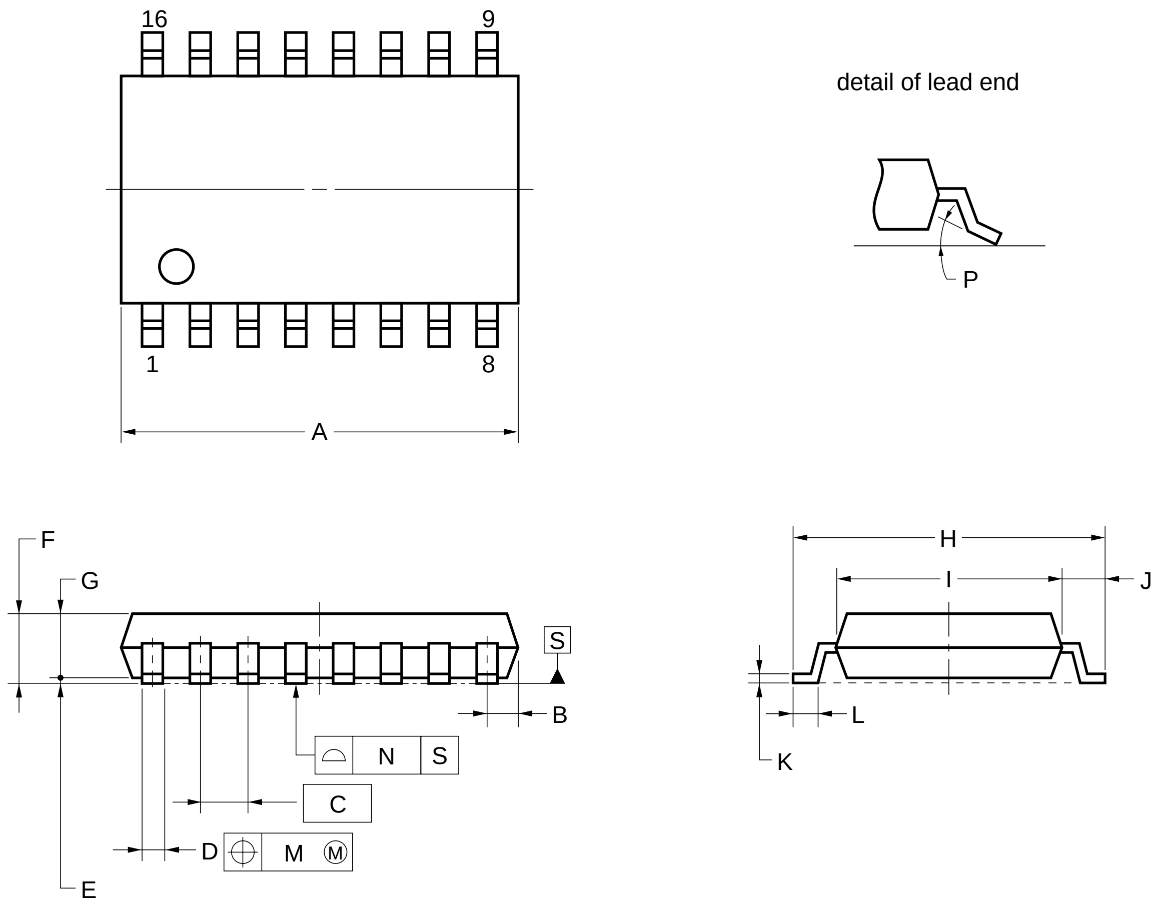
1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

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±0.10	$0.020^{+0.004}_{-0.005}$
F	1.1 MIN.	0.043 MIN.
G	3.5±0.3	0.138±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.
R	0~15°	0~15°

P16C-100-300B-1

16 PIN PLASTIC SOP (300 mil)



NOTE

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

ITEM	MILLIMETERS
A	10.2±0.2
B	0.78 MAX.
C	1.27 (T.P.)
D	$0.42^{+0.08}_{-0.07}$
E	0.1±0.1
F	1.65±0.15
G	1.55
H	7.7±0.3
I	5.6±0.2
J	1.1±0.2
K	$0.22^{+0.08}_{-0.07}$
L	0.6±0.2
M	0.12
N	0.10
P	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$

P16GM-50-300B-5

RECOMMENDED SOLDERING CONDITIONS

The μPC1909 should be soldered and mounted under the following recommended conditions. For the details of the recommended soldering conditions, refer to the document **Semiconductor Device Mounting Technology Manual (C10535E)**. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

Insertion Type

μPC1909CX: 16-pin plastic DIP (300 mils)

Soldering Method	Soldering Conditions
Wave soldering (pins only)	Solder bath temperature: 260°C Max., Time: 10 seconds max.
Partial heating	Pin temperature: 300°C max., Time: 3 seconds max. (per pin)

Caution Apply wave soldering only to the pins and be careful not to bring solder into direct contact with the package.

Surface Mounting Type

μPC1909GS: 16-pin plastic SOP (300 mils)

Soldering Method	Soldering Conditions	Recommended Condition symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Twice or less	IR35-00-2
VPS	Package peak temperature: 215°C, Time: 40 seconds max. (at 200°C or higher), Count: Twice or less	VP15-00-2
Wave soldering	Soldering bath temperature: 260°C or less, Time: 10 seconds max., Count: Once, Preheating temperature: 120°C MAX. (package surface temperature)	WS60-00-1

Caution Do not use different soldering methods together.

[MEMO]

[MEMO]

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