M5T494P, FP, GP

SWITCHING REGULATOR CONTROL

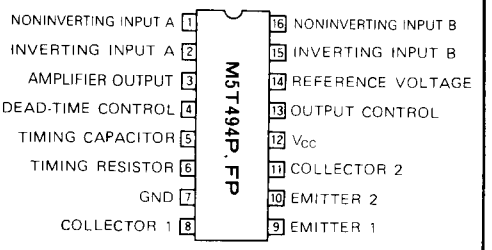
DESCRIPTION

The M5T494 is a monolithic IC designed for a pulse-width-modulation control circuit.

It contains all functions necessary to control single-ended or push-pull switching power supplies. It employs an on-chip 5-volt regulator, two error amplifiers, an adjustable oscillator, a dead-time control comparator, a pulse-steering flip-flop, output-control circuitry and an undervoltage-lockout (UVLO) function.

The UVLO prevents irregular operation at the IC outputs when the IC supply voltage is excessively low.

PIN CONFIGURATION (TOP VIEW)



Outline 16P4(P)
16P2N
16P2S

FEATURES

- Undervoltage lockout (inhibits output for low V_{CC})
- Built-in 5-volt reference regulator
  . . . . . (Reference volrage 5V ± 5%)
- Output control selectable for single-ended or push-pull operation.
- Uncommitted outputs for 200-mA sink or source.

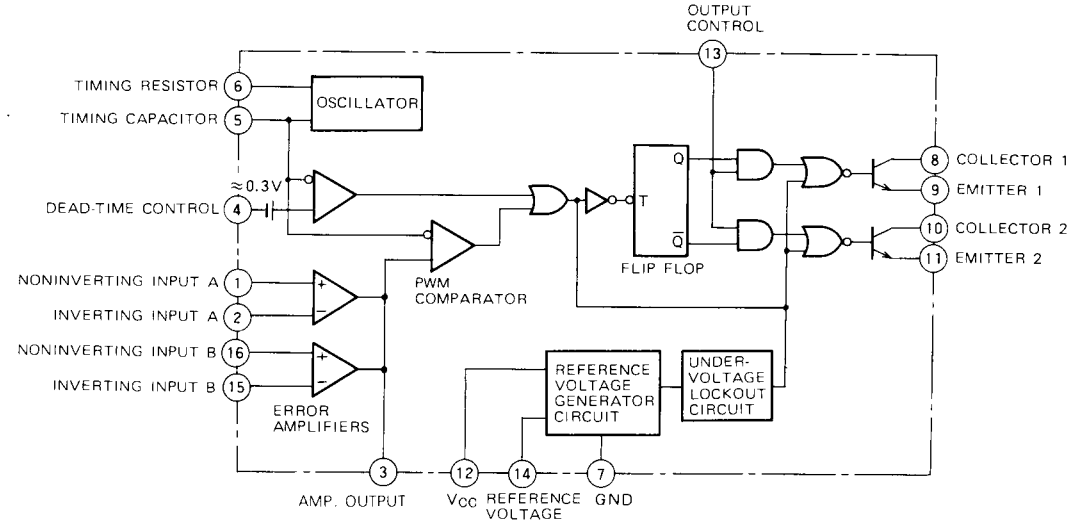
APPLICATION

Switching voltage regulators, Step-up step-down regulators, Voltage inversion regulators.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range . . . . . 7 ~ 40V
Pin 3 sink current . . . . . Less than 0.3mA
Timing capacitor, C_T . . . . . 470pF ~ 3.3μF
Timing resistor, R_T . . . . . 1.8 ~ 500kΩ
Oscillator frequency . . . . . Lower than 300kHz

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C, unless otherwise noted)

Symbol	Parameter	Conditions	Limits	Unit
V_{CC}	Supply voltage		41	V
V_{ICM}	common input voltage		−0.3 ~ V_{CC}	V
V_{ID}	Differential input voltage		V_{CC}	V
V_O	Output voltage		41	V
I_O	Output current		200	mA
$V_{⑬}$	Input voltage		−0.3 ~ $V_{⑭}$ + 0.3	V
Pd	Power dissipation		1000(P)/800(FP)/550(GP)	mW
K_θ	Thermal derating	Ta ≧ 25°C	8(P)/6.4(FP)/4.4(GP)	mW/°C
Topr	Operating temperature		−20 ~ +85	°C
Tstg	Storage temperature		−40 ~ +125	°C

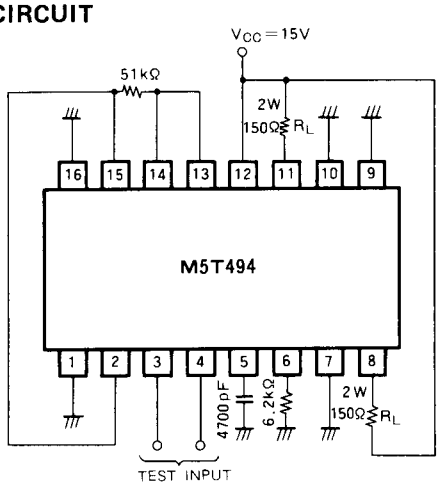
ELECTRICAL CHARACTERISTICS (V_{CC} = 15V, fosc = 40kHz, Ta = −20 ~ +70°C, unless otherwise noted)

Symbol	Block	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
Vref	REFERENCE	Output voltage	Iref = −1mA, T_j = 25°C	4.75	5	5.25	V
$\Delta V_{ref IN}$		Input regulation	V_{CC} = 7 ~ 40V, Iref = −1mA, T_j = 25°C		1	10	mV
$\Delta V_{ref L}$		Load regulation	Iref = −1 ~ −10mA, T_j = 25°C		2	20	mV
$\Delta V_{ref}/\Delta T_a$		Temperature coefficient output voltage	Ta = −20 + 85°C, Iref = −1mA		0.01	0.03	%/°C
I_S		Short circuit current	Vref = 0	−50	−30	−15	mA
fosc	OSCILLATOR	Frequency	C_T = 4700pF, R_T = 6.2kΩ	37	41	45	kHz
$\Delta f/f_S$		Standard deviation of frequency	V_{CC} = 7 ~ 40V, Ta = 25°C C_T, R_T		10		%
$\Delta f/f_{IN}$		Frequency change with voltage	V_{CC} = 7 ~ 40V, Ta = 25°C C_T = 4700pF, R_T = 6.2kΩ		0.5	1.5	%
$\Delta f/f_{Ta}$		Frequency change with temperature	Ta = 0 ~ 70°C C_T = 4700pF, R_T = 6.2kΩ		1	2	%
$I_{④}$	DEAD-TIME CONTROL	Input bias current	V ④ = 0 ~ 5.25V	−7	−0.7		μA
D_{MAX}		Maximum duty cycle (each output)	$V_{④}$ = 0V	42	45	48	%
$V_{④TH1}$		Input threshold voltage 1	Zero duty cycle (each output)		2.45	2.80	V
$V_{⑧TH2}$		Input threshold voltage 2	Maximum duty cycle (each output)	0			V
V_{AMPIO}	ERROR AMPLIFIERS	Input offset voltage	$V_{(3)}$ = 2.5V		1	7	mV
I_{AMPIO}		Input offset current	$V_{(3)}$ = 2.5V		5	200	nA
I_{AMPIB}		Input bias current	$V_{(3)}$ = 2.5V	−700	−100		nA
V_{AMPICM}		Common input voltage range	V_{CC} = 7 ~ 40V	−0.3		V_{CC} −2	V
A_V		Open loop voltage gain	$V_{(3)}$ = 0.5 ~ 3.5V, Ta = 25°C	70	110		dB
f_T		Gain bandwidth product	Ta = 25°C	500	900		kHz
CMRR		Common mode rejection ratio	V_{CC} = 40V, Ta = 25°C	65	85		dB
$I_{③SINK}$		Output sink current	$V_{(3)}$ = 0.7V	0.3	0.7		mA
$I_{③SOURCE}$		Output source current	$V_{(3)}$ = 3.5V		−10	−2	mA
$V_{③RANGE}$		Output voltage range "L" level	$I_{(3)}$ = 0		0.1	0.3	V
		Output voltage range "H" level	$I_{(3)}$ = 0	4.2	4.9		V
$V_{③TH}$	PWM COMPARATOR	Input threshold voltage	Zero duty cycle (each output)		3.4	3.8	V
$I_{③SINK}$		Input sink current	$V_{(3)}$ = 0.7V	0.3	0.7		mA

ELECTRICAL CHARACTERISTICS

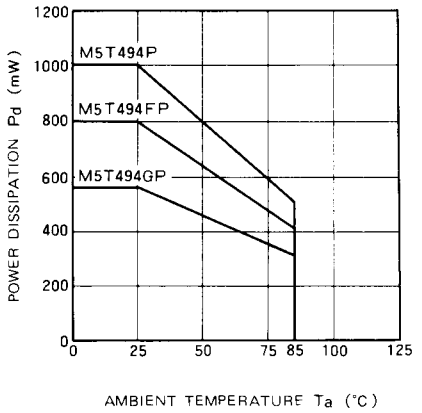
Symbol	Section	Parameter	Test conditions	Limits			Unit
				Min	Typ	Max	
I_{CL}	OUTPUT	Collector leak current	$V_{CE}=40V$, $V_{CC}=40V$ (Common-emitter)		0.01	100	μA
I_{EL}		Emitter leak current	$V_{CC}=V_C=40V$, $V_E=0$ (Emitter follower)	−100	−0.01		μA
V_{CESAT}		Output saturation voltage (Common-emitter)	$I_C=200mA$, $V_E=0$		0.95	1.3	V
V_{CEON}		Output saturation voltage (Emitter follower)	$I_E=-200mA$, $V_C=15V$		1.6	2.5	V
t_{r1}		Output-voltage rise time	$V_{CC}=15V$, $R_L=150\Omega$, $I_C=100mA$,		80	200	ns
t_{f1}		Output-voltage fall time	$Ta=25°C$ (Common-emitter)		30	100	ns
t_{r2}		Output-voltage rise time	$V_{CC}=V_C=15V$, $R_L=150\Omega$, $I_E=$		200	400	ns
t_{f2}		Output-voltage fall time	$-100mA$, $Ta=25°C$ (Emitter follower)		30	100	ns
$I_{⑬}$		Output-control input current	$V_{⑬}=Vref$	270	550	1000	μA
V_{CCLO}	UNDER VOLTAGE LOCK-OUT	Lockout voltage	Supply voltage at output cut-off	3.8	5	5.7	V
ΔV_{CCLO}		Hysteresis		100	200	380	mV
I_{CCSB}	CIRCUIT CURRENT	Standby supply current	$V_{CC}=15V$ All other inputs and outputs open		6.7	11.5	mA
I_{CCBI}		Average bias current	$V_{④}=2V$,		7.3	13	mA

TEST CIRCUIT

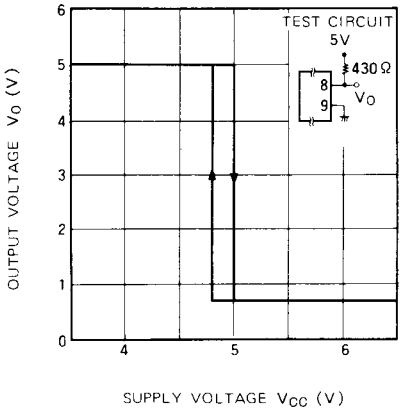


Note: To obtain output voltage from the emitter follower, connect pins ⑧ and ⑪ to V_{CC}, and connect each of pins ⑨ and ⑩ to ground through resistor R_L.

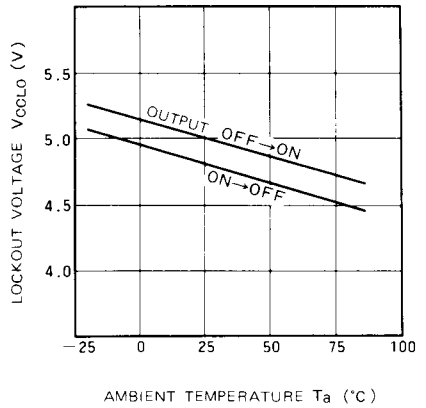
THERMAL DERATING (MAXIMUM RATING)



UNDERVOLTAGE LOCKOUT CHARACTERISTICS

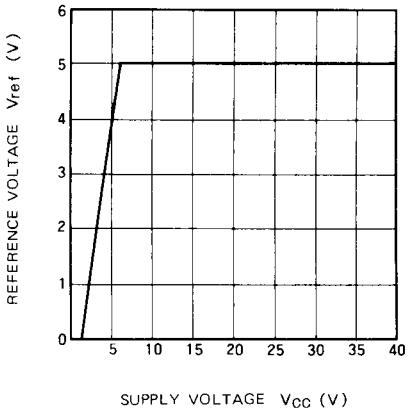


LOCKOUT VOLTAGE VS AMBIENT TEMEPRATURE

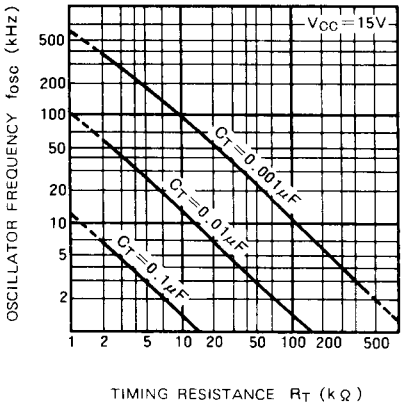


MITSUBISHI ELECTRIC

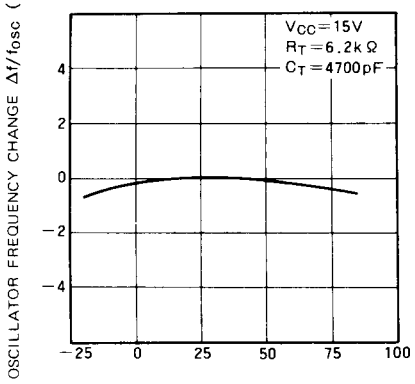
REFERENCE VOLTAGE VS SUPPLY VOLTAGE



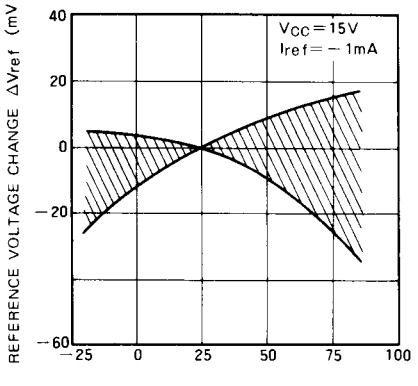
OSCILLATOR FREQUENCY VS TIMING RESISTANCE



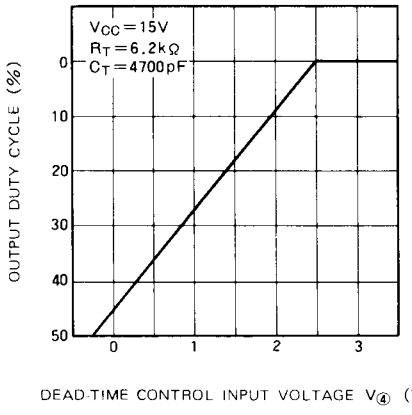
OSCILLATOR FREQUENCY CHANGE VS AMBIENT TEMPERATURE



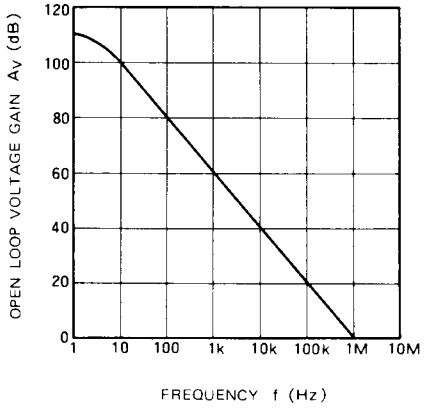
REFERENCE VOLTAGE CHANGE VS AMBIENT TEMPERATURE



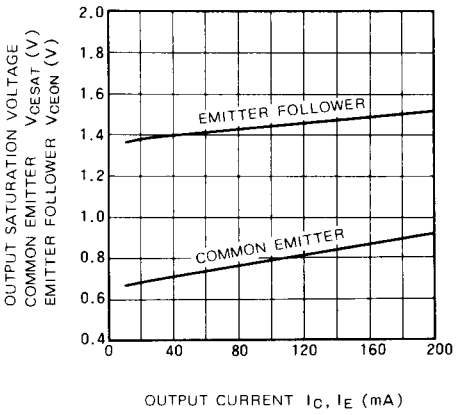
OUTPUT DUTY CYCLE VS DEAD-TIME CONTROL INPUT VOLTAGE



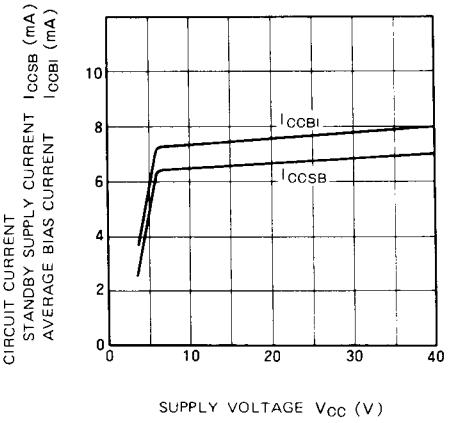
ERROR AMP OPEN LOOP VOLTAGE GAIN VS FREQUENCY



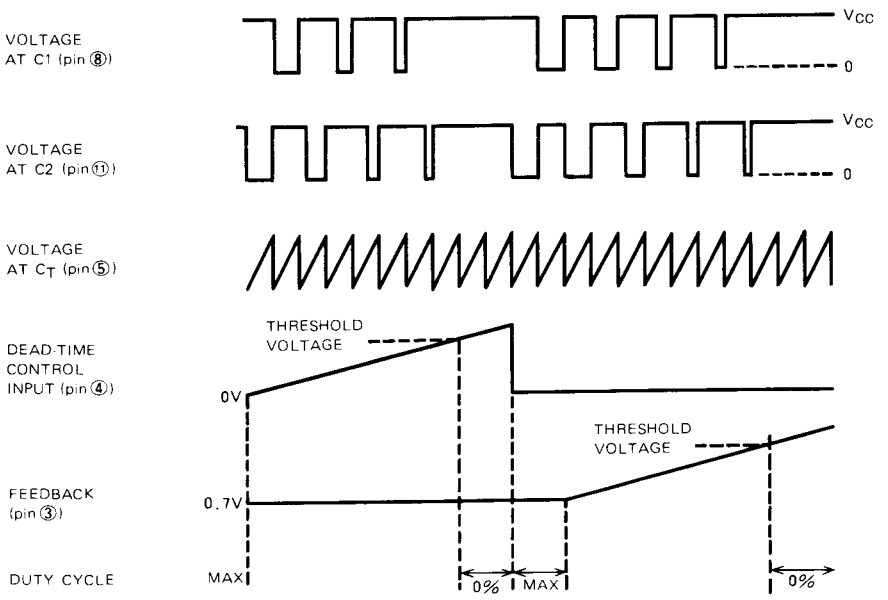
OUTPUT SATURATION VOLTAGE VS OUTPUT CURRENT



CIRCUIT CURRENT VS SUPPLY VOLTAGE



VOLTAGE WAVEFORMS



FUNCTION TABLE

OUTPUT CONTROL (pin ⑬)	OUTPUT FUNCTION
V_{ref}	Push-pull operation
GND	Single-ended or parallel operation