Pulse-Width Modulating Regulator

GENERAL DESCRIPTION

The XR-495 is a monolithic pulse width modulating regulator designed to contain all blocks necessary for a switching regulator. Included in the 16 pin dual in-line packages is a voltage reference, oscillator, control logic, error amplifiers, and dual uncommitted outputs. This device can be used for switching regulators of either polarity, polarity converters, transformer coupled DC to DC converters, transformerless voltage doublers, and many other power control applications. A 39V zener diode allows operation with supply voltages exceeding 40V. The XR-495M is fully specified for operation over the full military temperature range from −55°C to +125°C, while the XR-495CN and XR-495CP are designed for commercial applications over 0°C to +70°C.

FEATURES

Complete PWM Power Control Circuitry
Uncommitted Outputs for 200-mA Sink or Source
Output Control Selects Single-Ended
 or Push-Pull Operation
Internal Circuitry Prohibits Double Pulse
 at Either Output
Variable Dead Time Provides Control Over Total Range
Internal Regulator Provides a Stable
 5-V Reference Supply
Circuit Architecture Provides Easy Synchronization
On-Chip 39-V Zener
External Control of Output Steering

APPLICATIONS

Pulse-Width Modulated Power Control Systems
Switching Regulators

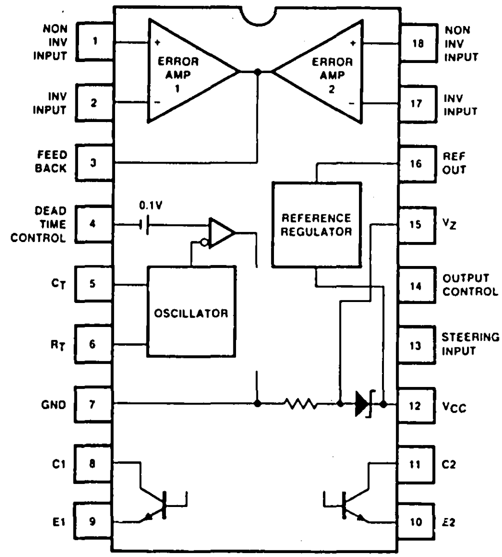
ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-495M	Ceramic	−55°C to +125°C
XR-495CN	Ceramic	0°C to +70°C
XR-495CP	Plastic	0°C to +70°C

ABSOLUTE MAXIMUM RATINGS, T_A = 25°C

Amplifier Input Voltages	V_{CC} + 0.3 Volts
Output Current	250 mA
Supply Voltage	41 Volts
Collector Output Voltage	41 Volts
Power Dissipation	
Total, at or below 25°C	1000 mW
Ceramic Package	
Derate above +28°C	8.2 mW/°C
Plastic Package	
Derate above +41°C	9.2 mW/°C

FUNCTIONAL BLOCK DIAGRAM



SYSTEM DESCRIPTION

All functions required to construct a pulse-width modulating regulator are incorporated on a single monolithic chip in the XR-495. The device is primarily designed for power supply control and contains a on-chip five volt regulator, two error amplifiers, an adjustable oscillator, dead-time control comparator, a pulse-steering flip-flop, and output control circuits. Either common emitter or emitter follower output capability is provided by the uncommitted output transistors. Single ended or push-pull output operation may be selected through the output control function. The XR-495 architecture prohibits the possibility of either output being pulsed twice during push-pull operation. The internal amplifier's circuitry allows for a common-mode input voltage range of −0.3 volt to V_{CC} −2 volts. The dead time control comparator provides approximately 5% dead time unless the dead time control is externally driven. The on-chip oscillator may be used to drive the common XR-495 circuitry and provide a sawtooth input for associated control circuitry in synchronous multiple-rail power supplies, or may be bypassed by terminating R_T (Pin 6) to the reference output and providing a sawtooth input to C_T (Pin 5).

The XR-495 also contains an on-chip 39 volt zener diode for high voltage applications where V_{CC} is greater than 40 volts, and an output steering control that overrides the internal control of the pulse steering flip-flop.

ELECTRICAL CHARACTERISTICS

Test Conditions: T_A = 25°C, unless specified otherwise.

PARAMETERS	XR-495 MIN	TYP	MAX	UNIT	CONDITIONS
Reference Section					
Output Voltage (V_{ref})	4.75	5.0	5.25	V	I_O = 1mA
Input Regulation		2.0	25.0	mV	V_{CC} = 7V to 40V
Output Regulation		1	15	mV	I_O = 1 to 10mA
Output Voltage Change with Temperature		0.2	1	%	ΔT_A = Min to Max
Short Circuit Output[1] Current	10	35	50	mA	V_{ref} = 0
Oscillator Section					
Frequency		10		kHz	C_T = 0.01 μ, R_T = 12kΩ
Standard Deviation[2] of Frequency		10		%	V_{CC}, C_T, R_T, T_A; all values constant
Frequency Change with Voltage		0.1		%	V_{CC} = 7V to 40V
Frequency Change with Temperature			2	%	C_T = 0.01μF, R_T = 12kΩ, ΔT_A = Min to Max
Dead Time Control Section (See Figure 2)					
Input Bias Current (Pin 4)		−2	−10	μA	V_I = 0 to 5.25V
Maximum Duty Cycle (each output)	45			%	V_I = 0 (Pin 4)
Input Threshold Voltage (Pin 4)		3	3.3	V	Zero Duty Cycle, Maximum Duty Cycle = 0V Min
Error-Amplifier Sections					
Input Offset Voltage		2	10	mV	V_O (Pin 3) = 2.5V
Input Offset Current		25	250	nA	V_O (Pin 3) = 2.5V
Input Bias Current		0.2	1	μA	V_O (Pin 3) = 2.5V
Common-Mode Input Voltage Range	−0.3 to V_{CC} −2			V	V_{CC} = 7V to 40V
Open Loop Voltage Amplification	70	95		dB	ΔV_O = 3V, V_O = 0.5V to 3.5V
Unity Gain Bandwidth		800		kHz	
Common-Mode Rejection Ratio	65	80		dB	V_{CC} = 40V
Output Sink Current (Pin 3)	0.3	0.7		mA	V_{ID} = −15mV to −5V, V (Pin 3) = 0.7V
Output Source Current (Pin 3)	−2			mA	V_{ID} = 15mV to 5V, V (Pin 3) = 3.5V
Output Section					
Collector Off-State Current		2	100	μA	V_{CE} = 40V, V_{CC} = 40V
Emitter Off-State Current			−100	μA	V_{CC} = V_C = 40V, V_E = 0, XR-494M Max = −150μA
Collector-Emitter Saturation Voltage Common-Emitter		1.1	1.3	V	V_E = 0, I_C = 200mA, XR-494M Max = 1.5V
Emitter-Follower		1.5	2.5	V	V_C = 15V, I_E = −200mA
Output Control Input Current			3.5	mA	V_I = V_{ref}
PWM Comparator Section					
Input Threshold Voltage (Pin 3)		4	4.5	V	Zero Duty Cycle
Input Sink Current (Pin 3)	0.3	0.7		mA	V (Pin 3) = 0.7V
Total Device					
Standby Supply Current		6	10	mA	V_{CC} = 15V, Pin 6 at V_{ref}
		9	15	mA	V_{CC} = 40V, All Other Inputs and Outputs Open
Average Supply Current		7.5		mA	V = 2V (Pin 4)

1. Duration of the short circuit should not exceed one second.
2. Standard deviation is a measure of the statistical distribution about the mean as derived from the formula σ =.

SWITCHING CHARACTERISTICS T_A = 25°C

PARAMETER	MIN	TYP[1]	MAX.	UNIT	TEST CONDITIONS
Output Voltage Rise Time		100	200	ns	Common-Emitter Configuration, See Figure 1
Output Voltage Fall Time		25	100	ns	
Output Voltage Rise Time		100	200	ns	Emitter-Follower Configuration, See Figure 2
Output Voltage Fall Time		40	100	ns	

1. All typical values except for temperature coefficients are at T_A = 25°C.

XR-495

RECOMMENDED OPERATING CONDITIONS

PARAMETERS	XR-495M MIN	XR-495M MAX	XR-495CN XR-495CP MIN	XR-495CN XR-495CP MAX	UNIT
Supply voltage, V_{CC}	7	40	7	40	V
Amplifier input voltages, V_I	−0.3	$V_{CC}-2$	−0.3	$V_{CC}-2$	V
Collector output voltage, V_O		40		40	V
Collector output current (each transistor)		200		200	mA
Current into feedback terminal		0.3		0.3	mA
Timing capacitor, C_T	0.47	10,000	0.47	10,000	nF
Timing resistor, R_T	1.8	500	1.8	500	kΩ
Oscillator frequency	1	300	1	300	kHz
Operating free-air temperature, T_A	−55	125	0	75	°C

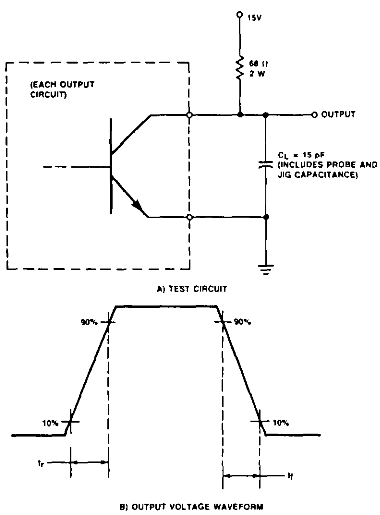


Figure 1. Common-Emitter Configuration

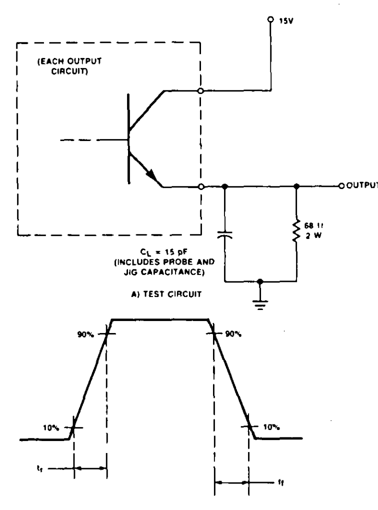


Figure 2. Emitter-Follower Configuration

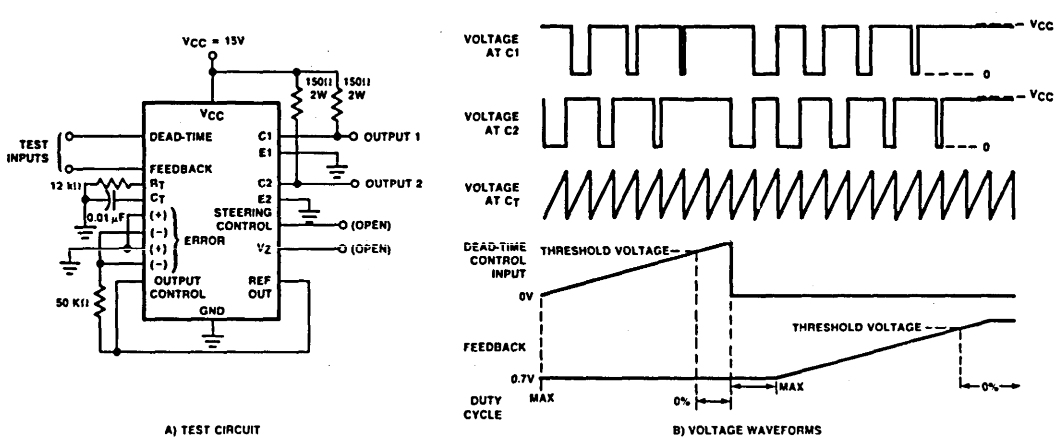
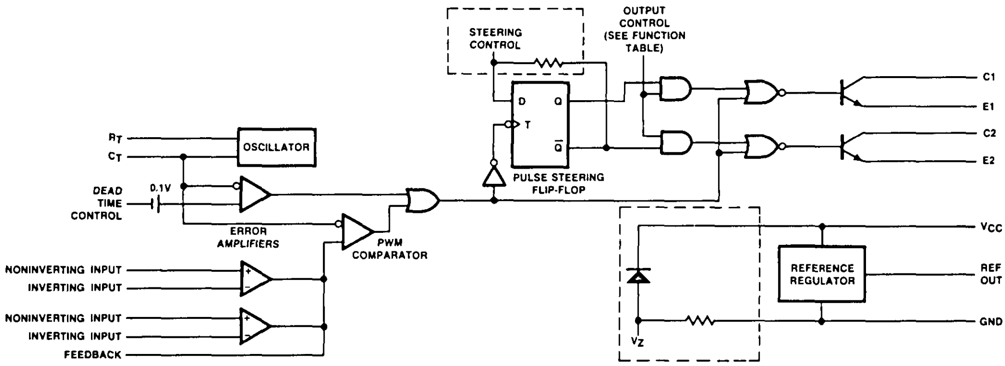


Figure 3. Dead-Time and Feedback Control



EQUIVALENT SCHEMATIC DIAGRAM

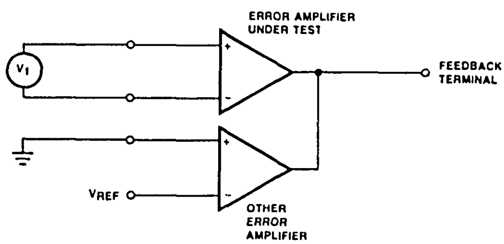
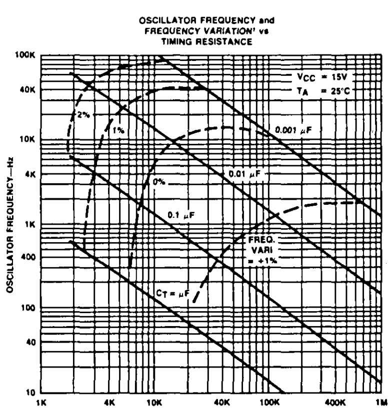


Figure 4. Error Amplifier Characteristics

FUNCTION TABLE

INPUTS		OUTPUT FUNCTION
OUTPUT CONTROL	STEERING INPUT	
Grounded	Open	Single-ended or parallel output
At V_{ref}	Open	Normal push-pull operation
At V_{ref}	$V_I < 0.4V$	PWM Output at Q1
At V_{ref}	$V_I > 0.4V$	PWM Output at Q2



[1] Frequency variation is the change in oscillator frequency that occurs over the full temperature range.

Figure 5. Oscillator Frequency and Frequency Variation[1] vs Timing Resistance

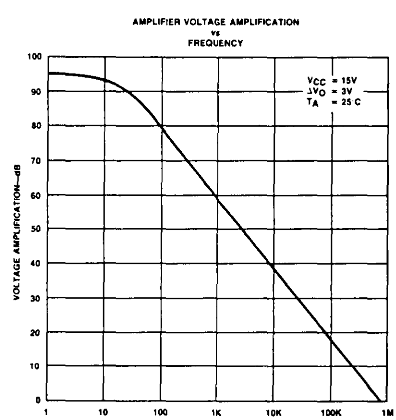


Figure 6. Amplifier Voltage Amplification vs Frequency