

Pulse-Width Modulating Regulator

GENERAL DESCRIPTION

The XR-494 is a monolithic pulse width modulating regulator designed to contain all the blocks necessary for a switching regulator. Included in a 16 pin dual in-line package 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. The XR-494M is fully specified for operation over the full military temperature range from -55°C to $+125^{\circ}\text{C}$, while the XR-494CN and XR-494CP are designed for commercial applications over 0°C to $+70^{\circ}\text{C}$.

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

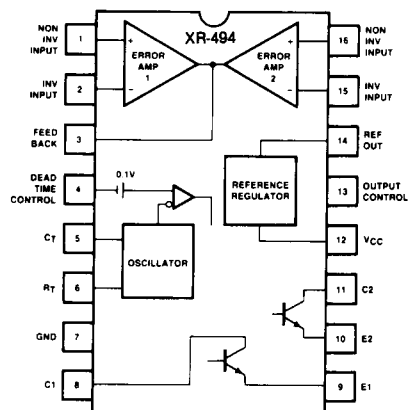
APPLICATIONS

Pulse-Width Modulated Power Control Systems
Switching Regulators

ABSOLUTE MAXIMUM RATINGS, $T_A = 25^{\circ}\text{C}$

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 $+28^{\circ}\text{C}$	8.2 mW/ $^{\circ}\text{C}$
Plastic Package	
Derate above $+41^{\circ}\text{C}$	9.2 mW/ $^{\circ}\text{C}$

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-494M *	Ceramic	-55°C to $+125^{\circ}\text{C}$
XR-494CN	Ceramic	0°C to $+70^{\circ}\text{C}$
XR-494CP	Plastic	0°C to $+70^{\circ}\text{C}$

*Consult factory for availability

SYSTEM DESCRIPTION

All functions required to construct a pulse-width modulating regulator are incorporated on a single monolithic chip in the XR-494. 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-494 architecture prohibits the possibility of either output being pulsed twice during push-pull operation. The internal amplifiers'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-494 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).

ELECTRICAL CHARACTERISTICS

Test Conditions: $T_A = 25^\circ\text{C}$, unless otherwise specified.

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

XR-494

RECOMMENDED OPERATING CONDITIONS

PARAMETERS	XR-494M		XR-494CN XR-494CP		UNIT
	MIN	MAX	MIN	MAX	
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	k Ω
Oscillator frequency	1	300	1	300	kHz
Operating free-air temperature, T_A	-55	125	0	75	$^{\circ}\text{C}$

SWITCHING CHARACTERISTICS $T_A = 25^{\circ}\text{C}$

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 $T_A = 25^{\circ}\text{C}$.

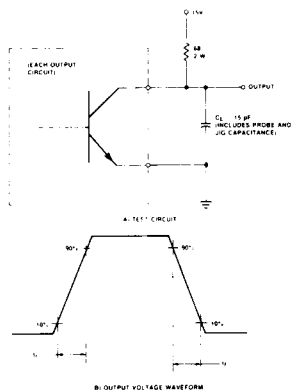


Figure 1. Common-Emitter Configuration

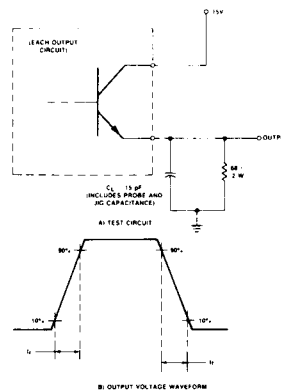


Figure 2. Emitter-Follower Configuration

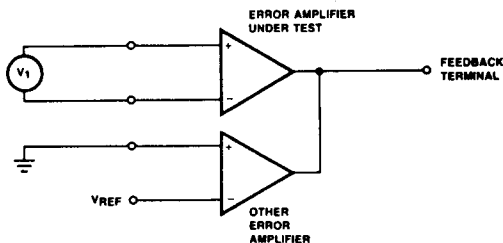
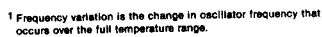


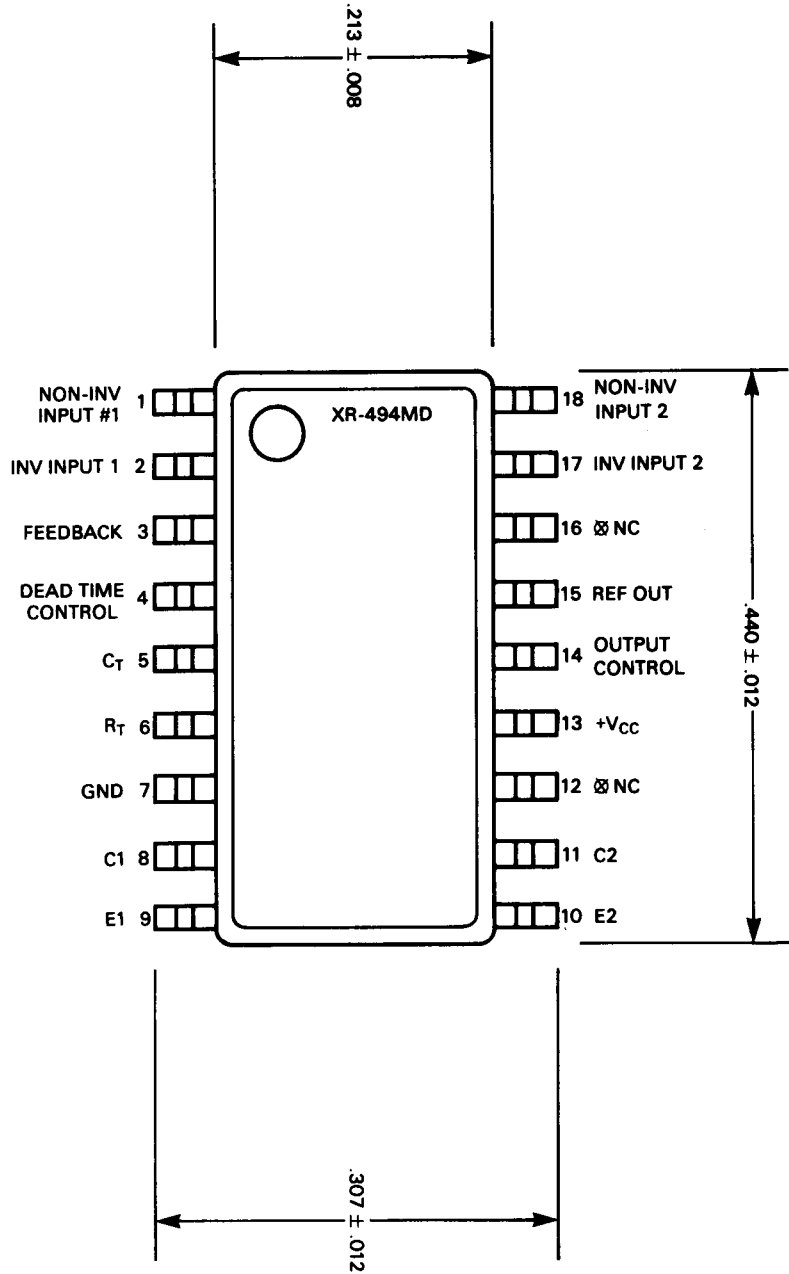
Figure 3. Error-Amplifier Characteristics

FUNCTION TABLE

INPUTS OUTPUT CONTROL	OUTPUT FUNCTION
Grounded	Single-ended or parallel output
At V_{ref}	Normal push-pull operation
At V_{ref}	PWM Output at Q1
At V_{ref}	PWM Output at Q2



XR-494



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XR-1488/1489A

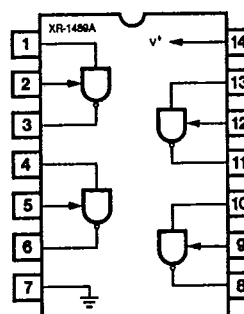
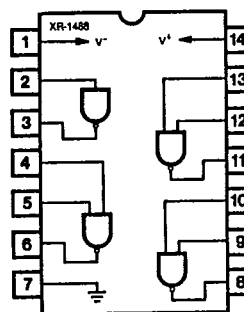
Quad Line Driver/Receiver

GENERAL DESCRIPTION

The XR-1488 is a monolithic quad line driver designed to interface data terminal equipment with data communications equipment in conformance with the specifications of EIA Standard No. RS232C. This extremely versatile integrated circuit can be used to perform a wide range of applications. Features such as output current limiting, independent positive and negative power supply driving elements, and compatibility with all DTL and TTL logic families greatly enhance the versatility of the circuit.

The XR-1489A is a monolithic quad line receiver designed to interface data terminal equipment with data communications equipment. The XR-1489A quad receiver along with its companion circuit, the XR-1488 quad driver, provide a complete interface system between DTL or TTL logic levels and the RS232C defined voltage and impedance levels.

FUNCTIONAL BLOCK DIAGRAMS



ABSOLUTE MAXIMUM RATINGS

Power Supply	
XR-1488	± 15 Vdc
XR-1489A	+ 10 Vdc
Power Dissipation	
Ceramic Package	1000 mW
Derate above +25°C	6.7 mW/°C
Plastic Package	650 mW/°C
Derate above +25°C	5 mW/°C

ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-1488N	Ceramic	0°C to +70°C
XR-1488P	Plastic	0°C to +70°C
XR-1489AN	Ceramic	0°C to +70°C
XR-1489AP	Plastic	0°C to +70°C

SYSTEM DESCRIPTION

The XR-1488 and XR-1489A are a matched set of quad line drivers and line receivers designed for interfacing between TTL/DTL and RS232C data communication lines.

The XR-1488 contains four independent split supply line drivers, each with a ± 10 mA current limited output. For RS232C applications, the slew rate can be reduced to the 30 V/ μ S limit by shunting the output to ground with a 410 pF capacitor. The XR-1489A contains four independent line receivers, designed for interfacing RS232C to TTL/DTL. Each receiver features independently programmable switching thresholds with hysteresis, and input protection to ± 30 V. The output can typically source 3 mA and sink 20 mA.