DATA SHEET
19 NOVEMBER 2003

No. 00024
REV 1-03

REPLACEMENT OF:
TL 494

MIK494

PULSE-WIDTH-MODULATION CONTROLLER

DESCRIPTION

The MIK494 incorporate on a single monolithic chip all the functions required in the construction of a pulse-width-modulation control circuit. Designed primarily for power supply control, these devices offer the systems engineer the flexibility to tailor the power supply control circuitry to his application.

The MIK494 contains an error amplifier, an on-chip adjustable oscillator, a dead-time control comparator, pulse-steering control flip-flop, a 5-volt, 5% precision regulator, and output-control circuits. The error amplifier exhibits a common-mode voltage range from -0.3 volts to V_{CC} -2 volts. The dead-time control comparator has a fixed offset that provides approximately 5% dead time when externally altered. The on-chip oscillator may be bypassed by terminating R_T (pin 6) to the reference output and providing a sawtooth input to C_T (pin 5), or it may be used to drive the common circuits in synchronous multiple-rail power supplies. The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Each device provides for push-pull or single-ended output operation, which may be selected through the output-control function. The architecture of these devices prohibits the possibility of either output being pulsed twice during push-pull operation.

FEATURES

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for 200 mA Sink or Source Current
- 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, 5%
- Circuit Architecture Allows Easy Synchronization

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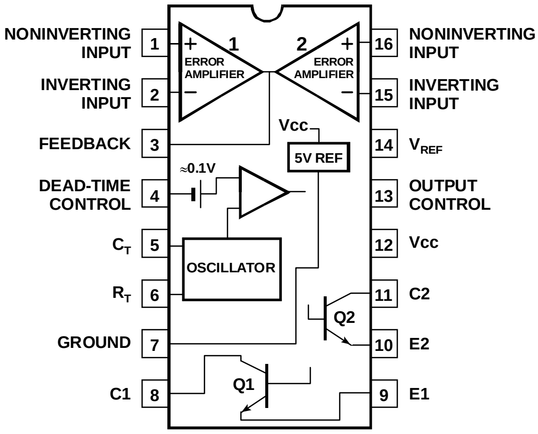
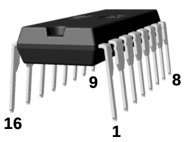
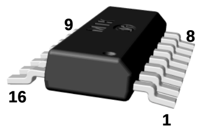
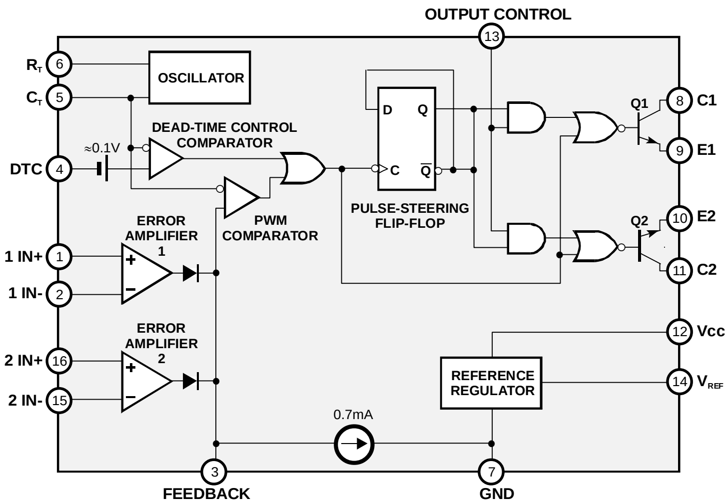
SCHEMATIC DIAGRAM



PIN DESCRIPTION

	MIK494 **CN**	MIK494 **CD**
	DIP-16	**SOP-16**
1 – 1 IN+ **2 – 1 IN-** **3 – FBACK** **4 – DTC** **5 – C_T** **6 – R_T** **7 – GND** **8 – C1** **9 – E1** **10 – E2** **11 – C2** **12 – Vcc** **13 – OUTCTRL** **14 – REF** **15 – 2 IN-** **16 – 2 IN+**		

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

(Full operating ambient temperature range applies, unless otherwise noted.)

SYMBOL	RATING	VALUE	UNIT
V_{CC}	Supply voltage	41	V
V_{IN}	Amplifier input voltage	V_{CC} + 0.3	
V_{OUT}	Collector output voltage	41	
I_{OUT}	Collector output current	250	mA
T_A	Operating free-air temperature range	0 to 70	°C
T_{STG}	Storage temperature range	-65 to 150	
T_{LEAD}	Lead temperature 1,6 mm from case for 10 seconds	260	

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	VALUE		UNIT
		MIN	MAX	
V_{CC}	Supply voltage	7	40	V
V_{IN}	Amplifier input voltage	-0.3	V_{CC}-2	
V_{OUT}	Collector output voltage		40	
I_{OUT1}, I_{OUT2}	Collector output current (each transistor)		200	mA
	Current into feedback terminal		0.3	
C_T	Timing capacitor	0.47	10000	nF
R_T	Timing resistor	1.8	500	kΩ
f_{OSC}	Oscillator frequency	1	300	kHz
T_A	Operating free-air temperature	0	70	°C

ELECTRICAL CHARACTERISTICS (Vcc = 15 V, C_T = 0.01 µF, R_T = 12 kΩ, unless otherwise noted.)

REFERENCE SECTION

PARAMETER	TEST CONDITIONS *	VALUE MIN	VALUE TYP **	VALUE MAX	UNIT
Output voltage (V_{ref})	I_{OUT} = 1mA	4.75	5	5.25	V
Input regulation	V_{CC} = 7V to 40V		2	25	mV
Output regulation	I_{OUT} = 1mA to 10mA		1	15	mV
Output voltage change with temperature	ΔT_A = MIN to MAX		0.2	1	%
Short-circuit output current ***	V_{REF} = 0		35		mA

OSCILLATOR SECTION (SEE FIGURE 1)

PARAMETER	TEST CONDITIONS *	VALUE MIN	VALUE TYP **	VALUE MAX	UNIT
Frequency	C_T = 0.01 µF, R_T = 12kΩ		10		kHz
Standard deviation of frequency ****	All values of V_{CC}, C_T, R_T, and T_A constant		10		%
Frequency change with voltage	V_{CC} = 7V to 40V, T_A = 25°C		0.1		%
Frequency change with temperature *****	C_T = 0.01 µF, R_T = 12kΩ, ΔT_A = MIN to MAX			1	%

AMPLIFIER SECTION (SEE FIGURE 2)

PARAMETER	TEST CONDITIONS	VALUE MIN	VALUE TYP **	VALUE MAX	UNIT
Input offset voltage	V_{OUT} (pin 3) = 2.5V		2	10	mV
Input offset current	V_{OUT} (pin 3) = 2.5V		25	250	nA
Input bias current	V_{OUT} (pin 3) = 2.5V		0.2	1	µA
Common-mode input voltage range	V_{CC} = 7V to 40V	-0.3 to V_{CC}-2			V
Open-loop voltage amplification	ΔV_{OUT} = 3V, R_L = 2kΩ, V_{OUT} = 0.5 to 3.5V	70	95		dB
Unity-gain bandwidth	V_{OUT} = 0.5 to 3.5V, R_L = 2kΩ		800		kHz
Common-mode rejection ratio	ΔV_{OUT} = 40V, T_A = 25°C	65	80		dB
Output sink current (pin 3)	V_{ID} = -15mV to -5V, $V_{(pin3)}$ = 0.7 V	0.3	0.7		mA
Output source current (pin 3)	V_{ID} = 15mV to 5V, $V_{(pin3)}$ = 3.5 V	-2			mA

* For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

** All typical values except for parameter changes with temperature are at T_A = 25 °C

*** Duration of the short-circuit should not exceed one second

**** Standard deviation Is a measure of the statistical distribution about the mean as derived from the formula: $\delta = \sqrt{\dfrac{\sum_{n=1}^{N}(x_n - \overline{X})^2}{N-1}}$

***** Temperature coefficient of timing capacitor and timing resistor not taken Into account

OUTPUT SECTION

PARAMETER		TEST CONDITIONS	VALUE MIN	VALUE TYP *	VALUE MAX	UNIT
Collector off-state current		V_{CE}= 40V, V_{CC}= 40V		2	100	µA
Emitter off-state current		V_{CC}= V_C= 40V, V_E= 0			-100	µA
Collector-emitter saturation voltage	Common-emitter	V_E= 0, I_C= 200 mA		1.1	1.3	V
	Emitter-follower	V_C= 15V, I_E= -200 mA		1.5	2.5	V
Output control input current		V_{IN}= V_{REF}			3.5	mA

DEAD-TIME CONTROL SECTION (SEE FIGURE 1)

PARAMETER	TEST CONDITIONS	VALUE MIN	VALUE TYP *	VALUE MAX	UNIT
Input bias current (pin 4)	V_{IN}= 0 to 5.25V		-2	-10	µA
Maximum duty cycle, each output	$V_{IN\ (pin\ 4)}$= 0, C_T= 0.1µF, R_T= 12kΩ		45		%
Input threshold voltage (pin 4)	Zero duty cycle		3	3.3	V
	Maximum duty cycle	0			V

ELECTRICAL CHARACTERISTICS (CONTINUED)

Vcc = 15 V, **C_T** = 0.01 µF, **R_T** = 12 kΩ, unless otherwise noted.

PWM COMPARATOR SECTION (SEE FIGURE 1)

PARAMETER	TEST CONDITIONS	VALUE			UNIT
		MIN	TYP *	MAX	
Input threshold voltage (pin 3)	Zero duty cycle		4	4.5	V
Input sink current (pin 3)	$V_{(pin\ 3)}$ = 0.7V	0.3	0.7		mA

TOTAL DEVICE

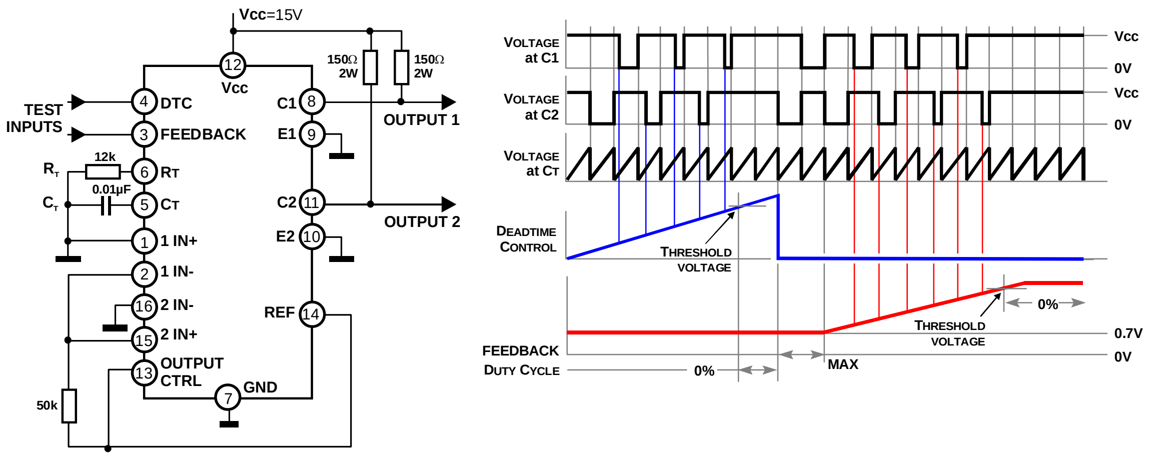
PARAMETER	TEST CONDITIONS		VALUE			UNIT
			MIN	TYP *	MAX	
Standby supply current	Pin 6 at V_{REF}, all other inputs and outputs open	V_{CC}= 15V	–	6	10	mA
		V_{CC}= 40V	–	9	15	mA
Average supply current	$V_{IN\ (pin\ 4)}$= 2V, See Figure 1		–	7.5	–	mA

SWITCHING CHARACTERISTICS

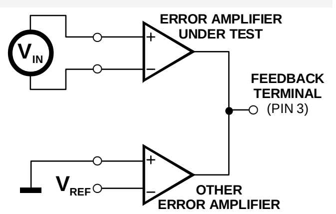
PARAMETER	TEST CONDITIONS	VALUE			UNIT
		MIN	TYP *	MAX	
Output voltage rise time	Common-emitter configuration. See Figure 3		100	200	ns
Output voltage fall time	Common-emitter configuration. See Figure 3		25	100	ns
Output voltage rise time	Emitter-follower configuration. See Figure 4		100	200	ns
Output voltage fall time	Emitter-follower configuration. See Figure 4		40	100	ns

***** All typical values except for temperature coefficient are at T_A=25 °C

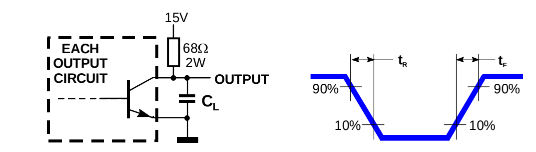
OPERATIONAL TEST CIRCUIT AND VOLTAGE WAVEFORMS — FIGURE 1



ERROR AMPLIFIER CHARACTERISTICS — FIGURE 2



COMMON—EMITTER CONFIGURATION — FIGURE 3

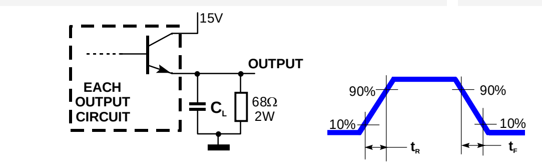


TEST CIRCUIT

OUTPUT VOLTAGE WAVEFORM

C_L=15pF (INCLUDES PROBE AND JIG CAPACITANCE)

EMITTER—FOLLOWER CONFIGURATION — FIGURE 4



TEST CIRCUIT

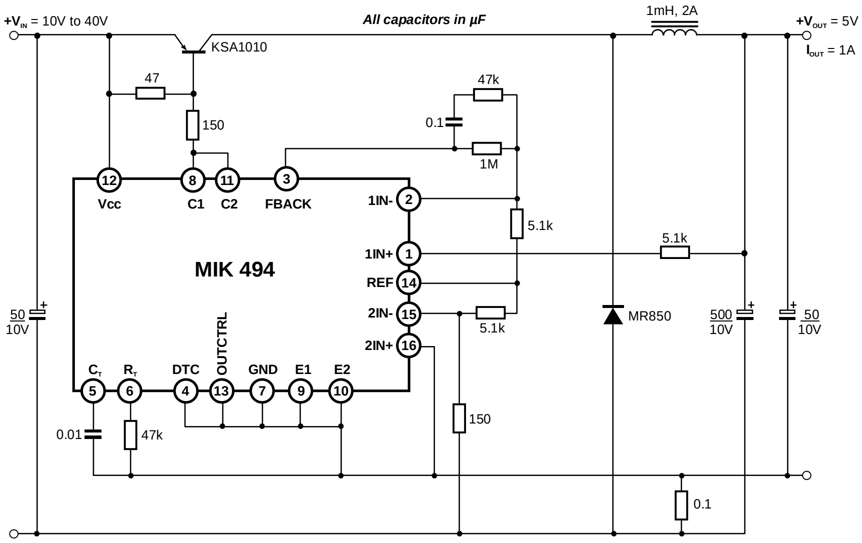
OUTPUT VOLTAGE WAVEFORM

C_L=15pF (INCLUDES PROBE AND JIG CAPACITANCE)

TYPICAL APPLICATIONS

PULSE WIDTH MODULATED STEP-DOWN CONVERTER

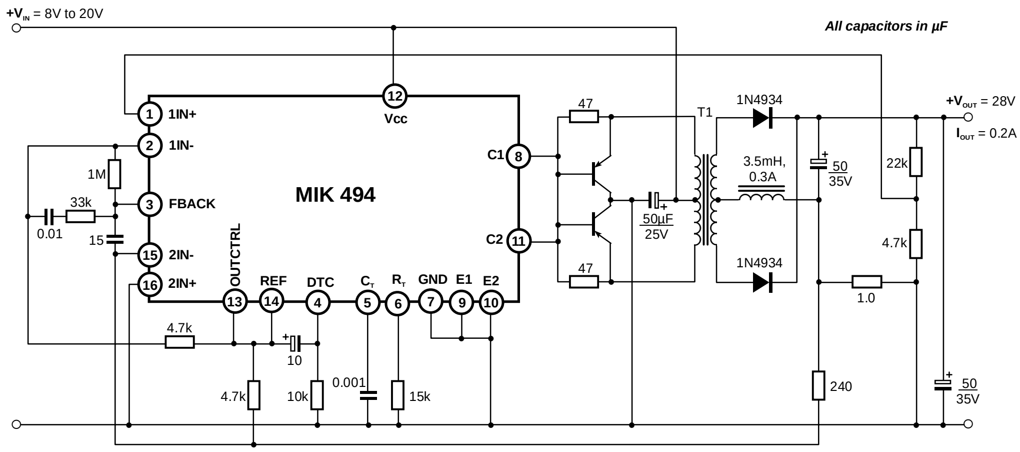
FIGURE 5



TEST	CONDITION	RESULTS
Line Regulation	V_{IN} = 8.0V to 40V	3mV 0.01%
Load Regulation	V_{IN} = 12.6V, I_{OUT} = 0.2mA to 200mA	5mV 0.02%
Output Ripple	V_{IN} = 12.6V, I_{OUT} = 200mA	40mV pp P.A.R.D.
Short Circuit Current	V_{IN} = 12.6V, R_L = 0.1 Ω	250mA
Efficiency	V_{IN} = 12.6V, I_{OUT} = 200mA	72%

PULSE WIDTH MODULATED PUSH-PULL CONVERTER

FIGURE 6



TEST	CONDITION	RESULTS
Line Regulation	V_{IN} = 8.0V to 40V	3mV 0.01%
Load Regulation	V_{IN} = 12.6V. I_{OUT} = 0.2mA to 200mA	5mV 0.02%
Output Ripple	V_{IN} = 12.6 V, I_{OUT} = 200mA	40mV pp P.A.R.D.
Short Circuit Current	V_{IN} = 12.6V, R_L = 0.1 Ω	250mA
Efficiency	V_{IN} = 12.6V I_{OUT} = 200mA	72%

APPLICATION INFORMATION

The MIK494 is a fixed-frequency pulse width modulation control circuit, incorporating the primary building blocks required for the control of a switching power supply. (See Figure 1.) An internal-linear sawtooth oscillator is frequency-programmable by two external components, R_T and C_T.

For more information refer to Figure 7.

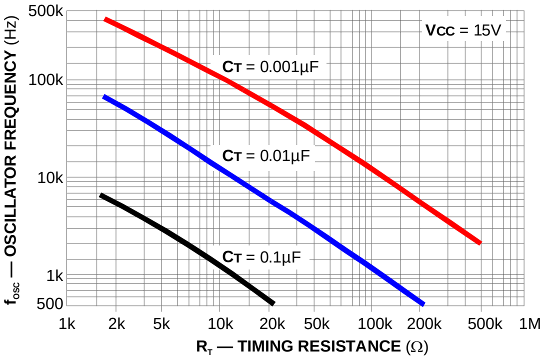


FIGURE 7 Oscillator Frequency versus Timing Resistance

Output pulse width modulation is accomplished by comparison of the positive sawtooth waveform across capacitor C_T to either of two control signals. The NOR gates, which drive output transistors Q1 and Q2, are enabled only when the flip-flop clock-input line is in its low state. This happens only during that portion of time when the sawtooth voltage is greater than the control signals. Therefore, an increase in control-signal amplitude causes a corresponding linear decrease of output pulse width. (Refer to the Timing Diagram shown in Figure 1.)

The control signals are external inputs that can be fed into the deadtime control, the error amplifier inputs, or the feedback input. The deadtime control comparator has an effective 120 mV input offset which limits the minimum output deadtime to approximately the first 4% of the sawtooth-cycle time. This would result in a maximum duty cycle on a given output of 96% with the output control grounded, and 48% with it connected to the reference line.

Additional deadtime may be imposed on the output by setting the deadtime-control input to a fixed voltage, ranging between 0 V to 3.3 V.

FUNCTIONAL TABLE

INPUT/OUTPUT CONTROLS	OUTPUT FUNCTION	fOUT/fOSC =
Grounded	Single–ended PWM @ Q1 and Q2	1.0
@ Vref	Push–pull Operation	0.5

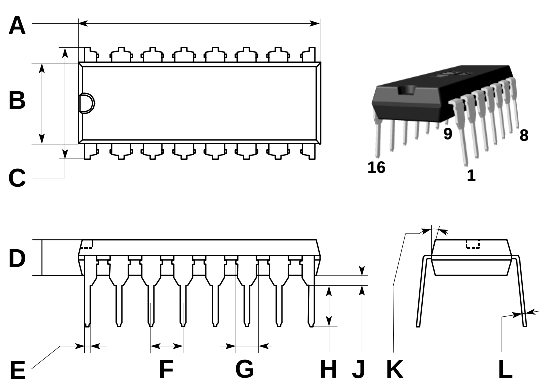
The pulse width modulator comparator provides a means for the error amplifiers to adjust the output pulse width from the maximum percent on-time, established by the deadtime control input, down to zero, as the voltage at the feedback pin varies from 0.5 V to 3.5 V. Both error amplifiers have a common mode input range from -0.3 V to (VCC – 2V), and may be used to sense power-supply output voltage and current. The error-amplifier outputs are active high and are ORed together at the noninverting input of the pulse-width modulator comparator. With this configuration, the amplifier that demands minimum output on time, dominates control of the loop.

When capacitor C_T is discharged, a positive pulse is generated on the output of the deadtime comparator, which clocks the pulse-steering flip-flop and inhibits the output transistors, Q1 and Q2. With the output-control connected to the reference line, the pulse-steering flip-flop directs the modulated pulses to each of the two output transistors alternately for push-pull operation. The output frequency is equal to half that of the oscillator. Output drive can also be taken from Q1 or Q2, when single-ended operation with a maximum on-time of less than 50% is required. This is desirable when the output transformer has a ringback winding with a catch diode used for snubbing. When higher output-drive currents are required for single-ended operation, Q1 and Q2 may be connected in parallel, and the output-mode pin must be tied to ground to disable the flip-flop. The output frequency will now be equal to that of the oscillator.

The MIK494 has an internal 5.0V reference capable of sourcing up to 10 mA of load current for external bias circuits. The reference has an internal accuracy of ±5.0% with a typical thermal drift of less than 50mV over an operating temperature range of 0° to 70°C.

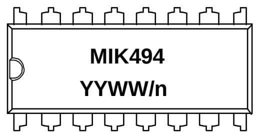
PHYSICAL DIMENSIONS AND MARKING DIAGRAMS

DIP-16
PACKAGE



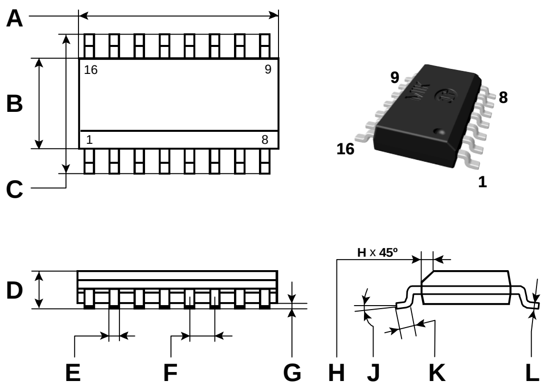
POS.	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	19,50	19,60	0,768	0,772
B	6,30	6,40	0,248	0,252
C	8,30	9,30	0,327	0,366
D	3,15	3,35	0,124	0,132
E	0,41	0,51	0,016	0,020
F	2,49	2,59	0,098	0,102
G	–	1,82	–	0,072
H	3,00	3,50	0,118	0,138
J	0,50	1,10	0,020	0,043
K	13°		13°	
L	0,20	0,30	0,008	0,012

DIP-16
MARKING DIAGRAM



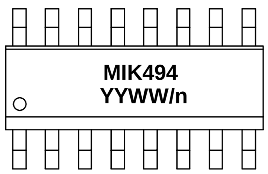
YY — Year
WW — Work Week
n — Assembly Location

SOP-16
PACKAGE



POS	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	5.80	6.20	0.229	0.244
D	1.35	1.75	0.054	0.068
E	0.35	0.49	0.014	0.019
F	1.27 BSC		0.05 BSC	
G	0.10	0.25	0.004	0.009
H	0.25	0.50	0.010	0.019
J	0°	7°	0°	7°
K	0.40	1.25	0.016	0.049
L	0.19	0.25	0.008	0.009

SOP-16
MARKING DIAGRAM



YY — Year
WW — Work Week
n — Assembly Location

ORDERING INFORMATION

ORDERING NUMBER	PACKAGE	OPERATING TEMPERATURE	SHIPPING
MIK 494 **CN**	DIP-16	0°C to +70°C	Rail, Reel and Tube
MIK 494 **CD**	SOP-16	0°C to +70°C	Rail, Reel and Tube

NOTE: The form of packing is stipulated in the contract.

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