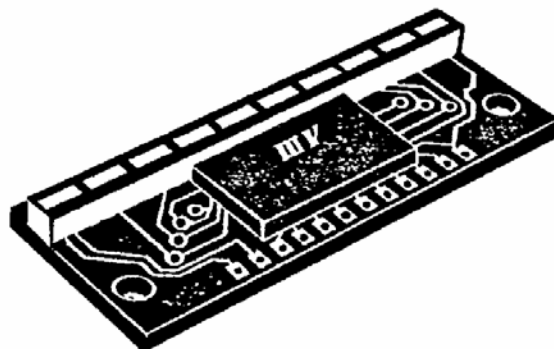




# INTEGRATED BAR GRAPH DISPLAYS

## TSM3914/15/16 SERIES

T-41-37



### PRODUCT MATRIX

Part Number	Function	Segment Color Designation
TSM3914	Linear	10 Standard Red
TSM39142	Linear	10 Green
TSM39143	Linear	10 Yellow
TSM39146	Linear	6 Green, 4 Red
TSM39147	Linear	8 Green, 2 Red
TSM39148	Linear	6 Green, 2 Yellow, 2 Red
TSM3915	Logarithmic	10 Standard Red
TSM39151	Logarithmic	10 High Efficiency Red
TSM39152	Logarithmic	10 Green
TSM39153	Logarithmic	10 Yellow
TSM39156	Logarithmic	6 Green, 2 Yellow, 2 Red
TSM3916	VU	10 Standard Red
TSM39162	VU	10 Green
TSM39163	VU	10 Yellow
TSM39166	VU	6 Green, 2 Yellow, 2 Red
TSM39169	VU	7 Green, 3 Red

### ABSOLUTE MAXIMUM RATINGS

Power Dissipation-Driver (Note 1): 500mW  
 V\* Voltage: 24V  
 VLED Voltage: 24V  
 Input Signal Overvoltage (Note 2): ±35V  
 Voltage on Resistor String: -100mV to V\*  
 Reference Load Current: 10mA  
 Signal Input Current  
 (With Overvoltage Applied): ±3.0mA  
 Operating Temperature Range: 0°C to +70°C  
 Storage Temperature Range: -20°C to +70°C  
 Lead Temperature Range  
 (Soldering, 5 Seconds): 230°C

### FEATURES

- Packages are End-Stackable up to 10 Cascaded Arrays (100 Bar Graph Elements)
- Linear, Logarithmic, and VU Meter Functions
- Bar or Dot Display Mode Externally Selectable
- LED Current Programmable from 2.0mA to 30mA
- Stable, Internal Voltage Reference for Full-Scale Analog Inputs from 1.2V to 12V
- Inputs Operate Down to Ground
- Signal Input Withstands 35V Without Damage or False Outputs
- Variety of Green/Yellow/Red Bar Sequences Available

### APPLICATIONS

- Power Meter in Stereo Systems
- S Meter in Ham and CB Radios
- VU Meter in Tape Recorders
- Process Control Meters
- Replacement for Edge Meters

### DESCRIPTION

The TSM3914/15/16 series are functional replacements for a variety of conventional meters. Each combines a 10-element LED array and a monolithic integrated circuit display driver. Successive LEDs light as the analog input voltage level increases past prescaled threshold points.

The TSM3914 provides a linear analog display, with internal threshold points linearly scaled. A logarithmic display is provided by the TSM3915 with threshold points set on 3dB intervals. The TSM3916 is a variation of the logarithmic display; the VU meter function is provided by using threshold points at common VU intervals.

The driver circuit contains an adjustable voltage reference which precisely sets LED thresholds. Current drives to the LEDs are regulated and programmable, eliminating the need for resistors. The entire display can operate from supply voltages as low as 3V and as high as 24V. The internal voltage reference is also connected to an accurate 10-step voltage divider, supplying reference voltages for 10 individual comparators. These comparators switch as the signal voltage exceeds the established thresholds as described above. The typical overall inaccuracy (deviation from ideal) is typically within 1% for the TSM3914 and below 1dB for the TSM3915 and TSM3916. A high impedance input buffer accepts signals down to ground, yet protects against signal inputs of 35V above or below ground. A single (mode) pin changes the display from a bar graph to a moving dot.



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## TSM3914/15/16 SERIES

F-19-36  
T-41-37

### OPTOELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions $T_A = 25^\circ\text{C}$	Min	Typ	Max	Units	
$V_{REF}$	Voltage Reference Output	$0.10\text{mA} \leq I_{LREF} \leq 4.0\text{mA}$ , $V^+ = 12.0\text{V}$ , $V_{LED} = 4.5\text{V}$	1.2	1.28	1.34	V	
$I_i$	Signal Input Bias Current	$0\text{V} \leq V_{IN} \leq V^+ - 1.5\text{V}$		25	100	nA	
$I_s$	Supply Current ( $V^+$ Lead)	$V^+ = 5.0\text{V}$ to $20\text{V}$ , $I_{LREF} = 1.0\text{mA}$		6.0	10	mA	
	Absolute Accuracy at each Threshold Point	TSM3914	Deviation from Straight Line through First and Last Threshold Point (Note 5)		-5.0	5.0	%
		TSM3915	$V_{IN} = -3.0$ to $18\text{dB}$ (Note 6) $V_{IN} = -21$ to $-27\text{dB}$ (Note 6)	-1.0 -2.0		1.5 2.0	dB dB
		TSM3916	$V_{IN} = +3.0$ to $-7.0\text{dB}$ (Note 7) $V_{IN} = -10$ to $-20\text{dB}$ (Note 7)	-1.0 -2.0		1.5 2.0	dB dB
$I_L$	LED Segment Intensity Red High Efficiency Red Green Yellow	$V^+ = 12.0\text{V}$ , $V_{LED} = 4.5\text{V}$ , $I_{LREF} = 1.0\text{mA}$		0.10	0.20	mcd	
				0.50	0.80	mcd	
				0.60	1.50	mcd	
				0.60	1.50	mcd	
	LED Intensity Matching (All Segments On)	$V_{IN} \geq 10\text{V}$ , $V^+ = 12\text{V}$ , $V_{LED} = 3.0\text{V}$ , $I_{LREF} = 1.0\text{mA}$		$\pm 33$		%	
$I_{LED}$	LED Current/Segment	$V^+ = 12\text{V}$ , $V_{LED} = 4.5\text{V}$ , $I_{LREF} = 1.0\text{mA}$		10		mA	
$\lambda_P$	Peak Wavelength Red High Efficiency Red Green Yellow			655		nm	
				635		nm	
				565		nm	
				585		nm	

Note 1: Driver dissipation is given by:  $P_{DM} = (V_{LSD} - 1.7\text{V}) I_{LSD} (\text{Total}) + (V_{V^+} - 10\text{mA})$  where  $V_{LSD}$  is the LED supply voltage, 1.7V is the nominal individual LED voltage drop and 10mA is the maximum current of the  $V^+$  supply.

Note 2: The addition of a 39k resistor in series with the input signal allows  $\pm 100\text{V}$  signals without damage.

Note 3: Unless otherwise stated, all specifications apply with the following conditions:  $V^+$  (supply) 3.0V to 20V; Input signal range 0.015V to ( $V^+ - 1.5\text{V}$ ) with a maximum of 12V<sub>DC</sub>; Comparator divider voltages, same limits;  $T_A = 25^\circ\text{C}$ ; Reference load current, 80 $\mu\text{A}$  minimum.

Note 4: The following situations can lead to incorrect operation (a)  $V_{LSD}$  exceeding  $V^+$  or more than 14V below  $V^+$ ; (b) signal and comparator divider voltage becoming higher than the limits of Note 1; (c) reference load capacitance above 0.05 $\mu\text{F}$ ; (d) reference current loading above 5.0mA.

Note 5: Divider non-linearity is measured with  $R_{LO}$  at 0.000V and  $R_{HI}$  at 10,000  $V_{DC}$ . (At lower divider voltages, buffer and comparator offset voltages may add significant error.)

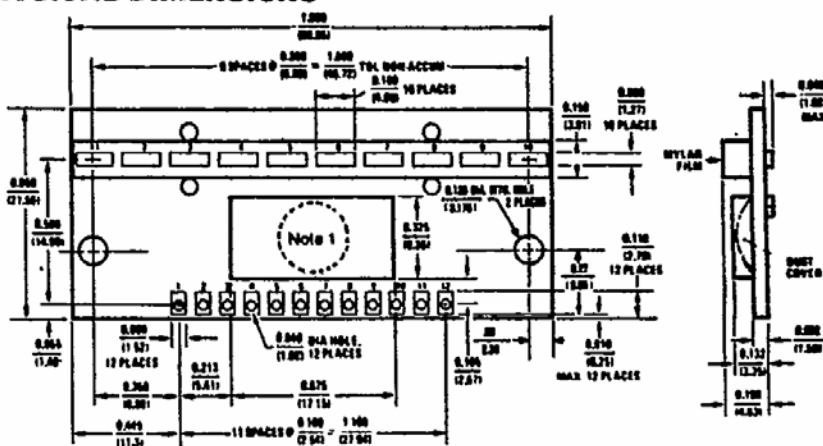
Note 6: Accuracy is measured referred to 0dB = 10,000  $V_{DC}$  at signal input, with  $R_{LO}$  at 0.000V and  $R_{HI}$  at 10,000  $V_{DC}$ . (At lower full-scale voltages, buffer and comparator offset voltages may add significant error.)

Note 7: Accuracy is measured referred to 3dB = 10,000  $V_{DC}$  at signal input, with  $R_{LO}$  at 0.000V and  $R_{HI}$  at 10,000  $V_{DC}$ . (At lower full-scale voltages, buffer and comparator offset voltages may add significant error.)

### PHYSICAL DIMENSIONS

PIN	ELECTRICAL CONNECTION
1	$V_{LED}$
2	LED 1
3	GROUND
4	$V^+$
5	$R_{LO}$
6	SIGNAL IN
7	$R_{HI}$
8	REFERENCE OUT
9	REFERENCE ADJUST
10	MODE
11	LED 9
12	LED 10

DIMENSIONS:  
INCHES  
(Millimeters)



Note 1: Standard package is provided with a rectangular dust cover or Epoxy blob.

WEIGHT: 0.12 Ounce  
3.40 Grams

TOLERANCES: 0.XXX  $\pm 0.015$   
(X XX  $\pm 0.38$ )



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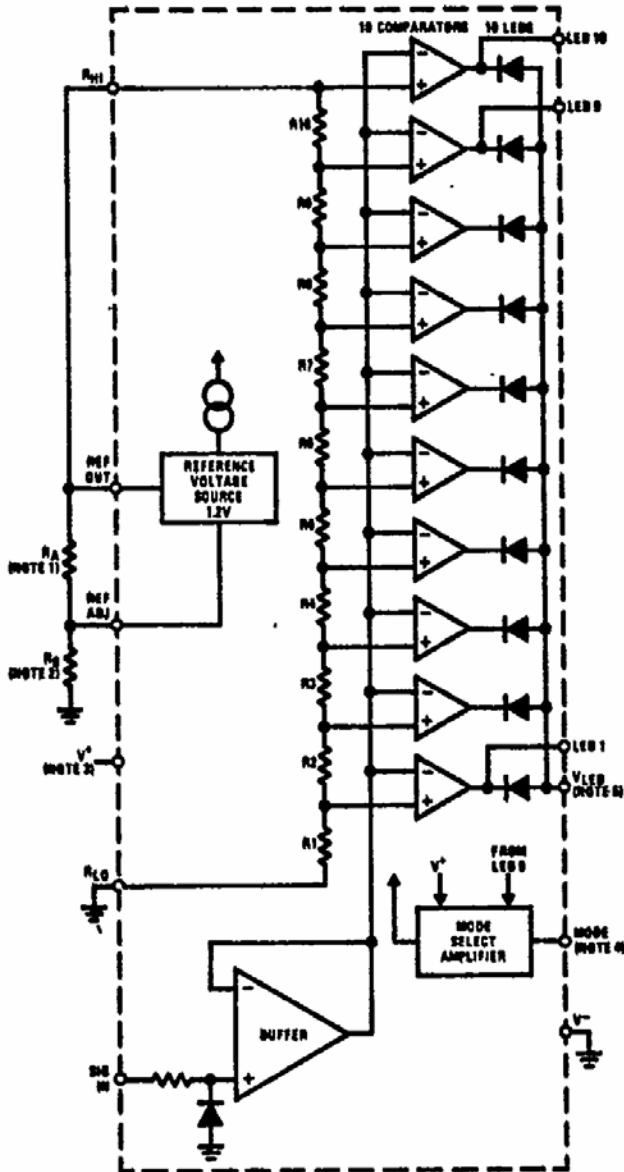
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### BLOCK DIAGRAM



### TYPICAL RESISTOR STRING VALUES

RESISTOR	TSM3914	TSM3915	TSM3916
R1	1.00k	1.00k	0.708k
R2	1.00k	0.41k	1.531k
R3	1.00k	0.59k	0.923k
R4	1.00k	0.83k	0.819k
R5	1.00k	1.17k	1.031k
R6	1.00k	1.66k	1.298k
R7	1.00k	2.34k	0.769k
R8	1.00k	3.31k	0.884k
R9	1.00k	4.69k	0.970k
R10	1.00k	6.63k	1.087k
Total	10k	22.6k	10k

Note 1:  $R_A$  determines  $I_{LED}$  and thus LED brightness:

$$I_{LED} \approx 10 \left( \frac{1.25V}{R_A} + \frac{V_{FS}}{R_{DIVIDER}} \right)$$

Note 2:  $R_B$  determines full-scale voltage.

$$V_{FS} \approx 1.25V \left( 1 + \frac{R_B}{R_A} \right) + I_{REF} R_B, \text{ where } I_{REF} \text{ is nominally } 80\mu A.$$

Note 3:  $V^*$  may be 3.0V to 20V, additionally, for proper operation  $V^* \geq V_{LED}, \geq V_{SIG} + 1.5V, \geq V_{REF} + 1.5V$ .

Note 4: Mode controls type of display. Connect to LED 9 for dot display and to  $V^*$  for bar display.

Note 5:  $V_{LED}$  may be 3.0V to 20V (see Note 3).  $V_{LED}$  may be limited by the driver circuit dissipation rating.

Note 6: Driver dissipation is given by  $P_{DR} = (V_{LED} - 1.7V) I_{LED} (Total) + (V_V^*) 10mA$  where  $V_{LED}$  is the LED supply voltage, 1.7V is the nominal individual LED voltage drop and 10mA is the maximum current of the  $V^*$  supply.



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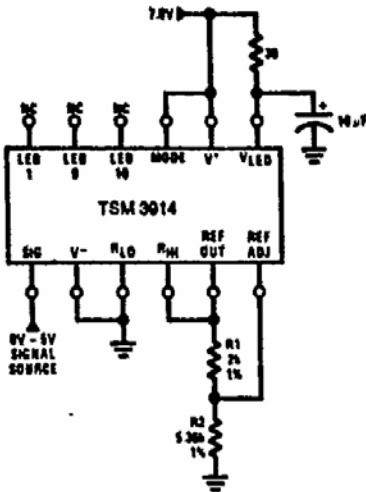
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# INTEGRATED BAR GRAPH DISPLAYS

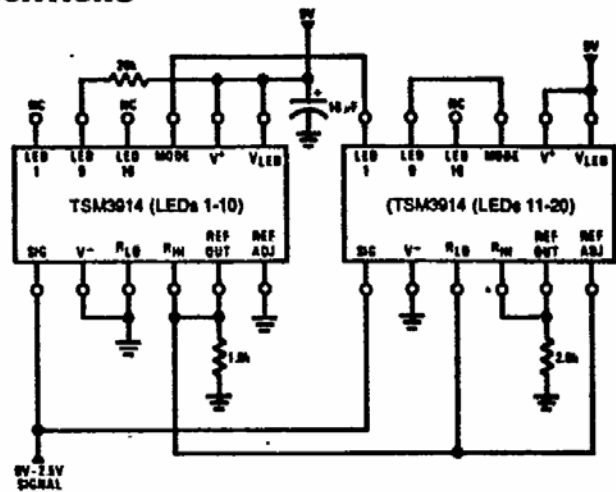
## TSM3914/15/16 SERIES

T-17-24  
T-41-37

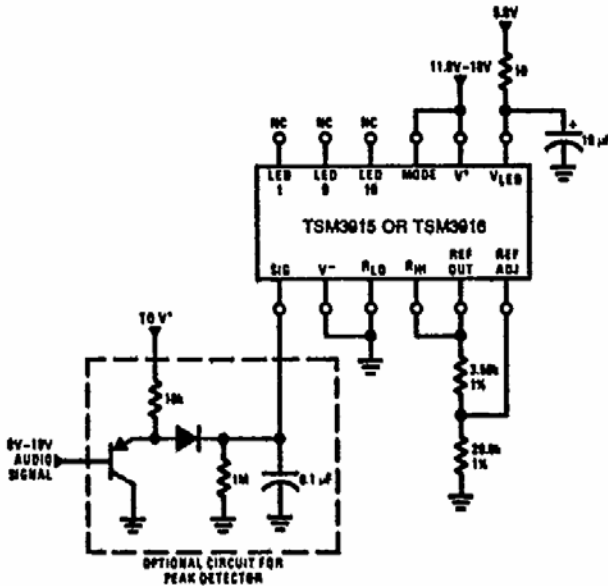
### TYPICAL APPLICATIONS



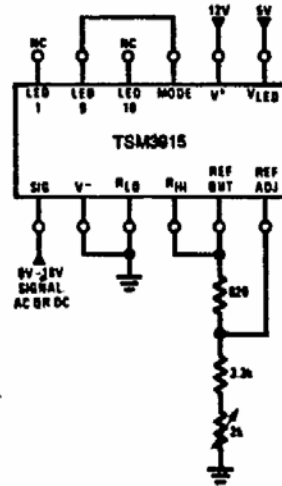
Linear Bar Graph (5V Full-Scale)



20-Segment Linear Dot Graph (2.5V Full-Scale)



Logarithmic (TSM3915) or VU (TSM3916) Audio Bar Graph



Logarithmic Audio Dot Graph (10V Full-Scale)

### RECOMMENDED DISPLAY PROCESSING

The TSM3914/15/16 is constructed on a standard printed circuit board substrate and covered with a plastic reflector. The edge connector tab will withstand 230°C for 5 seconds. Permanent damage to the display will result if reflector temperature exceeds 70°C. Since the display is not hermetic, immersion of the entire package during flux and clean operation may cause condensation of flux or cleaner on the underside of the reflector. Only the edge

connectors should be immersed.

Rosin core solder, solid core solder, and low activity organic fluxes are recommended. Freon TF, Isopropanol, Methanol or Ethanol solvents are recommended only at room temperature and for short periods. The use of other solvents or elevated temperature use of the recommended solvents may cause permanent damage to the reflector or display.



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