DATA SHEET

LM139/239/239A/339/339A/LM2901/MC 3302

Quad voltage comparator

Product specification

1995 Nov 27

IC11 Data Handbook

Philips
Semiconductors

PHILIPS

Quad voltage comparator

LM139/239/239A/339/339A /LM2901/MC3302

DESCRIPTION

The LM139 series consists of four independent precision voltage comparators, with an offset voltage specification as low as 2.0mV max for each comparator, which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common–mode voltage range includes ground, even though they are operated from a single power supply voltage.

The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM139 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

FEATURES

- Wide single supply voltage range 2.0V_{DC} to 36V_{DC} or dual supplies ±1.0V_{DC} to ±18V_{DC}
- Very low supply current drain (0.8mA) independent of supply voltage (1.0mW/comparator at 5.0V_{DC})
- Low input biasing current 25nA
- Low input offset current ±5nA and offset voltage
- Input common–mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Low output 250mV at 4mA saturation voltage
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems

APPLICATIONS

- A/D converters
- Wide range VCO
- MOS clock generator
- High voltage logic gate
- Multivibrators

PIN CONFIGURATION

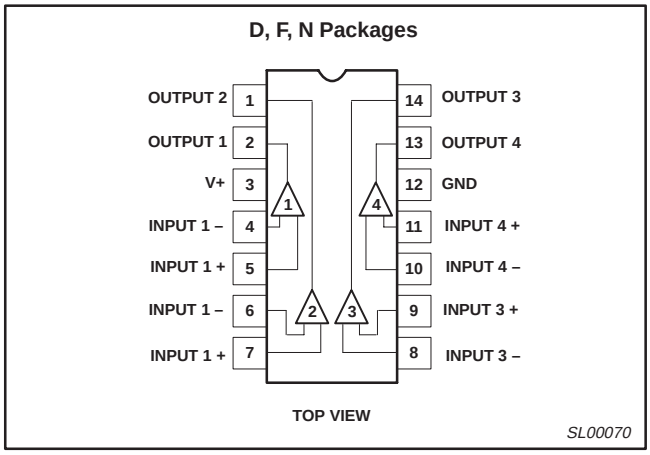


Figure 1. Pin Configuration

EQUIVALENT CIRCUIT

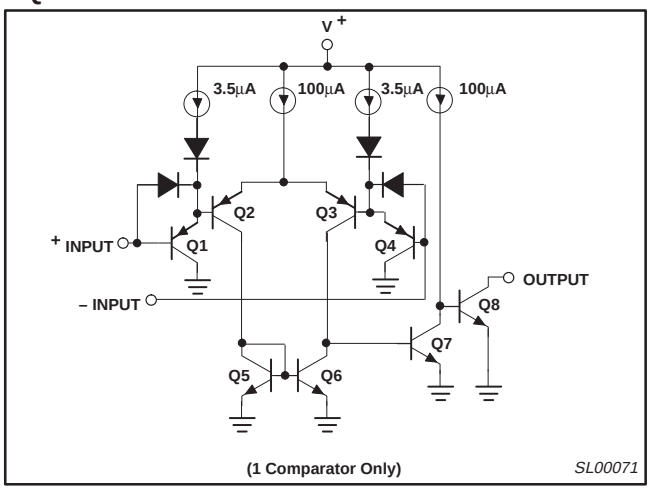


Figure 2. Equivalent Circuit

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
14–Pin Ceramic Dual In-Line Package (Cerdip)	–55 to +125°C	LM139F	0581B
14–Pin Plastic Dual In-Line Package (DIP)	–25°C to +85°C	LM239AN	SOT27-1
14–Pin Plastic Dual In-Line Package (DIP)	–25°C to +85°C	LM239N	SOT27-1
14–Pin Plastic Small Outline (SO) Package	–25°C to +85°C	LM239D	SOT108-1
14–Pin Plastic Dual In-Line Package (DIP)	–40°C to +125°C	LM2901N	SOT27-1
14–Pin Plastic Small Outline (SO) Package	–40°C to +125°C	LM2901D	SOT108-1
14–Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	LM339AN	SOT27-1
14–Pin Plastic Small Outline (SO) Package	0 to +70°C	LM339D	SOT108-1
14–Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	LM339N	SOT27-1
14–Pin Plastic Small Outline (SO) Package	–40°C to +85°C	MC3302D	SOT108-1
14–Pin Ceramic Dual In-Line Package (Cerdip)	–40°C to +85°C	MC3302F	0581B
14–Pin Plastic Dual In-Line Package (DIP)	–40°C to +85°C	MC3302N	SOT27-1
14–Pin Plastic Dual In-Line Package (DIP)	–55 to +125°C	LM139N	SOT27-1

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	V_{CC} supply voltage	36 or ±18	V_{DC}
V_{DIFF}	Differential input voltage	36	V_{DC}
V_{IN}	Input voltage	–0.3 to +36	V_{DC}
P_D	Maximum power dissipation, T_A=25°C (still–air)[1]		
	F package	1190	mW
	N package	1420	mW
	D package	1040	mW
	Output short–circuit to ground[2]	Continuous	
I_{IN}	Input current (V_{IN}<–0.3V_{DC})[3]	50	mA
T_A	Operating temperature range		
	LM139	–55 to +125	°C
	LM239/239A	–25 to +85	°C
	LM339/339A	0 to +70	°C
	LM2901	–40 to +125	°C
	MC3302	–40 to +85	°C
T_{STG}	Storage temperature range	–65 to +150	°C
T_{SOLD}	Lead soldering temperature (10sec max)	300	°C

NOTES:

1. Derate above 25°C, at the following rates:
   F Package at 9.5mW/°C
   N Package at 11.4mW/°C
   D Package at 8.3mW/°C
2. Short circuits from the output to V+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA independent of the magnitude of V+.
3. This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector–base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the comparators to go to the V+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will reestablish when the input voltage, which was negative, again returns to a value greater than –0.3V_{DC}.

DC AND AC ELECTRICAL CHARACTERISTICS

V+=5V_{DC}, LM139: –55°C ≤ T_A ≤ 125°C; LM239/239A: –25°C ≤ T_A ≤ 85°C; LM339/339A: 0°C ≤ T_A ≤ 70°C;; LM2901: –40°C ≤ T_A ≤ 125°C, MC3302: –40°C ≤ T_A ≤ 85°C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM239A/339A			UNIT
			Min	Typ	Max	
V_{OS}	Input offset voltage[2]	T_A=25°C Over temp.		±1.0	±2.0 ±4.0	mV mV
V_{CM}	Input common–mode voltage range[3]	T_A=25°C Over temp.	0 0		V+–1.5 V+–2.0	V
V_{IDR}	Differential input voltage[1]	Keep all V_{IN}'s≥0V_{DC} (or V– if need)			V+	V
I_{BIAS}	Input bias current[4]	$I_{IN(+)}$ or $I_{IN(–)}$ with output in linear range T_A=25°C Over temp.		25	250 400	nA nA
I_{OS}	Input offset current	$I_{IN(+)}$–$I_{IN(–)}$ T_A=25°C Over temp.		±5.0	±50 ±150	nA nA
I_{OL}	Output sink current	$V_{IN(–)}$≥1V_{DC}, V_{IN}(+)=0, V_O≤1.5V_{DC}, T_A=25°C	6.0	16		mA
	Output leakage current	$V_{IN(+)}$≥1V_{DC}, V_{IN}(–)=0 V_O=5V_{DC}, T_A=25°C V_O=30V_{DC}, over temp.		0.1	 1.0	 nA µA
I_{CC}	Supply current	R_L=∞ on comparators, T_A=25°C V+=30V		0.8	2.0	mA
A_V	Voltage gain	R_L≥15kΩ, V+=15V_{DC}	50	200		V/mV
V_{OL}	Saturation voltage	$V_{IN(–)}$≥1V_{DC}, $V_{IN(+)}$=0, I_{SINK}≤4mA T_A=25°C Over temp.		250	400 700	mV mV
t_{LSR}	Large–signal response time	V_{IN}=TTL logic swing, V_{REF}=1.4V_{DC}, V_{RL}=5V_{DC}, R_L=5.1kΩ, T_A=25°C		300		ns
t_R	Response time[5]	V_{RL}=5V_{DC}, R_L=5.1kΩ, T_A=25°C		1.3		µs

See notes at the end of the Electrical Characteristics.

DC AND AC ELECTRICAL CHARACTERISTICS

V+=5V_{DC}, LM139: –55°C ≤ T_A ≤ 125°C; LM239/239A: –25°C ≤ T_A ≤ 85°C; LM339/339A: 0°C ≤ T_A ≤ 70°C; LM2901: –40°C ≤ T_A ≤ 125°C, MC3302: –40°C ≤ T_A ≤ 85°C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM139			LM239/339			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage[2]	T_A=25°C Over temp.		±2.0	±5.0 ±9.0		±2.0	±5.0 ±9.0	mV mV
V_{CM}	Input common–mode voltage range[3]	T_A=25°C Over temp.	0 0		V+–1.5 V+–2.0	0 0		V+–1.5 V+–2.0	V
V_{IDR}	Differential input voltage[1]	Keep all V_{IN}'s≥0V_{DC} (or V– if need)			V+			V+	V
I_{BIAS}	Input bias current[4]	$I_{IN(+)}$ or $I_{IN(–)}$ with output in linear range T_A=25°C Over temp.		25	100 300		25	250 400	nA nA
I_{OS}	Input offset current	$I_{IN(+)}$–$I_{IN(–)}$ T_A=25°C Over temp.		±3.0	±25 ±100		±5.0	±50 ±150	nA nA
I_{OL}	Output sink current	$V_{IN(–)}$≥1V_{DC}, V_{IN}(+)=0, V_O≤1.5V_{DC}, T_A=25°C	6.0	16		6.0	16		mA
	Output leakage current	$V_{IN(+)}$≥1V_{DC}, V_{IN}(–)=0 V_O=5V_{DC}, T_A=25°C V_O=30V_{DC}, over temp.		0.1	 1.0		0.1	 1.0	nA µA
I_{CC}	Supply current	R_L=∞ on comparators, T_A=25°C V+=30V		0.8	2.0		0.8	2.0	mA
A_V	Voltage gain	R_L≥15kΩ, V+=15V_{DC}	50	200		50	200		V/mV
V_{OL}	Saturation voltage	$V_{IN(–)}$≥1V_{DC}, $V_{IN(+)}$=0, I_{SINK}≤4mA T_A=25°C Over temp.		250	400 700		250	400 700	mV mV
t_{LSR}	Large–signal response time	V_{IN}=TTL logic swing, V_{REF}=1.4V_{DC}, V_{RL}=5V_{DC}, R_L=5.1kΩ, T_A=25°C		300			300		ns
t_R	Response time[5]	V_{RL}=5V_{DC}, R_L=5.1kΩ, T_A=25°C		1.3			1.3		µs

See notes on following page.

DC AND AC ELECTRICAL CHARACTERISTICS

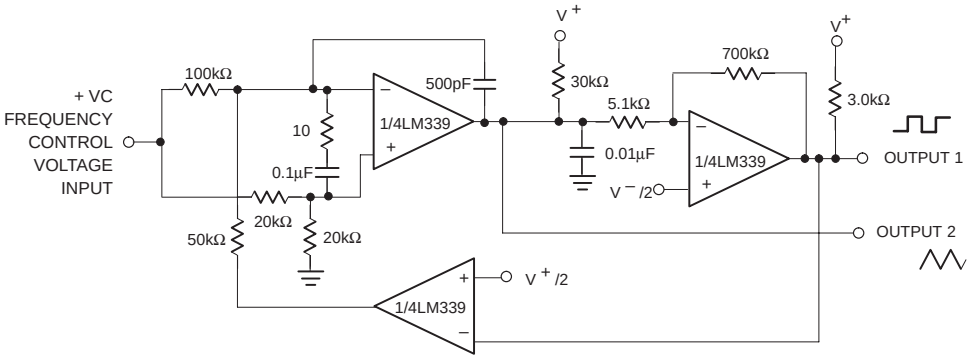
$V+=5V_{DC}$, LM139: $–55°C \le T_A \le 125°C$; LM239/239A: $–25°C \le T_A \le 85°C$; LM339/339A: $0°C \le T_A \le 70°C$; LM2901: $–40°C \le T_A \le 125°C$, MC3302: $–40°C \le T_A \le 85°C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM2901			MC3302			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage[2]	T_A=25°C Over temp.		±2.0 ±9	±7.0 ±15		±3.0	±20 ±40	mV mV
V_{CM}	Input common–mode voltage range[3]	T_A=25°C Over temp.	0 0		V+–1.5 V+–2.0	0 0		V+–1.5 V+–2.0	V
V_{IDR}	Differential input voltage[1]	Keep all V_{IN}s≥0V_{DC} (or V– if need)			V+			V+	V
I_{BIAS}	Input bias current[4]	$I_{IN(+)}$ or $I_{IN(–)}$ with output in linear range T_A=25°C Over temp.		 25 200	 250 500		 25	 500 1000	 nA nA
I_{OS}	Input offset current	$I_{IN(+)}–I_{IN(–)}$ T_A=25°C Over temp.		 ±5 ±50	 ±50 ±200		 ±5	 ±100 ±300	 nA nA
I_{OL}	Output sink current	$V_{IN(–)}$≥1V_{DC}, V_{IN}(+)=0, V_O≤1.5V_{DC}, T_A=25°C	6.0	16		6	16		mA
	Output leakage current	$V_{IN(+)}$≥1V_{DC}, V_{IN}(–)=0 V_O=5V_{DC}, T_A=25°C V_O=30V_{DC}, over temp.		0.1	 1.0		0.1	 1.0	nA µA
I_{CC}	Supply current	R_L=∞ on all comparators,					.8	1.8	mA
		T_A=25°C		0.8	2.0				
		R_L=∞ on all comparators, V+=30V		1.0	2.5				mA
A_V	Voltage gain	R_L≥15kΩ, V+=15V_{DC}	25	100		2	100		V/mV
V_{OL}	Saturation voltage	$V_{IN(–)}$≥1V_{DC}, $V_{IN(+)}$=0, I_{SINK}≤4mA T_A=25°C Over temp.		 400	 700		 150	 400 700	 mV mV
t_{LSR}	Large–signal response time	V_{IN}=TTL logic swing, V_{REF}=1.4V_{DC}, V_{RL}=5V_{DC}, R_L=5.1kΩ, T_A=25°C		300			300		ns
t_R	Response time[5]	V_{RL}=5V_{DC}, R_L=5.1kΩ, T_A=25°C		1.3			1.3		µs

NOTES:

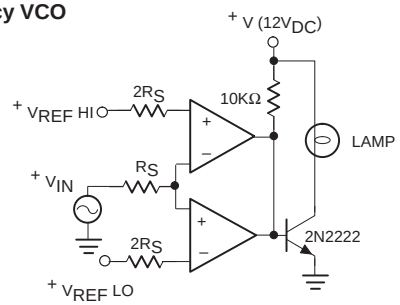
1. Positive excursions of input voltage may exceed the power supply level by 17V. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than –0.3V_{DC} (or 0.3V_{DC} below the magnitude of the negative power supply, if used).
2. At output switch point, $V_O \approx 1.4V_{DC}$, R_S=0Ω with V+ from 5V_{DC} to 30V_{DC}; and over the full input common–mode range (0V_{DC} to V+ – 1.5V_{DC}). Inputs of unused comparators should be grounded.
3. The input common–mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common–mode voltage range is V+ – 1.5V, but either or both inputs can go to 30V_{DC} without damage.
4. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
5. The response time specified is for a 100mV input step with a 5mV overdrive. For larger overdrive signals, 300ns can be obtained (see typical performance characteristics section).

EQUIVALENT CIRCUIT

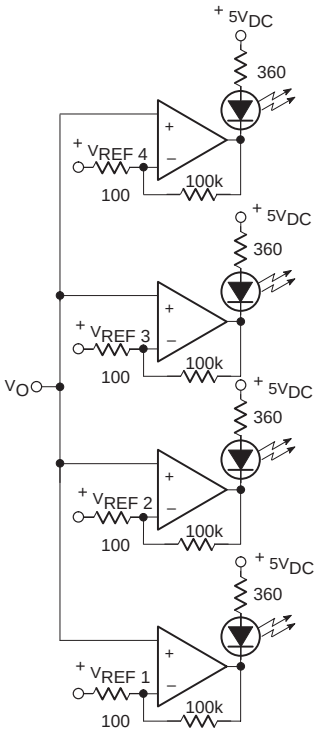


NOTES:
V+ = $30V_{DC}$
+ 250m $V_{DC} \leq V_C = 50V_{DC}$
$700H \leq f_O = 100kHz$

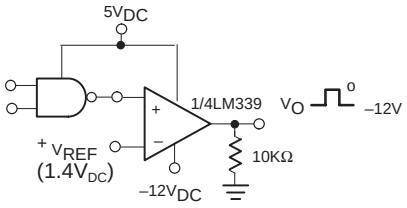
Two–Decade High–Frequency VCO



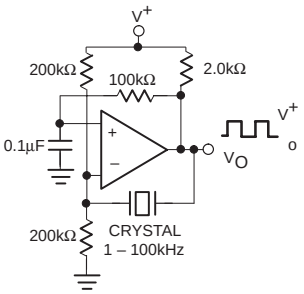
Limit Comparator



Visible Voltage Indicator



TTL–to–MOS Logic Converter



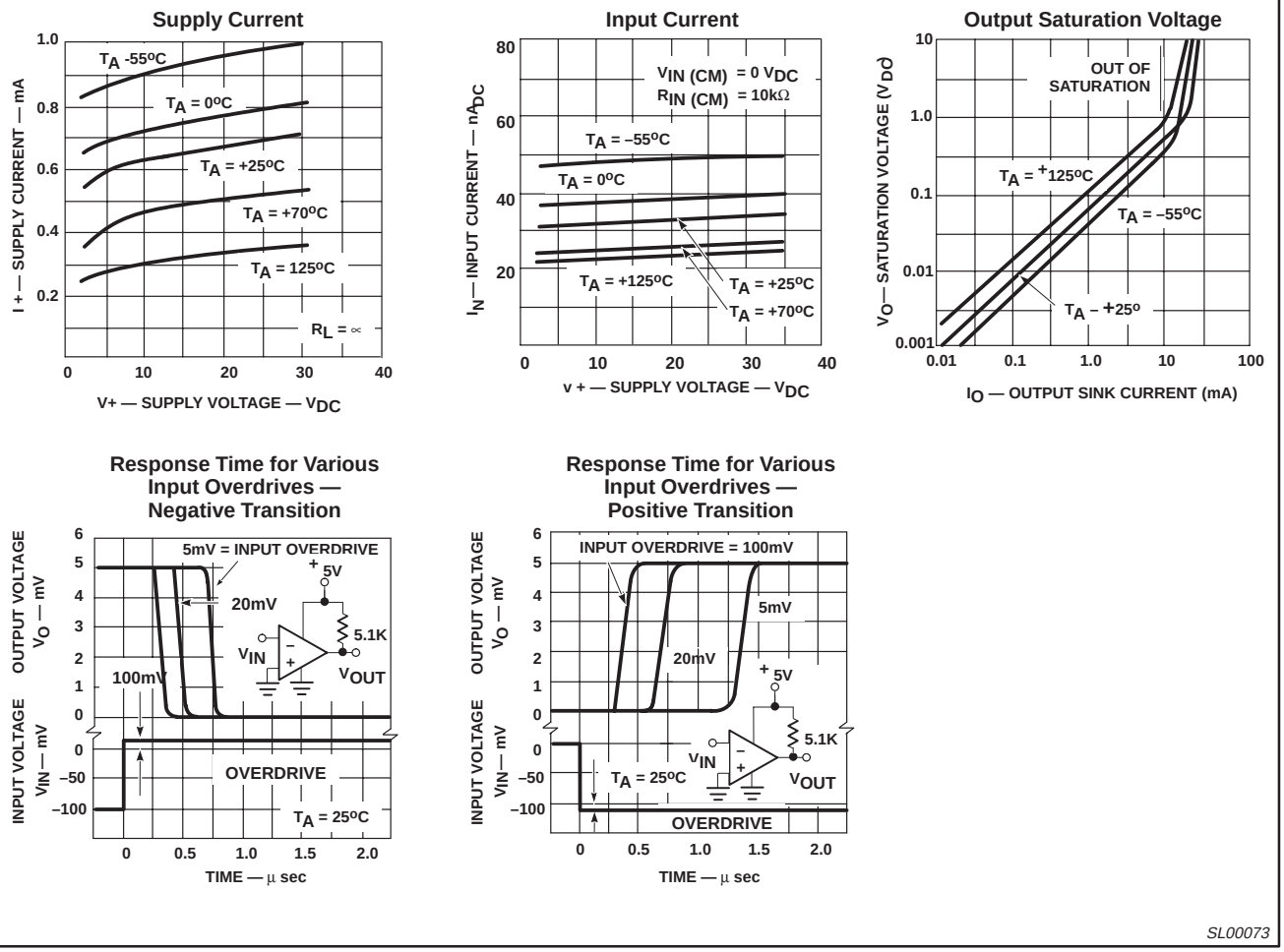
Crystal–Controlled Oscillator

NOTE:
Input of unused comparators should be grounded.

SL00072

Figure 3. Equivalent Circuit

TYPICAL PERFORMANCE CHARACTERISTICS



SL00073

Figure 4. Typical Performance Characteristics

DEFINITIONS

Data Sheet Identification	Product Status	Definition
Objective Specification	Formative or in Design	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
Preliminary Specification	Preproduction Product	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product Specification	Full Production	This data sheet contains Final Specifications. Philips Semiconductors reserves the right to make changes at any time without notice, in order to improve design and supply the best possible product.

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850-0007 FORM A 02/95

PREPARED BY:

Dresser	W	9226	4645	60	PAGE Nov 27, 1995	OF SVL
LAST NAME	INIT	DEPT	EXT	BIN#	DATE	PLANT

ECN NUMBER & DATE

PERMANENT X IMMEDIATE ___ TEMPORARY ___ AFTER-HOURS ___

APPROVAL
DATE: _____
EXPIRATION
DATE: _____

MASTER SIGNOFF:
YES: ___ NO: ___ INITIALS: _____

ECN CONTINUATION ATTACHED:
YES: ___ NO: ___

PRODUCT GROUP: **Communication Products Group**

ROUTER : DATE

PART NUMBER	PKG/REV	BASIC DIE/REV	CUSTOMER PART #/REV	ALPHA

DOCUMENT TITLE: **See description below**
DOCUMENT TYPE: **Data Sheet** DOCUMENT NUMBER: **853-** REV: ___

DESCRIPTION OF CHANGE: INCLUDE FROM/TO INFO WHERE APPROPRIATE

LM2901 ..... 853-0930 13721 ..... 94 Aug 31
LM2902 ..... 853-0929 13721 ..... 94 Aug 31
LM2903 ..... 853-0932 13721 ..... 94 Aug 31
LM2904 ..... 853-1241 13721 ..... 94 Aug 31

All data sheets reflect change from 85°C to 125°C.

EFFECT: ( )MAJOR ( )MINOR

PROVIDE CPCN STATUS, JUSTIFICATION FOR THE CHANGE AND AN EXPLANATION OF EFFECT

OIDS/DOCUMENTS AFFECTED:

___ PRIME	___ PDYM	___ FPOID	___ PROBE DIAGRAM
___ CDDB	___ ESORT	___ APL	___ BONDING DIAGRAM
___ DDDB	___ EMCR	___ FT/PA	___ SCHEMATIC
___ FAB XREF	___ PMF/PDDB	___ FT FLOW	___ TABLE _____
		___ MPO	X OTHER **853-** _____

KEY SPONSOR:	_____	_____	_____	_____
CO-SPONSORS:	_____	_____	_____	_____
	DEPT#	SIGNATURE	DATE	EXT/USER ID

ECN DISTRIBUTION: _____ _____ _____ _____ _____ _____
DEPT# DEPT# DEPT#

MISCELLANEOUS DISTRIBUTION: _____ _____ _____ _____ _____ _____
DEPT# DEPT# DEPT#

MATERIAL DISPOSITION:

	FAB	ESORT	DS	ASSY	SEAL	SYMB	M/V	FT	PA	PACK	FG	MATL STRS	OTHER
USE AS IS	___	_____	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
REWORK	___	_____	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
SCRAP													