LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

Single Supply Quad Comparators

These comparators are designed for use in level detection, low–level sensing and memory applications in consumer, automotive, and industrial electronic applications.

- Single or Split Supply Operation
- Low Input Bias Current: 25 nA (Typ)
- Low Input Offset Current: ±5.0 nA (Typ)
- Low Input Offset Voltage
- Input Common Mode Voltage Range to Gnd
- Low Output Saturation Voltage: 130 mV (Typ) @ 4.0 mA
- TTL and CMOS Compatible
- ESD Clamps on the Inputs Increase Reliability without Affecting Device Operation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage LM239/LM339/LM2901, V MC3302	V_{CC}	 +36 or ±18 +30 or ±15	Vdc
Input Differential Voltage Range LM239/LM339/LM2901, V MC3302	V_{IDR}	 36 30	Vdc
Input Common Mode Voltage Range	V_{ICMR}	–0.3 to V_{CC}	Vdc
Output Short Circuit to Ground (Note 1)	I_{SC}	Continuous	
Power Dissipation @ T_A = 25°C Plastic Package Derate above 25°C	P_D $1/R_{\theta JA}$	 1.0 8.0	 W mW/°C
Junction Temperature	T_J	150	°C
Operating Ambient Temperature Range LM239 MC3302 LM2901 LM2901V, NCV2901 LM339	T_A	 –25 to +85 –40 to +85 –40 to +105 –40 to +125 0 to +70	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

1. The maximum output current may be as high as 20 mA, independent of the magnitude of V_{CC}. Output short circuits to V_{CC} can cause excessive heating and eventual destruction.

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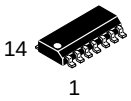
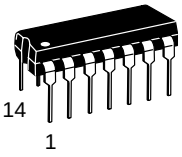
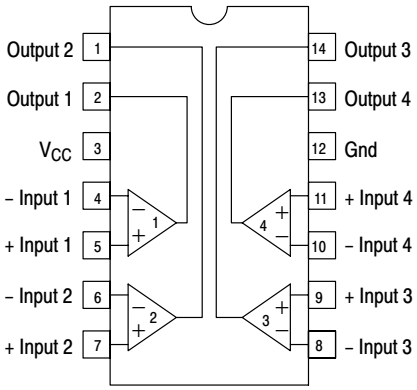


SO–14
D SUFFIX
CASE 751A



PDIP–14
N, P SUFFIX
CASE 646

PIN CONNECTIONS



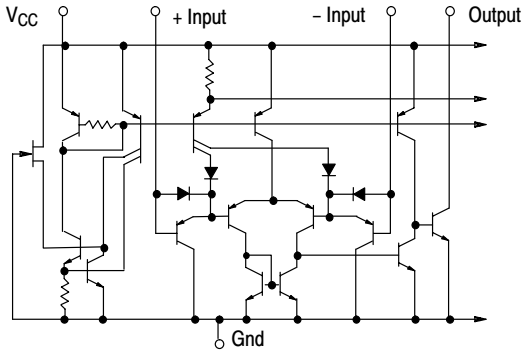
(Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 6 of this data sheet.



NOTE: Diagram shown is for 1 comparator.

Figure 1. Circuit Schematic

ELECTRICAL CHARACTERISTICS (V_{CC} = +5.0 Vdc, T_A = +25°C, unless otherwise noted)

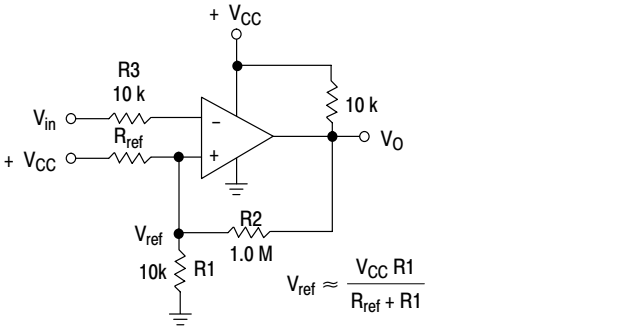
Characteristic	Symbol	LM239/339			LM2901/2901V/ NCV2901			MC3302			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 3)	V_{IO}	–	±2.0	±5.0	–	±2.0	±7.0	–	±3.0	±20	mVdc
Input Bias Current (Notes 3, 4) (Output in Analog Range)	I_{IB}	–	25	250	–	25	250	–	25	500	nA
Input Offset Current (Note 3)	I_{IO}	–	±5.0	±50	–	±5.0	±50	–	±3.0	±100	nA
Input Common Mode Voltage Range	V_{ICMR}	0	–	V_{CC} –1.5	0	–	V_{CC} –1.5	0	–	V_{CC} –1.5	V
Supply Current	I_{CC}										mA
R_L = ∞ (For All Comparators)		–	0.8	2.0	–	0.8	2.0	–	0.8	2.0	
R_L = ∞, V_{CC} = 30 Vdc		–	1.0	2.5	–	1.0	2.5	–	1.0	2.5	
Voltage Gain R_L ≥ 15 kΩ, V_{CC} = 15 Vdc	A_{VOL}	50	200	–	25	100	–	25	100	–	V/mV
Large Signal Response Time V_I = TTL Logic Swing, V_{ref} = 1.4 Vdc, V_{RL} = 5.0 Vdc, R_L = 5.1 kΩ	–	–	300	–	–	300	–	–	300	–	ns
Response Time (Note 5) V_{RL} = 5.0 Vdc, R_L = 5.1 kΩ	–	–	1.3	–	–	1.3	–	–	1.3	–	μs
Output Sink Current V_I (–) ≥ +1.0 Vdc, V_I(+) = 0, V_O ≤ 1.5 Vdc	I_{Sink}	6.0	16	–	6.0	16	–	6.0	16	–	mA
Saturation Voltage V_I(–) ≥ +1.0 Vdc, V_I(+) = 0, I_{sink} ≤ 4.0 mA	V_{sat}	–	130	400	–	130	400	–	130	500	mV
Output Leakage Current V_I(+) ≥ +1.0 Vdc, V_I(–) = 0, V_O = +5.0 Vdc	I_{OL}	–	0.1	–	–	0.1	–	–	0.1	–	nA

2. (LM239) T_{low} = –25°C, T_{high} = +85°
   (LM339) T_{low} = 0°C, T_{high} = +70°C
   (MC3302) T_{low} = –40°C, T_{high} = +85°C
   (LM2901) T_{low} = –40°C, T_{high} = +105°
   (LM2901V & NCV2901) T_{low} = –40°C, T_{high} = +125°C
   NCV2901 is qualified for automotive use.
3. At the output switch point, $V_O \simeq$ 1.4 Vdc, $R_S \leq$ 100 Ω 5.0 Vdc ≤ V_{CC} ≤ 30 Vdc, with the inputs over the full common mode range (0 Vdc to V_{CC} –1.5 Vdc).
4. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
5. The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.

PERFORMANCE CHARACTERISTICS (V_{CC} = +5.0 Vdc, $T_A = T_{low}$ to T_{high} [Note 6])

Characteristic	Symbol	LM239/339			LM2901/2901V/ NCV2901			MC3302			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 7)	V_{IO}	–	–	±9.0	–	–	±15	–	–	±40	mVdc
Input Bias Current (Notes 7, 8) (Output in Analog Range)	I_{IB}	–	–	400	–	–	500	–	–	1000	nA
Input Offset Current (Note 7)	I_{IO}	–	–	±150	–	–	±200	–	–	±300	nA
Input Common Mode Voltage Range	V_{ICMR}	0	–	V_{CC} –2.0	0	–	V_{CC} –2.0	0	–	V_{CC} –2.0	V
Saturation Voltage $V_I(-) \geq +1.0$ Vdc, $V_I(+) = 0$, $I_{sink} \leq 4.0$ mA	V_{sat}	–	–	700	–	–	700	–	–	700	mV
Output Leakage Current $V_I(+) \geq +1.0$ Vdc, $V_I(-) = 0$, $V_O = 30$ Vdc	I_{OL}	–	–	1.0	–	–	1.0	–	–	1.0	μA
Differential Input Voltage All $V_I \geq 0$ Vdc	V_{ID}	–	–	V_{CC}	–	–	V_{CC}	–	–	V_{CC}	Vdc

6. (LM239) T_{low} = –25°C, T_{high} = +85°
   (LM339) T_{low} = 0°C, T_{high} = +70°C
   (MC3302) T_{low} = –40°C, T_{high} = +85°C
   (LM2901) T_{low} = –40°C, T_{high} = +105°
   (LM2901V & NCV2901) T_{low} = –40°C, T_{high} = +125°C
   NCV2901 is qualified for automotive use.
7. At the output switch point, $V_O \simeq$ 1.4 Vdc, $R_S \leq 100\ \Omega$ 5.0 Vdc ≤ V_{CC} ≤ 30 Vdc, with the inputs over the full common mode range (0 Vdc to V_{CC} –1.5 Vdc).
8. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
9. The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.



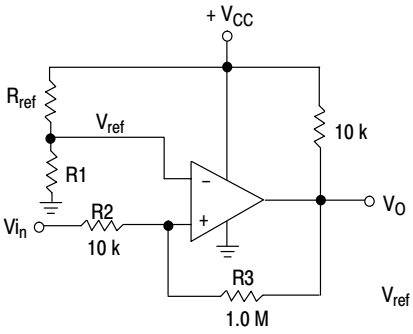
$$V_{ref} \simeq \frac{V_{CC}\ R1}{R_{ref} + R1}$$

$$R3 \simeq R1\ //\ R_{ref}\ //\ R2$$

$$V_H = \frac{R1\ //\ R_{ref}}{R1//\ R_{ref} + R2}\ [V_{O(max)} - V_{O(min)}]$$

$$R2 \gg Rref\ //\ R1$$

Figure 2. Inverting Comparator with Hystersis



$$V_{ref} = \frac{V_{CC}\ R1}{R_{ref} + R1}$$

$$R2 \approx R1\ //\ R_{ref}$$

Amount of Hysteresis V_H

$$V_H = \frac{R2}{R2 + R3}\ [(V_{O(max)} - V_{O(min)}]$$

Figure 3. Noninverting Comparator with Hysteresis

Typical Characteristics

(V_{CC} = 15 Vdc, T_A = +25°C (each comparator) unless otherwise noted.)

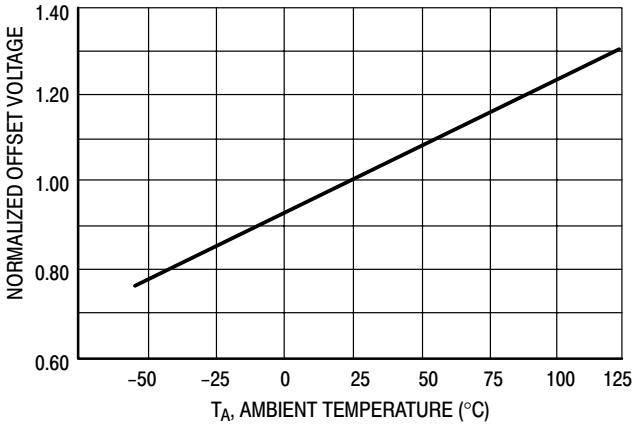


Figure 4. Normalized Input Offset Voltage

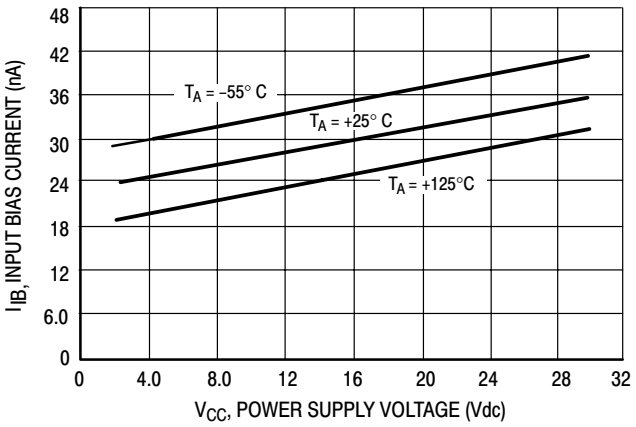


Figure 5. Input Bias Current

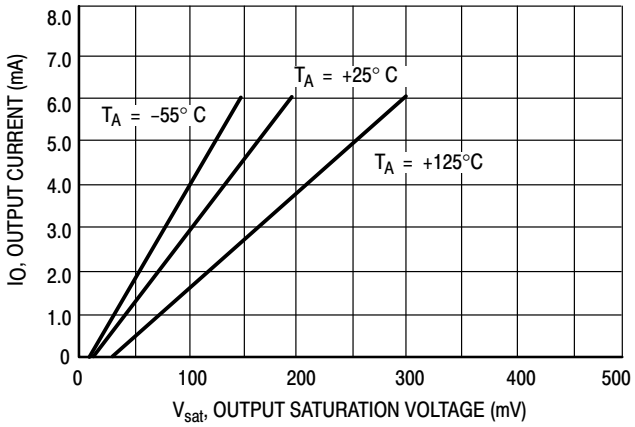
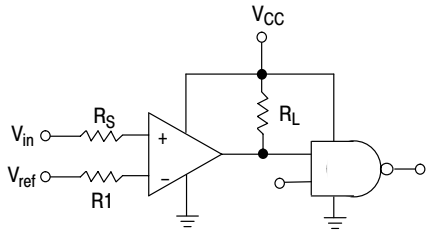


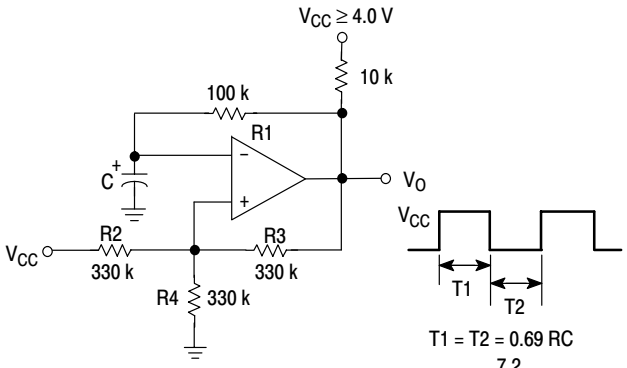
Figure 6. Output Sink Current versus Output Saturation Voltage



R_S = Source Resistance
$R1 \simeq R_S$

Logic	Device	V_{CC} (V)	R_L kΩ
CMOS	1/4 MC14001	+15	100
TTL	1/4 MC7400	+5.0	10

Figure 7. Driving Logic



T1 = T2 = 0.69 RC

$f \approx \frac{7.2}{C(\mu F)}$

R2 = R3 = R4

R1 ≈ R2 // R3 // R4

Figure 8. Squarewave Oscillator

APPLICATIONS INFORMATION

These quad comparators feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitively coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions (V_{OL} to V_{OH}). To alleviate this situation input resistors < 10 kΩ should be used. The addition of positive feedback (< 10 mV) is also recommended. It is good design practice to ground all unused input pins.

Differential input voltages may be larger than supply voltages without damaging the comparator's inputs. Voltages more negative than –300 mV should not be used.

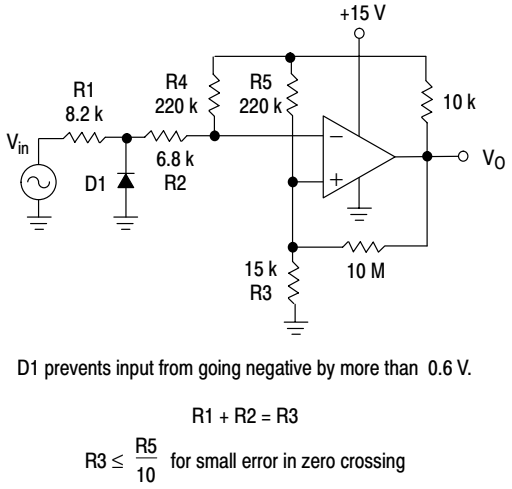


Figure 9. Zero Crossing Detector (Single Supply)

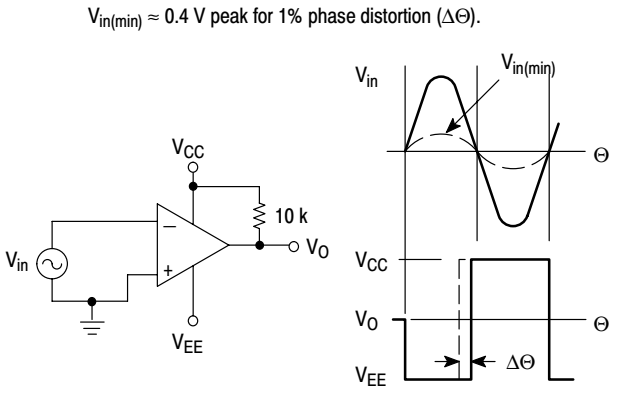


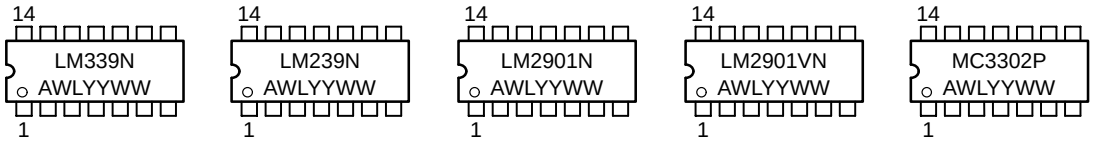
Figure 10. Zero Crossing Detector (Split Supplies)

ORDERING INFORMATION

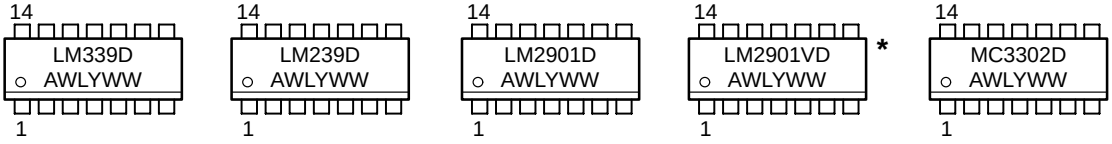
Device	Package	Shipping
LM239D	SO–14	55 Units/Rail
LM239DR2	SO–14	2500 Units/Tape & Reel
LM239N	PDIP–14	25 Units/Rail
LM339D	SO–14	55 Units/Rail
LM339DR2	SO–14	2500 Units/Tape & Reel
LM339N	PDIP–14	25 Units/Rail
LM2901D	SO–14	55 Units/Rail
LM2901DR2	SO–14	2500 Units/Tape & Reel
LM2901N	PDIP–14	25 Units/Rail
LM2901VDR2	SO–14	2500 Units/Tape & Reel
LM2901VN	PDIP–14	25 Units/Rail
NCV2901DR2	SO–14	2500 Units/Tape & Reel
MC3302D	SO–14	55 Units/Rail
MC3302DR2	SO–14	2500 Units/Tape & Reel
MC3302P	PDIP–14	25 Units/Rail

MARKING DIAGRAMS

PDIP–14
N, P SUFFIX
CASE 646



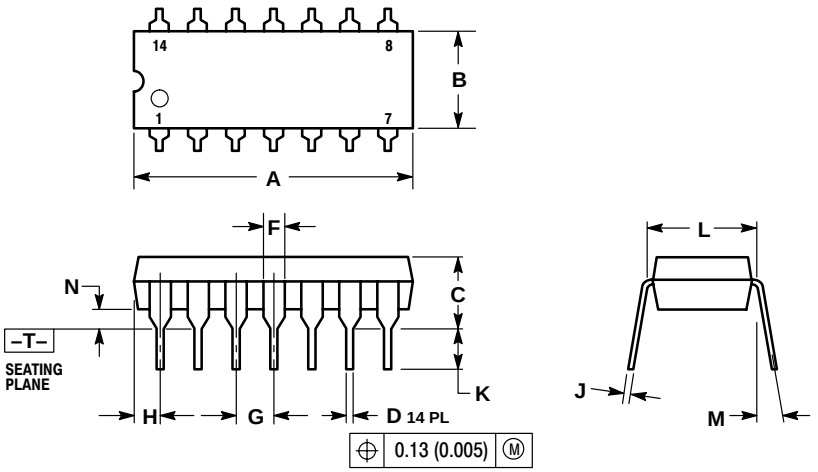
SO–14
D SUFFIX
CASE 751A



A = Assembly Location
WL = Wafer Lot
YY, Y = Year
WW = Work Week
*This marking diagram also applies to NCV2901.

PACKAGE DIMENSIONS

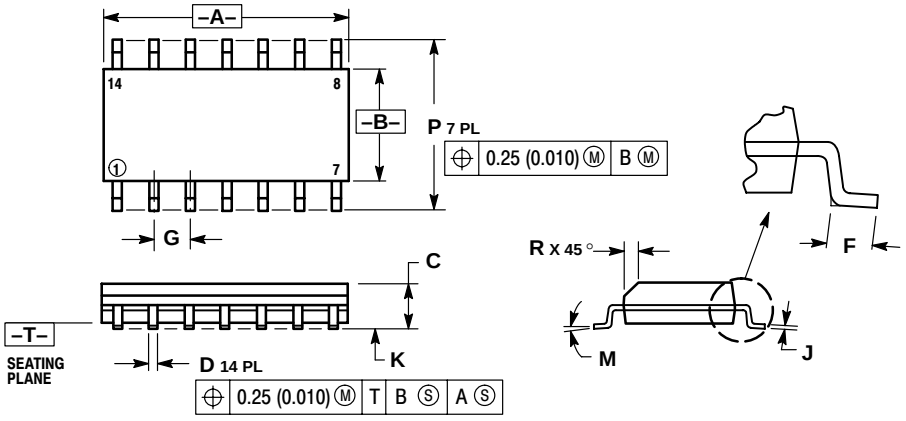
PDIP–14
P SUFFIX
CASE 646–06
ISSUE M



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	18.80
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.290	0.310	7.37	7.87
M	---	10°	---	10°
N	0.015	0.039	0.38	1.01

SO–14
D SUFFIX
CASE 751A–03
ISSUE F



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0 °	7 °	0 °	7 °
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

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