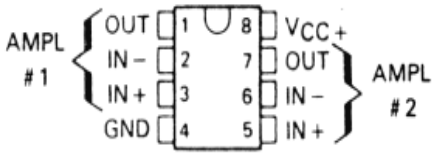
LM358
DUAL OPERATIONAL AMPLIFIERS

GENERAL DESCRIPTION

The LM358 consists of two independent, high-gain, internally frequency-compensated operational amplifiers, which were designed specifically to operate from a single power supply over a wide range of voltages. The device 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.
Its application areas include transducer amplifiers, dc gain blocks and all the conventional operational amplifier circuits.

PIN CONFIGURATION



FEATURES

- Wide range of supply voltages
- Low supply current drain independent of the supply voltage
- Low input biasing current
- Low input offset voltage and offset current
- Input common-mode voltage range including the Ground
- Differential input voltage range equal to the power supply voltage
- DC voltage gain 100 V/mV (typ.)
- Internal frequency compensation

APPLICATIONS

- Transducer amplifiers
- Dc gain blocks
- Conventional op-amp circuits in single power supply systems

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Ratings
Supply voltage	V_{CC}	45V
Input voltage	V_{IN}	-0.3V to +45V
Input current	I_{IN}	50mA at V_{IN} = -0.3V
Maximum output current	I_{OUT}	100mA
Maximum Operating Junction Temperature	T_J	-40°C to 125°C
Storage Temperature Range	T_{STG}	-65°C to 150°C
Lead Temperature (soldering, 10 seconds)	-	260°C
ESD protection (HBM)	-	700V

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Ratings
Input Voltage	V_{IN}	40V
Junction Temperature	T_J	-40°C to +85°C

ELECTRICAL CHARACTERISTICS

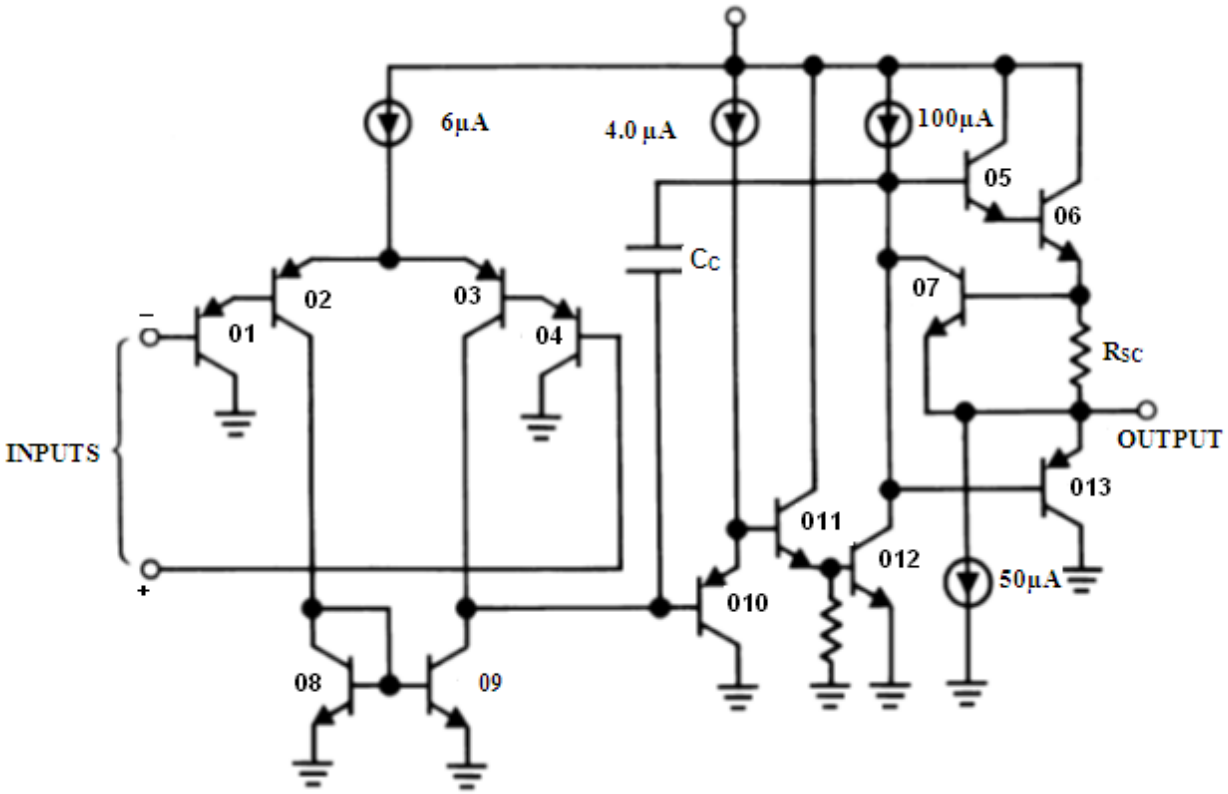
(At specified free-air temperature, V_{CC} = 5V, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input Offset Voltage	V_{IO}	V_{CC} = 5V to MAX, $V_{IC} = V_{ICR(min)}$, V_O =1.4V	25°C		3	7	mV
			Full range			9	
Average Temperature Coefficient of Input Offset Voltage	αV_{IO}		Full range		7		μV/°C
Input Offset Current	I_{IO}	V_O = 1.4V	25°C		2	50	nA
			Full range			150	
Average Temperature Coefficient of Input Offset Current	αI_{IO}		Full range		10		pA/°C
Input Bias Current	I_{IB}	V_O = 1.4V	25°C		-20	-250	nA
			Full range			-500	
Common-mode Input Voltage Range	V_{ICR}	V_{CC} = 5V to MAX	25°C	0 to Vcc-1.5			V
			Full range	0 to Vcc-2.0			
High-level Output Voltage	V_{OH}	V_{CC} = MAX, R_L = 2kΩ	Full range	26			V
		V_{CC} = MAX, $R_L \geq$ 10kΩ	Full range	27	28		
Low-level Output Voltage	V_{OL}	$R_L \geq$ 10kΩ	Full range		5	20	mV
Large-signal Differential Voltage Amplification	A_{VD}	V_{CC} = 15V, V_{OUT} = 1V to 11V, $R_L \geq$ 2kΩ	25°C	25	100		V/mV
			Full range	15			
Common-mode Rejection Ratio	CMRR	V_{CC} = 5V to MAX, $V_{IC} = V_{ICR(min)}$	25°C	65	80		dB
Supply Voltage Rejection Ratio ($\Delta Vcc/\Delta V_{IO}$)	k_{SVR}	V_{CC} = 5V to MAX	25°C	65	100		dB
Crosstalk Attenuation	V_O1/V_O2	f =1 kHz to 20 kHz	25°C		120		dB
Output Current	I_{OUT}	V_{CC} = 15V, V_{ID} = 1V, V_O = 0	25°C	-30	-50		mA
			Full range	-20			
		V_{CC} = 15V, V_{ID} = -1V, V_O = 15V	25°C	15	35		
			Full range	7			
		V_{CC} = 15V, V_{ID} = -1V, V_O = 2V	25°C	15	28		mA
		V_{ID} = - 1V, V_O = 200mV	25°C	12	50		μA
Short-circuit Output Current	I_{OS}	V_{ID} = - 1V, V_O = 15V	25°C		50	70	mA

Supply Current (two amplifiers)	I_{CC}	V_O = 2.5V, No load	Full range		0.7	1.2	mA
		V_{CC} = MAX, V_O = 0.5V_{CC}, No load	Full range		1	2	
Slew Rate	SR	V_{CC} = 15V, V_{IN} = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, unity gain	25°C		0.7		V/μs
Gain Bandwidth	GBW	V_{CC} = 30V, f = 100kHz, V_{IN} = 10mV, R_L = 2kΩ, C_L = 100pF	25°C		700		kHz
Total Harmonic Distortion	THD	f = 1kHz, A_V = 20dB, R_L = 2kΩ, V_O = 2Vpp, C_L = 100pF,	25°C		0.04		%

*All characteristics are measured under the open-loop conditions with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 36V, $V_{cc(max)}$ = 45V. Full range is -40°C to +125°C.

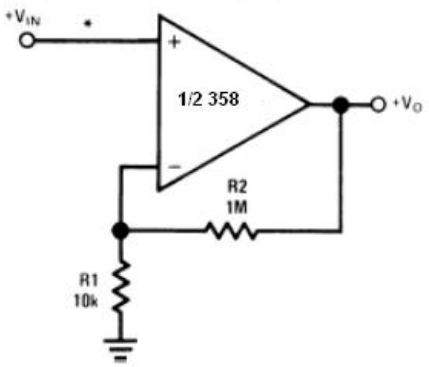
BLOCK DIAGRAM

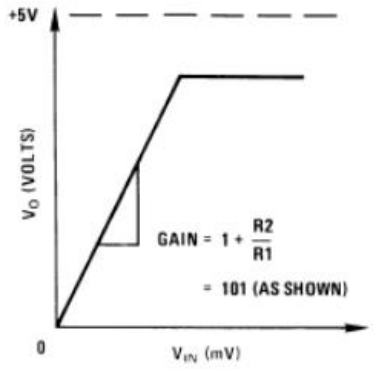


Typical Single-Supply Applications

(V^+ = 5.0 V_{DC})

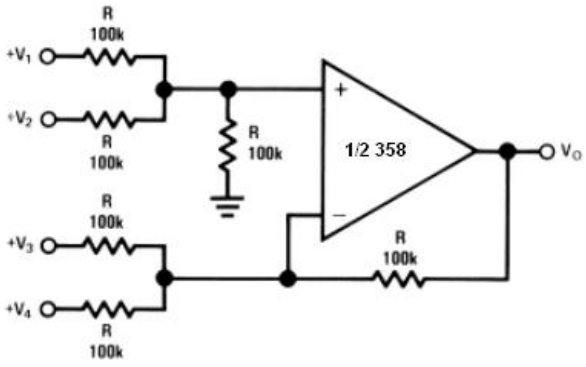
Non-Inverting DC Gain (0V Output)





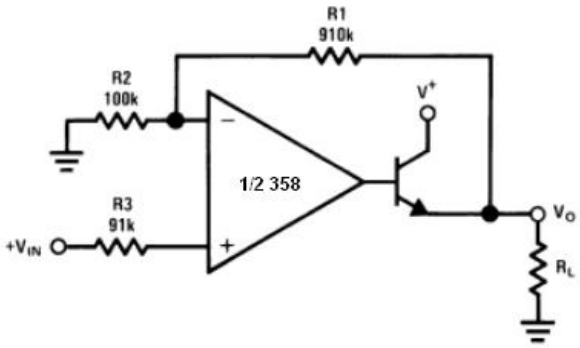
*R not needed due to temperature independent I_{IN}

DC Summing Amplifier
(V_{IN}'S ≥ 0 V_{DC} and V_O ≥ 0 V_{DC})



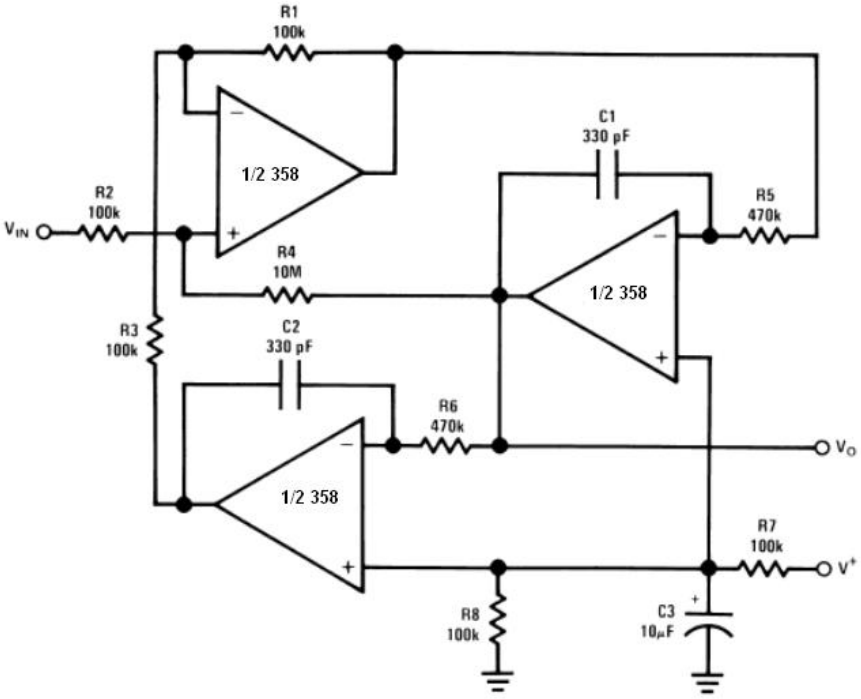
Where: $V_O = V_1 + V_2 - V_3 - V_4$
$(V_1 + V_2) \geq (V_3 + V_4)$ to keep $V_O > 0$ V_{DC}

Power Amplifier



V_O = 0 V_{DC} for V_{IN} = 0 V_{DC}
A_V = 10

“BI-QUAD” RC Active Bandpass Filter

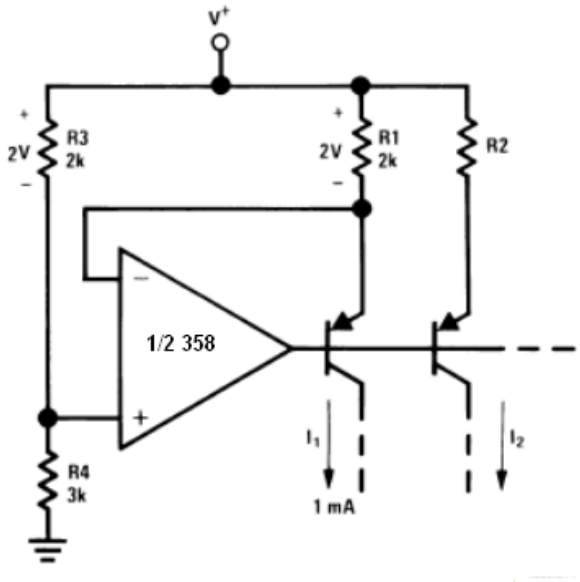


f_{O} = 1 kHz

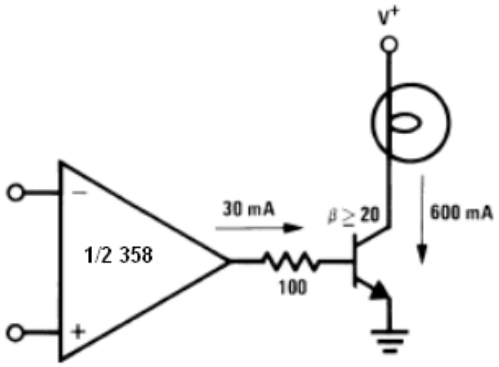
Q =50

Av =100 (40 dB)

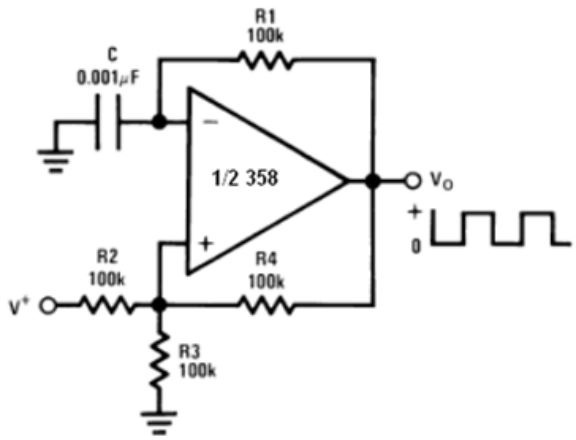
Fixed Current Sources



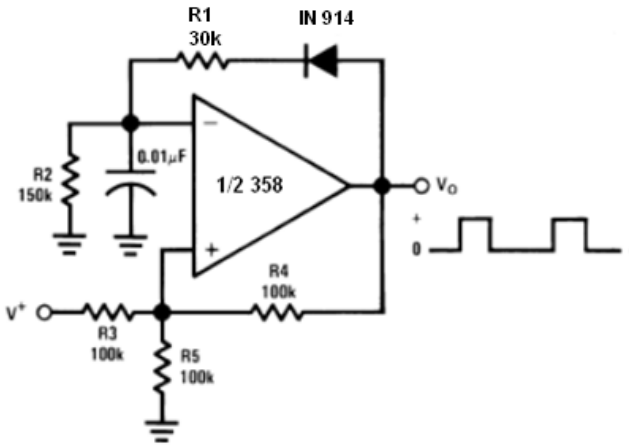
Lamp Driver



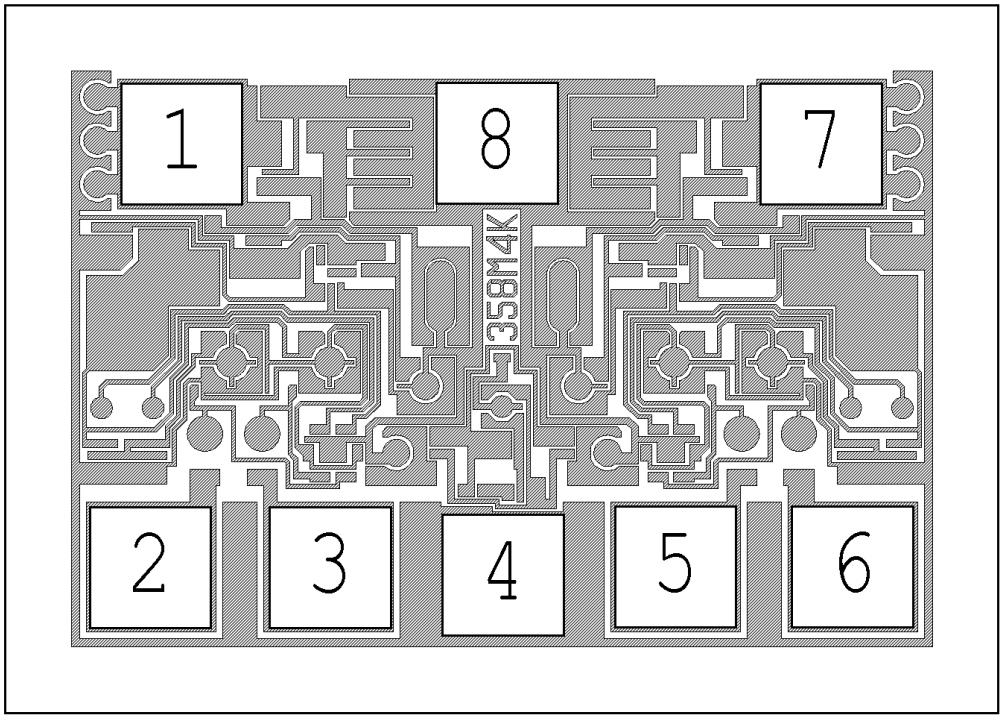
Squarewave Oscillator



Pulse Generator



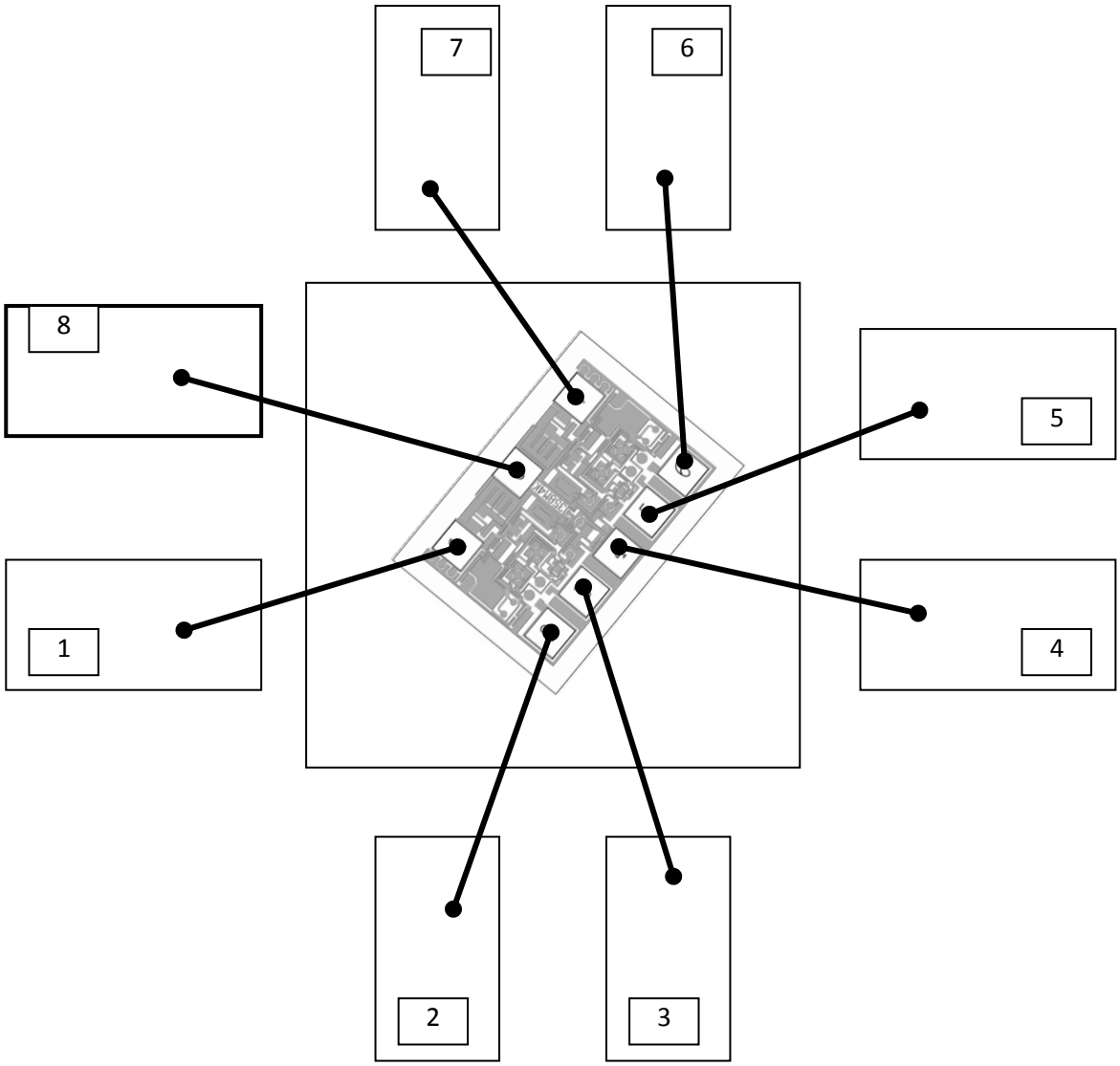
PAD LOCATION AND COORDINATES



Die size (including scribe line): 0.73mm×0.52mm

# Pad	Pin Name (Package)	Pad centers coordinates (μm)		Pad Size (μm×μm)
		X	Y	
1	# 1 OUT	130	417	90×90
2	#1 IN-	107	107	90×90
3	#1 IN+	237	107	90×90
4	GND	364	100	90×90
5	#2 IN+	492	107	90×90
6	#2 IN-	622	107	90×90
7	#2 OUT	599	417	90×90
8	VCC	364	417	90×90

BONDING DIAGRAM



ASSEMBLY CHARACTERISTICS

No.	Assembly Characteristics	Value
1	Wafer Size	6 Inch
2	Wafer Thickness before Grinding	675 +/-20 µm
3	Scribe Street Width	80 µm
4	Chip Size (including Scribe Line)	0.73×0.52 mm^2
5	Die Attach Material	Substrate is connected to Gnd
6	Quantity of Bond Pad Metal Layers	1
7	Pad Thickness	1.6 µm
8	Composition of Metal Layers	Al+Si(1.0%)+Ti(0.5%)
9	Min. Bond Pad Opening Size	90 ×90 µm
10	Min. Bond Pad Pitch	130 µm
11	Min. Wire Diameters	1 mil (25 .4µm)
12	Circuit Under Pad Design (CUP)	No

ADDITIONAL INFORMATION

Pb-free products:

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.

Green products:

- Lead-free (RoHS compliant)
- Halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

The appearance complies with the requirements of the company standards