## Resistor Tunable Filter


# SR-4BL/4FL SR-4BH/4FH SR-2BLH SR-1BP/2BP SR-2BE

SR series filters are small resistor tunable filters in single-inline package (SIP).
An easy setting of cutoff (center) frequency is assured with the external resistors.
The abundance of filter types extends the range of choice

| | |
|---|---|
| SR-4BL1/2/3 | 4-pole Butterworth low pass |
| SR-4FL1/2/3 | 4-pole Ellipic low pass |
| SR-4BH1/2 | 4-pole Butterworth high pass |
| SR-4FH1/2 | 4-pole Elliptic high pass |
| SR-2BLH1/2/3 | 2-pole Butterworth low/high pass |
| SR-1BP1/2 | 1-pole pair band pass |
| SR-2BP1/2 | 2-pole pair band pass |
| SR-2BE1/2 | 2-pole pair band elimination |



| Model | SR-4BL | SR-4FL | SR-4BH | SR-4FH | SR-2BLH | SR-1BP | SR-2BP | SR-2BE |
|---|---|---|---|---|---|---|---|---|
| Filter characteristics | Butterworth Low pass | Elliptic Low pass | Butterworth High pass | Elliptic High pass | Butterworth Low/high pass | Butterworth Band pass | Butterworth Band pass | Butterworth Band elimination |
| Order | 4-pole | | | | 2-pole | 1-pole pair | 2-pole pair | 2-pole pair |

### ▼Absolute maximum ratings

| | |
|---|---|
| Supply voltage (±Vs) | ±18 V |
| Input voltage | ±Vs |

### ▼Cut-off ($f_c$, -3 dB) / center ($f_0$) frequency characteristics

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Range | Type 1 | 40 Hz to 1.6 kHz *1 | | | | | | |
| | Type 2 | 400 Hz to 20 kHz *1 | | 400 Hz to 5 kHz*1 | | 400 Hz to 20 kHz*1 | 400 Hz to 10 kHz *1 | |
| | Type 3 | 5 kHz to 100 kHz *1 | | — | | 5 kHz to 100 kHz *1 | — | |
| Accuracy *2 | | Max. ±3% | | | | | | |
| Setting method | | Connected with external resistors (4 pcs.) | | | | Connected with external resistors (2 pcs.) | Connected with external resistors (4 pcs.) | |

### ▼Pass-band characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Gain *3 | 0 ±0.3 dB | | 0 ±1 dB | | 0 ±0.3 dB | 0 ±1 dB | 0 ±0.3 dB |
| Ripple | — | 0.28 dB p-p (typ.) | — | 0.28 dB p-p (typ.) | | — | |
| Upper limit freq. (small signal) *2 | — | | 50 kHz (±1 dB) | | 100 kHz (±1 dB, HPF)*2 | — | 50 kHz (±1 dB) |

### ▼Attenuation characteristics

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Rolloff | 24 dB/oct | 42 dB/oct equiv. | 24 dB/oct | 42 dB/oct equiv. | 12 dB/oct | — | | |
| Q | — | | | | | 5*4 | | |
| Characteristics (1/2 fc or 2fc) | 24 dB (typ.) | 55 dB (typ.) | 24 dB (typ.) | 55 dB (typ.) | 12 dB (typ.) | 17.5 dB (typ.) | 35 dB (typ.) | — |
| Minimum attenuation | — | 46 dB (typ.) | — | 46 dB (typ.) | | — | | |
| High freq. attenuation (up to 1 MHz) | Min. 70 dB | | — | | Min. 70 dB (LPF) | Min. 70 dB | | — |
| Maximum attenuation ($f_0$) | — | | | | | | | 60 dB (typ.) |

### ▼Input characteristics

| | | |
|---|---|---|
| Input impedance | | Min. 50 kΩ |
| Max. input Voltage (linear) | ≤ 10 kHz | ±10 V |
| | ≤ 50 kHz | ±5 V, ±10 V for 4BL3/4FL3/2BLH3 (≤100 kHz) |

### ▼Output characteristics

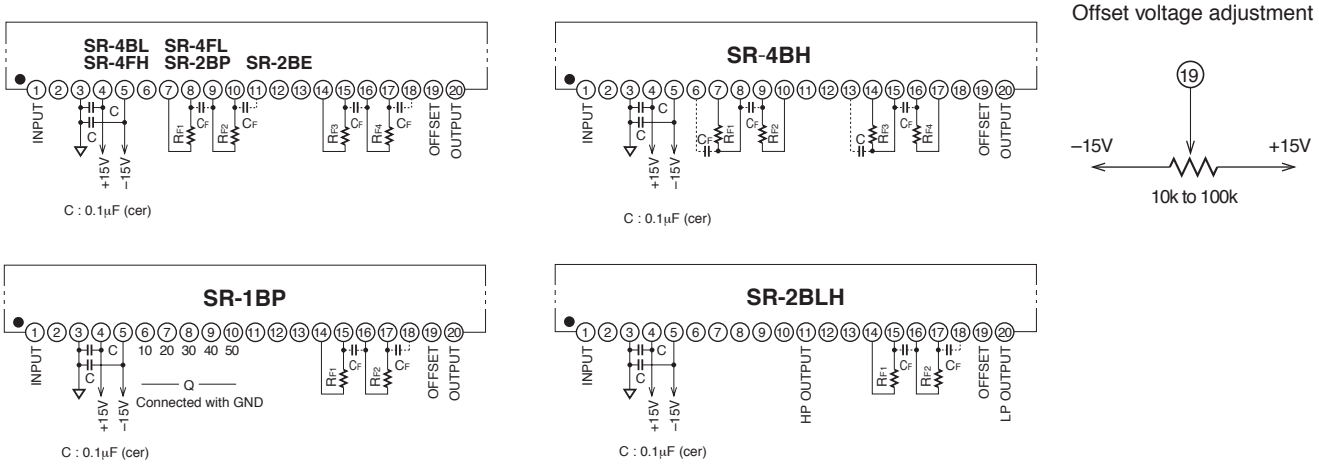
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Output impedance | | Max.100 Ω | | | | | | |
| Maximum output voltage | | ±10 V (Max. 100 kHz for 4BL3/4FL3/2BLH3, Max. 10 kHz for other filters) | | | | | | |
| Load resistance | | Min. 10 kΩ | | | | | | |
| Noise | | Max.140 μVrms (10Hz to 500 kHz) | | | | | | |
| DC offset | Voltage | Max. ±30 mV | | | | | | |
| | Adjustment | Enabled | | | | | | |
| | Drift | 30 μV/°C (typ.) | | 15 μV/°C (typ.) | | | | 30 μV/°C (typ.) |
| Distortion (typ.) *3 | | 0.01% | | 0.1% | | 0.01% (LPF) | 0.01% | |
| Slew rate (typ.) | | — | | 2 V/μs *6 | | | — | 2 V/μs |

### ▼Others

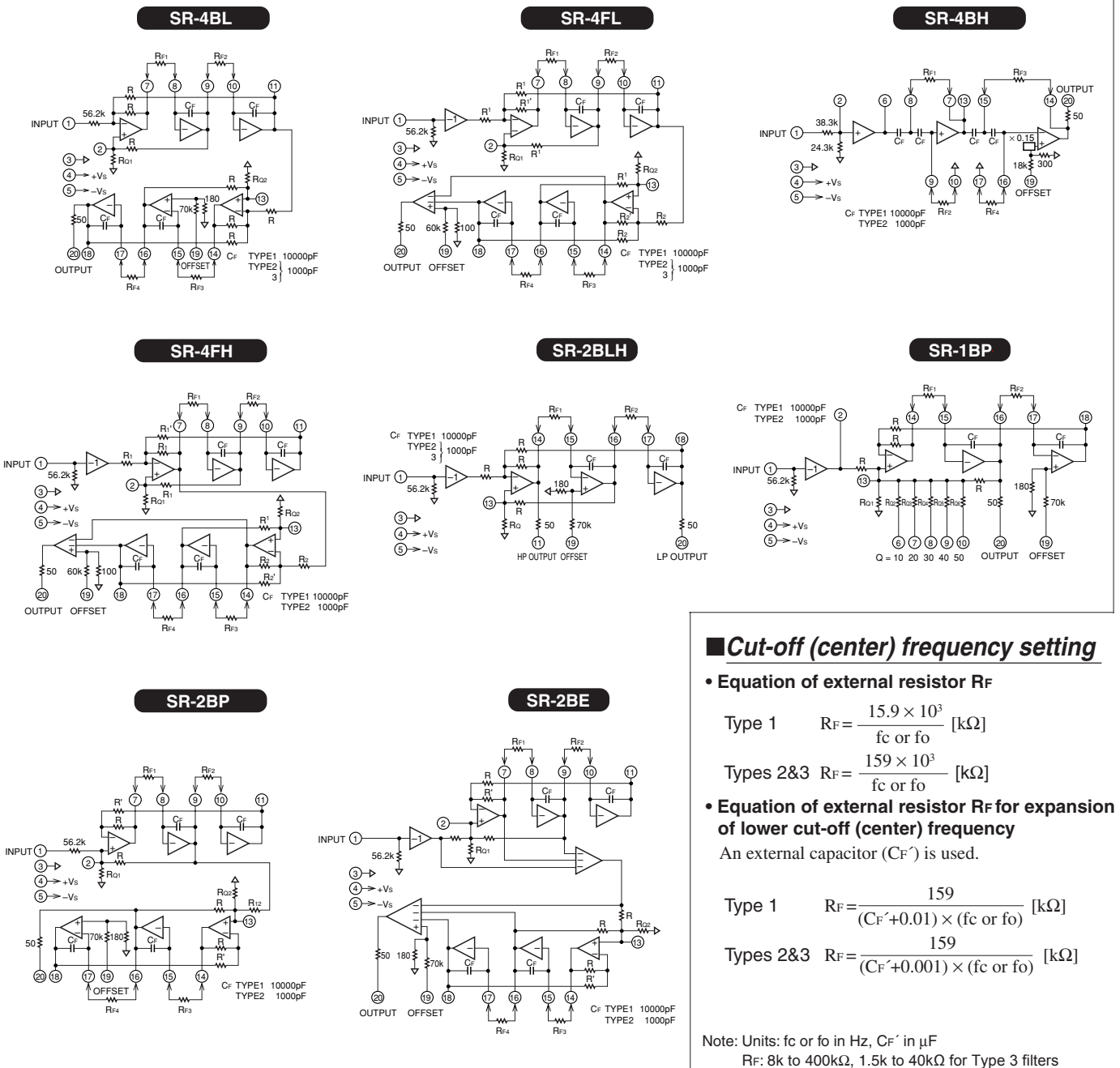
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Supply voltage | | ±15 V (±5 V to ±18 V) | | | | | | |
| Quiescent current (typ.) | | ±12 mA (Type 1 & 2) ±27 mA (Type 3) | ±16 mA (Type 1 & 2) ±36 mA (Type 3) | ±8 mA | ±16 mA | ±8 mA (Type 1 & 2) ±18 mA (Type 3) | ±8 mA | ±12 mA | ±20 mA |
| Temperature/ humidity range | Operation | -20°C to 70°C, 10% to 95% RH | | | | | | |
| | Storage | -30°C to 80°C, 10% to 80% RH | | | | | | |
| Dimensions | | 51.5×14 mm S20 type, 5.5 mm in thickness for Type 3 and 2BE filters, 4 mm in thickness for other filters | | | | | | |

Note: The specifications are applied unless otherwise specified : Rf=31.8 kΩ, 23°C±5°C, ±15 V.
*1 As to SR series, expansion of the lower cut-off (center) frequency with the external capacitors (2 or 4 pcs.) is enabled. *2 Gain in frequency (*3 ): 0 dB *3 4FL, 4BL: fc/10, 4FH: 10fc (fc≤3 kHz), 3.3fc (fc>3 kHz), 4BH: 3.3fc, 2BLH: LPF fc/10, HPF 10fc (Type 1&2), 3.3fc (Type 3) *4 As to 1BP filter, Q=10, 20, 30, 40, 50 is available if a designated pin is connected with GND. Range: 1.81≤Q≤50 if connected with the external resistors *5 Type 3: 1 MHz+0, Max.-3 dB (HPF) *6 SR-2BLH3 only: 10V/μs

## Basic connection diagram




## Block diagram




## ■*Cut-off (center) frequency setting*

- **Equation of external resistor $R_F$**

Type 1 $$R_F = \frac{15.9 \times 10^3}{fc \text{ or } fo} \ [k\Omega]$$

Types 2&3 $$R_F = \frac{159 \times 10^3}{fc \text{ or } fo} \ [k\Omega]$$

- **Equation of external resistor $R_F$ for expansion of lower cut-off (center) frequency**

An external capacitor ($C_F'$) is used.

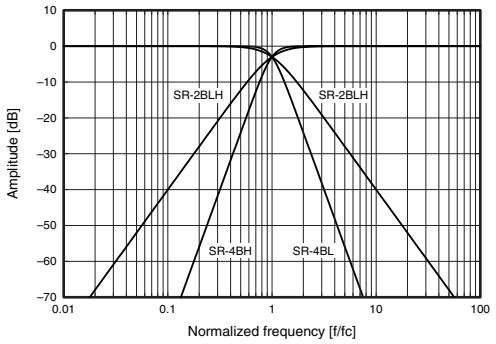
Type 1 $$R_F = \frac{159}{(C_F' + 0.01) \times (fc \text{ or } fo)} \ [k\Omega]$$

Types 2&3 $$R_F = \frac{159}{(C_F' + 0.001) \times (fc \text{ or } fo)} \ [k\Omega]$$

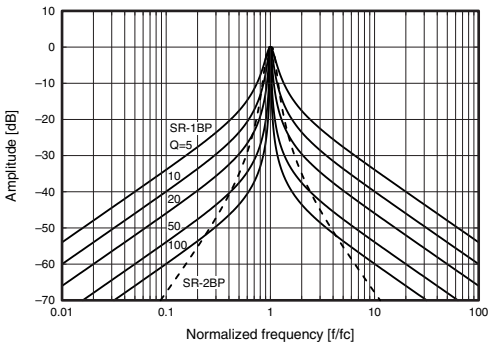
Note: Units: fc or fo in Hz, $C_F'$ in μF
$R_F$: 8k to 400kΩ, 1.5k to 40kΩ for Type 3 filters
Be sure to use a resistor and capacitor with tolerance of 1%.

## Characteristics

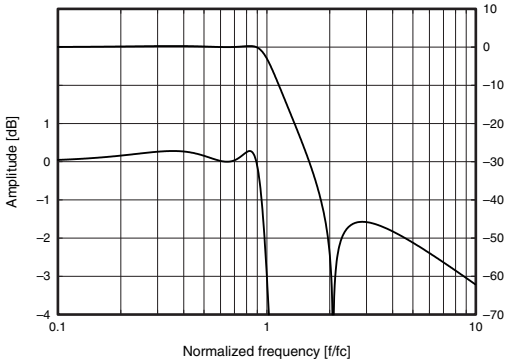
4BL/4BH/2BLH



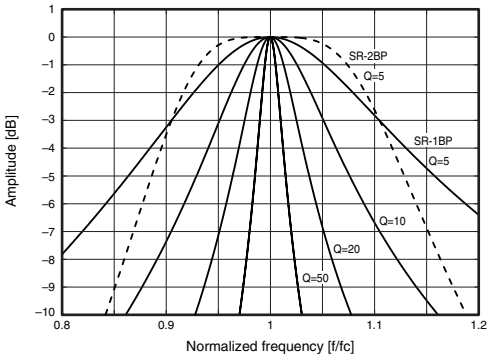

1BP/2BP



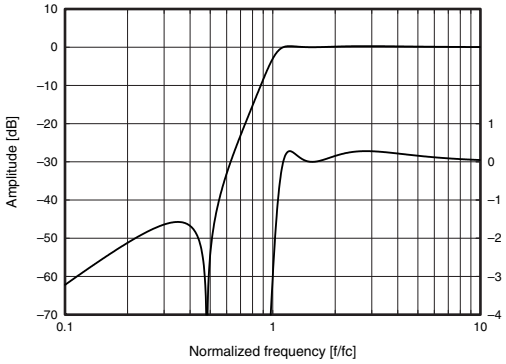

4FL



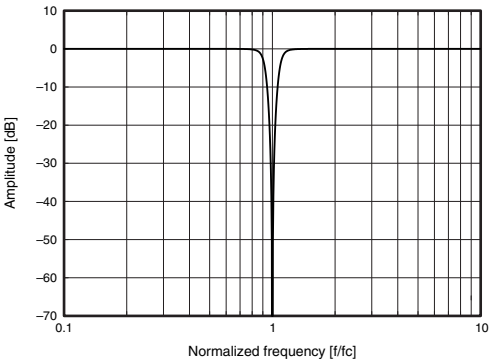

1BP/2BP(Magnified view)




4FH

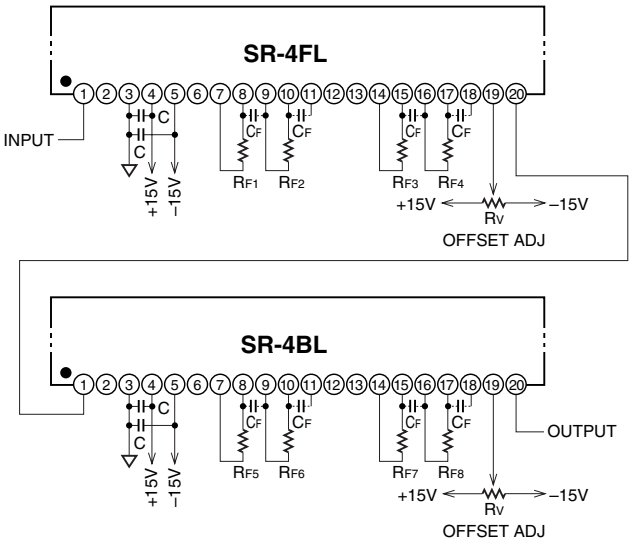



2BE



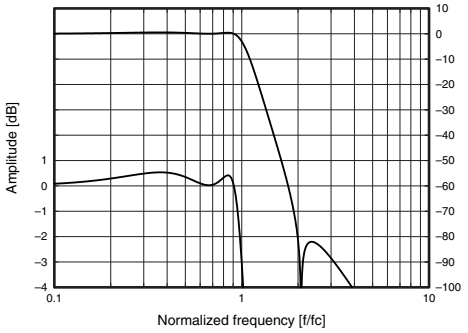
## Application

### 8-pole low pass/ elliptic

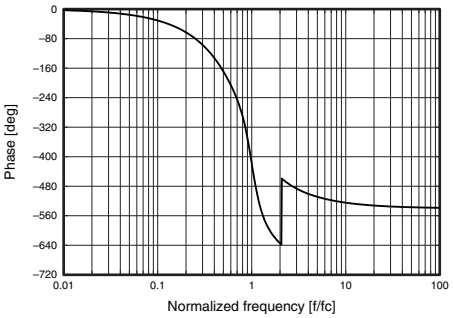



RV : 10 to 50kΩ
C : 0.1μF (cer)

Amplitude characteristics




Phase characteristics




**• Cut-off frequency setting (ripple: 0.53dB)**

External resistor ($R_{F1}$ to $R_{F8}$) is derived from the following equation.

$$R_{F1} = R_{F2} = R_{F3} = R_{F4} = R_F$$
$$R_{F5} = 1.801R_F \quad R_{F6} = 1.221R_F$$
$$R_{F7} = 1.797R_F \quad R_{F8} = 0.4788R_F$$

Type 1 $R_F = \dfrac{15.9 \times 10^3}{fc}$ (kΩ)

Type 2 $R_F = \dfrac{159 \times 10^3}{fc}$ (kΩ)

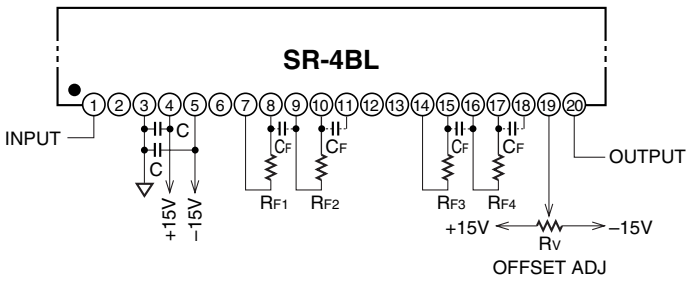
**• Equation of external resistor for expansion of lower cut-off frequency**

Type 1 $R_F = \dfrac{159}{(C_F+0.01) \times fc}$ (kΩ)

Type 2 $R_F = \dfrac{159}{(C_F+0.001) \times fc}$ (kΩ)

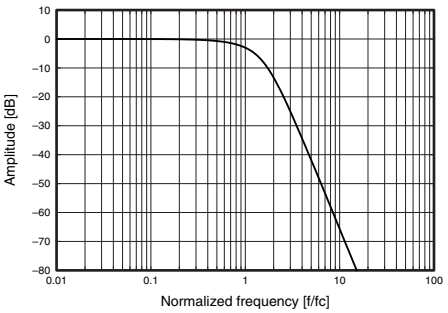
Note: Units: fc in Hz, $C_F$ in μF

### 4-pole low pass/ Bessel

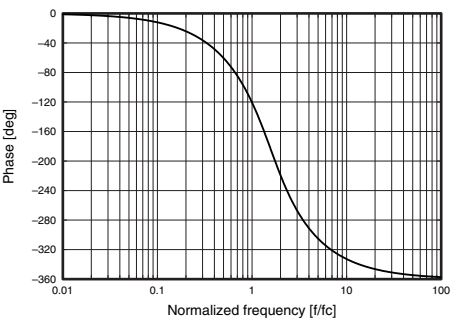



RV : 10 to 50kΩ
C : 0.1μF (cer)

Amplitude characteristics




Phase characteristics




**• Cut-off frequency setting**

External resistor ($R_{F1}$ to $R_{F4}$) is derived from the following equation.

$$R_{F1} = 0.673 \times R_F \quad R_{F2} = 0.712 \times R_F$$
$$R_{F3} = 0.384 \times R_F \quad R_{F4} = 1.014 \times R_F$$

Type 1 $R_F = \dfrac{15.9 \times 10^3}{fc}$ (kΩ)

Types 2&3 $R_F = \dfrac{159 \times 10^3}{fc}$ (kΩ)

**• Equation of external resistor for expansion of lower cut-off frequency**

Type 1 $R_F = \dfrac{159}{(C_F + 0.01) \times fc}$ (kΩ)

Types 2&3 $R_F = \dfrac{159}{(C_F + 0.001) \times fc}$ (kΩ)

Note : Units: fc in Hz, CF in μF