

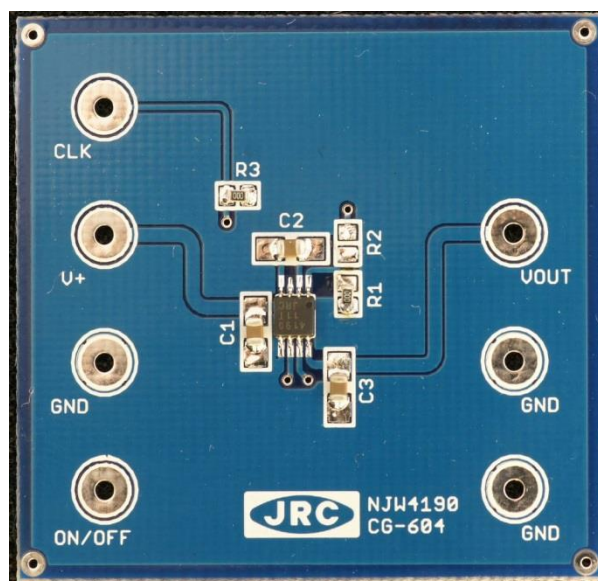
## ■Board Information

Board Name: NJW4190 CG-604  
 Function: Doubler type output of Charge Pump

## ■Application Spec

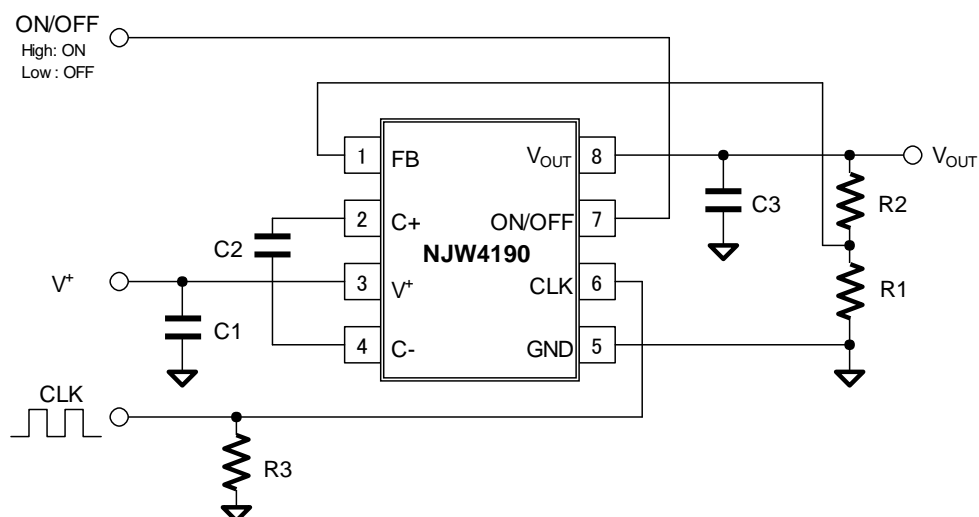
IC: NJW4190  
 Input voltage: +5V to +17V  
 Output voltage: +10V to +34V  
 Output current ability: 55mA  
 ON/OFF Terminal Voltage: -0.3V to +6.0V  
 Recommended Capacitor: 1 $\mu$ F or large  
 Setting Output Voltage:  $V_{out} = (1+R2/R1)*1.24$        $R1+R2 \leq 2M\Omega$   
 In case of FB Terminal unused:  $R1=0\Omega$ ,  $R2=open$   
 CLK Terminal Voltage: -0.3V to +6.0V  
 External Clock: 300kHz to 2MHz  
 External Clock Duty: 45% to 80%  
 In case of CLK Terminal unused:  $R3=0\Omega$

## ■Board Image

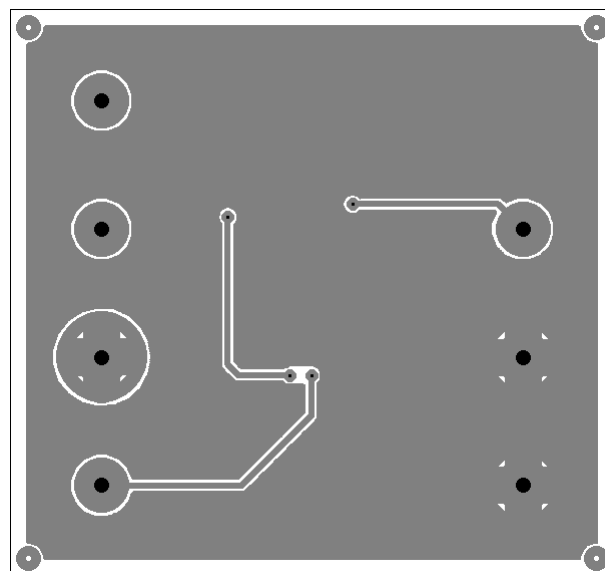
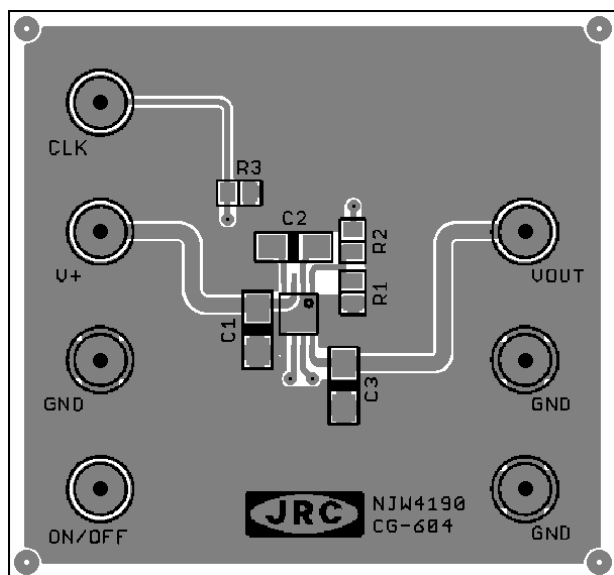


# NJW4190 Application Board

## ■Application Circuit



## ■PCB Layout

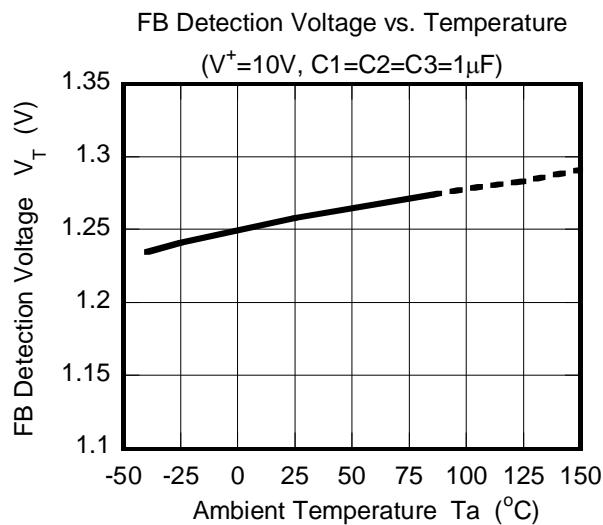
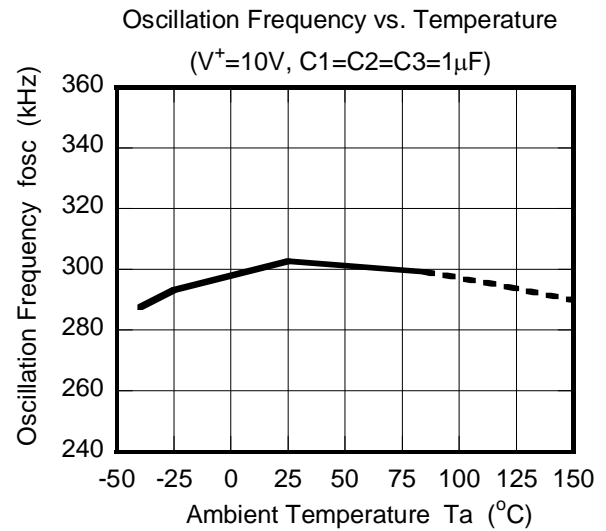
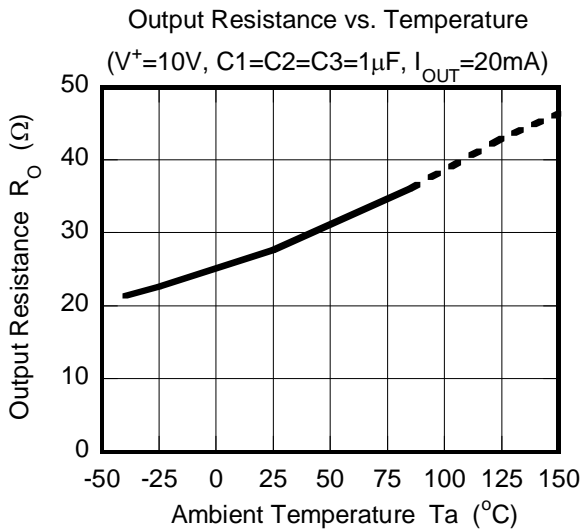
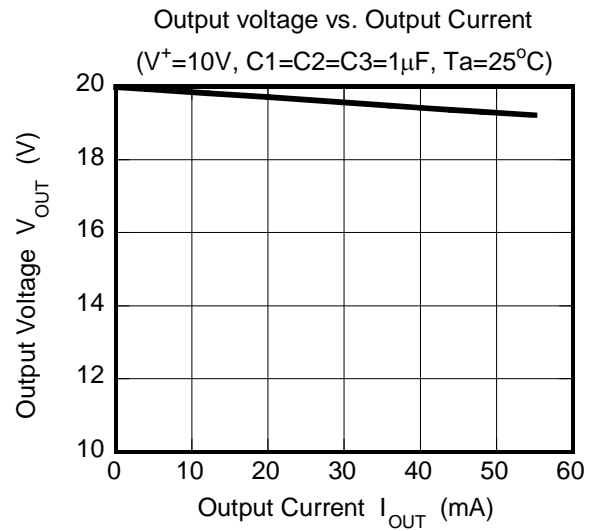
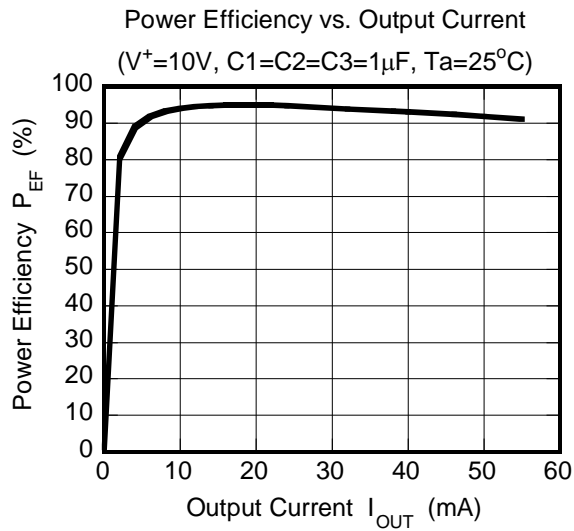


## ■BOM

Reference	Qty.	Part Number	Description	Manufacturer
IC	1	NJW4190	Doubler Charge Pump IC	New JRC
R1	1	0Ω	Short bar	Std.
R2	1	Depend on output voltage		Std.
R3	1	0Ω	Short bar	Std.
C1	1	GRM21BB31H105K	1μF/50V	Murata
C2	1	GRM21BB31H105K	1μF/50V	Murata
C3	1	GRM21BB31H105K	1μF/50V	Murata

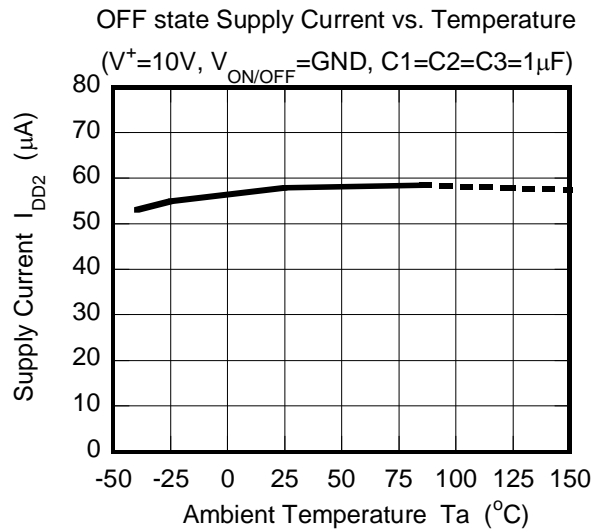
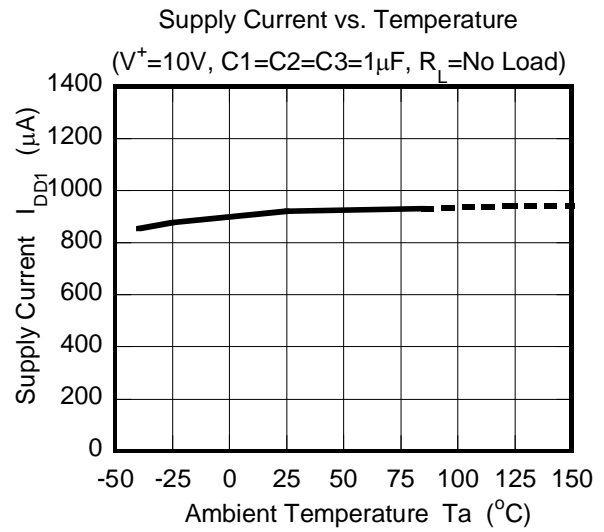
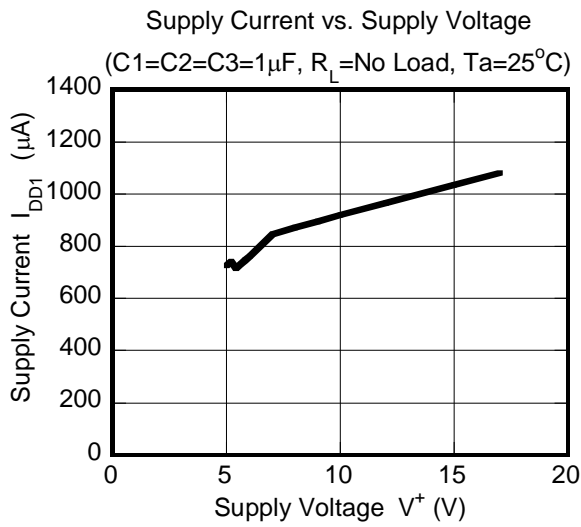
# NJW4190 Application Board

## ■ Application Characteristics



# NJW4190 Application Board

## ■ Application Characteristics



## ■ Application Information

### ● Capacitor Selection

The capacitor select is very important for NJW4190's characteristics, stable operation, ripple voltage and noise basically. To reduce a ripple voltage and/or noise, it required low ESR capacitor for input capacitor (C1) and output capacitor (C3) and recommended capacitor value is 1 $\mu$ F or large value for both.

The ripple voltage (peak-to-peak voltage) can calculate as below formula with output capacitor (C3), oscillation frequency ( $f_{OSC}$ ) and output current ( $I_{OUT}$ ). Although large output-capacitor reduces the ripple voltage, the inrush current becomes higher value. The relation is trade-off between ripple voltage and inrush current.

$$V_{RIP-p-p} \cong \frac{I_{OUT}}{2 \times f_{OSC} \times C3}$$

The transient change (dv/dt) becomes small at charging/discharging period by large electrolytic capacitor for the output capacitor (C3) and reduces output ripple voltage. The spike noise of high frequency domain reduces by ceramic capacitor (C3) with superior characteristics of high frequency. It is better solution to connect both ceramic and electrolytic capacitor according to applications. Moreover, it is effective to use a low pass filter like RC filter.

In addition, the ripple voltage reduces by higher external clock.

The charge pump strength depends on the flying capacitor (C2) value. It required a nonpolar type for flying capacitor (C2) to avoid invert output at startup period. The recommend flying capacitor (C2) is the low ESR type (MLCC), 1 $\mu$ F or larger for stable output current.

The theoretical formula of the minimum output resistance is given by the following:

$$R_{OL} = \frac{2V_{IN} - V_{OUT}}{I_{OUT}} \cong \frac{1}{f_{OSC} \times C2}$$

The output resistance  $R_{OL}$  is 30 $\Omega$  (typ.) and actual output resistance is shown as follows:

$$R_O = R_{ON(SW)} + R_{OL}$$

### ● Rush Current

The NJW4190 has some rush current at startup/release to the shutdown mode. The spike current becomes large from power supply, if the voltage difference is large between  $V^+$  and  $V_{OUT}$ . The output current limits by its effective output impedance of charge pump. It recommends verify the stable power supply at startup or release to the shutdown mode.

# NJW4190 Application Board

## ■ Application Information (Continued)

### ● Output Voltage

It has programmable output voltage function, and output voltage can adjust by feedback resistor both R1 and R2 under the condition:

$$V^+ < V_{OUT}$$

The operation flow is below and repeats from 1 to 3:

1. The charge pump operation works until setting voltage.
2. The charge pump operation stops exceed setting voltage.
3. The charge pump operation restarts under setting value.

The total resistance (R1+R2) should be less than 2MΩ to avoid malfunction by exogenous noise. The output voltage with selected R2 shows below:

$$V_{OUT} = (1 + R2/R1) \times 1.24 [V]$$

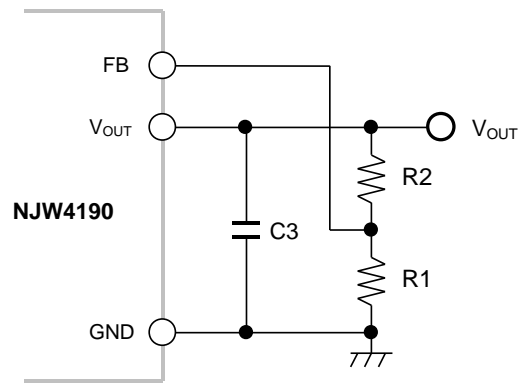
The FB pin connects to GND, when enable the programmable output voltage function.

The discharge period of output capacitor varies by a load condition at charge pump operation, and the ripple voltage varies by intermittent operation. When input voltage is higher, the ripple voltage becomes large due to an electric charge of the output capacitor increases. The ripple voltage increases with large flying capacitor (C2).

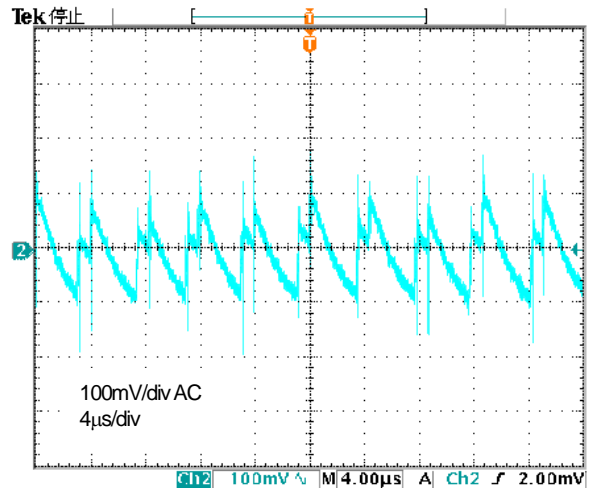
The large output capacitor (C3) reduces the ripple voltage of intermittent operation by small transient change (dv/dt), and the low frequency ripple decrease. The small flying capacitor (C2) reduces the low frequency ripple with light load and/or high input voltage applications. The reason is charge amount of output capacitor (C3) per clock becomes lower. However, small flying capacitor (C2) becomes lower efficiency and lower maximum-output-current.

### ● External Clock Synchronization Function

It has external clock synchronization function, and set the following conditions: external clock; 45% to 80%, and 300kHz to 2MHz (for A ver.) The CLK pin connects to GND when disable the external clock synchronization function.



Configuration of output circuit



$$(V^+ = 12V, V_{OUT} \approx 20V, I_{OUT} = 30mA)$$

$$R1 = 15k\Omega, R2 = 240k\Omega, C1 = C2 = C3 = 1\mu F$$

Output Ripple Voltage Characteristic example

# NJW4190 Application Board

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## ■ Application Information (Continued)

### ● Application Tip

The maximum output current is 55mA. It required current limit circuit and other solution if the output current over the rated current.

### ● Layout Tips

It is very important adequate PCB layout to reduce a switching noise and/or a ripple voltage. The all capacitors connect as much as possible near NJW4190, and the feedback resistor arrange as much as possible near FB pin because of the sensitive exogenous noise.

## ■ Regarding replacement to an inverting application from NJU7660/62

The NJW4190 is upper product of competitor's 7660/7662 series and against NJU7660/62. The condition of each pin show the below table:

	NJU7660/62		NJW4190
1pin:	NC pin	→	FB pin connect to GND line.
6pin:	VR pin	→	CLK pin connect to GND line.
7pin:	OSC pin	→	ON/OFF pin connect to 5V power line.

The advanced point of NJW4190 does not require the startup circuit, and NJU7660 requires a resistor and a diode for start-up circuit.

# NJW4190 Application Board

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