

# BI-CMOSIC For Brushless Motor Drive PWM Driver IC

## **Overview**

The LV8829LFQA is a PWM-type driver IC designed for 3-phase brushless motors. The rotational speed can be controlled by inputting the PWM pulse from the outside, and changing Duty. The IC incorporates a latch-type constraint protection circuit.

## Features

- IO max = 1.5A (built-in output Tr)
- Speed control and synchronous rectification using direct PWM input (supports 3.3V inputs)
- 1-Hall FG output
- Latch type constraint protection circuit (the latch is released by S/S and F/R.)
- Forward/reverse switching circuit, Hall bias pin
- Power save circuit (Power save in stop mode)
- Current limiter circuit, Low-voltage protection circuit, Overheat protection circuit
- Charge pump circuit, 5V regulator output.
- Start/stop circuit (short brake when motor is to be stopped)

## Specifications

#### Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V <sub>CC</sub> max	V <sub>CC</sub> pin	36	V
	V <sub>G</sub> max	V <sub>G</sub> pin	42	V
Output current	I <sub>O</sub> max	t ≤ 500ms *1	1.5	Α
Allowable power dissipation	Pd max	Mounted on a circuit board.*2	1.35	W
Junction temperature	Tj max		150	°C
Operating temperature	Topr		-40 to +80	°C
Storage temperature	Tstg		-55 to +150	°C

\*1 : Tj cannot exceed Tj max = 150°C

\*2 : Specified circuit board : 40mm  $\times$  50mm  $\times$  0.8mm, glass epoxy (four-layer board)

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.

Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

## Allowable Operating range at $Ta = 25^{\circ}C$

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range	V <sub>CC</sub>		8.0 to 35	V
5V constant voltage output current	IREG		0 to -10	mA
HB pin output current	I <sub>HB</sub>		0 to -200	μA
FG pin applied voltage	V <sub>FG</sub>		0 to 6	V
FG pin output current	IFG		0 to 10	mA

## **Electrical Characteristics** at Ta = $25^{\circ}$ C, V<sub>CC</sub> = 24V

Part alteries         SynOD         Colliability         min         typ         max         Outing           Supply current 2         LoC2         At stop         0.7         0.8         mA           Output block         0.7         0.67	Decemeter	Cumbol	Conditions		Ratings		Lloit
Supply current 1         IgC 1         main 1           Supply current 2         IgC 2         At stop         0.7         0.0         mA           Supply current 2         IgC 2         At stop         0.7         0.0         mA           Cubrupt block         1         0.47         0.65         0<	Parameter	Symbol	Conditions	min	typ	max	Unit
Supply current 2         I <sub>CC</sub> 2         At stop         0.7         0.8         mA           Output block         U           Low-side output ON resistance         R <sub>ON</sub> (11) $0 = 1.0A$ 0.47         0.65 $\Omega$ High-side output ON resistance         R <sub>ON</sub> (H1) $0 = -1.0A$ 0.0         0.67         0.93 $\Omega$ Low-side diade output feak current         I <sub>L</sub> (H)         -         0.67         0.93 $\Omega$ Use-side diade forward voltage         V <sub>D</sub> (11)         I <sub>D</sub> = -1.0A         1.0         1.2         V           Output voltage         VREG $0 = -5mA$ 4.8         5.1         5.4         V           Output voltage         VREG $0 = -5mA$ 4.8         5.1         5.4         V           Low regulation         AV (REG1) $V_{CC} = 8 to 35V, 1_D = -5mA$ 4.8         5.1         5.4         V           Load regulation         AV (REG1) $V_{CC} = 8 to 35V, 1_D = -5mA$ 4.8         5.1         7.4           Common-mode input voltage range 1         VICM1         When using Hall elements         0.3         V REG-1.7         V           Common-mode input voltage range 2         VICM2	Supply current 1	I <sub>CC</sub> 1			3.3	4.0	mA
Output block         Low-side output CN resistance         R <sub>O</sub> (11)         I <sub>0</sub> = 1.0A         I.0         I.0.47         0.63         Ω           Low-side output CN resistance         R <sub>O</sub> (H1)         I <sub>0</sub> = 1.0A         I.0.67         0.33         Ω           Low-side output leak current         I <sub>L</sub> (H)         I <sub>0</sub> = 1.0A         II.0         VI.0         VI.0         II.0         II.0         II.0         II.0         VI.0         VI.	Supply current 2	I <sub>CC</sub> 2	At stop		0.7	0.8	mA
Low-side output CN resistance         R <sub>QN</sub> (L1)         l <sub>Q</sub> = 1.0A         0.47         0.65         Ω           High-side output CN resistance         R <sub>QN</sub> (H1)         l <sub>Q</sub> = -1.0A	Output block						
High-side output ON resistance $P_{ON}$ (H1) $l_{O}$ = -1.0A         0.67         0.97         0.9         0.           Low-side doupt leak current $l_{L}$ (H)            50         µA           Low-side diode forward voltage         VD (H1) $l_{D}$ = -1.0A          1.0         1.1         1.3         V           VD (H1) $l_{D}$ = -1.0A          1.1         1.3         V           SV Constant-voltage Output          0.1         1.1         1.3         V           OUtput voltage         VD (H1) $l_{D}$ = -5m A         4.8         5.1         5.4         V           Line regulation $\Delta V$ (REG1) $V_{CC}$ = 8 to 35V, $l_{D}$ = -5m A         .0         1.00         mV           Load regulation $\Delta V$ (REG2) $l_{O}$ = 5m to -10mA         .0         .0         mV           Hall magnifier         input voltage range 1         VICM1         When using Hall elements         .0.3         .0         .0         mVp.p           Hall input sensitivity         VH1N         SIN wave         .03         .0         .0         mVp.p           High level output voltage range 1         VICM1         W	Low-side output ON resistance	R <sub>ON</sub> (L1)	I <sub>O</sub> = 1.0A		0.47	0.65	Ω
Low-side output leak current         IL (L)         Common Mark         MA           High-side output leak current         IL (H)         Index-side output leak current         MA           Low-side olode forward voltage         VD (L1)         ID = 1.0A         1.0         1.2         V           High-side olde forward voltage         VD (H1)         ID = 1.0A         1.1         1.1         V           SV Constant-voltage Output         VD (H1)         ID = -5mA         4.8         5.1         5.4         V           Courput voltage         VA (REG1)         V <sub>CC</sub> = 8 to 35V, ID = -5mA         4.8         5.1         5.4         V           Load regulation         AV (REG1)         V <sub>CC</sub> = 8 to 35V, ID = -5mA         6.0         V         MD         mV           Load regulation         AV (REG2)         ID = -5m to -10mA         6.0         0.0         mV           Hald Amplitier         Imput bias current         IB (HA)         -2         Impl A         MA           Common-mode input voltage range 1         VICM1         When using Hail elements         0.3         VREG-1.7         V           Common-mode input voltage range 2         VICM2         A to ne-side input bias (Hail Capplication)         0         mVPp           High tevel o	High-side output ON resistance	R <sub>ON</sub> (H1)	I <sub>O</sub> = -1.0A		0.67	0.9	Ω
High-side output leak current         IL (H)         -50 $\mu$ $\mu$ A           Low-side diode forward voltage         VD (L1)         ID = -1.0A         1.0         1.1.2         V           High-side diode forward voltage         VD (H1)         ID = 1.0A         1.1         1.3         V           SV Constant-voltage Output         VD (H1)         ID = -5mA         4.8         5.1         5.4         V           Clip regulation $\Delta V$ (REG)         IQ = -5mA         4.8         5.1         5.4         V           Lad regulation $\Delta V$ (REG)         IQ = -5m to -10mA         4.8         5.1         5.4         V           Hall Amplifer         Input bias current         IB (HA)         IQ = -5m to -10mA         0         VREG -1.7         V           Common-mode input voltage range 1         VICM1         When using Hall elements         0.3         VREG -1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         VREG -1.7         V           Common-mode input voltage VN (HA)         SN wave         80         mVPp         MVPp           Hysteresis width $\Delta V_N$ (MA)         SN wave         9         20	Low-side output leak current	۱ <sub>L</sub> (L)				50	μA
	High-side output leak current	I <sub>L</sub> (Н)		-50			μA
High-side diode forward voltage         VD (H1)         ID = 1.0A         1.1         1.3         V           SV Constant-voltage Output         VREG         ID = -5mA         4.8         5.1         5.4         V           Culput voltage         VREG         ID = -5mA         4.8         5.1         5.4         V           Lade regulation $\Delta V$ (REG2)         ID = -5m to -10mA         100         mV           Hall Amplifier         Incommon-mode input voltage range 1         VICM2         At one-side input bias (Hall IC application)         0.3         VREG-1.7         V           Common-mode input voltage range 1         VICM2         At one-side input bias (Hall IC application)         0         VREG-1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         WREG-1.7         V           Common-mode input voltage range 1         VICM2         At one-side input bias (Hall IC application)         0         WREG-1.7         V           Common-mode input voltage range 1         VICM2         At one-side input bias (Hall IC application)         0         mV         M           Hall input sensitivity         VHIN         SIN wave         80         mV         mV           Hage Low → Hig	Low-side diode forward voltage	V <sub>D</sub> (L1)	I <sub>D</sub> = -1.0A		1.0	1.2	V
SV Constant-voltage Output           Output voltage         VREG $I_O = -5mA$ 4.8         5.1         5.4         V           Line regulation $\Delta V$ (REG) $V_{CC} = 8$ to 35V, $I_O = -5mA$	High-side diode forward voltage	V <sub>D</sub> (H1)	I <sub>D</sub> = 1.0A		1.1	1.3	V
Output voltage         VREG         I_O = -5mA         4.8         5.1         5.4         V           Line regulation $\Delta V$ (REG1) $V_{CC}$ = 8 to 35V, I_O = -5mA         I         I         500         mV           Load regulation $\Delta V$ (REG2) $I_O$ = -5m to -10mA         I         I         1000         mV           Hall Amplifier         I         IDp U bias current         IB (HA)         I         Q         I         µA           Common-mode input voltage range 1         VICM1         When using Hall elements         0.3         I         VREG 1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         VREG 1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         VREG 1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         VREG 1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         1.6         mV           Input voltage Low → High         VSL         Input oblitage toup → High         VSL	5V Constant-voltage Output						
Line regulation $\Delta V$ (REG1) $V_{CC} = 8$ to 35V, $I_{O} = -5mA$ (m)         (m)           Load regulation $\Delta V$ (REG2) $I_{O} = -5m$ to $-10mA$ (m)         (m)           Hall Amplifier           (m)         (m)           Common-mode input voltage range 1         VICM         When using Hall elements         0.3         VREG-1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         VREG         V           Hall input sensitivity         VHN         SIN wave         80         (m)         mVp-p           Hysteresis width $\Delta V_{IN}$ (HA)         SIN wave         9         20         35         mV           Input voltage Low $\rightarrow$ High         VSLH         Input soltage         9         16         mV           CSD oscillator circuit         VSHL         Input soltage         VO_I (CSD)         1.1         1.3         V           Low level output voltage         VO_I (CSD)         Input soltage         VO_I (CSD)         1.1         1.3         V           Low level output voltage         VO_I (CSD)         Input soltage         VO_I (CSD)         Input soltage         1.1         1.3	Output voltage	VREG	I <sub>O</sub> = -5mA	4.8	5.1	5.4	V
Load regulation $\Lambda V$ (REG2) $I_O$ = -5m to -10mA         (m)         m/V           Hall Amplifier         Input bias current         IB (HA)         -2         (M         ////////////////////////////////////	Line regulation	∆V (REG1)	$V_{CC} = 8$ to 35V, $I_O = -5mA$			50	mV
Hall AmplifierInput bias currentIB (HA)IB (HA)Imput bias currentImput bias currentImput bias currentImput bias (HAII IC application)Imput bias (HAII IC application)VREG-1.7VCommon-mode input voltage range 2VICM2At one-side input bias (HAII IC application)Imput bias (HAII IC application)VREG-1.7VHall input sensitivityVHNSIN wave80Imput bias (HAII IC application)Imput bias (HAII IC application)VREG-1.7VHall input sensitivityVHNSIN wave80Imput bias (HAII IC application)NVMVppHysteresis widthAVIN (HA)Imput voltage Low -> HighVSLHImput sensitivityImput sensitivity	Load regulation	ΔV (REG2)	I <sub>O</sub> = -5m to -10mA			100	mV
Input bias current         IB (HA)        2         //         //           Common-mode input voltage range 1         VICM1         When using Hall elements         0.3         VREG-1.7         V           Common-mode input voltage range 2         VICM2         At one-side input bias (Hall IC application)         0         VREG-1.7         V           Hall input sensitivity         VHN         SIN wave         80         mV         mV/pp           Hysteresis width $\Delta V_{IN}$ (HA)         9         0         0         mV           Input voltage Low -> High         VSL	Hall Amplifier						
Common-mode input voltage range 1VICM1When using Hall elements0.3VREG-1.7VCommon-mode input voltage range 2VICM2At one-side input bias (Hall IC application)0VREG-1.7VHall input sensitivityVHNSIN wave80mV/p-pHysteresis width $\Delta V_{IN}$ (HA)920335mVInput voltage Low $\rightarrow$ HighVSLH3916mVInput voltage Low $\rightarrow$ HighVSLH10105CSD oscillator circuit3.03.3VLow level output voltageV <sub>OH</sub> (CSD)0.91.11.13VAmplitudeV (CSD)0.91.11.13VAmplitudeV (CSD)0.91.11.13VExternal capacitor charge currentICHG1 (CSD)VCHG1 = 2.0V-14-11.5-9 $\mu$ AOscillation frequencyf (CSD)C = 0.022 µF (Design target value)130HzHzCharge pump output (VG pin)CGUTC = 0.022 µF (Design target value)130VVOutput ON resistance (High level)V <sub>OH</sub> (CP1)ICP1 = -2mA350500 $\Omega$ $\Omega$ Output ON resistance (Low level)V <sub>OL</sub> (CP1)ICP1 = -2mA350500 $\Omega$ $\Omega$ Output ON resistance (Low level)V <sub>OL</sub> (CP1)ICP1 = -2mA350500 $\Omega$ Charge pump frequencyf (CP)ICP1 = 2mA350500 $\Omega$ <tr <td="">Singlation freque</tr>	Input bias current	IB (HA)		-2			μA
Common-mode input voltage range 2VICM2At one-side input bias (Hall IC application)0VVVVHall input sensitivityVHINSIN wave80mVp-pHysteresis width $\Delta V_{IN}$ (HA)92035mVInput voltage Low $\rightarrow$ HighVSLH3916mVInput voltage High $\rightarrow$ LowVSHL-19-11-5mV <b>CSD oscillator circuit</b> -19-11-5mVHigh level output voltageV <sub>OL</sub> (CSD)2.73.03.3VLow level output voltageV <sub>OL</sub> (CSD)0.91.11.3VAmplitudeV (CSD)1.61.92.2Vp-pExternal capacitor charge currentICHG1 (CSD)VCHG1 = 2.0V-14-11.5-9 $\mu$ ACharge pump output (VG pin)C0.022 µC (Design target value)130Hz $\mu$ ACharge pump output (VG pin)VGOUTC0.022 µC (P4.5VVOutput ON resistance (High level)V <sub>OL</sub> (CP1)ICP1 = 2mA350500 $\Omega$ Output ON resistance (Low level)V <sub>OL</sub> (CP1)ICP1 = 2mA350500 $\Omega$ Charge pump frequencyf (CP)ICP1 = 2mA350500 $\Omega$ Charge pump frequencyf (PWM)ICP1 = 2mA4151.562kHzInternal PVM frequencyf (PWM)ICP1 = 2mA0.190.210.23V	Common-mode input voltage range 1	VICM1	When using Hall elements	0.3		VREG-1.7	V
Hall input sensitivityVHINSIN wave80mVppHysteresis width $\Delta V_{IN}$ (HA)92035mVInput voltage Low $\rightarrow$ HighVSLH3916mVInput voltage High $\rightarrow$ LowVSHL-19-11-5mVCSD oscillator circuitHigh level output voltage $V_{OH}$ (CSD)2.73.03.3VLow level output voltage $V_{OL}$ (CSD)0.91.11.3VAmplitudeV (CSD)1.61.92.2Vp-pExternal capacitor charge currentICHG1 (CSD)VCHG1 = 2.0V.14-11.5.9 $\mu$ AExternal capacitor discharge currentICHG2 (CSD)VCHG2 = 2.0V9.51214.5 $\mu$ AOscillation frequencyf (CSD)C = 0.022 \muF (Design target value)130HzHzOutput voltageVGOUTC0.023 $\mu$ Ce+4.5VOutput voltageVGOUTCOutput VG pinOutput ON resistance (High level)VO <sub>L</sub> (CP1)ICP1 = 2mA350500 $\Omega$ Charge pump frequencyf (CP)ICP1 = 2mA82103124kHzInternal PVM frequencyOscillation frequencyf (PWM)1615.62kHzInternal PVM frequencyOutput ON resistance (Low level)VQLCP1 = 2mA3505.02 $\Omega$ Output ON resistance (Low level) <t< td=""><td>Common-mode input voltage range 2</td><td>VICM2</td><td>At one-side input bias (Hall IC application)</td><td>0</td><td></td><td>VREG</td><td>V</td></t<>	Common-mode input voltage range 2	VICM2	At one-side input bias (Hall IC application)	0		VREG	V
Hysteresis width $\Delta V_{  N}$ (HA)92035mVInput voltage Low $\rightarrow$ HighVSLH3916mVInput voltage High $\rightarrow$ LowVSHL-19-11-5mVCSD oscillator circuitHigh level output voltageV <sub>OH</sub> (CSD)2.73.03.3VLow level output voltageV <sub>OL</sub> (CSD)0.91.11.3VAmplitudeV (CSD)1.61.92.2Vp-pExternal capacitor charge currentICHG1 (CSD)VCHG1 = 2.0V-14-11.5-9 $\mu$ AExternal capacitor discharge currentICHG2 (CSD)VCHG2 = 2.0V9.51214.5 $\mu$ AOscillation frequencyf (CSD)C = 0.022µF (Design target value)130HzCharge pump output (VG pin)Output voltageVGOUTICP1 = -2mA500700 $\Omega$ Output ON resistance (Lim level)V <sub>OL</sub> (CP1)ICP1 = -2mA350500 $\Omega$ Charge pump frequencyf (CP)ICP1 = 2mA350500 $\Omega$ Charge pump frequencyf (CP)ICP1 = 2mA350500 $\Omega$ Charge pump frequencyf (PWM)4151.562kHzInternal PWM frequencyOutput frequencyf (PWA)0.190.210.23V	Hall input sensitivity	VHIN	SIN wave	80			mVp-p
$\begin{tabular}{ c c c c c } \begin{tabular}{ c c c c } \begin{tabular}{ c c c c c } \begin{tabular}{ c c c c } \begin{tabular}{ c c c c } \begin{tabular}{ c c c c c } \begin{tabular}{ c c c c c c } \begin{tabular}{ c c c c c c c } \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Hysteresis width	$\Delta V_{IN}$ (HA)		9	20	35	mV
$\begin{tabular}{ c                                   $	Input voltage Low $\rightarrow$ High	VSLH		3	9	16	mV
CSD oscillator circuit           High level output voltage         V <sub>OH</sub> (CSD)         2.7         3.0         3.3         V           Low level output voltage         V <sub>OL</sub> (CSD)         0.9         1.1         1.3         V           Amplitude         V (CSD)         1.6         1.9         2.2         Vp-p           External capacitor charge current         ICHG1 (CSD)         VCHG1 = 2.0V         -14         -11.5         -9         μA           External capacitor discharge current         ICHG2 (CSD)         VCHG2 = 2.0V         9.5         12         14.5         μA           Oscillation frequency         f (CSD)         C = 0.022 μF (Design target value)         0.5         12         14.5         μA           Charge pump output (VG pin)         CGUT         C = 0.022 μF (Design target value)         130         V         V           Output voltage         VGOUT         C = 0.022 μF (Design target value)         130         V         V           Charge pump output (VG pin)         VGOUT         C = 0.022 μF (Design target value)         V <sub>CC</sub> +4.5         V         V           Output voltage         VGOUT         ICP1 = -2mA         V         S00         700         Ω           Output ON resistance (Low level)         <	Input voltage High $\rightarrow$ Low	VSHL		-19	-11	-5	mV
High level output voltage         V <sub>OH</sub> (CSD)         2.7         3.0         3.3         V           Low level output voltage         V <sub>OL</sub> (CSD)         0.9         1.1         1.3         V           Amplitude         V (CSD)         1.6         1.9         2.2         Vp-p           External capacitor charge current         ICHG1 (CSD)         VCHG1 = 2.0V         -14         -11.5         -9         μA           External capacitor discharge current         ICHG2 (CSD)         VCHG2 = 2.0V         9.5         12         14.5         μA           Oscillation frequency         f (CSD)         C = 0.022μF (Design target value)         130         Hz           Charge pump output (VG pin)         0         C = 0.022μF (Design target value)         130         Hz           Output voltage         VGOUT         C = 0.022μF (Design target value)         130         V         V           CP1 pin         0         U         VCC+4.5         V         V           Output ON resistance (Ligh level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         500         700         Ω           Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         350         500         Ω           Internal PWM frequency <td< td=""><td>CSD oscillator circuit</td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	CSD oscillator circuit						
Low level output voltage $V_{OL}$ (CSD)         0.9         1.1         1.3         V           Amplitude         V (CSD)         1.6         1.9         2.2         Vp-p           External capacitor charge current         ICHG1 (CSD)         VCHG1 = 2.0V         -14         -11.5         -9 $\mu$ A           External capacitor discharge current         ICHG2 (CSD)         VCHG2 = 2.0V         9.5         12         14.5 $\mu$ A           Oscillation frequency         f (CSD)         C = 0.022 \mu F (Design target value)         130         Hz           Charge pump output (VG pin)         0utput voltage         VGOUT         C         V <sub>CC</sub> +4.5         V           Output voltage         VGOUT         ICP1 = -2mA         500         700 $\Omega$ Output ON resistance (High level)         V <sub>OL</sub> (CP1)         ICP1 = -2mA         350         500 $\Omega$ Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         350         500 $\Omega$ Charge pump frequency         f (CP)         ICP1 = 2mA         350         500 $\Omega$ Oscillation frequency         f (PWM)         A         51.5         62         kHz           Current limite	High level output voltage	V <sub>OH</sub> (CSD)		2.7	3.0	3.3	V
Amplitude         V (CSD)         1.6         1.9         2.2         Vp-p           External capacitor charge current         ICHG1 (CSD)         VCHG1 = 2.0V         -14         -11.5         -9 $\mu$ A           External capacitor discharge current         ICHG2 (CSD)         VCHG2 = 2.0V         9.5         12         14.5 $\mu$ A           Oscillation frequency         f (CSD)         C = 0.022 $\mu$ F (Design target value)         130         Hz           Charge pump output (VG pin)         C         0         V <sub>CC</sub> +4.5         V           Output voltage         VGOUT         CP1 pin         VO_CC+4.5         V           Output ON resistance (High level)         V <sub>OL</sub> (CP1)         ICP1 = -2mA         500         700 $\Omega$ Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = -2mA         350         500 $\Omega$ Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         350         500 $\Omega$ Charge pump frequency         f (CP)         ICP1 = 2mA         41         51.5         62         kHz           Internal PWM frequency         f (PWM)         Internal PWI frequency         41         51.5         62         kHz	Low level output voltage	V <sub>OL</sub> (CSD)		0.9	1.1	1.3	V
External capacitor charge current         ICHG1 (CSD)         VCHG1 = 2.0V         -14         -11.5         -9         μA           External capacitor discharge current         ICHG2 (CSD)         VCHG2 = 2.0V         9.5         12         14.5         μA           Oscillation frequency         f (CSD)         C = 0.022μF (Design target value)         130         Hz           Charge pump output (VG pin)           V         V           Output voltage         VGOUT          V         V           CP1 pin          VOL (CP1)         ICP1 = -2mA         500         700         Ω           Output ON resistance (High level)         VOL (CP1)         ICP1 = 2mA         350         500         Ω           Charge pump frequency         f (CP)         ICP1 = 2mA         350         500         Ω           Output ON resistance (Low level)         VOL (CP1)         ICP1 = 2mA         350         500         Ω           Charge pump frequency         f (CP)         ICP1 = 2mA         41         51.5         62         KHz           Internal PWM frequency         f (PWM)         ICP1 = 2mA         41         51.5         62         KHz           Current limiter operation <t< td=""><td>Amplitude</td><td>V (CSD)</td><td></td><td>1.6</td><td>1.9</td><td>2.2</td><td>Vp-p</td></t<>	Amplitude	V (CSD)		1.6	1.9	2.2	Vp-p
External capacitor discharge currentICHG2 (CSD)VCHG2 = $2.0V$ 9.51214.5 $\mu$ AOscillation frequencyf (CSD)C = $0.022\mu$ F (Design target value)130HzCharge pump output (VG pin)Output voltageVGOUTVCC+4.5VCP1 pinOutput ON resistance (High level)VOH (CP1)ICP1 = $-2mA$ 500700 $\Omega$ Output ON resistance (Low level)VOL (CP1)ICP1 = $-2mA$ 350500 $\Omega$ Charge pump frequencyf (CP)ICP1 = $2mA$ 4151.562kHzInternal PWM frequencyf (PWM)ICP1 = $2mA$ 0.190.210.23V	External capacitor charge current	ICHG1 (CSD)	VCHG1 = 2.0V	-14	-11.5	-9	μA
Oscillation frequency         f (CSD)         C = 0.022μF (Design target value)         130         Hz           Charge pump output (VG pin)         VGOUT         V         V         V           Output voltage         VGOUT         V         V         V         V           CP1 pin         ICP1 = -2mA         S00         700         Ω           Output ON resistance (High level)         V <sub>OL</sub> (CP1)         ICP1 = -2mA         500         700         Ω           Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         350         500         Ω           Charge pump frequency         f (CP)         ICP1 = 2mA         82         103         124         KHz           Internal PWM frequency         f (CP)         ICP1 = 2mA         41         51.5         62         KHz           Oscillation frequency         f (PWM)         Internal PWM frequency         41         51.5         62         KHz           Limiter voltage         VRF         Internal PC.         0.19         0.21         0.23         V	External capacitor discharge current	ICHG2 (CSD)	VCHG2 = 2.0V	9.5	12	14.5	μA
Charge pump output (VG pin)         VGOUT         Image Pump output (VG pin)         V <sub>CC</sub> +4.5         V           Output voltage         VGOUT         Image Pump output (VG pin)         V         V           CP1 pin         Output ON resistance (High level)         V <sub>OH</sub> (CP1)         ICP1 = -2mA         500         700         Ω           Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         350         500         Ω           Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         82         103         124         kHz           Internal PWM frequency         f (CP)         Image Pump frequency         41         51.5         62         kHz           Oscillation frequency         f (PWM)         41         51.5         62         kHz           Limiter voltage         VRF         0.19         0.21         0.23         V	Oscillation frequency	f (CSD)	$C = 0.022 \mu F$ (Design target value)		130		Hz
Output voltage         V GOUT         V           CP1 pin $V_{OL}$ (CP1)         ICP1 = -2mA         500         700         Ω           Output ON resistance (High level) $V_{OL}$ (CP1)         ICP1 = -2mA         350         500         Ω           Output ON resistance (Low level) $V_{OL}$ (CP1)         ICP1 = 2mA         350         500         Ω           Charge pump frequency         f (CP)         ICP1 = 2mA         82         103         124         kHz           Internal PWM frequency         f (P)          41         51.5         62         kHz           Oscillation frequency         f (PWM)         41         51.5         62         kHz           Limiter voltage         VRF         0.19         0.21         0.23         V	Charge pump output (VG pin)						
CP1 pinOutput ON resistance (High level) $V_{OH}$ (CP1)ICP1 = -2mA500700 $\Omega$ Output ON resistance (Low level) $V_{OL}$ (CP1)ICP1 = 2mA350500 $\Omega$ Charge pump frequencyf (CP)ICP1 = 2mA82103124kHzInternal PWM frequencyOscillation frequencyf (PWM)4151.562kHzCurrent limiter operationLimiter voltageVRF0.190.210.23V	Output voltage	VGOUT			V <sub>CC</sub> +4.5		V
Output ON resistance (High level)V <sub>OH</sub> (CP1)ICP1 = -2mA500700ΩOutput ON resistance (Low level)V <sub>OL</sub> (CP1)ICP1 = 2mA350500ΩCharge pump frequencyf (CP)82103124kHzInternal PWM frequencyf (PWM)Control of the second	CP1 pin						
Output ON resistance (Low level)         V <sub>OL</sub> (CP1)         ICP1 = 2mA         350         500         Ω           Charge pump frequency         f (CP)          82         103         124         kHz           Internal PWM frequency          f (PWM)         41         51.5         62         kHz           Oscillation frequency         f (PWM)         41         51.5         62         kHz           Limiter voltage         VRF         0.19         0.21         0.23         V	Output ON resistance (High level)	V <sub>OH</sub> (CP1)	ICP1 = -2mA		500	700	Ω
Charge pump frequency         f (CP)         82         103         124         kHz           Internal PWM frequency         50         62         kHz           Oscillation frequency         f (PWM)         41         51.5         62         kHz           Current limiter operation         URF         0.19         0.21         0.23         V	Output ON resistance (Low level)	V <sub>OL</sub> (CP1)	ICP1 = 2mA		350	500	Ω
Internal PWM frequency           Oscillation frequency         f (PWM)         41         51.5         62         kHz           Current limiter operation         Use         0.19         0.21         0.23         V	Charge pump frequency	f (CP)		82	103	124	kHz
Oscillation frequency         f (PWM)         41         51.5         62         kHz           Current limiter operation         VRF         0.19         0.21         0.23         V	Internal PWM frequency						
Current limiter operation           Limiter voltage         VRF         0.19         0.21         0.23         V	Oscillation frequency	f (PWM)		41	51.5	62	kHz
Limiter voltage         VRF         0.19         0.21         0.23         V	Current limiter operation						
	Limiter voltage	VRF		0.19	0.21	0.23	V

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Continued from preceding page.						
Parameter	Symbol	Conditions	Ratings			Llnit
i arameter	Gymbol	Conditions	min	typ	max	Offic
Thermal shutdown operation						
Thermal shutdown operation temperature	TSD	*Design target value (junction temperature)	150	165	180	°C
Hysteresis width	ΔTSD	*Design target value (junction temperature)		30		°C
HB pin	1					<u>.                                    </u>
Output voltage	VHB	IHB = -100μA	3.4	3.6	3.8	V
Low-voltage protection (5V consta	int-voltage output d	letection)				<u>.                                    </u>
Operation voltage	VSD		3.95	4.15	4.35	V
Hysteresis width	ΔVSD		0.2	0.3	0.4	V
FG pin (3FG pin)	•					
Output ON resistance	VOL (FG)	IFG = 5mA		40	60	Ω
Output leak current	IL (FG)	V <sub>O</sub> = 5V			10	μA
S/S pin	•	•				
High level input voltage	V <sub>IH</sub> (SS)		2.0		VREG	V
Low level input voltage	V <sub>IL</sub> (SS)		0		1.0	V
Input open voltage	V <sub>IO</sub> (SS)		VREG-2.2	VREG-2.0	VREG-1.8	V
Hysteresis width	V <sub>IS</sub> (SS)		0.25	0.33	0.4	V
High level input current	I <sub>IH</sub> (SS)	V <sub>SS</sub> = VREG	45	60	75	μA
Low level input current	I <sub>IL</sub> (SS)	$V_{SS} = 0V$	-115	-90	-65	μA
PWMIN pin						
Recommended input frequency	f(PWIN)		0.5		60	kHz
High level input voltage	V <sub>IH</sub> (PWIN)		2.0		VREG	V
Low level input voltage	V <sub>IL</sub> (PWIN)		0		1.0	V
Input open voltage	V <sub>IO</sub> (PWIN)		VREG-2.2	VREG-2.0	VREG-1.8	V
Hysteresis width	V <sub>IS</sub> (PWIN)		0.25	0.33	0.4	V
High level input current	I <sub>IH</sub> (PWIN)	VPWIN = VREG	45	60	75	μA
Low level input current	I <sub>IL</sub> (PWIN)	VPWIN = 0V	-115	-90	-65	μA
F/R pin						
High level input voltage	V <sub>IH</sub> (FR)	*Design target value	2.0		VREG	V
Low level input voltage	V <sub>IL</sub> (FR)	*Design target value	0		1.0	V
Input open voltage	V <sub>IO</sub> (FR)		VREG-2.2	VREG-2.0	VREG-1.8	V
Hysteresis width	V <sub>IS</sub> (FR)	*Design target value	0.25	0.33	0.4	V
High level input current	I <sub>IH</sub> (FR)	VF/R = VREG	45	60	75	μΑ
Low level input current	I <sub>IL</sub> (FR)	VF/R = 0V	-115	-90	-65	μA

\* : Design target value and no measurement is made.

## Package Dimensions

unit : mm (typ) 3430





## **Pin Assignment**



## **Three-phase logic truth table** (IN = "High" indicates the state where $IN^+ > IN^-$ .)

("H" = SOURCE, "L" = SINK, and "M" = output OFF are shown with OUT1 to 3.)

	F/R = ⌈H⌋			F/R = [L]			Output	
IN1	IN2	IN3	IN1	IN2	IN3	OUT1	OUT2	OUT3
Н	L	Н	L	Н	L	L	Н	М
Н	L	L	L	Н	Н	L	М	Н
Н	Н	L	L	L	Н	М	L	Н
L	Н	L	Н	L	Н	Н	L	М
L	Н	Н	Н	L	L	Н	М	L
L	L	Н	Н	Н	L	М	Н	L

FG output					
IN1	IN2	IN3	FG		
Н	L	Н	L		
Н	L	L	L		
Н	Н	L	L		
L	Н	L	Н		
L	Н	Н	Н		
L	L	Н	Н		

## S/S pin, PWMIN pin

Input state	S/S pin	PWMIN pin
High or Open	Stop (short brake)	Output OFF
Low	Start	Output ON

CSD function

When the S/S pin is in a STOP state When the F/R pin is switched When 0% duty is detected at the PWMIN pin input  $\rightarrow$  Protection released and count reset When low-voltage condition is detected When TSD condition is detected

 $\rightarrow$  Protection released and count reset(Initial reset)

Protection released and count reset  $\rightarrow$ 

Protection released and count reset (Initial reset)  $\rightarrow$ 

Stop counting  $\rightarrow$ 

# Internal Equivalent Circuit and Sample External Component Circuit



# Pin Functions

Pin No.	Pin Name	Pin function	Equivalent Circuit
1 2 3 4 5 6	IN3 <sup>-</sup> IN3 <sup>+</sup> IN2 <sup>-</sup> IN2 <sup>+</sup> IN1 <sup>-</sup> IN1 <sup>+</sup>	Hall input pin. •High when IN <sup>+</sup> > IN <sup>-</sup> . Low in reverse relationship. The input amplitude of over 100mVp-p (differential) is desirable in the Hall inputs. Insert a capacitor between the IN <sup>+</sup> and IN <sup>-</sup> pins if the noise on the Hall signal is a problem.	135
7	SGND	Control circuit block ground pin.	
8	VHEG	5V regulator output pin (control circuit power supply). Insert a capacitor between this pin and ground for stabilization. About 1μF is necessary. (Refer to 11 pages "5 is Low-voltage Protection Circuit.", 12 pages "10 is VREG Stabilization.")	VCC
9 10	CP2	Charge pump capacitor connection pin.	
11 12	V <sub>CC</sub> 1 V <sub>CC</sub> 2	For Control (Pin 11) and for output (Pin 12) power pin. Insert a capacitor between this pin and ground to prevent the influence of noise, etc. (Refer to 12 pages "9 is Power Supply Stabilization.")	
13	VG	Charge pump output pin. (Upper-side FET gate power supply) Insert a capacitor between this pin and V <sub>CC</sub> . (Refer to 12 pages "11 is Charge pump Circuit.")	$V_{CC}$

Continued on next page.

Continued from	m preceding page.	1	
Pin No.	Pin Name	Pin function	Equivalent Circuit
14 15 16	OUT1 OUT3 OUT2	Output pin. PWM is controlled by the upper-side FET.	
17	RF	Output current detection pin. Insert a low resistance resistor (Rf) between this pin and ground. (Refer to 10 pages "2 is Current Limiter Circuit.")	VREG
18	PGND	Out circuit block ground pin.	
19	S/S	Pin to select the start/stop type. Stop = High or open Start = Low (Refer to 12 pages "8 is Power Saving Circuit.")	VREG $50k\Omega \neq 5k\Omega$ $50k\Omega \neq 5k\Omega$ $75k\Omega \neq 19$ $75k\Omega \neq 75k\Omega \neq 75k\Omega$
20	FG	1-Hall FG signal output pin. Open drain output.	

Continued on next page.

Continued from	m preceding page.		
Pin No.	Pin Name	Pin function	Equivalent Circuit
21	F/R	Pin to select the forward/reverse type. This pin goes to the high level when open.	VREG 50kΩ \$ 50kΩ \$ 50kΩ \$ 50kΩ \$ 50kΩ \$ 75kΩ \$
22	CSD	Pin to set the constraint protection circuit operating time and initial reset pulse. Insert a capacitor between this pin and ground. Insert a resistor in parallel with the capacitor if the protection circuit is not to be used. (Refer to 10 pages "4 is Constraint Protection Circuit.")	VREG
23	PWMIN	External PWM input pin. Apply an external PWM input signal to this pin. (Input frequency range is from 0.5 to 60kHz.) PWM ON = Low PWM OFF = High or open (Refer to 10 pages "3 is Speed control method.")	VREG 50kΩ \$ 50kΩ \$ 50kΩ \$ 50kΩ \$ 75kΩ \$
24	НВ	HALL bias pin (3.6V output). Connect an NPN transistor. (Refer to 11 pages "7 Hall Input Signal.")	VREG 3000 2500 (24) (24) (24)

#### Description of LV8829LFQA

#### 1. Output Drive Circuit

This IC adopts a direct PWM drive method to reduce power loss in the output. It regulates the drive force of the motor by changing the output on duty. The output PWM switching is performed by the upper-side output transistor. The current regeneration route during the normal PWMOFF passes through the parasitic diode of the output DMOS. This IC performs synchronous rectification, and is intended to reduce heat generation compared to diode regeneration.

#### 2. Current Limiter Circuit

The current limiter circuit limits the output current peak value to a level determined by the equation  $I = V_{RF}/Rf$  (V<sub>RF</sub> = 0.21V (typical), Rf: current detection resistor). This circuit suppresses the output current by reducing the output on duty.

The current limiter circuit has an operation delay (approx. 700ns) to detect reverse recovery current flowing in the diode due to the PWM operation, and prevent a malfunction of the current limiting operation. If the coil resistance of the motor is small, or the inductance is low, the current at startup (the state in which there is no back electromotive force generated in the motor) will change rapidly. As a result, the operation delay may sometimes cause the current limiting operation to take place at a value above the set current. In such a case, it is necessary to set the current limit value while taking into consideration the increase in current due to the delay.

\* Regarding the PWM frequency in the current limiter circuit

The PWM frequency in the current limiter circuit is determined by the internal reference oscillator, and is approximately 50kHz.

#### 3. Speed control method

Pulses are input to the PWMIN pin, and the output can be controlled by varying the duty cycle of these pulses. When a low-level input voltage is applied to the PWMIN pin, the output at the PWM side (upper side) is set to ON. When a high-level input voltage is applied to the PWMIN pin, the output at the PWM side (upper side) is set to OFF. If it is necessary to input pulses using inverted logic, this can be done by adding an external transistor (NPN). When the input to the PWMIN pin remains high-level for a certain period, the IC judges that the duty is 0%, causing the CSD circuit count to be reset and the output from the HB pin to become low level.

#### 4. Constraint Protection Circuit

The LV8829LFQA includes a constraint protection circuit for protecting the IC and the motor in a motor constraint mode.

This circuit operates when the motor is in an operation condition and the Hall signal does not switch over for a certain period. Note that while this constraint protection is operating, the upper-side output transistor will be OFF. Time setting is performed according to the capacitance of the capacitor connected to the CSD pin.

#### Set time (s) $\approx 90 \times C (\mu F)$

When a  $0.022\mu$ F capacitor is connected, the protection time becomes approximately 2.0 seconds. The set time must be selected to a value that provides adequate margin with respect to the motor startup time.

Conditions for releasing the constraint protection state:

- When the S/S pin is in a STOP state  $\rightarrow$ Protection released and count reset(Initial reset) • When the F/R pin is switched  $\rightarrow$ Protection released and count reset • When 0% duty is detected at the PWMIN pin input Protection released and count reset  $\rightarrow$ • When low-voltage condition is detected Protection released and count reset (Initial reset)  $\rightarrow$  $\rightarrow$ Stop counting)
- (• When TSD condition is detected
- The CSD pin also functions as the initial reset pulse generation pin. If it is connected to ground, the logic circuit will go into a reset state, preventing speed control from taking place. Consequently, when not using constraint protection, connect a resistor of approximately  $220k\Omega$  and a capacitor of about 4700pF in parallel to ground.

#### 5. Low-voltage Protection Circuit

The LV8829LFOA incorporates a comparator that uses the band gap voltage as the reference. The circuit monitors the voltage at the VREG pin (5V) while the S/S pin is low and activates the protection circuit when the voltage at the VREG pin falls below 4.15V (typ.).

When this happens, the state of the output transistors for all phases set to OFF.

In order to ensure that the IC does not exhibit any unstable behavior when the VREG voltage has increased or decreased around 4.15V, a hysteresis of 0.3V (typ.) is provided. As a result, when the VREG voltage recovers to 4.45V (typ.) after the low-voltage protection circuit has been activated, all output transistors return to their operating state.

#### 6. Thermal shutdown Circuit

When the IC junction temperature exceeds 165°C (design target value), the thermal shutdown circuit is activated, and all the output transistors are set to OFF.

When the IC junction temperature goes below the hysteresis temperature of 30°C (design target value) or more, all the output transistors return to their operating state.

However, as the thermal shutdown circuit is activated only when the junction temperature of the IC has exceeded the rating, its activation does not constitute a guarantee that the product that incorporates this circuit will be protected from damage or destruction.

7. Hall Input Signal

A pulse input with the amplitude in excess of the hysteresis (35mV maximum) is required for the Hall inputs.

It is desirable that the amplitude of the Hall input signal be 100mVp-p or more in consideration of the effect of noise and phase displacement.

If disturbances to the output waveform (during phase switching) occur due to noise, connect a capacitor between the Hall input pins to prevent such disturbances. In the constraint protection circuit, the Hall input is utilized as a judgment signal. Although the circuit ignores a certain amount of noise, caution is necessary.

If all three phases of the Hall input signal go to the same input state (HHH or LLL), the outputs are all set to the OFF state.

If the Hall IC is used, fixing one side of the inputs (either the + or - side) at a voltage within the common-mode input voltage range (between 0.3V and VREG-1.7V) allows the other input side to be used as an input over the 0V to VREG range. (1)



• A current limiting resistor is necessary.

• The amplitude varies with temperature.

#### • HB pin

The HB pin is used for cutting off the current flowing in the Hall elements during standby (for saving electricity). The output from the HB pin is set to OFF in the following cases.

- When the S/S pin is in a STOP state
- When 0% duty is detected at the PWMIN pin input

#### 8. Power Saving Circuit (Start/Stop circuit)

To save power when the LV8829LFQA is in the stop state, most of the circuit is stopped, aiming at reducing current consumption. If the Hall bias pin is used, the current consumption in the power-saving mode will be approximately  $700\mu$ A. Even in the power-saving mode, a 5V regulator voltage is output. Also, in the power-saving mode, the IC is in a short break state. (lower-side shorted)

#### 9. Power Supply Stabilization

This IC generates a large output current, and employs a switching drive method, so the power supply line level can be disturbed easily. For this reason, it is necessary to connect a capacitor (electrolytic) of sufficient capacitance between the V<sub>CC</sub> pin and ground to ensure a stable voltage. Connect the ground side of the capacitor to the PGND pin, which is the power ground, as close as possible to the pin. If it is not possible to connect a capacitor of sufficiently large capacitance close to the pin, connect a ceramic capacitor of approximately  $0.1\mu$ F to the vicinity of the pin. If diodes are inserted in the power supply line to prevent IC destruction resulting from reverse-connecting the power supply, the power supply lines are even more easily disrupted. And even larger capacitor is required.

#### 10. VREG Stabilization

To stabilize the VREG voltage, which is the power supply for the control circuit, connect a capacitor of  $0.1\mu$ F or larger. Connect the ground of this capacitor as close as possible to the control block ground (SGND pin) of the IC.

#### 11. Charge pump Circuit

The voltage is stepped-up by the charge pump circuit, causing the gate voltage of the upper-side output FET to be generated. The voltage is stepped-up by capacitor CP connected between pins CP1 and CP2, causing charge to accumulate in capacitor CG connected between pins VG and V<sub>CC</sub>. The capacitance of CP and CG must always satisfy the following relationship.

 $CG \ge 4 \times CP$ 

Charging and discharging of capacitor CP take place based on a frequency of 100kHz. When the capacitance of capacitor CP is large, the current supply capability of power supply VG will increase. However, if the capacitance is too large, the charging and discharging operations will be insufficient. The larger the capacitance of capacitor CG, the more stable voltage VG will become. However, if the capacitance is made too large, the period during which voltage VG is generated when the power is switched ON will become long, so caution is necessary.

The capacitance settings of CP and CG should be the following.

 $CP = 0.01 \mu F$  $CG = 0.1 \mu F$ 

#### 12. Difference point of LV8829LFQA and LV8827LFQA

This difference that IC is the more following compared with LV8827LFQA exists.

	LV8829LFQA	LV8827LFQA
When Duty=0% of PWM input is	Synchronous rectification OFF	Short brake
detected	(Free run)	
At the low frequency number of PWM	Synchronous rectification OFF	Like synchronous rectification ON
input		
(About 7.5kHz under)		
At low ON Duty of the PWM input	Synchronous rectification OFF	Like synchronous rectification ON
(ex. frequency: 20kHz, ON Duty: 3%		
under)		
Backflow current detecting function	It is.	non
	(At detection -> Synchronous rectification OFF)	

#### 13. Metal part at the rear of the IC

The metal part at the rear of the IC (exposed die-pad) constitutes the sub ground of the IC, so connect it to the control ground (SGND pin) and power ground pin (PGND) at points close to the IC.

#### 14. Notes on Using the IC

This IC performs synchronous rectification in order to achieve high-efficiency drive.

The synchronous rectification operation reduces the output transistor loss so it has the effect of reducing heat generation and improving efficiency.

However, the synchronous rectification operation may cause the supply voltage to rise depending on the conditions under which the IC is used, such as:

- When the output duty ratio has suddenly decreased
- When the PWM input frequency is low, etc.

Protective measures must be taken to ensure that the maximum ratings are not exceeded even when the supply voltage has risen. These measures include:

- Appropriate selection of the capacitance of the capacitor inserted between the power supply and the ground
- Insertion of a zener diode between the power supply and the ground

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