

# KA2822D

## 3-Phase BLDC Motor Driver

### Features

- 3-phase, full-wave, linear BLDC motor driver with 2 hall sensors
- Built-in soft switching drive circuit
- 300 or 360 RPM speed control
- Snubberless
- Built-in chip enable function
- Built-in digital speed control circuit
- Built-in current limit circuit
- Index sensorless
- Built-in TSD (Thermal shutdown)
- Low saturation voltage
- Digital input: TTL, 5V CMOS compatible
- Built-in current-mode control circuit (I<sub>PEAK</sub>: 1A)

### Description

The KA2822D is a monolithic integrated circuit, and suitable for the three-phase spindle motor driver of FDD system.



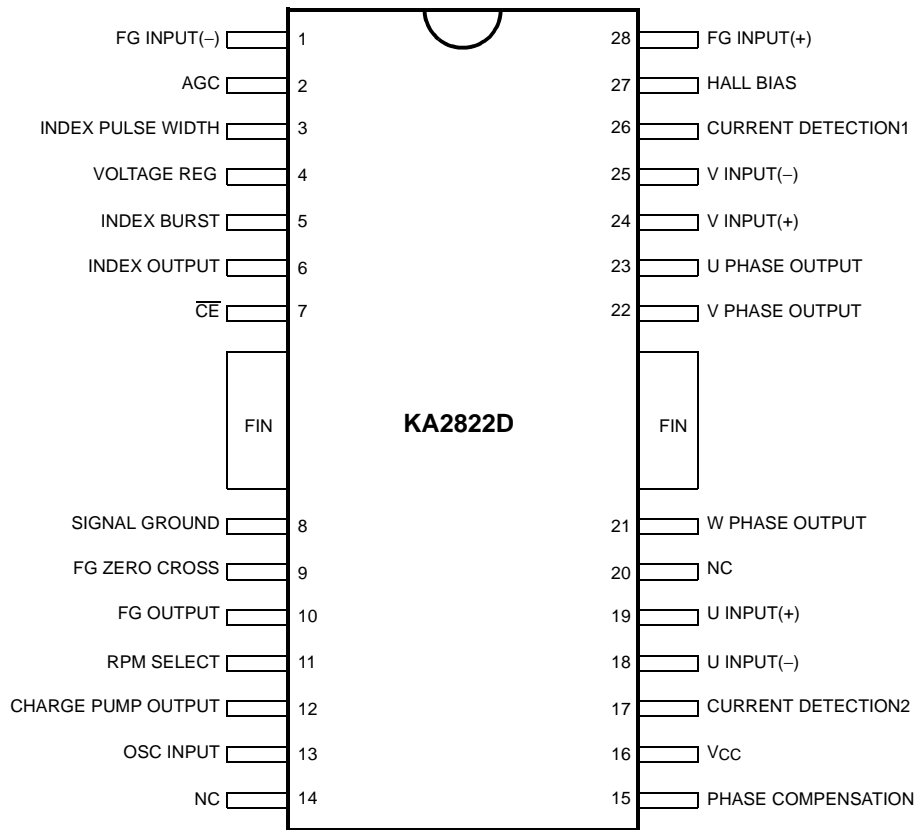
### Typical Application

- 3.5-inch floppy disk drive (FDD) spindle motor
- Other 3-phase BLDC motor

### Ordering Information

| Device     | Package      | Operating Temp. |
|------------|--------------|-----------------|
| KA2822D    | 28-SSOPH-375 | 0 ~ 75°C        |
| KA2822DTF  | 28-SSOPH-375 | 0 ~ 75°C        |
| KA2822BD   | 28-SSOPH-375 | 0 ~ 75°C        |
| KA2822BDTF | 28-SSOPH-375 | 0 ~ 75°C        |

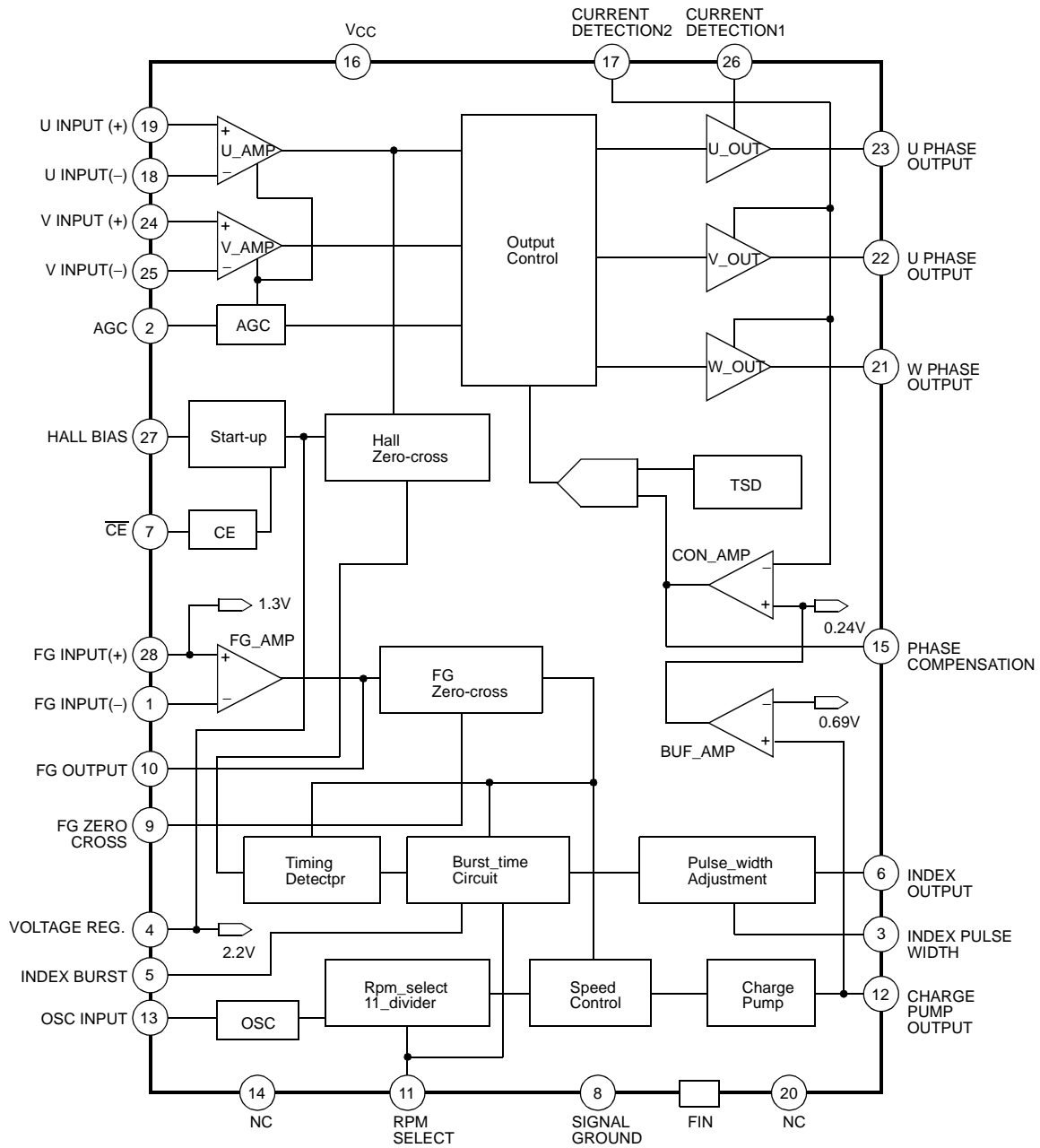
## Pin Assignments



## Pin Definitions

| Pin Number | Pin Name           | I/O | Pin Function Description               |
|------------|--------------------|-----|--|
| 1          | FG_INPUT           | I   | Negative input pin FG signal amp.      |
| 2          | AGC                | I   | Automatic gain control input pin       |
| 3          | INDEX PULSE WIDTH  | O   | Index pulse width detection (1.1V) pin |
| 4          | VOLTAGE REGULATOR  | O   | Voltage (2.2V) generator output pin    |
| 5          | INDEX BURST        | O   | Index pulse width detection (1.4V) pin |
| 6          | INDEX OUTPUT       | O   | Index pulse output pin                 |
| 7          | CE                 | I   | Chip enable (Active low)               |
| 8          | SIGNAL GROUND      | -   | Signal ground                          |
| 9          | FG ZERO CROSS      | O   | FG signal zero cross detection pin     |
| 10         | FG OUTPUT          | O   | FG signal output pin                   |
| 11         | RPM SELECT         | I   | RPM selection pin (L: 300, H: 360rpm)  |
| 12         | CHARGE PUMP OUTPUT | O   | Charge pump output pin                 |
| 13         | OSC INPUT          | I   | 1MHz oscillation input pin             |
| 14         | NC                 | -   | No connection                          |
| 15         | PHASE COMPENSATION | I   | Phase compensation cap. connection pin |
| 16         | Vcc                | -   | 5V power supply pin                    |
| 17         | CURRENT DETECTION2 | I   | Over current detection pin             |
| 18         | U INPUT (-)        | I   | Negative input pin of U phase amp      |
| 19         | U INPUT (+)        | I   | Positive input pin of U phase amp      |
| 20         | NC                 | -   | No connection                          |
| 21         | W PHASE OUTPUT     | O   | W phase output pin                     |
| 22         | V PHASE OUTPUT     | O   | V phase output pin                     |
| 23         | U PHASE OUTPUT     | O   | U phase output pin                     |
| 24         | U INPUT (+)        | I   | Positive input pin of V phase amp      |
| 25         | V INPUT (-)        | I   | Negative input pin of V phase amp      |
| 26         | CURRENT DETECTION1 | I   | Over current detection pin             |
| 27         | HALL BIAS          | I   | Hall sensor bias input pin             |
| 28         | FG INPUT (+)       | I   | Positive input pin of FG signal amp    |
| FIN        | POWER GROUND       | -   | Power ground                           |

# Internal Block Diagram



## Equivalent Circuits

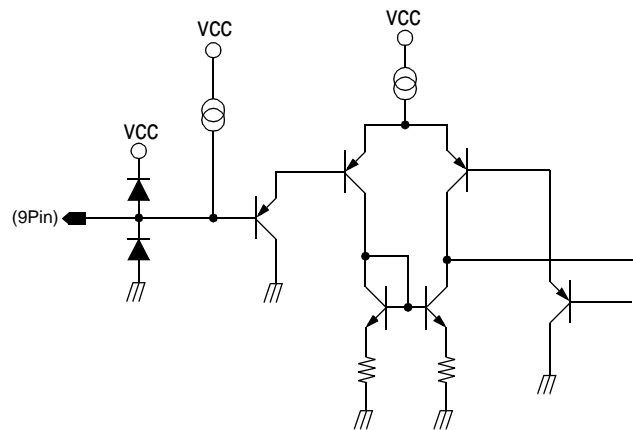
|                               |  |
|-------------------------------|--|
| <p>U_amp, V_amp input</p>     | <p>U, V, W drive output and current detection 1, 2</p> |
|                               |  |
| <p>FG input and FG output</p> | <p>OSC input</p>                                       |
|                               |  |
| <p>CE input</p>               | <p>Hall bias input and voltage regulator output</p>    |
|                               |  |

## Equivalent Circuits (Continued)

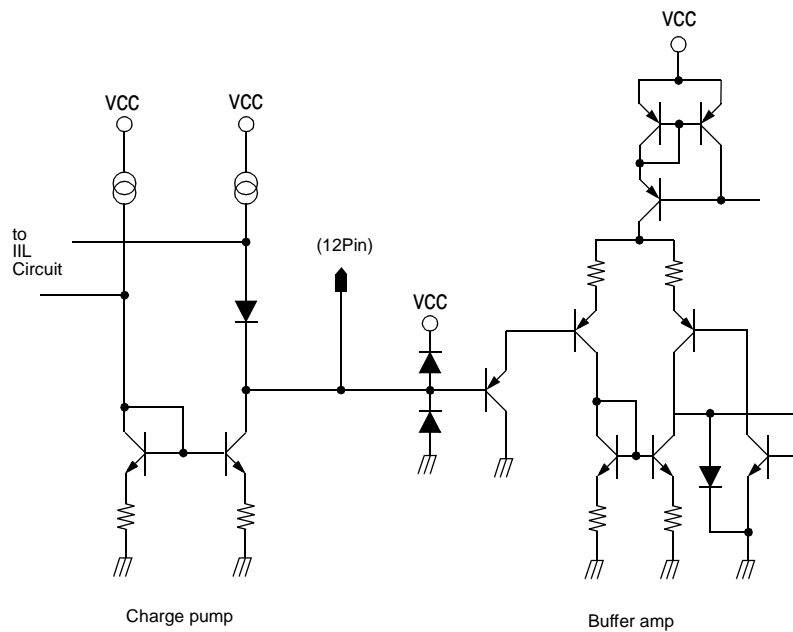
|   |  |
|---|--|
| <p style="text-align: center;">Index pulse width detection output</p> | <p style="text-align: center;">Phase compensation and current detection 1, 2</p> |
| <p style="text-align: center;">RPM select input</p>                   | <p style="text-align: center;">AGC input</p>                                     |
| <p style="text-align: center;">Index output</p>                       | <p style="text-align: center;">Index burst output</p>                            |

## Equivalent Circuits (Continued)

FG zero cross output



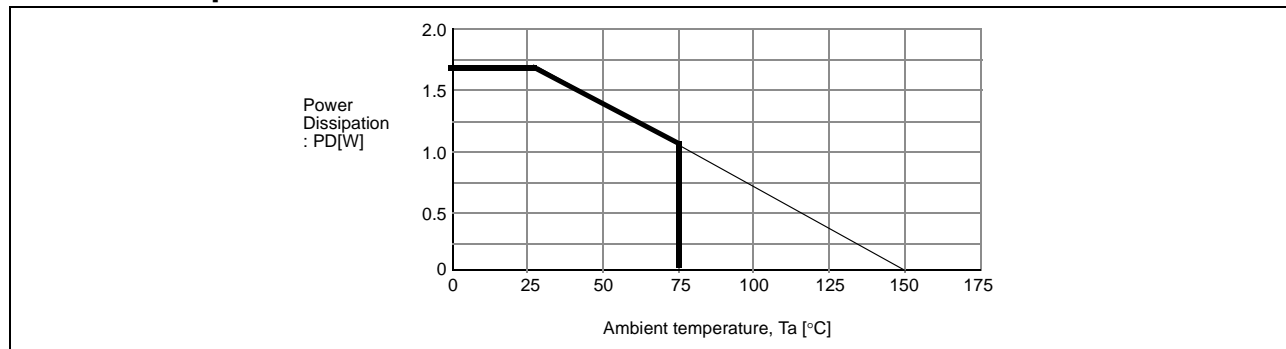
Charge pump output



## Absolute Maximum Rating (Ta=25°C)

| Parameter                    | Symbol | Value      | Unit |
|------------------------------|--------|------------|------|
| Maximum power supply voltage | VCCMAX | 7.0        | V    |
| Maximum input voltage        | VINMAX | 0 ~ VCC    | V    |
| Maximum output current       | IOMAX  | 1          | A    |
| Normal output current        | IO     | 0.7        | A    |
| Power dissipation            | PD     | 1.5        | W    |
| Operating temperature        | TA     | 0 ~ 75     | °C   |
| Junction temperature         | TJ     | 150        | °C   |
| Storage temperature          | TSTG   | -55 ~ +125 | °C   |

## Power Dissipation Curve



Power dissipation decreases in the rate of 13.5mW / °C when mounted on 50mm × 50mm × 1mm PCB (Phenolic resin material) and used above Ta=25°C.

## Recommended Operating Conditions (Ta=25°C)

| Parameter                           | Symbol     | Min. | Typ. | Max  | Unit |
|-------------------------------------|------------|------|------|------|------|
| Supply voltage                      | VCC1, VCC2 | 10.8 | 12.0 | 13.2 | V    |
| Supply voltage in logic part        | VCC3       | 4.5  | 5.0  | 5.5  | V    |
| Ambient operating temperature range | Ta         | 0    | -    | +70  | °C   |

## Temperature Characteristic

| Parameter                                    | Symbol | Min. | Typ. | Max | Unit |
|--|--------|------|------|-----|------|
| Thermal shutdown temperature <sup>note</sup> | TSD    | 125  | 150  | -   | °C   |

### NOTE:

Reference value



## Electrical Characteristics

(Ta=25°C, VCC=5V)

| Parameter  | Symbol | Conditions                 | Min.  | Typ.  | Max.  | Units |
|--|--------|----------------------------|-------|-------|-------|-------|
| <b>SUPPLY CURRENT</b>                            |        |                            |       |       |       |       |
| Supply current 1                                 | ICCO   | VCC=6.5V<br>CE=H, RPM=L    | -     | 1.0   | 2.0   | mA    |
| Supply current 2                                 | ICC    | VCC=6.5V, CE=L             | -     | 15    | 23    | mA    |
| <b>CHIP ENABLE</b>                               |        |                            |       |       |       |       |
| Input current                                    | ICE    | CE=0~5V                    | -     | 5     | 10    | μA    |
| Input low voltage                                | ICE1   | -                          | -     | -     | 1.0   | V     |
| Input high voltage                               | ICEH1  | -                          | 3.5   | -     | -     | V     |
| <b>RPM SELECT</b>                                |        |                            |       |       |       |       |
| Input current                                    | IRPM   | CE=0~5V                    | -     | 5     | 10    | μA    |
| Input low voltage                                | VRPM1  | -                          | -     | -     | 1.0   | V     |
| Input high voltage                               | VRPMH  | -                          | 3.5   | -     | -     | V     |
| <b>HALL AMP</b>                                  |        |                            |       |       |       |       |
| Input resistance <sup>note</sup>                 | RIN    | -                          | 1     | 10    | -     | kΩ    |
| Common mode input voltage range <sup>note</sup>  | VCOM   | -                          | 2.0   | -     | VCC   | V     |
| Differential input voltage range <sup>note</sup> | VDIF   | -                          | 100   | -     | 420   | mVPP  |
| <b>START-UP</b>                                  |        |                            |       |       |       |       |
| Hall bias voltage 1                              | VHB1   | I <sub>H</sub> =4mA, CE=L  | 2.3   | 2.5   | 2.7   | V     |
| Hall bias voltage 2                              | VHB2   | I <sub>H</sub> =10mA, CE=L | 2.7   | 2.9   | 3.1   | V     |
| Reference voltage                                | Vref   | I <sub>O</sub> =1mA, CE=L  | 1.7   | 2.2   | 2.7   | V     |
| Bias off current                                 | IHOFF  | V <sub>H</sub> =7V, CE=H   | -     | 5     | 10    | μA    |
| <b>OUTPUT AMP</b>                                |        |                            |       |       |       |       |
| Leakage current                                  | ICER   | -                          | -     | 0.5   | 1     | mA    |
| Saturation voltage 1                             | Vsat1  | I <sub>O</sub> =0.35A      | -     | 1.0   | 1.2   | V     |
| Saturation voltage 2                             | Vsat2  | I <sub>O</sub> =0.7A       | -     | 1.3   | 1.8   | V     |
| <b>BUFFER &amp; CONTROL AMP</b>                  |        |                            |       |       |       |       |
| Voltage gain 1 <sup>note</sup>                   | GCT1   | -                          | -     | -11   | -     | dB    |
| Reference voltage 1 <sup>note</sup>              | Vref1  | Current limiter voltage    | 0.205 | 0.208 | 0.210 | V     |
| Reference voltage 2 <sup>note</sup>              | Vref2  | Control begin voltage      | -     | 0.69  | -     | V     |

### Notes:

Reference value

## Electrical Characteristics (Continued)

(Ta=25°C, VCC=5V)

| Parameter                              | Symbol           | Conditions             | Min. | Typ.   | Max. | Units             |
|--|------------------|------------------------|------|--------|------|-------------------|
| <b>CHARGE PUMP</b>                     |                  |                        |      |        |      |                   |
| Charge current                         | ICP-             | RPM=L                  | -15  | -20    | -25  | μA                |
| Discharge current                      | ICP+             | RPM=L                  | 15   | 20     | 25   | μA                |
| Current ratio <sup>note</sup>          | IR               | ICP+ / ICP-            | 0.9  | 1.0    | 1.1  | -                 |
| Off current                            | I <sub>OFF</sub> | V <sub>CP</sub> =0.63V | -    | -      | 50   | nA                |
| Clamp voltage <sup>note</sup>          | V <sub>CLP</sub> | -                      | -    | 1.3    | 1.5  | V                 |
| <b>FG AMP</b>                          |                  |                        |      |        |      |                   |
| Output DC voltage <sup>note</sup>      | V <sub>FG</sub>  | -                      | 1.0  | 1.3    | 1.6  | V                 |
| Voltage gain 2                         | G <sub>FG</sub>  | -                      | 24   | 34     | 44   | dB                |
| Input voltage range <sup>note</sup>    | V <sub>IN</sub>  | -                      | 2.0  | -      | 20   | mV <sub>P-P</sub> |
| Noise margin 1 <sup>note</sup>         | N <sub>D</sub>   | Differential noise     | -    | -      | 0.5  | mV <sub>P-P</sub> |
| Noise margin 2 <sup>note</sup>         | N <sub>C</sub>   | Common mode noise      | -    | -      | 0.5  | V <sub>P-P</sub>  |
| <b>SPEED CONTROL</b>                   |                  |                        |      |        |      |                   |
| Count range 1 <sup>note</sup>          | N1               | RPM=L                  | -    | 1666.5 | -    | -                 |
| Count range 2 <sup>note</sup>          | N2               | RPM=H                  | -    | 1388.5 | -    | -                 |
| Operating freq.                        | F <sub>D</sub>   | -                      | -    | 1.0    | 1.1  | MHz               |
| <b>BURST ADJUSTMENT</b>                |                  |                        |      |        |      |                   |
| Input current                          | I <sub>BI</sub>  | -                      | -    | 1      | 2    | μA                |
| Threshold voltage 1                    | V <sub>TH1</sub> | RPM=L                  | 1.2  | 1.45   | 1.7  | V                 |
| Threshold voltage 2                    | V <sub>TH2</sub> | RPM=H                  | 1.05 | 1.3    | 1.55 | V                 |
| <b>PULSE WIDTH ADJUSTMENT</b>          |                  |                        |      |        |      |                   |
| Ct2 charge current                     | I <sub>CT2</sub> | -                      | -19  | -25    | -36  | μA                |
| Threshold voltage 3                    | V <sub>TH3</sub> | -                      | 0.9  | 1.1    | 1.3  | V                 |
| <b>INDEX OUTPUT</b>                    |                  |                        |      |        |      |                   |
| Output leakage current <sup>note</sup> | I <sub>OH</sub>  | -                      | -    | 1      | 2    | μA                |
| Output low voltage                     | V <sub>O1</sub>  | I <sub>O</sub> =1mA    | -    | 0.2    | 0.4  | V                 |

**Notes:**

Reference value

## Application Information

### 1. CHIP ENABLE

This function turns on or off all blocks by low or high signal.

### 2. U, V AND W PHASE OUTPUT AMP

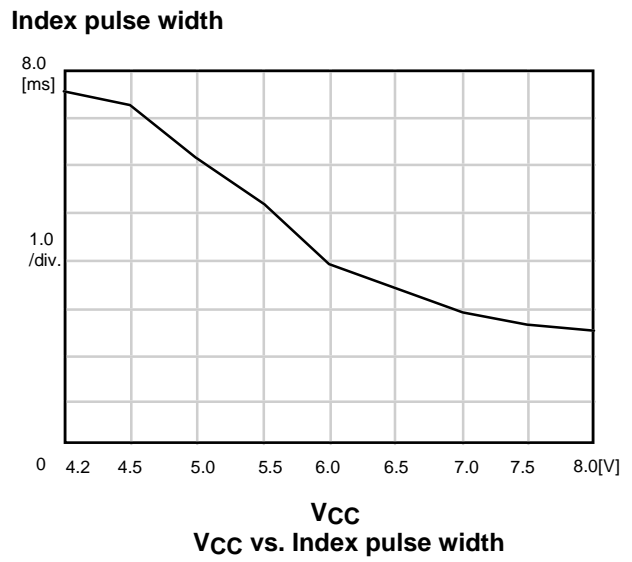
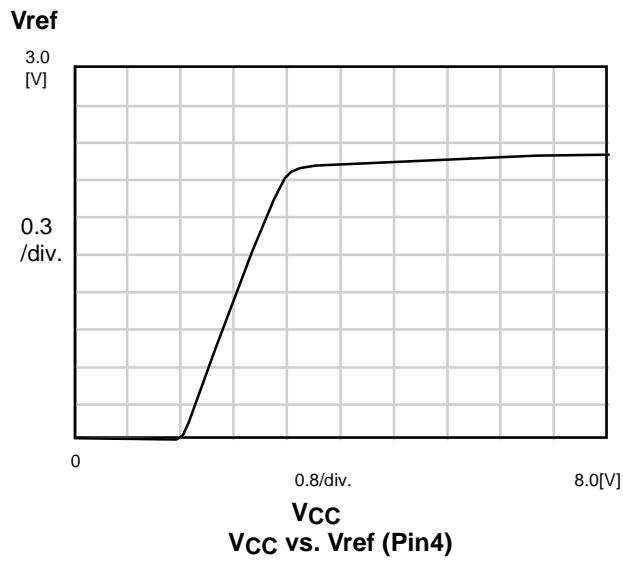
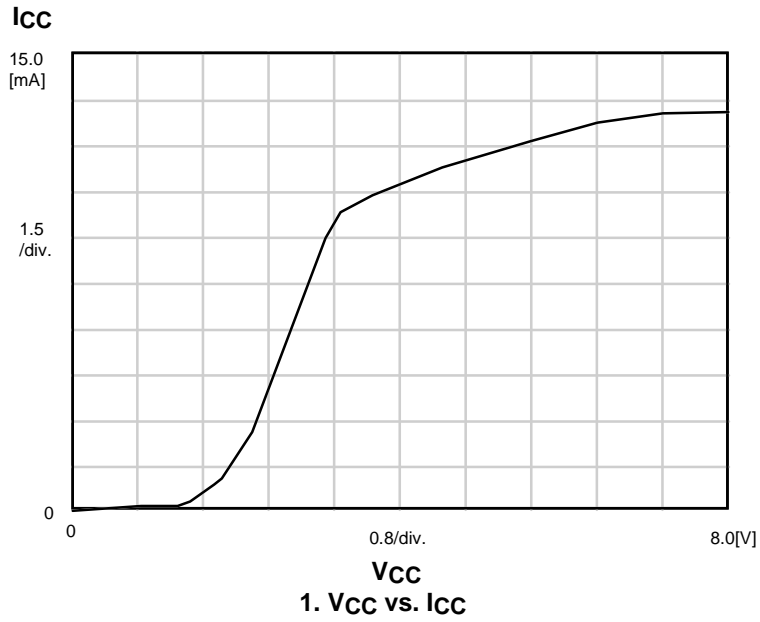
These amplifiers drives three output phases - U, V, and W which have 120(degree) phase differences with each other. The three phase waveforms are made with the two hall sensor signals by synthesizing the third phase signal.

### 3. SPEED CONTROL PART

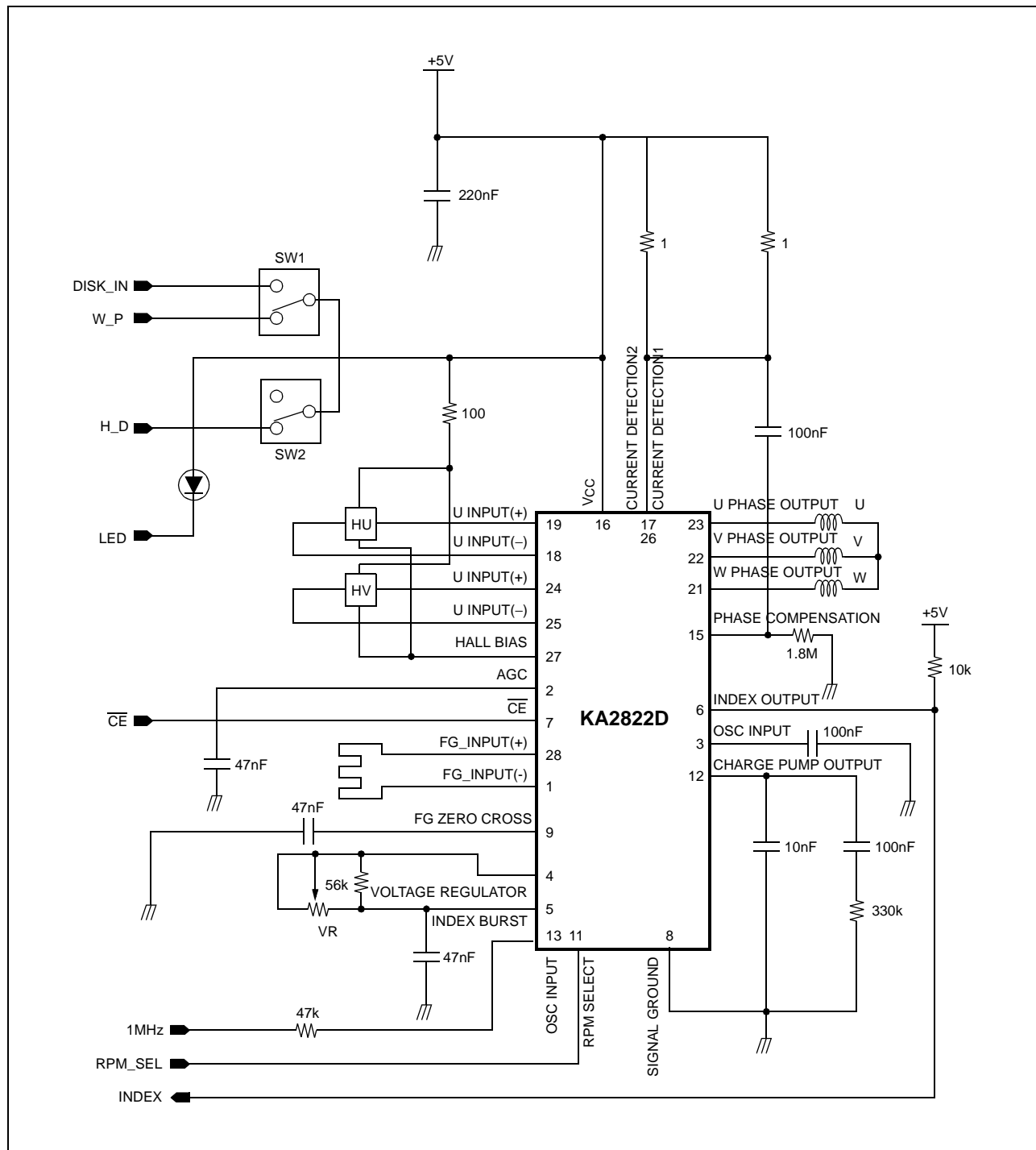
This function compares the real motor rotation frequency with the 300 or 360Hz pulse divided from 1MHz clock pulse for removing speed error when motor is on and speed error is detected by PLL.

The speed error sent to charge pump part which repeats charge and discharge controls the output current of the output amp to keep a stable rotation.

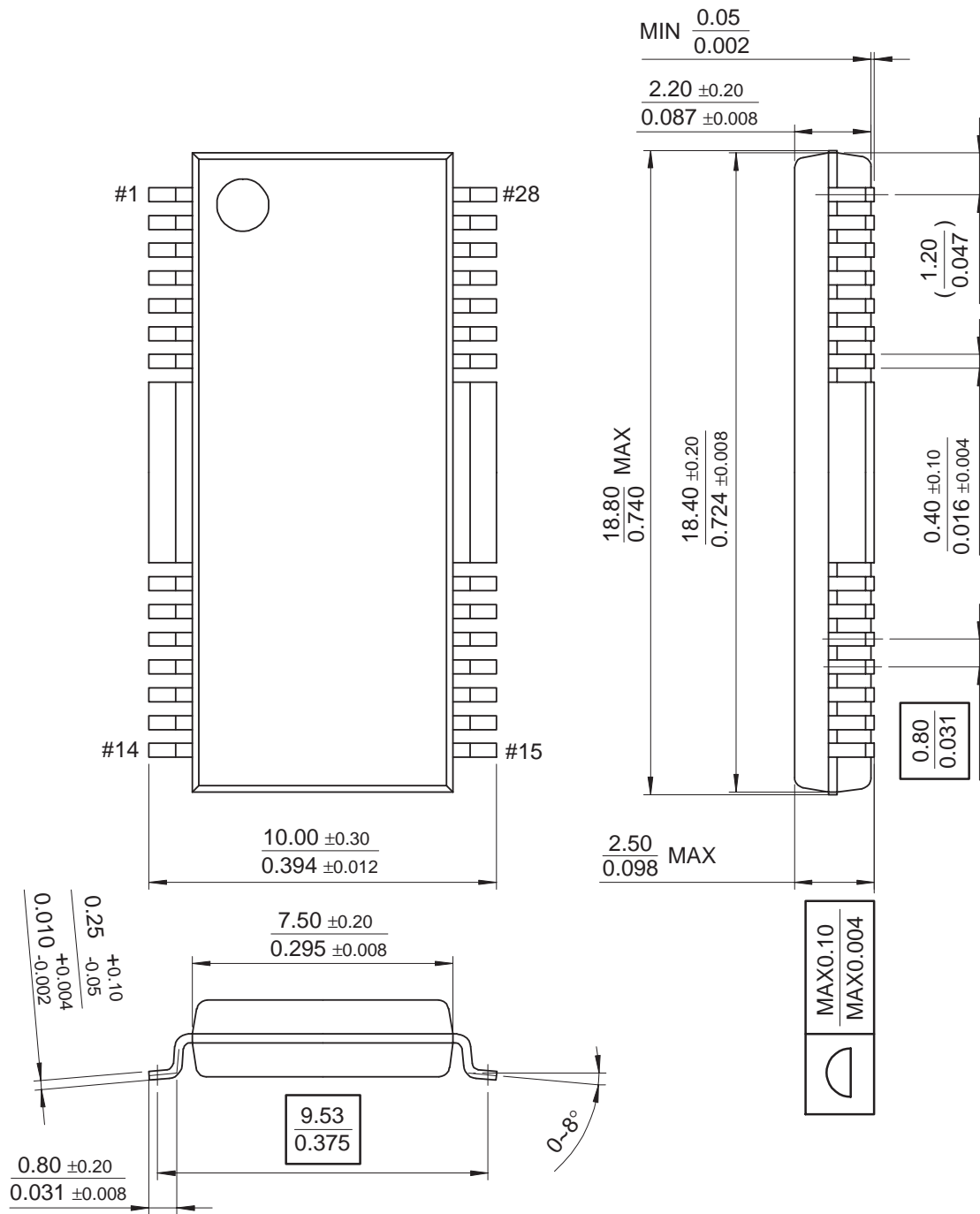
## Typical Performance Characteristics



## Typical Application Circuits



# 28-SSOPH-375



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| FACT Quiet Series <sup>TM</sup>   | POP <sup>TM</sup>                | TinyLogic <sup>TM</sup>          |                   |
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