

# TB6534F/FG

## Video Camera Cylinder Motor Controllers and Capstan Motor Controllers

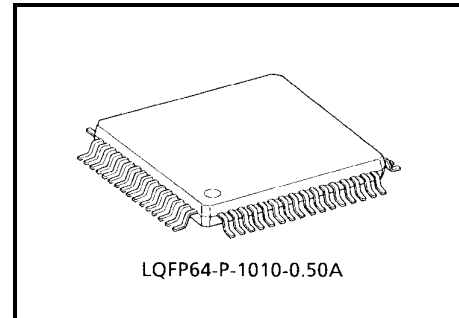
The TB6534F/FG is a single-chip IC for video camera cylinder motor controllers and capstan motor controllers.

The cylinder section is a soft-switching pre-driver based on a 3-phase full-wave sensorless driver and 180° trapezoidal wave commutation control.

The capstan section is a soft-switching pre-driver based on 3-phase full-wave drive and pseudo-sine wave commutation control.

### Features

- Operating voltage:  $V_{CC (opr)} = 2.7$  to  $5.5$  V
- <Cylinder part>
- Built-in FG/PG amplifier
  - CW, CCW, and stop modes are available
  - Detect upper VCE, and output PWM for external switch regulator
  - Built-in current limiter
  - Built-in VM short-protection
- <Capstan part>
- 2-way FG amplifier
  - CW, CCW, and stop modes are available
  - Detect upper VCE, and output PWM for external switch regulator
  - Built-in current limiter
  - Built-in VM short-protection



Weight: 0.34 g (typ.)

#### TB6534FG:

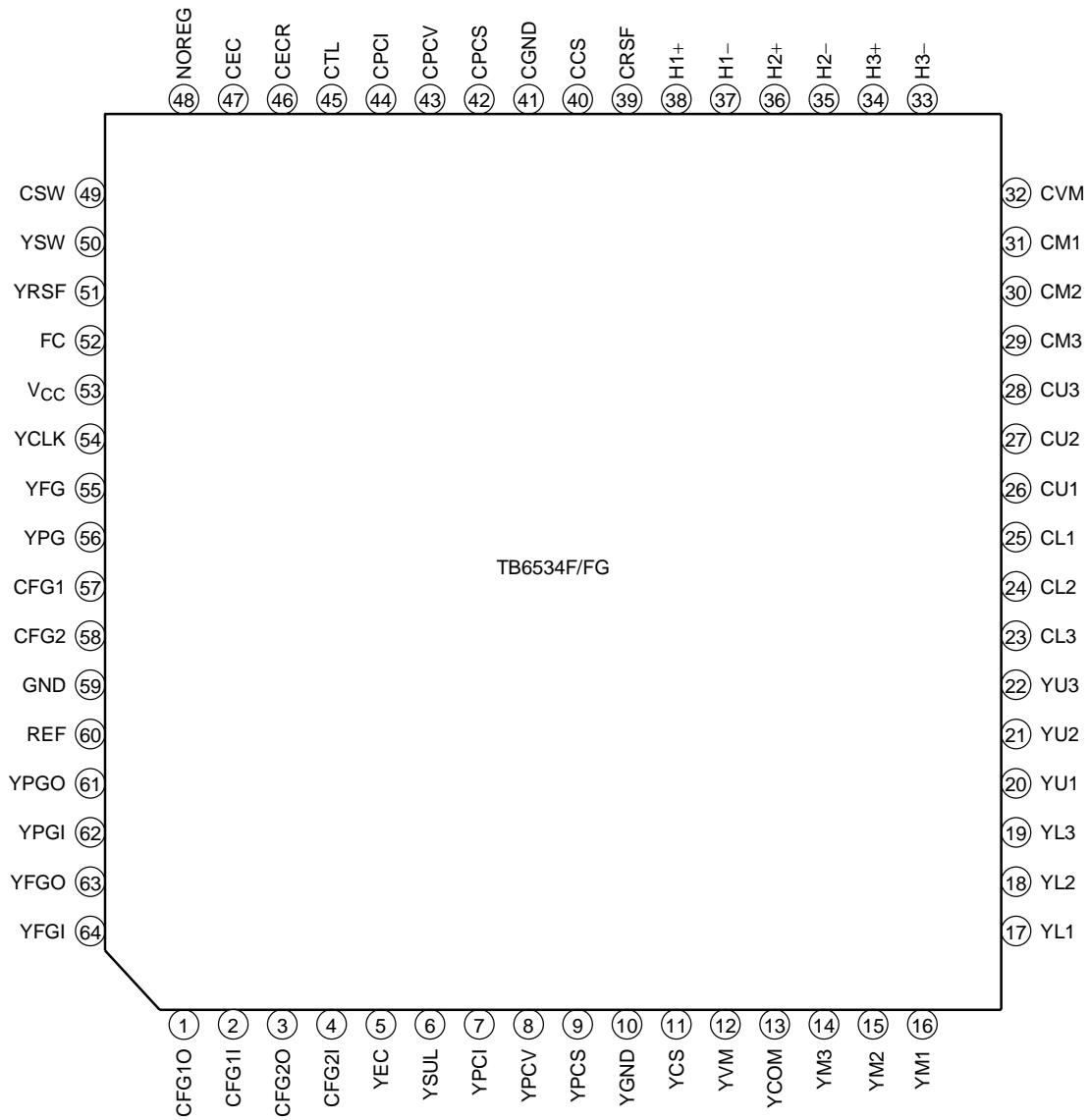
The TB6534FG is a Pb-free product.

The following conditions apply to solderability:

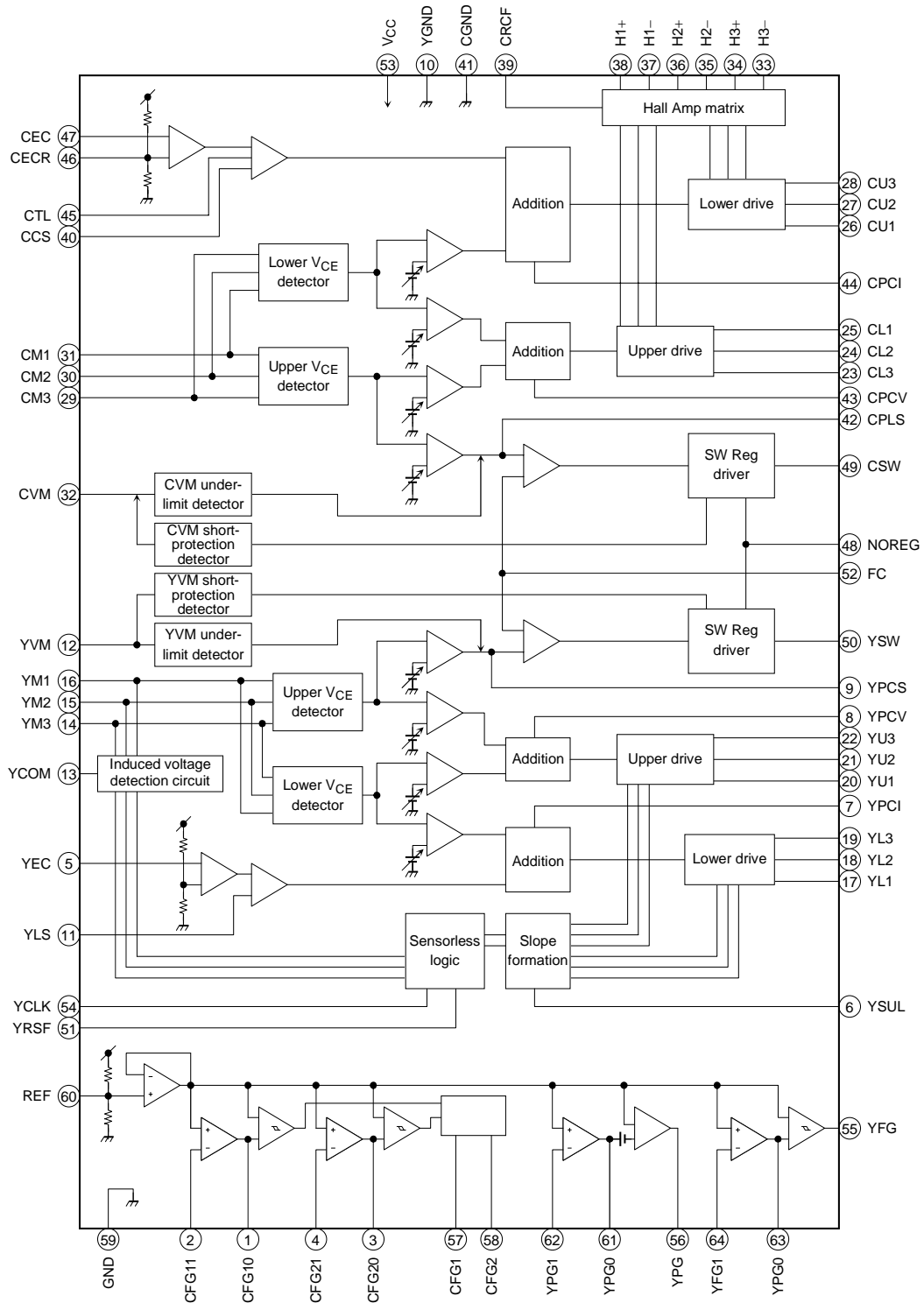
#### \*Solderability

1. Use of Sn-37Pb solder bath
  - \*solder bath temperature = 230°C
  - \*dipping time = 5 seconds
  - \*number of times = once
  - \*use of R-type flux
2. Use of Sn-3.0Ag-0.5Cu solder bath
  - \*solder bath temperature = 245°C
  - \*dipping time = 5 seconds
  - \*the number of times = once
  - \*use of R-type flux

## Pin Connection



Block Diagram



**Pin Function**

Pin No.	Symbol	Functional Description	Pin No.	Symbol	Functional Description
1	CFG1O	Capstan part FG amplifier output pin 1	33	H3-	Capstan motor hall element input pin
2	CFG1I	Capstan part FG input pin 1	34	H3+	
3	CFG2O	Capstan part FG amplifier output pin 2	35	H2-	
4	CFG2I	Capstan part FG input pin 2	36	H2+	
5	YEC	Cylinder part torque command input pin	37	H1-	
6	YSUL	Cylinder part slope voltage pin	38	H1+	
7	YPCI	Cylinder part current feedback phase compensation	39	CRSF	Capstan part directional control input pin
8	YPCV	Cylinder part voltage feedback phase compensation	40	CCS	Capstan part current detection input pin
9	YPCS	Cylinder part switching voltage control output pin	41	CGND	Capstan part ground pin
10	YGND	Cylinder part ground pin	42	CPCS	Capstan part switching voltage control output
11	YCS	Cylinder part current detection input pin	43	CPCV	Capstan part voltage feedback phase compensation
12	YVM	Cylinder motor power voltage pin	44	CPCI	Capstan part current feedback phase compensation
13	YCOM	Cylinder motor coil neutral pin	45	CTL	Capstan part torque limit
14	YM3	Cylinder motor coil pin	46	CECR	Capstan part torque command reference voltage
15	YM2		47	CEC	Capstan part torque command input pin
16	YM1		48	NOREG	SW Transistor charge removal pin
17	YL1	Cylinder motor lower pre-driver output pin	49	CSW	Capstan part switching pre-driver output
18	YL2		50	YSW	Cylinder part switching pre-driver output
19	YL3		51	YRSF	Cylinder part standby switch input
20	YU1	Cylinder motor upper pre-driver output pin	52	FC	Switching comparator's triangular-wave input pin
21	YU2		53	V <sub>CC</sub>	Power voltage supply pin for Logic
22	YU3		54	YCLK	Cylinder part clock input pin
23	CL3	Capstan motor lower pre-driver output pin	55	YFG	Cylinder part FG pulse wave output
24	CL2		56	YPG	Cylinder part PG pulse wave output
25	CL1		57	CFG1	Capstan part FG pulse wave output 1
26	CU1	Capstan motor upper pre-driver output pin	58	CFG2	Capstan part PG pulse wave output 2
27	CU2		59	GND	FG/PG part GND pin
28	CU3		60	REF	FG/PG part reference voltage pin
29	CM3	Capstan motor coil pin	61	YPGO	Cylinder part PG amplifier output pin
30	CM2		62	YPGI	Cylinder part PG input
31	CM1		63	YFGO	Cylinder part FG amplifier output pin
32	CVM	Capstan motor power voltage pin	64	YFGI	Cylinder part FG input

## Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit	Note
Supply voltage	V <sub>CC</sub>	8	V	V <sub>CC</sub>
Motor supply voltage	V <sub>M</sub>	12	V	YVM, CVM
Battery supply voltage	V <sub>B</sub>	12	V	NOREG (VB), YSW, CSW
Output pin voltage	V <sub>N</sub>	12	V	YM1, YM2, YM3, YU1, YU2, YU3, YL1, YL2, YL3, CM1, CM2, CM3, CU1, CU2, CU3, CL1, CL2, CL3
Input pin voltage	V <sub>I</sub>	-0.3 to V <sub>CC</sub> + 0.3	V	YSTB, YCLK, FC, YPGi, YFGi, CFG1i, CFG2i, CRSF, YCS, CCS, CTL, CECR, CEC, YEC
Power dissipation	P <sub>D</sub>	0.95	W	Before mounting on a PCB
Operating temperature	T <sub>opr</sub>	-20 to 85	°C	
Storage temperature	T <sub>stg</sub>	-55 to 125	°C	

## Recommended Operating Condition

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Supply voltage	V <sub>CC</sub>	—	—	2.7	3.0	3.3	V
Clock input frequency	V <sub>sl</sub>	—	—	400	430	440	kHz

## Electrical Characteristics (unless otherwise specified, Ta = 25°C, VCC = 3.0 V, Vb = 7.2 V)

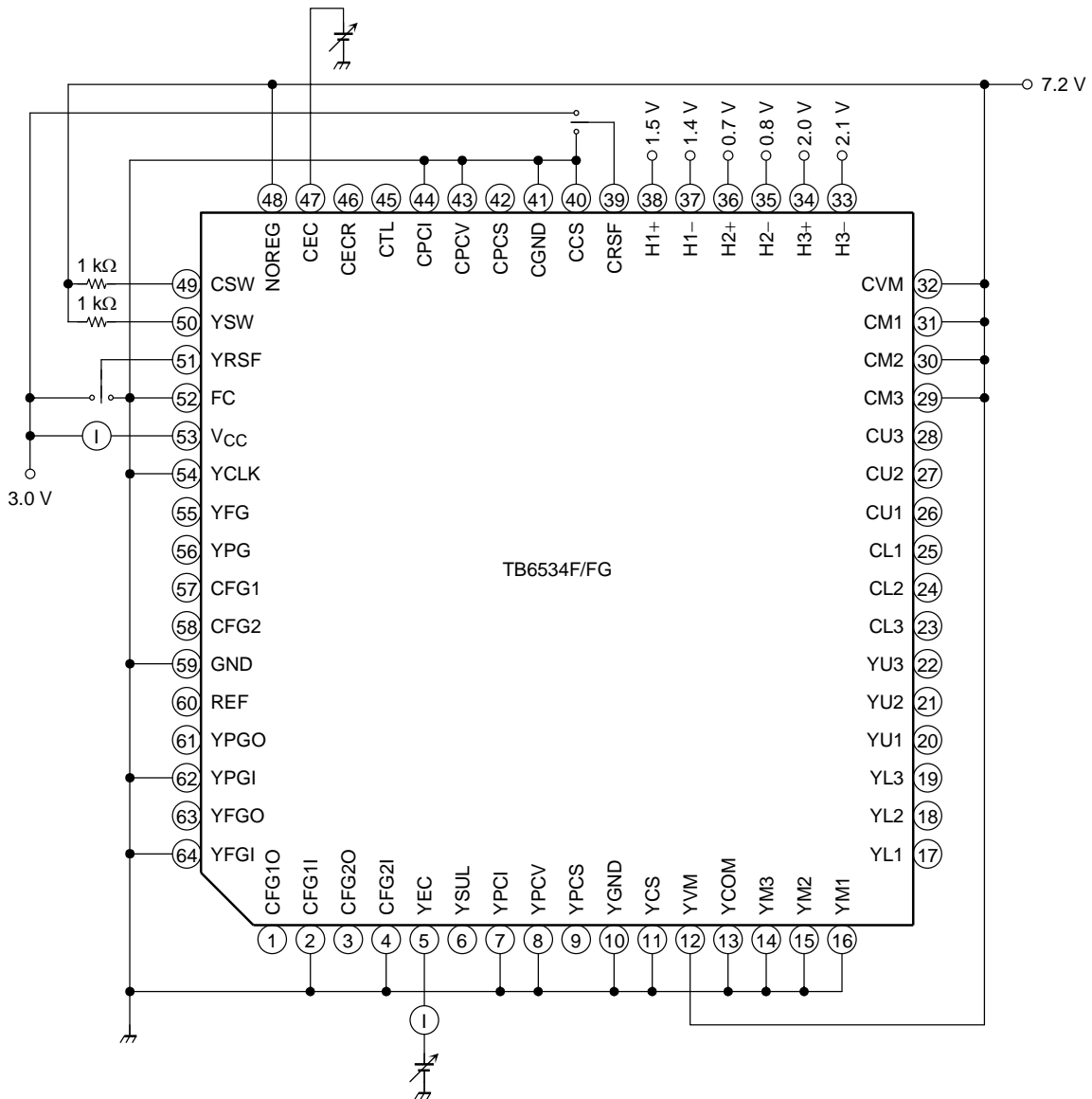
### Cylinder Part

No.	Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
1	Supply current (1)	I <sub>CC (1)</sub>	1	Both cylinder and capstan parts are during operation.	—	15	20	mA
2	Supply current (2)	I <sub>CC (2)</sub>	1	Both cylinder and capstan parts are during standby state.	—	6.1	12	mA
3	ECR voltage	VECR	2	—	1.5	1.7	1.9	V
4	Torque control input current	YIEC	1	YEC = 0 V	-5	-2	—	μA
5	Input/output gain	YGio	2	—	0.15	0.17	0.20	
6	Maximum output voltage	YCSmax	2	RYCS = 0.22 Ω	150	168	183	mV
7	Lower side output voltage (1)	VL (1)	3	YCS = 54 mV	0.15	0.2	0.3	V
8	Lower side output voltage (2)	VL (2)	3	YECR = 1.5 V, YEC = 0 V	0.35	0.5	0.65	V
9	Upper side drive current	YIU	4	YIU = -10 mA	—	0.65	1.2	V
10	Lower side drive current	YIL	4	YIL = 10 mA	1.1	1.6	—	V
11	YFG amp gain	YGFG	5	V <sub>p-p</sub> = 1.5 mV, f = 1 kHz	45	—	—	
12	YFG high level	YFG (H)	6	IYFG = -100 μA	2.5	2.8	—	V
13	YFG low level	YFG (L)	6	IYFG = 100 μA	—	0.1	0.5	V
14	PG amp gain	YGPG	5	V <sub>p-p</sub> = 1.5 mV, f = 1 kHz	45	—	—	
15	PG amp offset voltage	ΔPGin	6	—	0.4	0.45	0.52	V
16	YPG high level	YPG (H)	6	IYPG = -100 μA	2.5	2.8	—	V
17	YPG low level	YPG (L)	6	IYPG = 100 μA	—	0.1	0.5	V
18	Forward rotation control voltage	YVf	7	—	—	—	0.5	V
19	STB control voltage	YVs	7	—	1.2	—	1.9	V
20	Reverse rotation control voltage	YVr	7	—	2.4	—	—	V
21	Amp reference voltage	V <sub>REF</sub>	2	—	1.0	1.24	1.5	V
22	Output idle voltage	YCSidle	2	RYCS = 0.22 Ω	—	0	5	mV
23	SW power voltage input offset	YSWofs	8	—	-30	—	30	mV
24	SW power voltage control output gain	YGPCS	9	—	—	80	—	
25	SW power voltage control output voltage (1)	YVUD (1)	9	YEC = 1.5 V, YPCS = 1.7 V	0.1	0.2	0.3	V
26	SW power voltage control output voltage (2)	YVUD (2)	9	YEC = 0 V	0.05	0.1	0.15	V
27	SW power voltage output maximum current	YISWB	9	YEC = 0 V	10	—	—	mA
28	V <sub>M</sub> under limit	YVML	10	—	1.2	1.5	1.7	V
29	V <sub>M</sub> short protection	YVMS	10	—	0.2	0.3	0.4	V
30	SW output enforced ON EC voltage	YSWEC	9	—	1.2	1.3	1.4	V

## Capstan Part

No.	Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
31	Torque control input current	CIEC	11	CEC = CE <sub>CR</sub> = 1.5 V	-3	-1	—	μA
32	Torque control reference voltage	CE <sub>CR</sub>	11	—	1.3	1.5	1.7	V
33	Torque control input voltage	CEC	12	—	0.2	—	2.8	V
34	Output maximum voltage	CCS <sub>max</sub>	12	RCCS = 0.27 Ω	0.19	0.23	—	V
35	Torque control I/O gain	CG <sub>io</sub>	12	—	0.21	0.24	0.26	V
36	Output idle voltage	CCS <sub>idle</sub>	12	—	—	0	4	mV
37	Torque control input offset	CEC <sub>ofs</sub>	12	—	-100	41	100	mV
38	Torque control dead zone	CEC <sub>dz</sub>	12	—	50	88	130	mV
39	Low side V <sub>CE</sub> voltage (1)	CVLL (1)	13	CCS = 60 mV	0.17	0.23	0.35	V
40	Low side V <sub>CE</sub> voltage (2)	CVLL (2)	13	CEC = 0 V, CTL = 1.0 V	0.45	0.62	0.75	V
41	Hall element permissible input voltage (1)	Hin (1)	14	—	1.2	—	1.8	V
42	Hall element permissible input voltage (2)	Hin (2)	14	—	0.4	—	1.3	V
43	Hall element permissible input voltage (3)	Hin (3)	14	—	1.9	—	2.7	V
44	Hall element input conversion offset	Hofs	15	—	-8	-2	8	mV
45	TL-CS offset	TLofs	16	CTL = 20 mV	8	12	16	mV
46	Forward rotation control voltage	CV <sub>f</sub>	17	—	—	—	0.5	V
47	Stop control voltage	CV <sub>s</sub>	17	—	1.2	—	2.0	V
48	Reverse rotation control voltage	CV <sub>r</sub>	17	—	2.4	—	—	V
49	Ripple cancel rate	R	18	CCS = 60 mV	7	9	14	%
50	Upper drive maximum voltage	CIU	19	CIU = -7 mA	—	0.55	0.7	V
51	Lower drive maximum voltage	CIL	19	CIL = 7 mA	1.4	1.7	—	V
52	SW power voltage input offset	CSWofs	20	—	-30	—	30	mV
53	SW power voltage control output gain	CGPCS	21	—	—	73	—	
54	SW power voltage control output voltage (1)	CVUD (1)	21	CEC = CE <sub>CR</sub> , CPCS = 1.7 V	0.1	0.2	0.3	V
55	SW power voltage control output voltage (2)	CVUD (2)	21	CEC = 0 V	—	0	0.1	V
56	SW power voltage output maximum current	CISWB	21	CEC = 0 V	10	—	—	mA
57	FG amplifier loop gain	CGFG	22	1 kΩ, 220 kΩ, 3 mV <sub>p-p</sub> , 1 kHz	46	—	—	
58	FG amplifier output voltage high level	CFGH	22	IFGH = -100 μA	2.5	—	—	V
59	FG amplifier output voltage low level	CFGL	22	IFGL = 100 μA	—	—	0.5	V
60	V <sub>M</sub> under limit	CVML	23	—	0.7	0.82	1.1	V
61	V <sub>M</sub> short protection	CVMS	23	—	0.2	0.32	0.4	V
62	SW output enforced ON EC voltage	CSWEC	21	—	—	—	0.6	V
63	NOREG pin current	IREG	20	—	—	0	2.0	μA

**Test Circuit 1 I<sub>CC</sub> (1), I<sub>CC</sub> (2), YIEC**



No.1 I<sub>CC</sub> (1)

The input current to V<sub>CC</sub> pin when YRSF = 0 V, YEC = 0 V, CEC = 0 V, and CRSF = 0 V

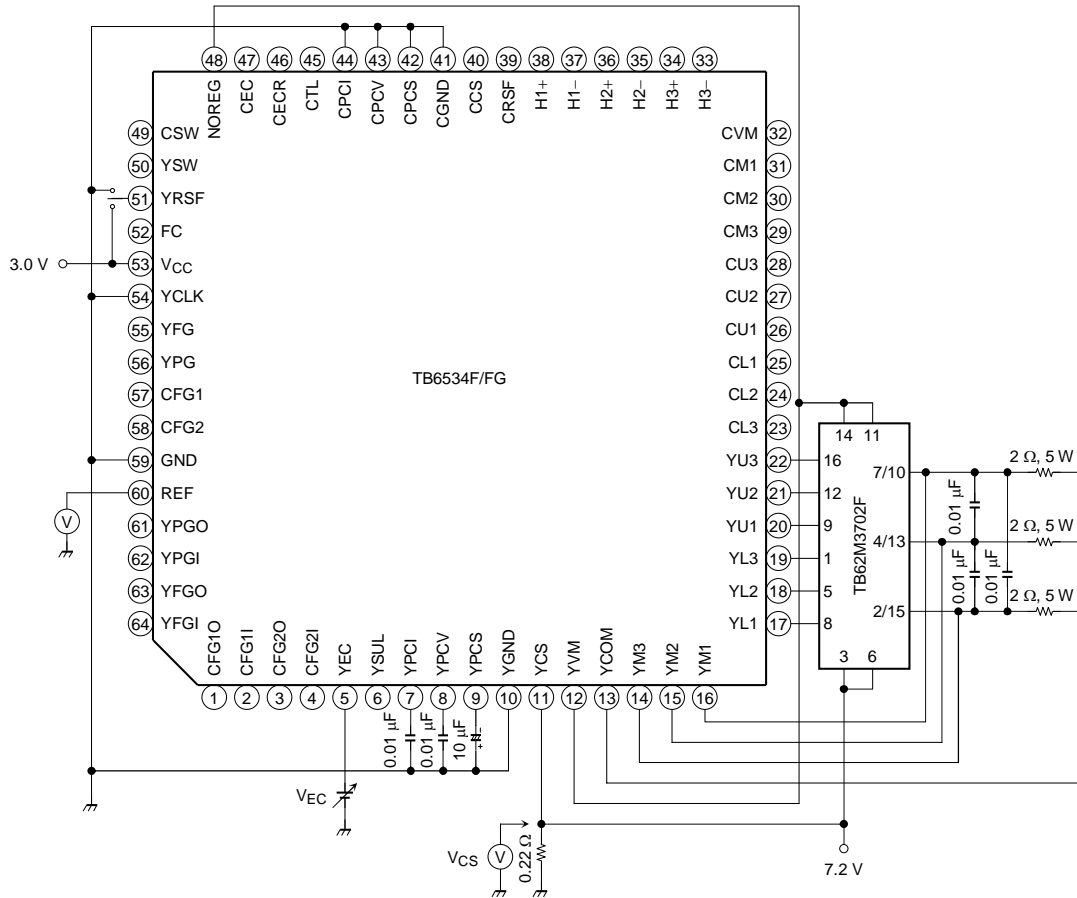
No.2 I<sub>CC</sub> (2)

Set YRSF = OPEN, YEC = 1.5 V, CEC = 1.5 V, and CRST = OPEN, then measure the current to V<sub>CC</sub> pin.

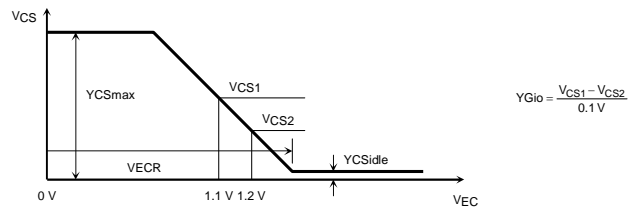
No.4 YIEC



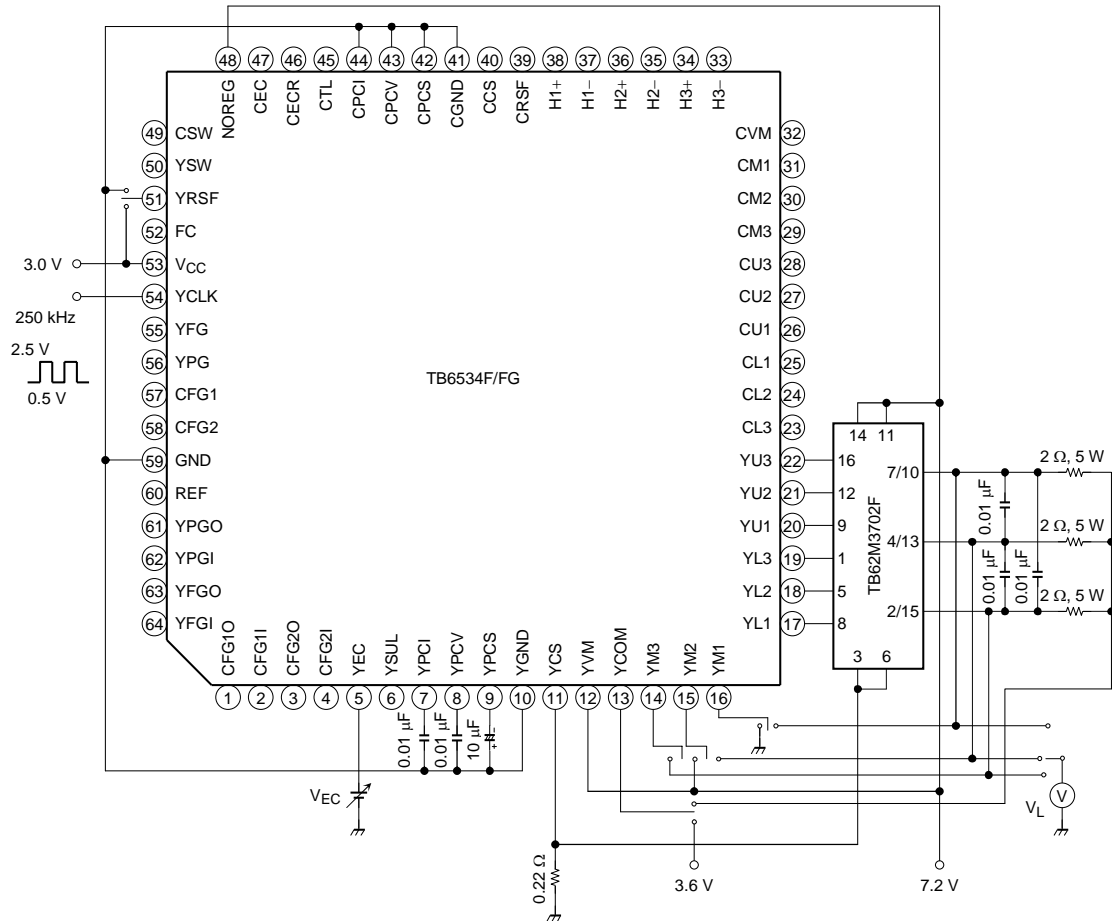
Test Circuit 2 VECR, YG<sub>io</sub>, YCS<sub>max</sub>, YCS<sub>idle</sub>, V<sub>REF</sub>



No.3 VECR, No.5 YG<sub>io</sub>, No.6 YCS<sub>max</sub>, No.21 V<sub>REF</sub>, No.22 YCS<sub>idle</sub>  
 Set YRSF = 0 V or 3 V, and change YEC from 0 V to 3 V, then measure the potential of YCS.



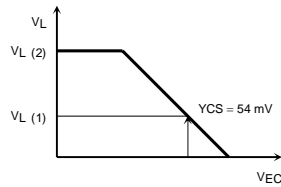
Test Circuit 3  $V_L(1)$ ,  $V_L(2)$



No.7  $V_L(1)$ , No.8  $V_L(2)$

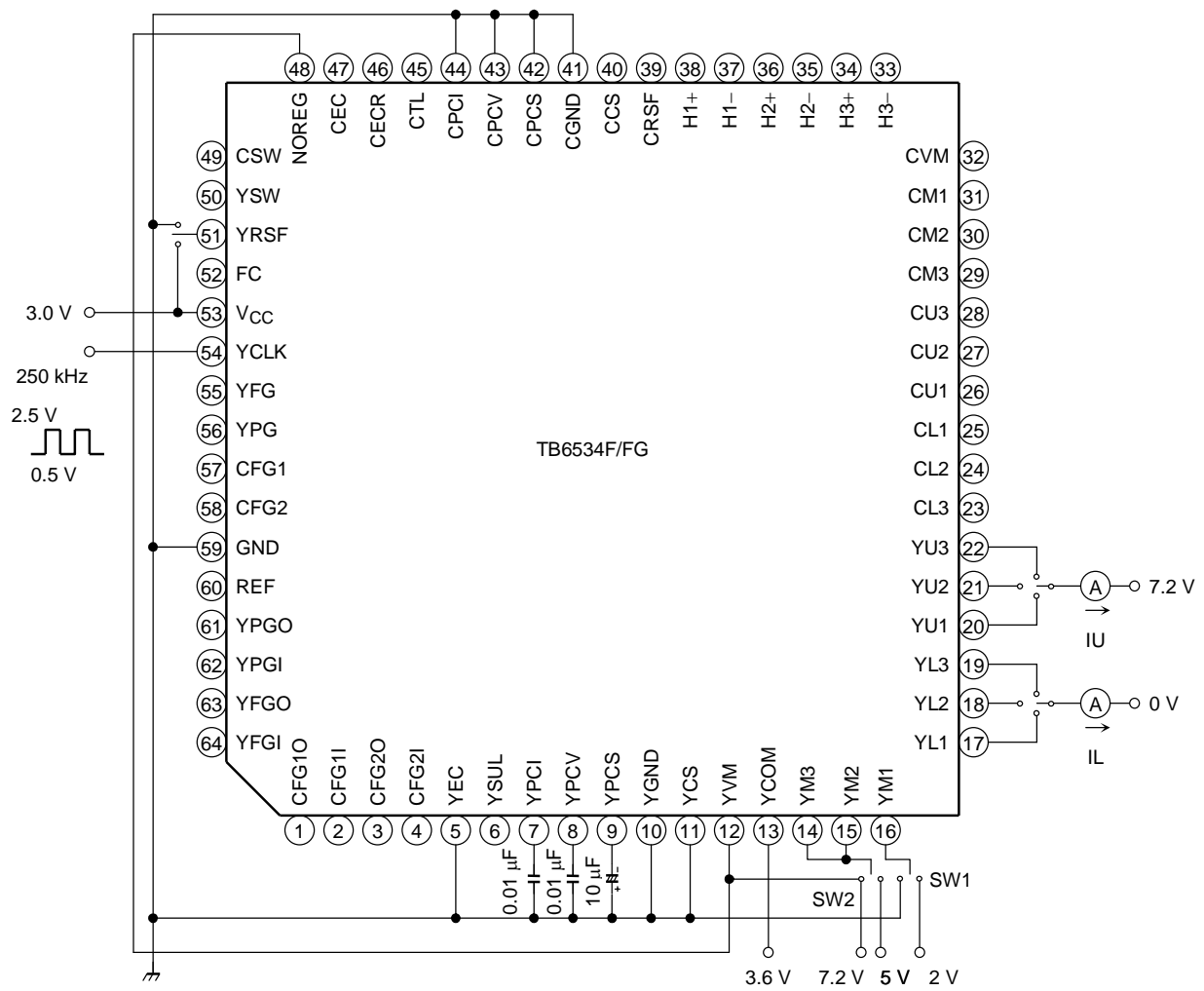
Change the pin YRSF from OPEN to L or H with  $Y_{M1} = 0V$ ,  $Y_{M2} = 6V$ ,  $Y_{M3} = 6V$ , and then enter the following clock counts into the pin YCLK in order to set the drive angle.

Connect the pins  $Y_{M1}$ ,  $Y_{M2}$ , and  $Y_{M3}$  to PWTR after setting the drive angle and then carry out the measurement.



Clock	160	300	540
Test pin	$Y_{M3}$	$Y_{M1}$	$Y_{M2}$

## Test Circuit 4 YIU, YIL

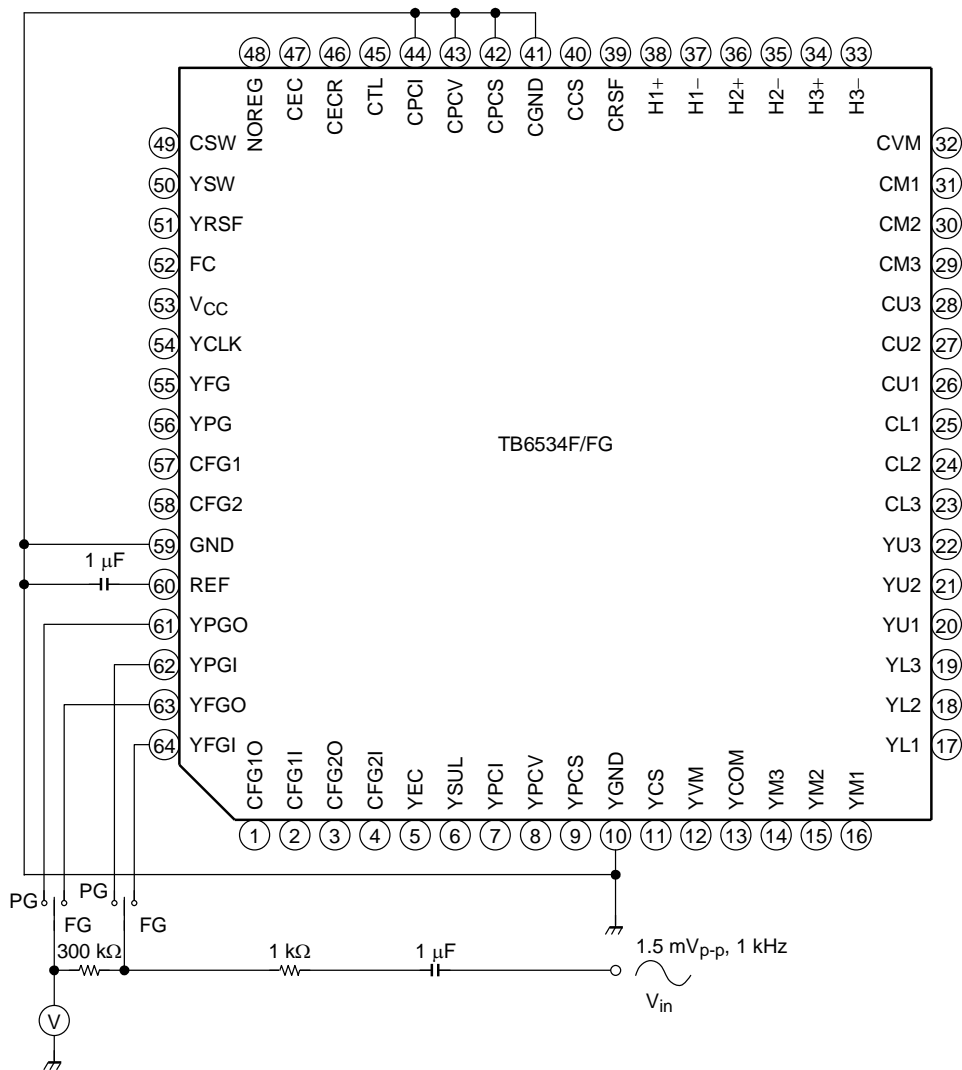


No.9 YIU, No.10 YIL

Change the pin YFRS from OPEN to L or H, and then enter the following clock counts into the pin YCLK in order to set the drive angle.

Clock	100		210		400	
Test Pin	YU1	YL3	YU2	YL1	YU3	YL2
SW1	0 V	2 V	0 V	2 V	0 V	2 V
SW2	5 V	7.2 V	5 V	7.2 V	5 V	7.2 V

## Test Circuit 5 YGFG, YGPG



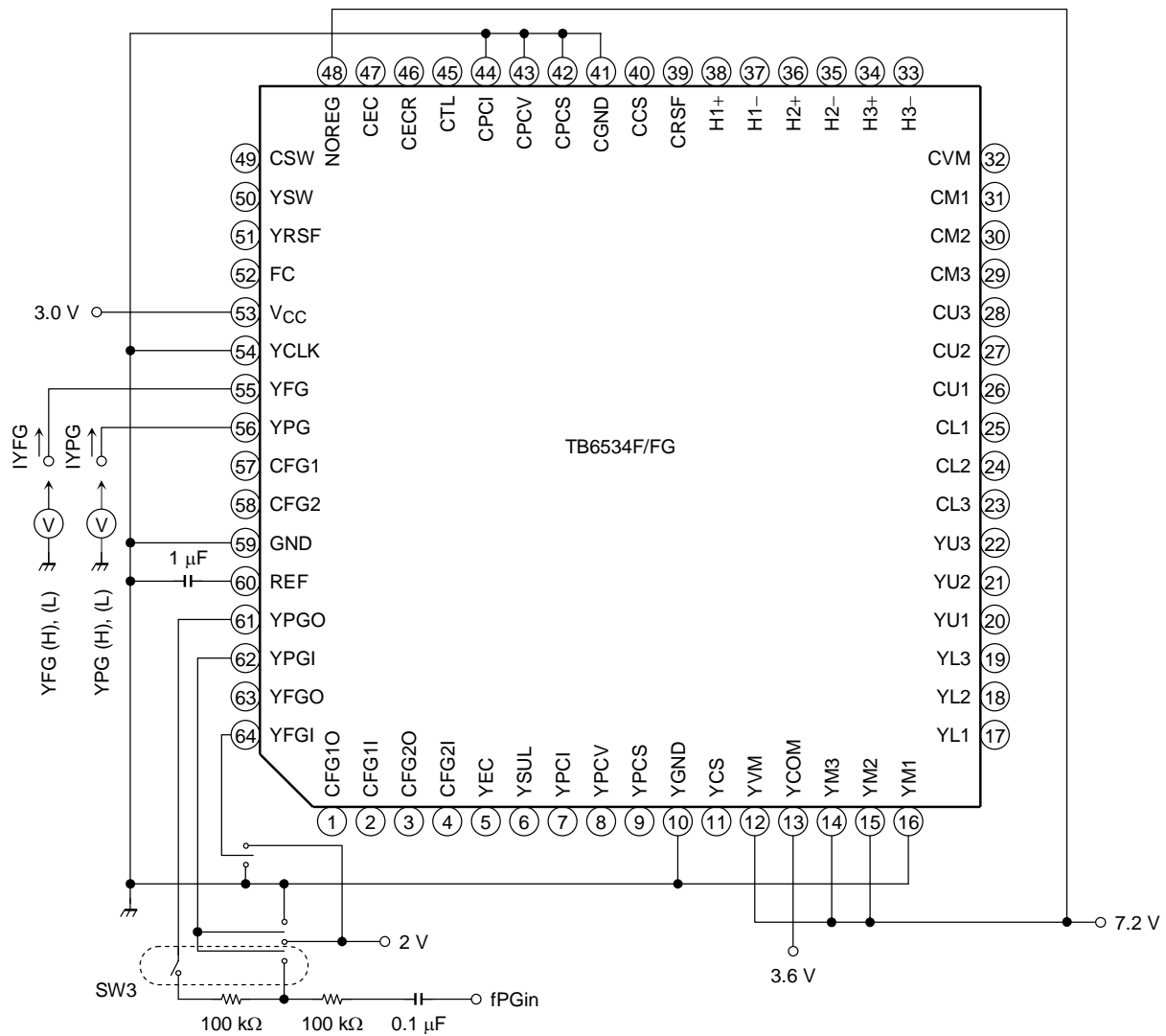
No.11 YGFG

Set the SW to FG, measure  $V_o$  when  $V_{in} = 1.5 \text{ mV}_{p-p}$  at 1 kHz and acquire  $GFG = 20 \log (V_o/V_{in})$

No.15 YGPG

Set the SW to PG, measure  $V_o$  when  $V_{in} = 1.5 \text{ mV}_{p-p}$  at 1 kHz and acquire  $GFG = 20 \log (V_o/V_{in})$

**Test Circuit 6 YFG (H), YFG (L), ΔPGin, YPG (H), YPG (L)**



**No.12 YFG (H)**

Apply 2 V to YFGin and set YFG to High. Then measure the YFG potential when  $-100\ \mu\text{A}$  is input to IYFG.

**No.13 YFG (L)**

Apply 0 V to YFGin and set YFG to Low. Then measure the YFG potential when  $100\ \mu\text{A}$  is input to IYFG.

**No.15 ΔPGin**

Turn SW3 on and input 10 kHz square wave from fPGin. Set fPGin to  $1.2\ \text{V}_{\text{p-p}}$  ( $\Delta\text{PGin} = 0.6\ \text{V}$ ) and check that the pin YPG is active.

Also, set  $\text{V}_{\text{p-p}}$  to  $0.8\ \text{V}$  ( $\Delta\text{PGin} = 0.4\ \text{V}$ ) and check that the pin YPG is not active.

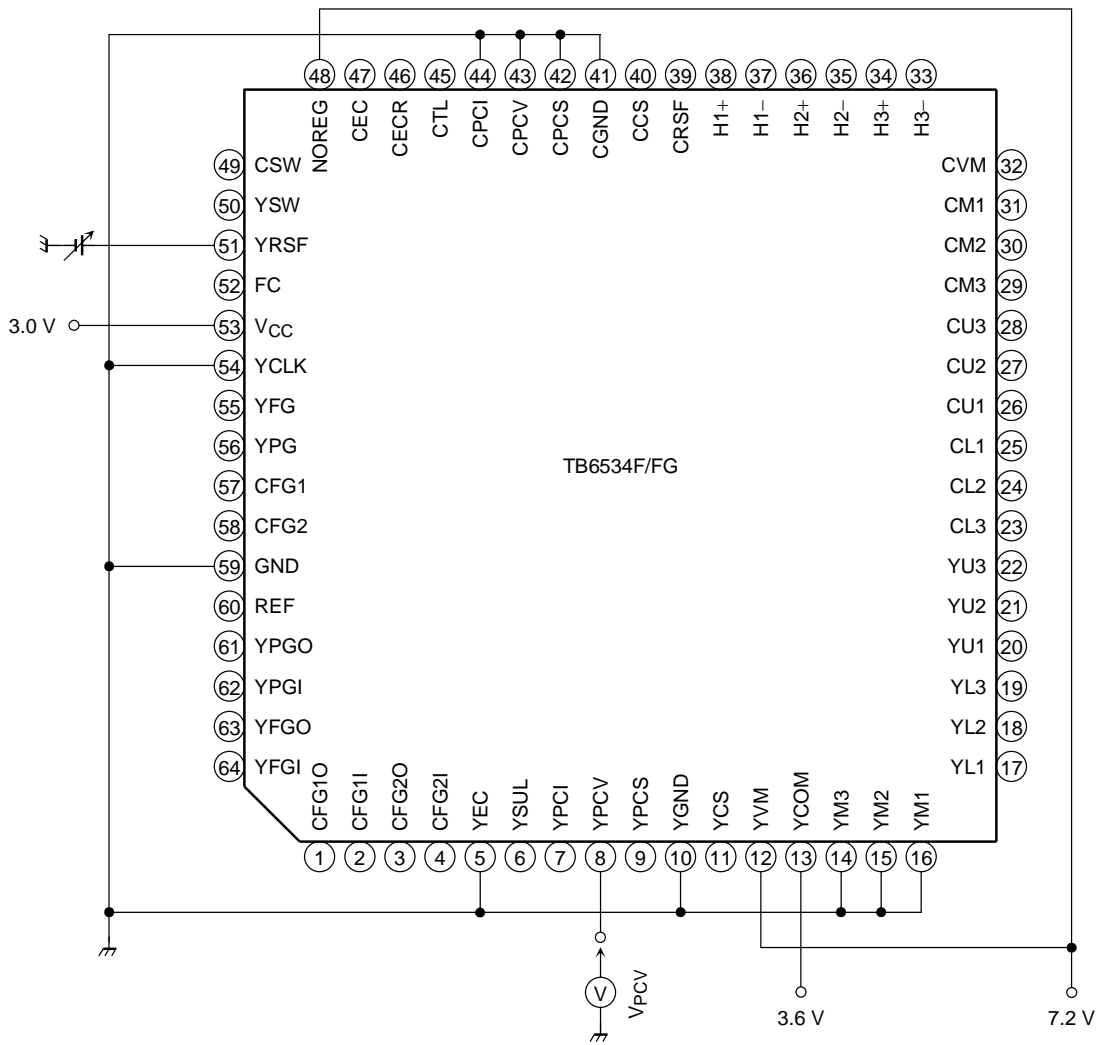
**No.16 YPG (H)**

Apply 2 V to YPGin and set YPG to High. Then measure the YFG potential when a current of  $\text{IYPG} = -100\ \mu\text{A}$  is obtained.

**No.17 YPG (L)**

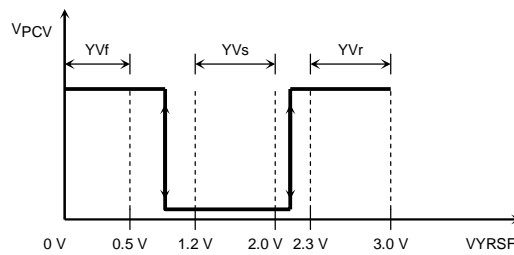
Apply 0 V to YPGin and set YPG to Low. Then measure the YFG potential when a current of  $\text{IYPG} = 100\ \mu\text{A}$  is obtained.

Test Circuit 7 YVf, YVs, YVr

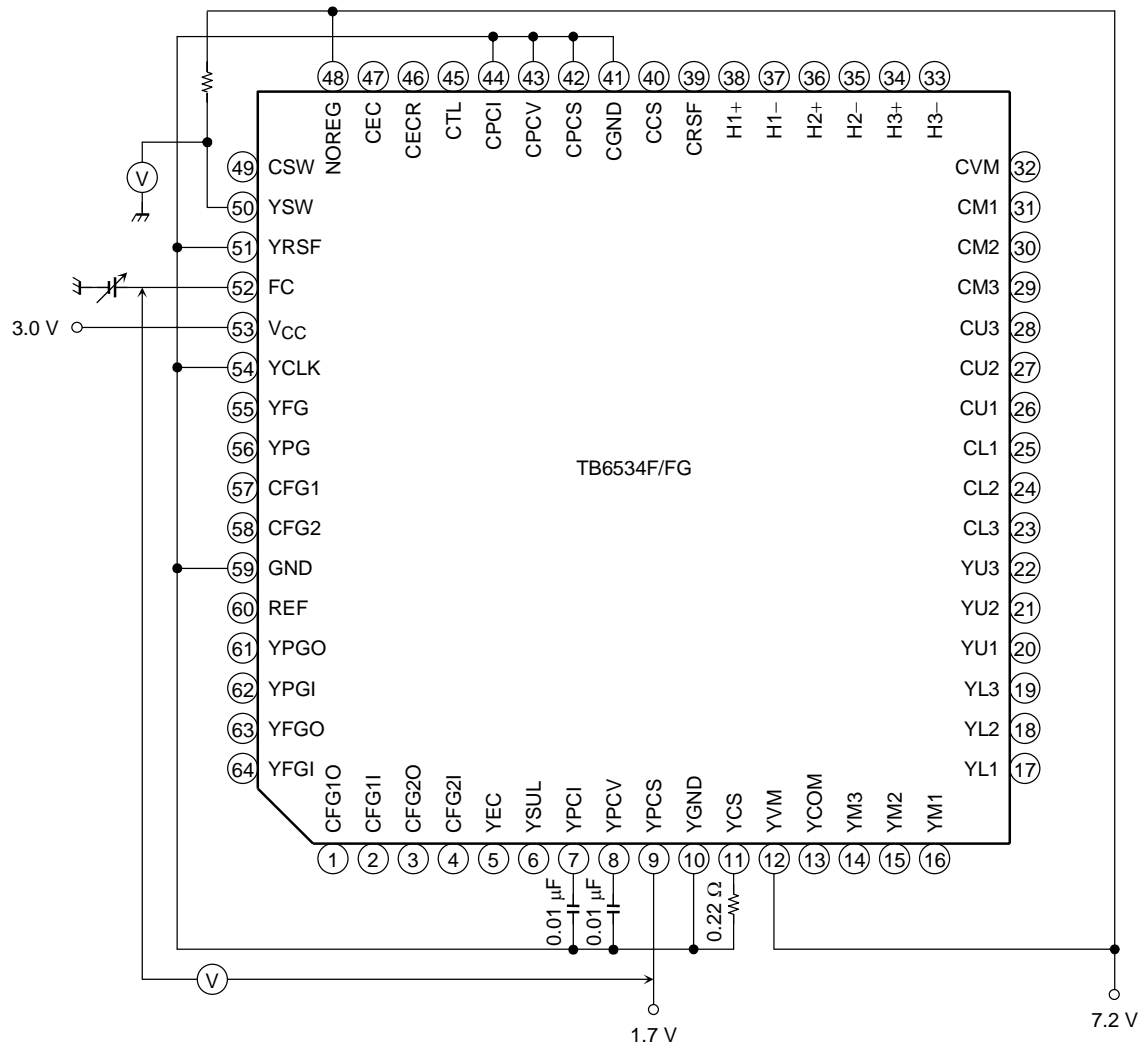


No.18 YVf, No.19 YVs, No.20 YVr

Change VRSF from 0 V to 3 V, and from 3 V to 0 V. Then measure VPCV.

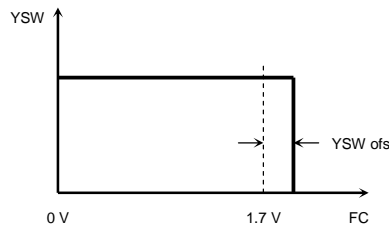


Test Circuit 8 YSW ofs

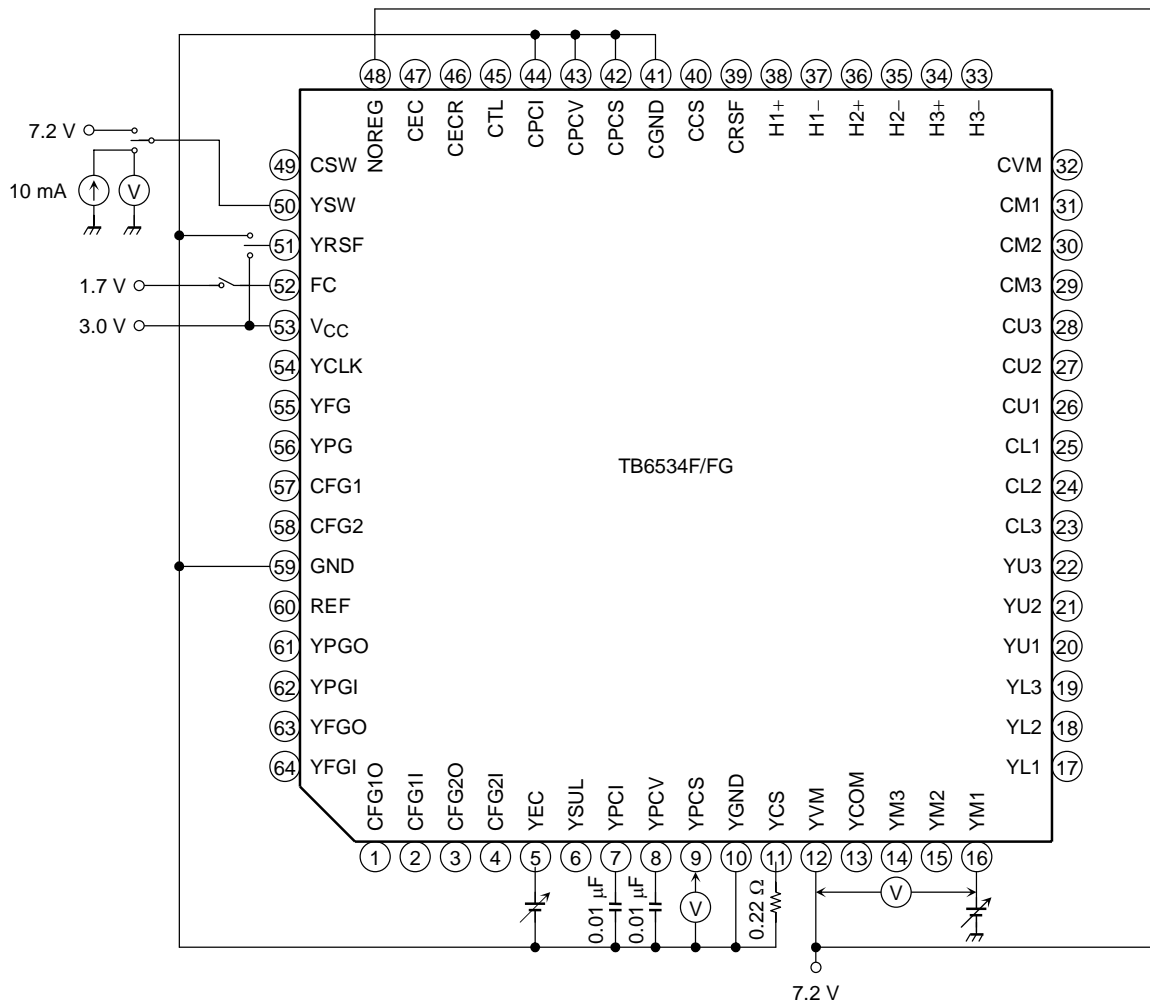


No.23 YSW ofs

Set YPCS = 1.7 V, and change FC from 0 V to 3.0 V. Then measure the potential difference between pins FC and YPCS (FC - YPCS) when YSW becomes Low from High.



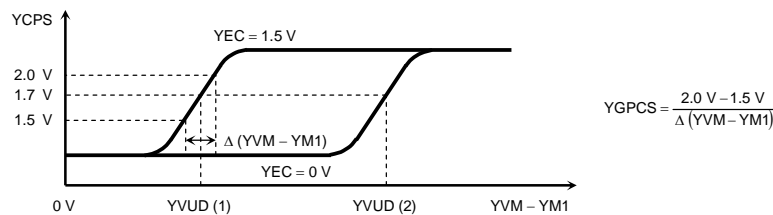
## Test Circuit 9 YGPCS, YVUD (1), YVUP (2), YISWB, YSWEC



No.24 YGPCS, No.25 YVUD (1), No.26 YVUD (2)

Set YEC = 0 V, and change CM1 from 7.2 V to 6.2 V. Then measure the potential difference between pins YVM and YM1 (YVM - YM1) when the potential of the pin YPCS becomes 1.7 V.

Set YEC = 1.5 V, and perform the same steps indicated above, and acquire the characteristics shown below.

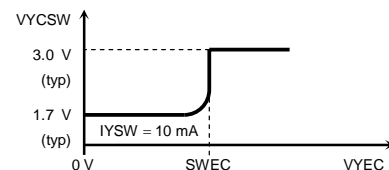


No.27 YISWB

Set FC = 1.7 V, YEC = 0 V, and YM1 = 7.2 V, and measure the current that flows into the pin YSW.

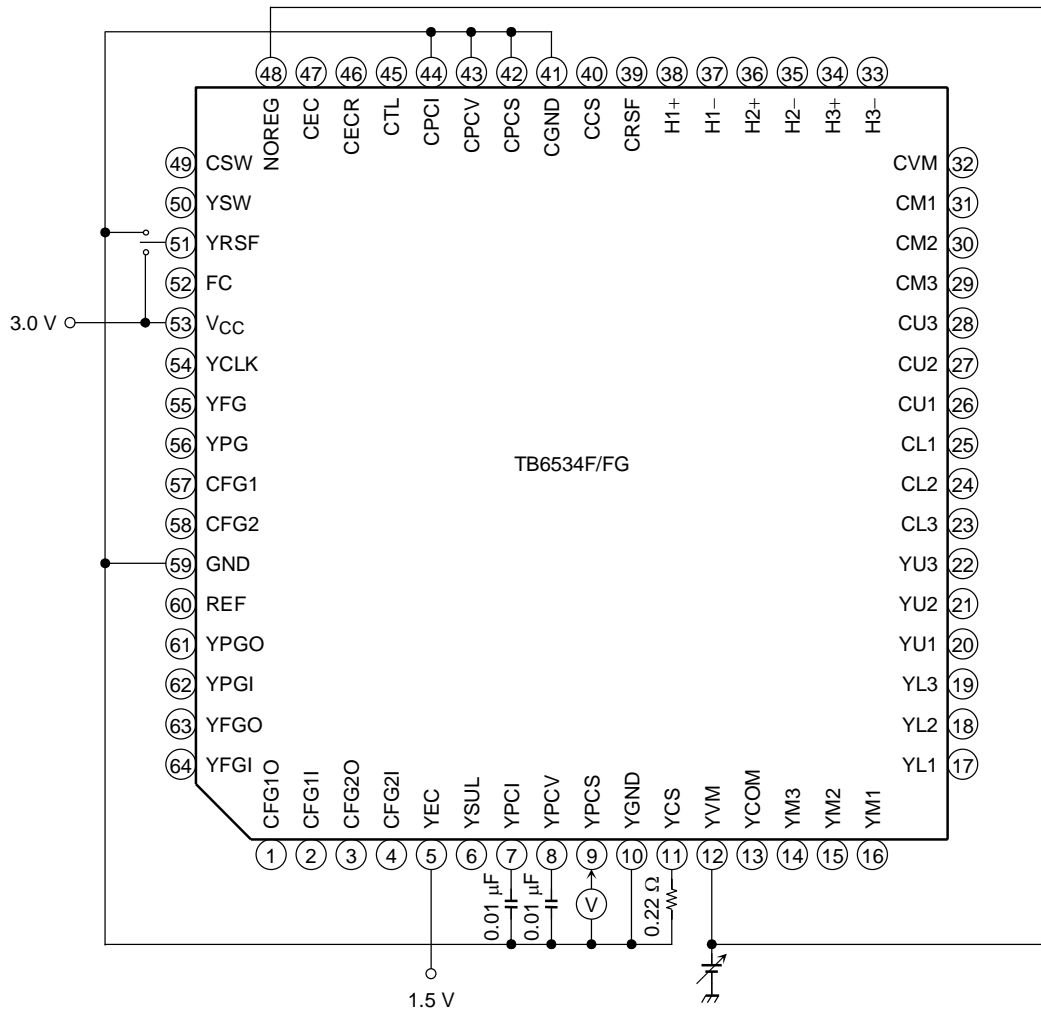
No.30 YSWEC

Apply 10 mA to the pin YSW, and voltage to the pin YEC. Then acquire the characteristics shown on the right.



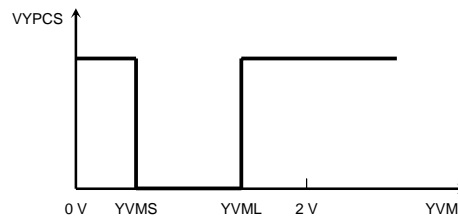


**Test Circuit 10 YVML, YVMS**

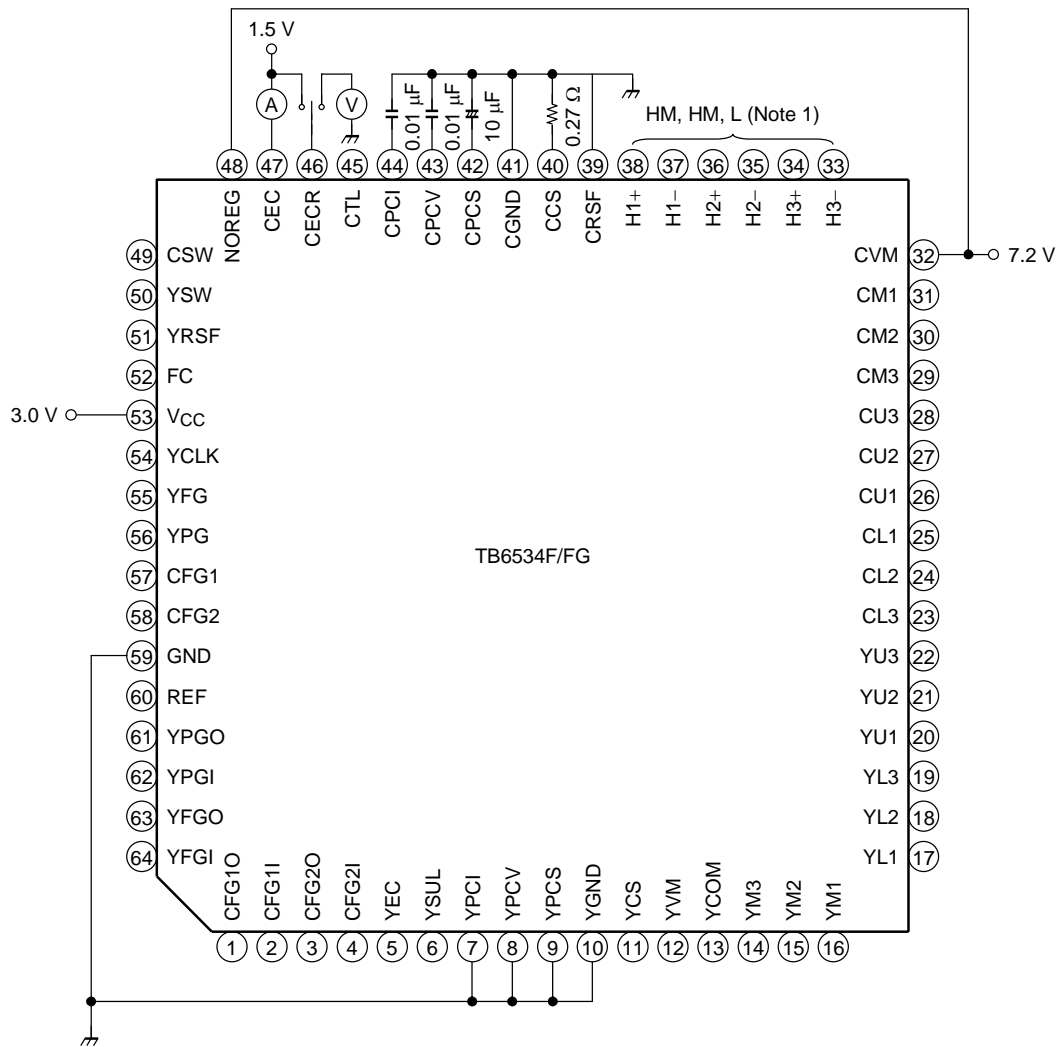


No.28 YVML, No.29 YVMS

Change YVM from 2 V to 0 V, and acquire the characteristics shown below.



Test Circuit 11 CIEC, CECR



Note 1: Hall input setting

	L	M	HM	H	Unit
H1+	1.45	1.5	1.525	1.55	V
H1-	1.5	1.5	1.5	1.5	V
H2+	0.65	0.7	0.725	0.75	V
H2-	0.7	0.7	0.7	0.7	V
H3+	1.95	2.0	2.025	2.05	V
H3-	2.0	2.0	2.0	2.0	V

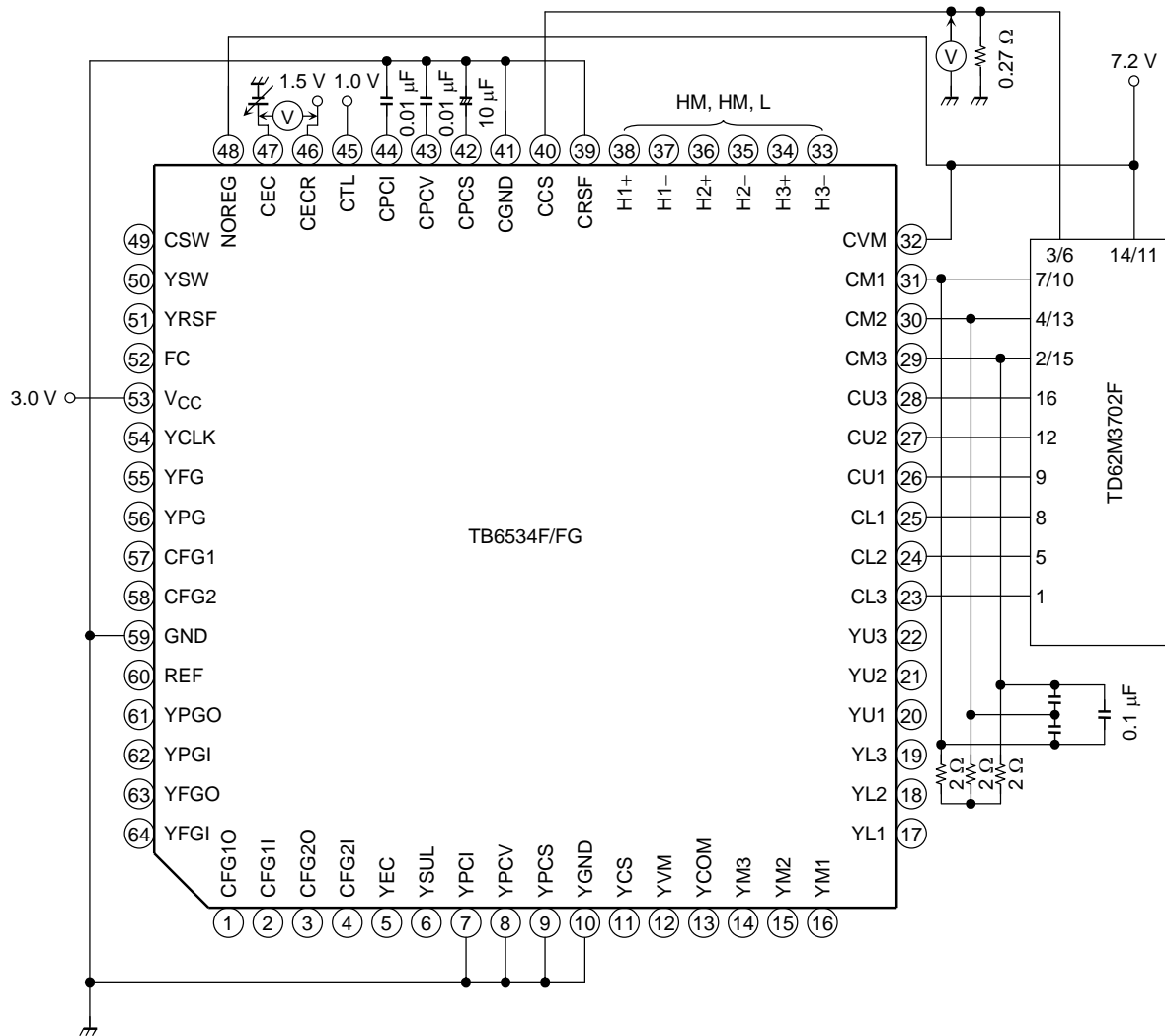
No.31 CIEC

Set CEC = CECR = 1.5 V, and measure the current that flows into the pin CEC.

No.32 CECR

Measure the voltage of the pin CECR.

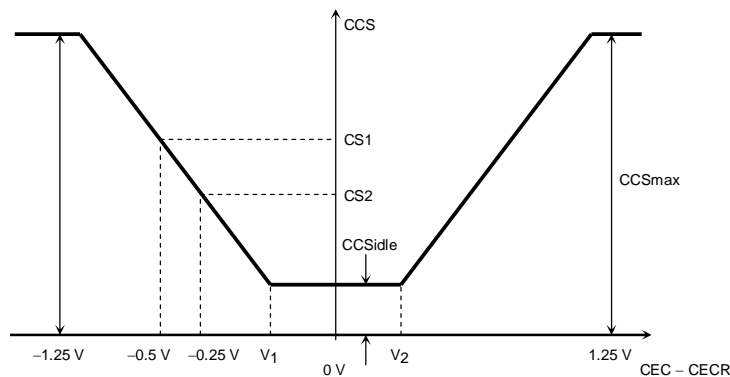
## Test Circuit 12 CEC, CCSmax, CGio, CCSidle, CECofs, CECdz



No.33 CEC, No.34 CCSmax, No.35 CGio, No.36 CCSidle

No.37 CECofs, No.38 CECdz

Set CTL = 1.0 V and CECR = 1.5 V, change CEC from 0 V to 3.0 V, and measure the potential of the pin CCS to confirm V characteristics.



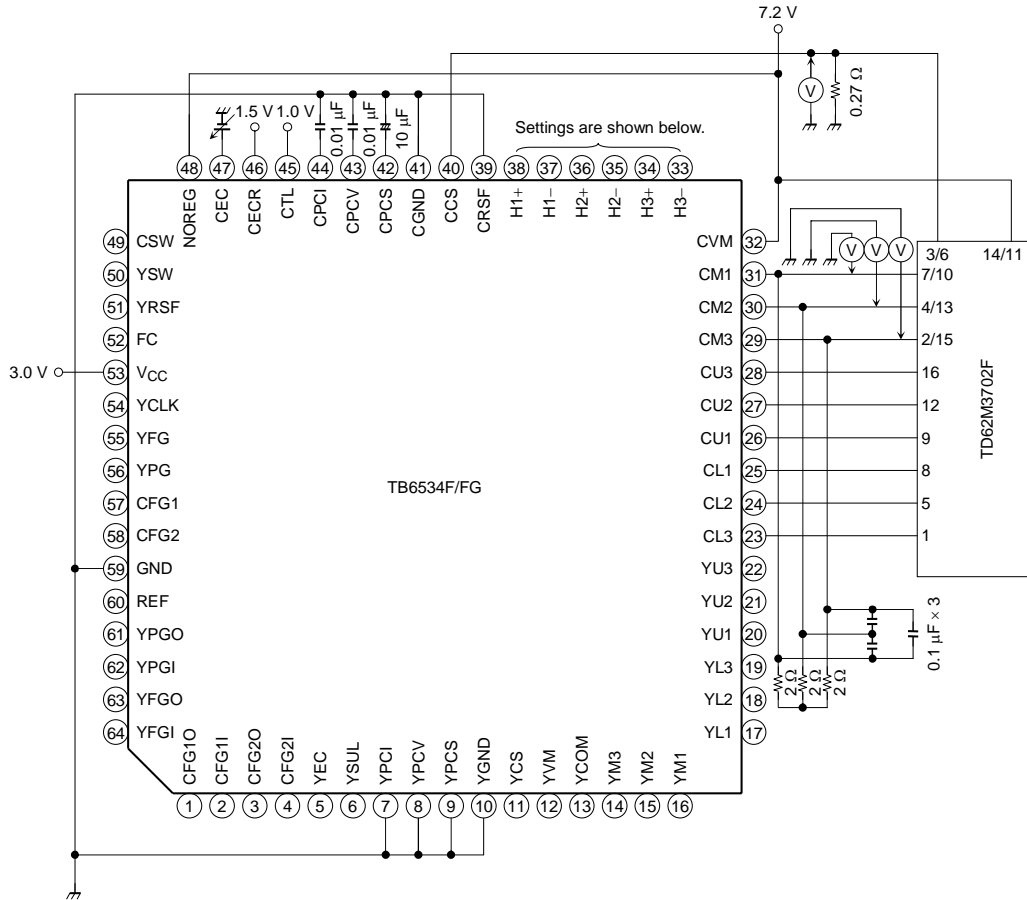
$$CGio = \frac{CS1 - CS2}{0.25 V}$$

CCSidle : The CS potential within the dead zone.

$$CECofs = \frac{V1 + V2}{2}$$

$$CECdz = V2 - V1$$

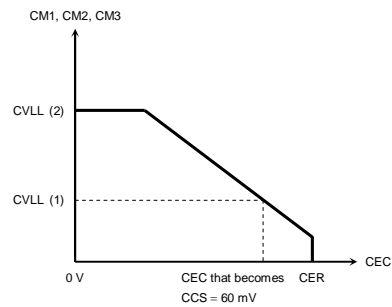
Test Circuit 13 CVLL (1), CVLL (2)



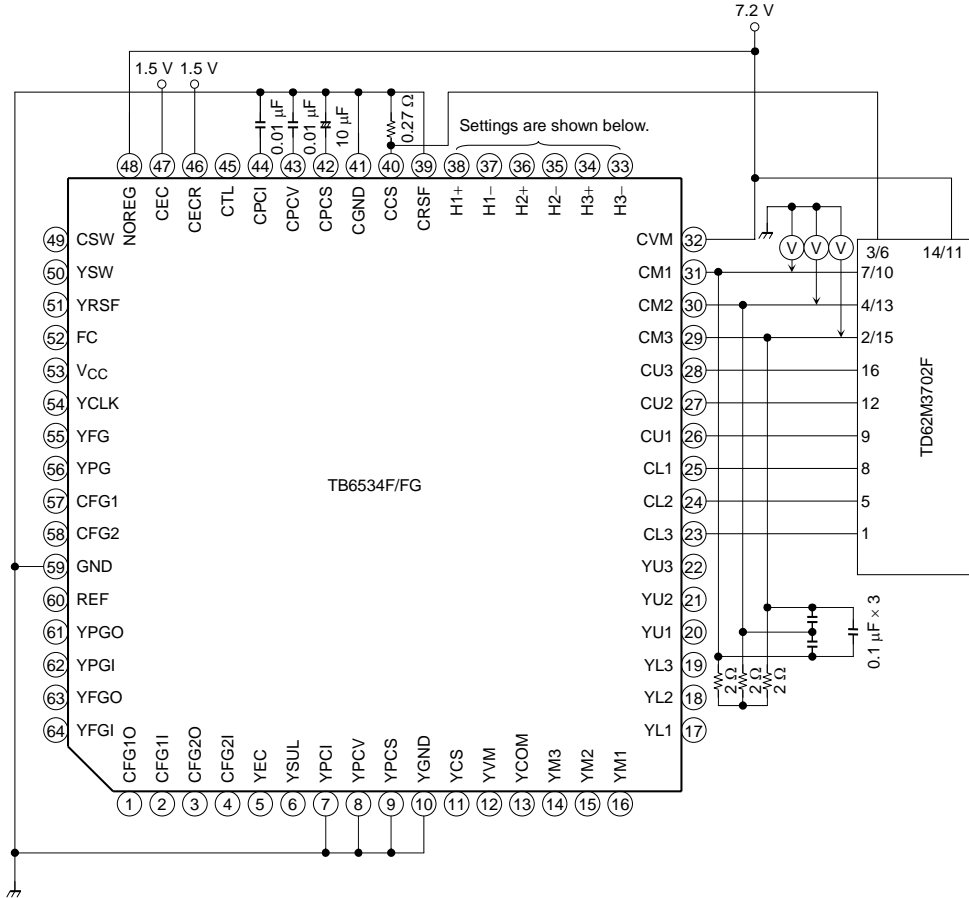
No.39 CVLL (1), No.40 CVLL (2)

CEC = 0 V when perform the setting as shown below, and adjust CEC voltage to CCS = 60 mV.

	M1	H2	H3	Test Pin
Setting 1	H	L	M	CM1
Setting 2	M	H	L	CM2
Setting 3	L	M	H	CM3



**Test Circuit 14 Hin (1), Hin (2), Hin (3)**

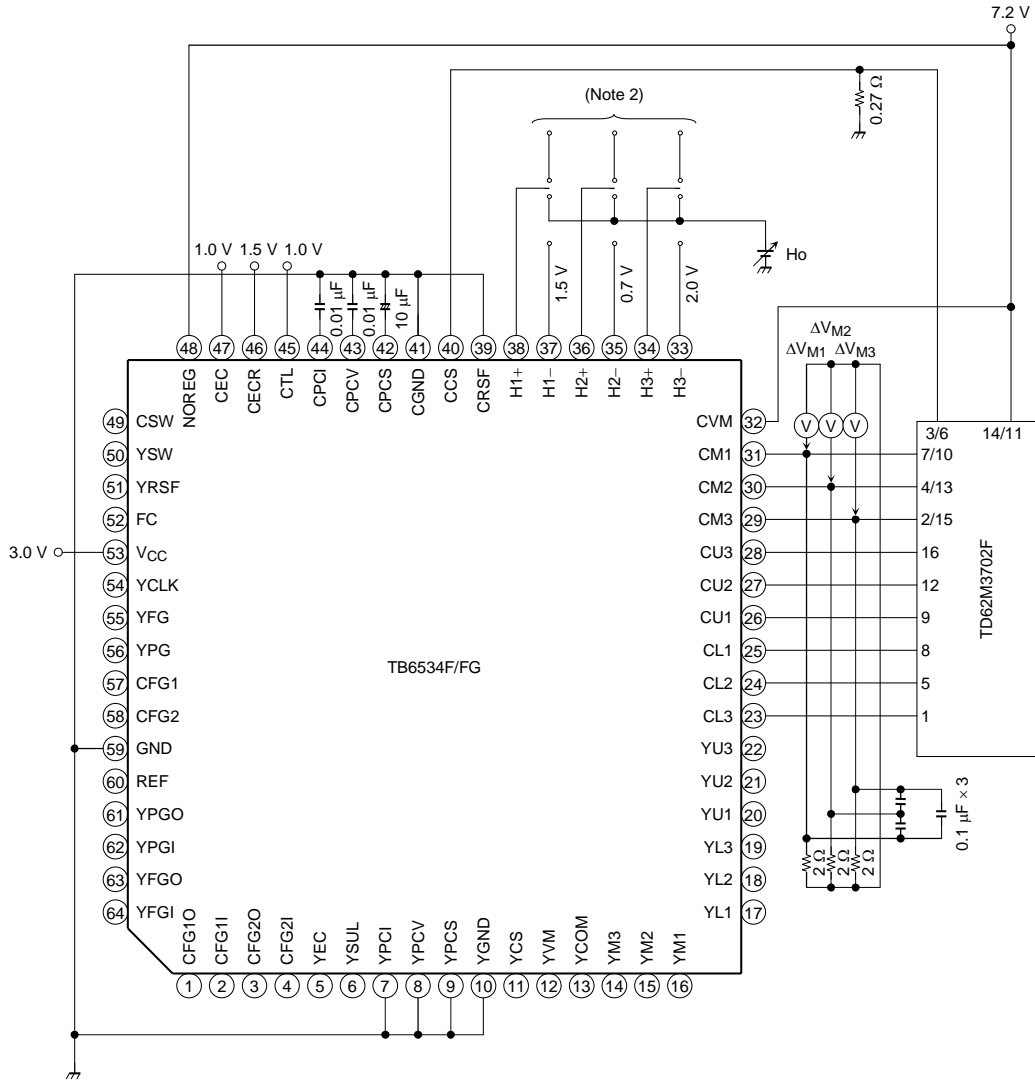


No.41 Hin (1), No.42 Hin (2), No.43 Hin (3)

Perform the setting as shown below, and measure the operating range of hall amp that does change in accordance with the changes in the Hin.

	H1+	H1-	H2+	H2-	H3+	H3-
Setting 1	Hin	Hin	HM	M	L	M
Setting 2	L	M	Hin	Hin	HM	M
Setting 3	HM	M	L	M	Hin	Hin

Test Circuit 15 Hofs



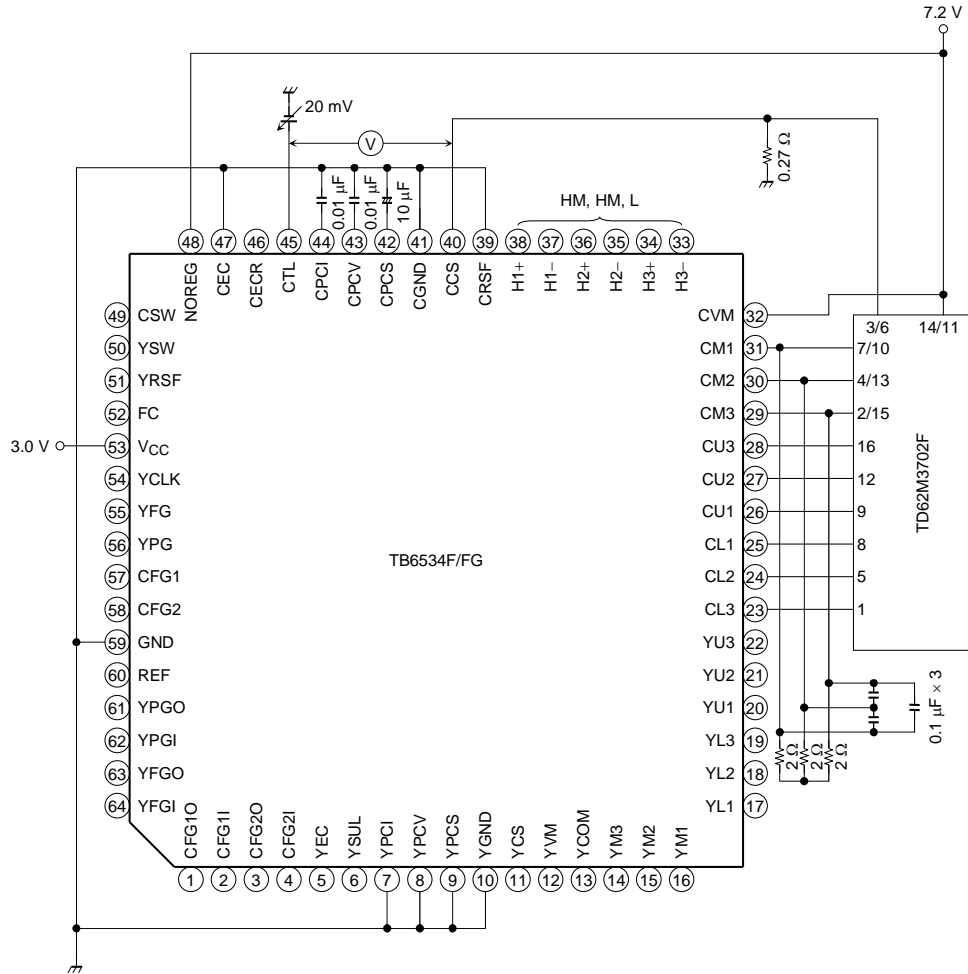
No.44 Hofs

Perform the setting as shown below, and measure the hall element input conversion offset.

	H1+	H2+	H3+	Offset Measurement
Setting 1	Ho	HM	L	$V_{Ho} - 1.525 \text{ V}$ when $\Delta V_{M1} = 0$
Setting 2	L	Ho	HM	$V_{Ho} - 0.725 \text{ V}$ when $\Delta V_{M2} = 0$
Setting 3	HM	L	Ho	$V_{Ho} - 2.025 \text{ V}$ when $\Delta V_{M3} = 0$

Note 2: H1- = 1.5 V, H2- = 0.7 V, H3- = 2.0 V fixed. (refer to the page of test circuit 11.)

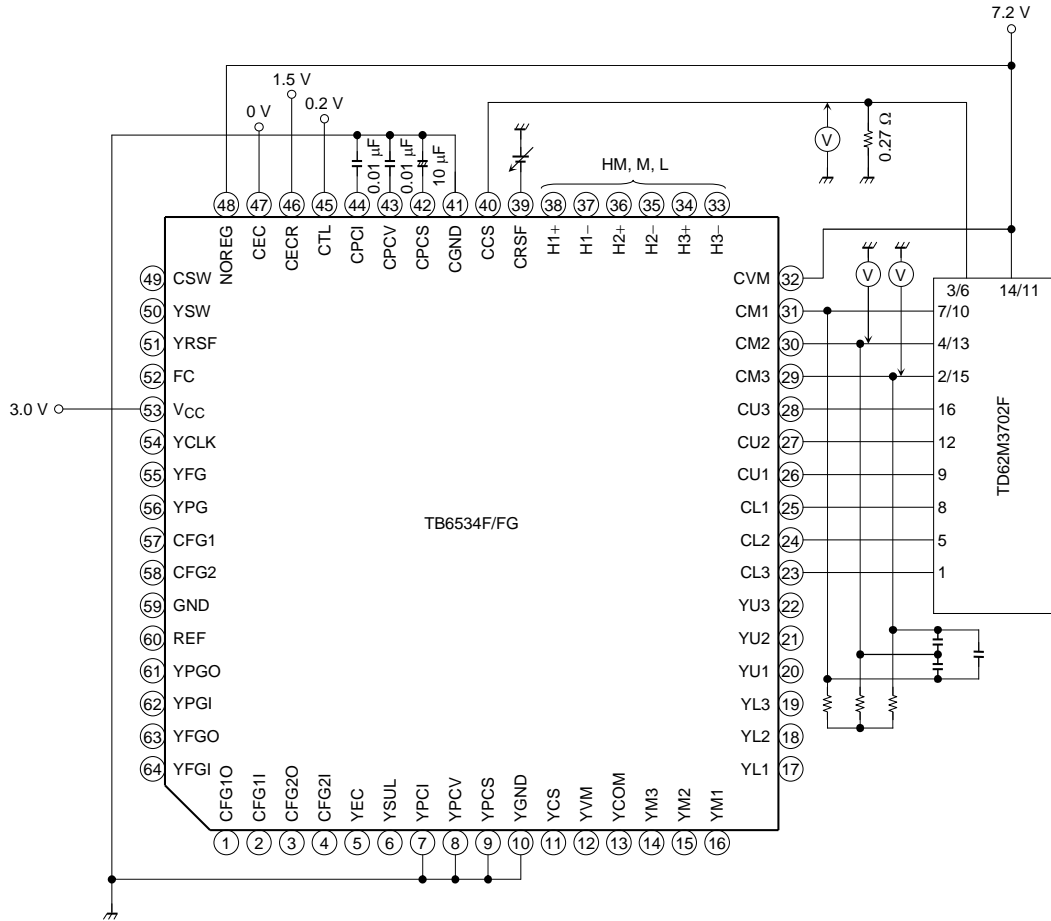
Test Circuit 16 TLofs



No.45 TLofs

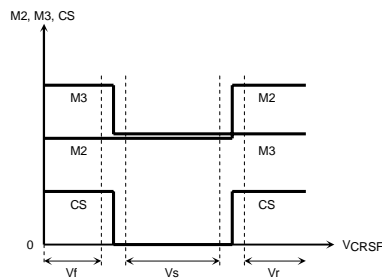
Measure the potential difference between the pin CTL and the pin CCS ( $CTL - CCS$ ) when  $CTL = 20\text{ mV}$ .

Test Circuit 17 CVf, CVs, CVr



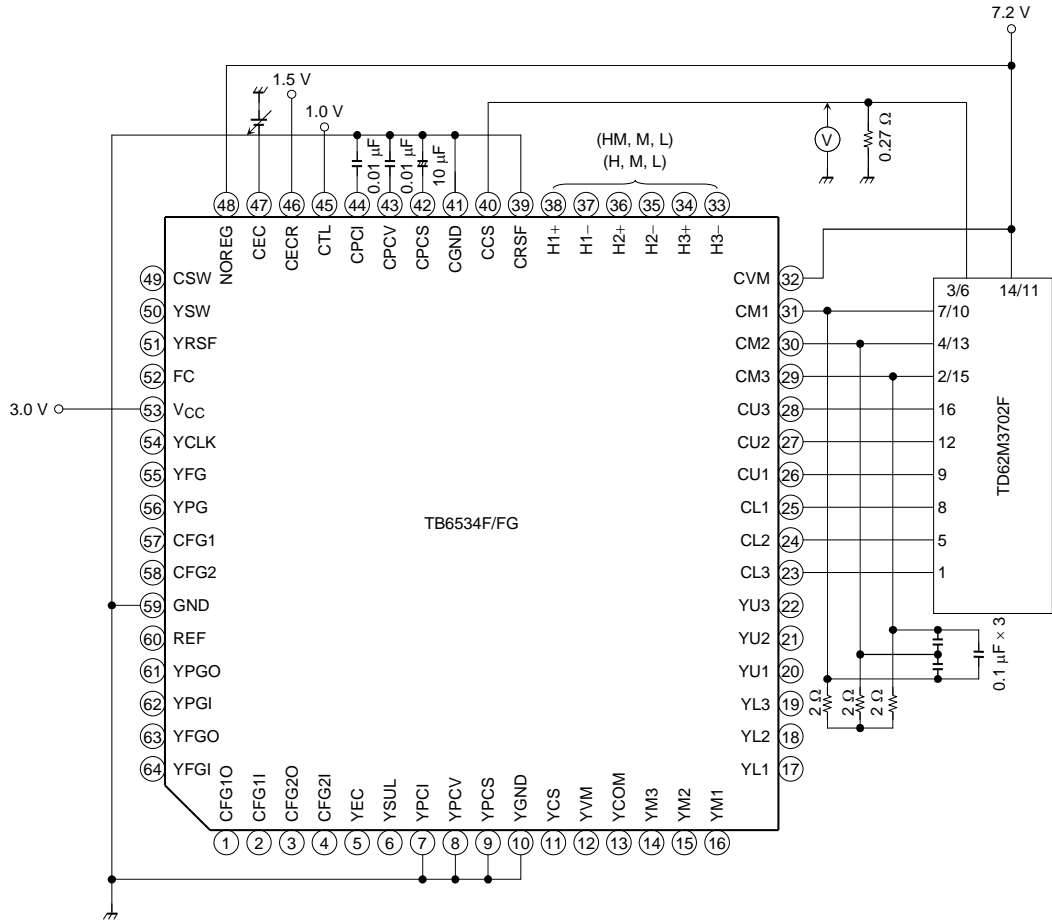
No.46 CVf, No.47 CVs, No.48 CVr

Change CRSF from 0 V to 3.0 V, acquire the characteristics as shown below, and measure the threshold voltage.





Test Circuit 18 R

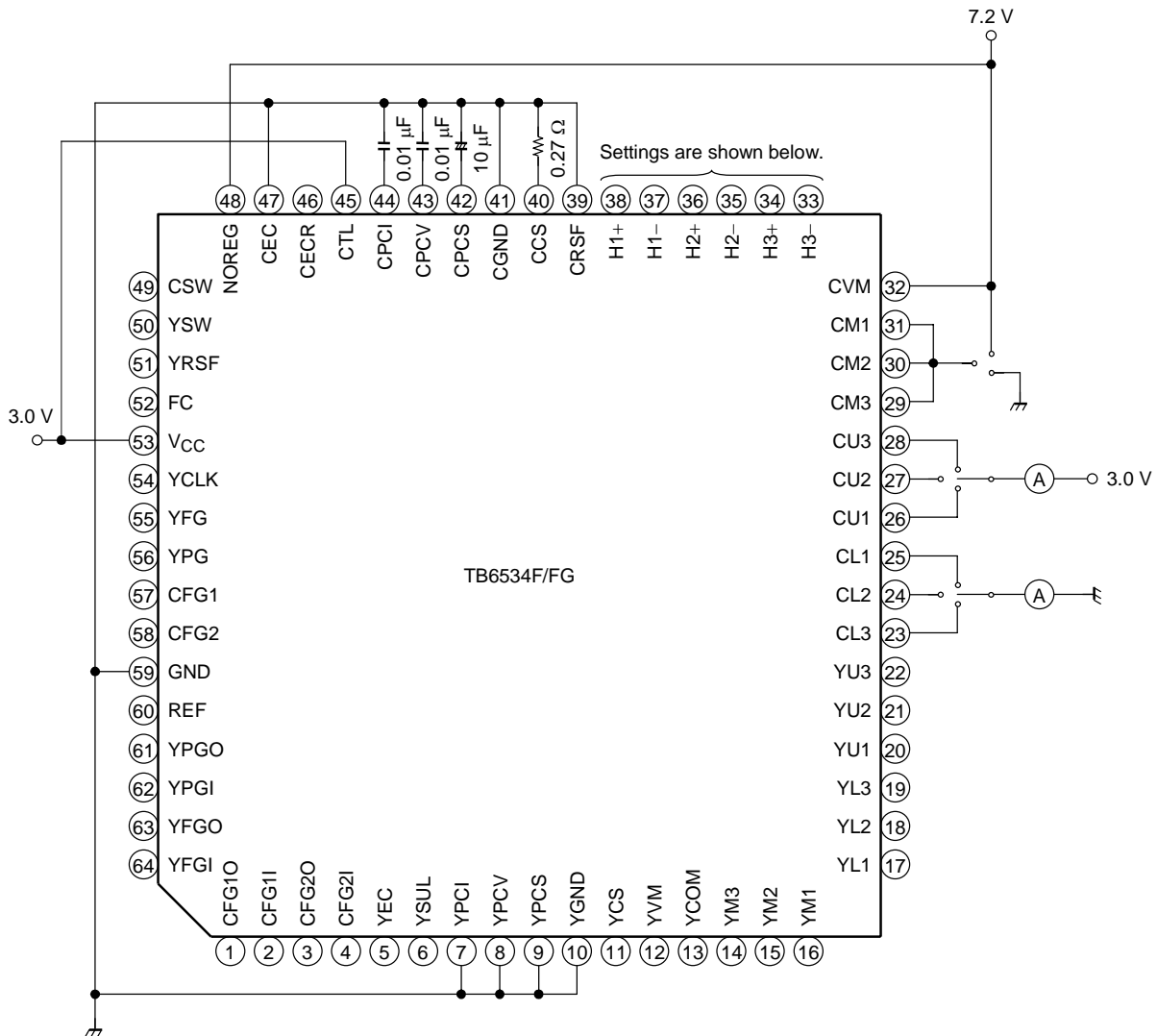


No.49 R

Adjust the CEC voltage so that CCS becomes 60 mV when H1+/-: "HM", H2+/-: "HM", and H3+/-: "L". Then measure CCS potential (CSH) when H1+/-: "H", H2+/-: "H", and H3+/-: "L".

$$R = \frac{CSH - 60 \text{ mV}}{60 \text{ mV}}$$

## Test Circuit 19 CIU, CIL

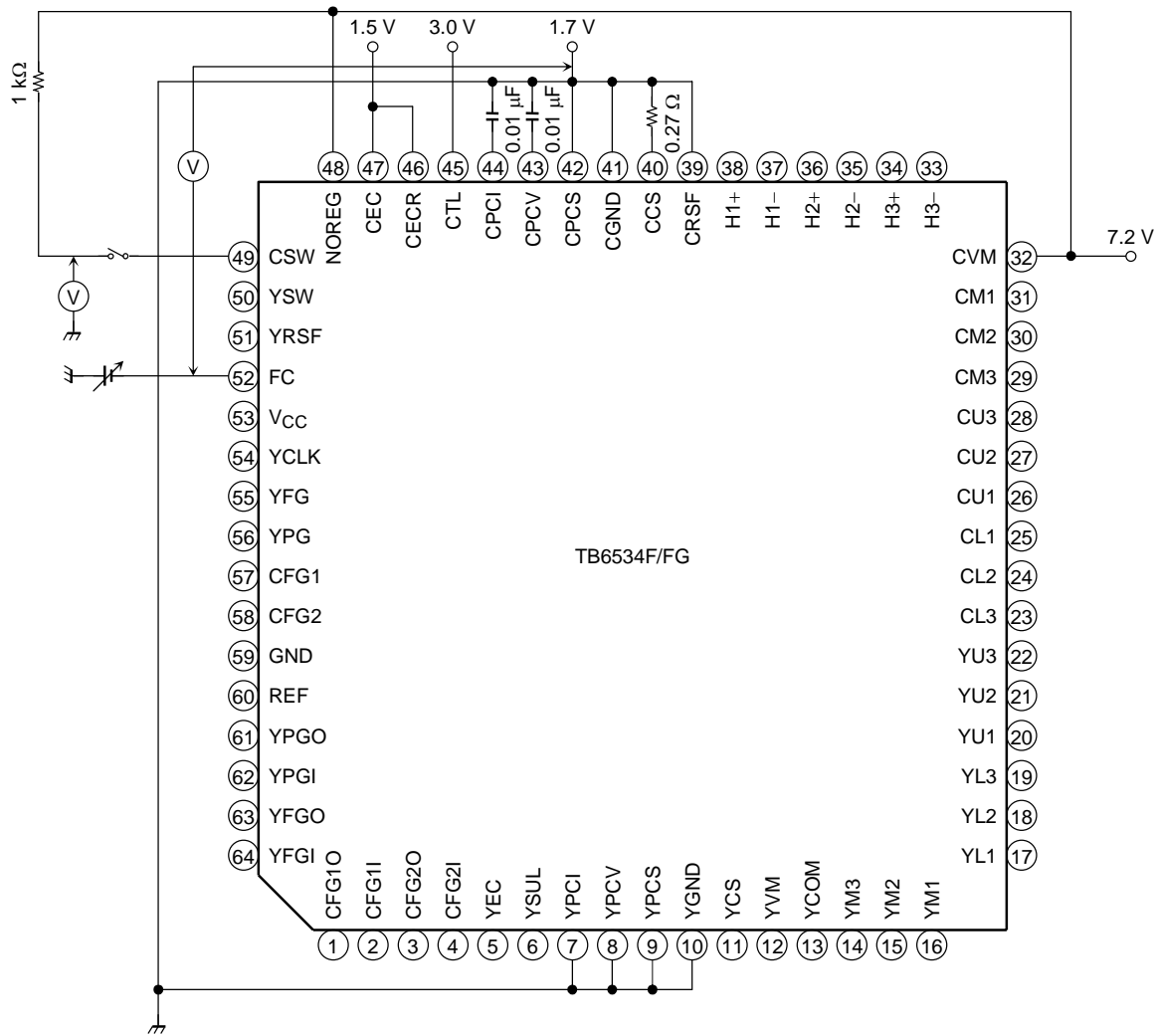


No.50 CIU, No.51 CIL

Perform the setting as shown below, measure the current to the pins CU1, CU2, CU3, CL1, CL2, and CL3.

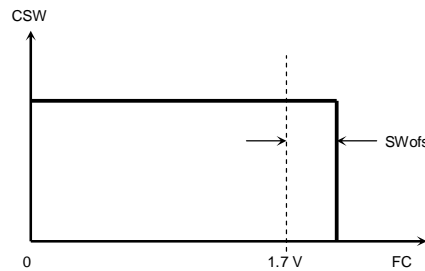
	H1	H2	H3	M1, M2, M3	Test Pin
Setting 1	L	H	M	GND	CU1
Setting 2	M	L	H	GND	CU2
Setting 3	H	M	H	GND	CU3
Setting 4	H	L	M	V <sub>M</sub>	CU1
Setting 5	M	H	L	V <sub>M</sub>	CU2
Setting 6	L	M	H	V <sub>M</sub>	CU3

**Test Circuit 20 CSWofs, IREG**



**No.52 CSWofs**

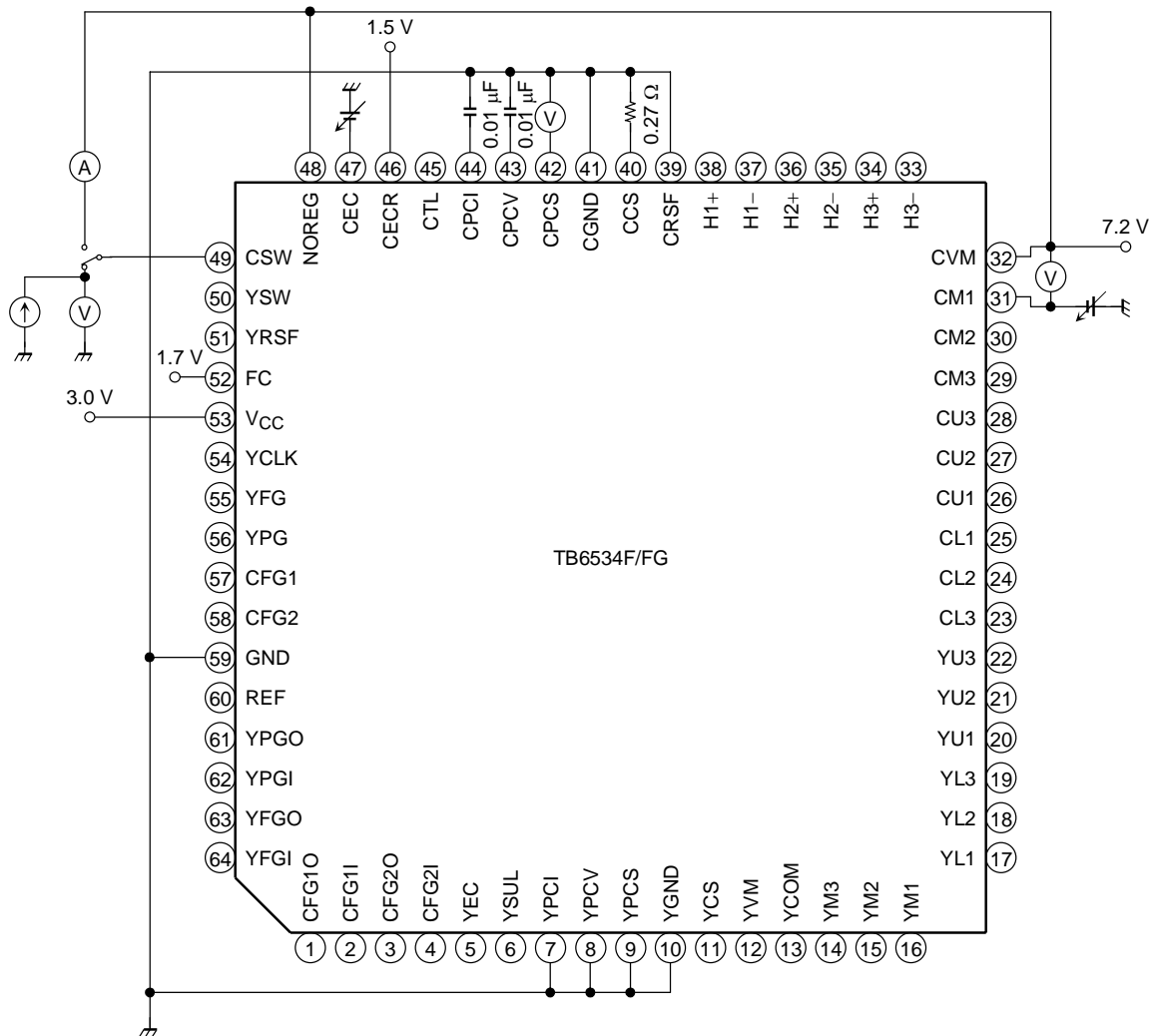
Set CPCS = 1.7 V, change FC from 0 V to 3.0 V, and measure the potential difference between the pins FC and CPCS (FC - CPCS) when CSW becomes Low from High.



**No.63 IREG**

Measure the current when CVM = 7.2 V, FC = 1.8 V, the pin CSW is open, and 7.2 V is applied from the pin NOREG.

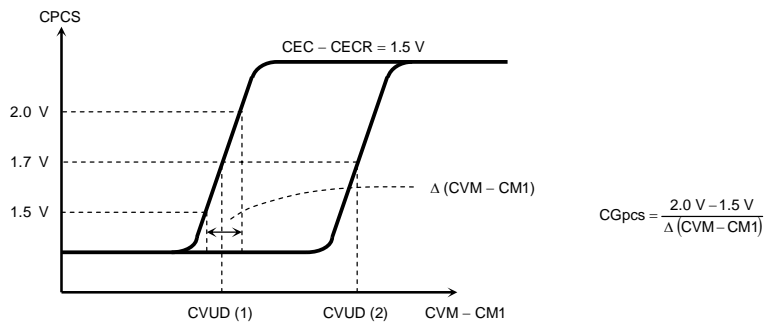
Test Circuit 21 CGPCS, CVUD (1), CVUD (2), CISWB, CSWEC



No.53 CGPCS, No.54 CVUD (1), No.55 CVUD (2)

Set CEC = 0 V, change CM1 from 7.2 V to 6 V, and measure the potential difference between the pins CVM and CM1 (CVM - CM1).

Set CEC = CECR = 1.5 V, follow the steps described above to acquire the characteristic as shown below.

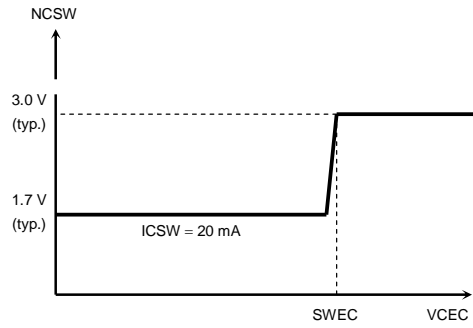


## No.56 CISWB

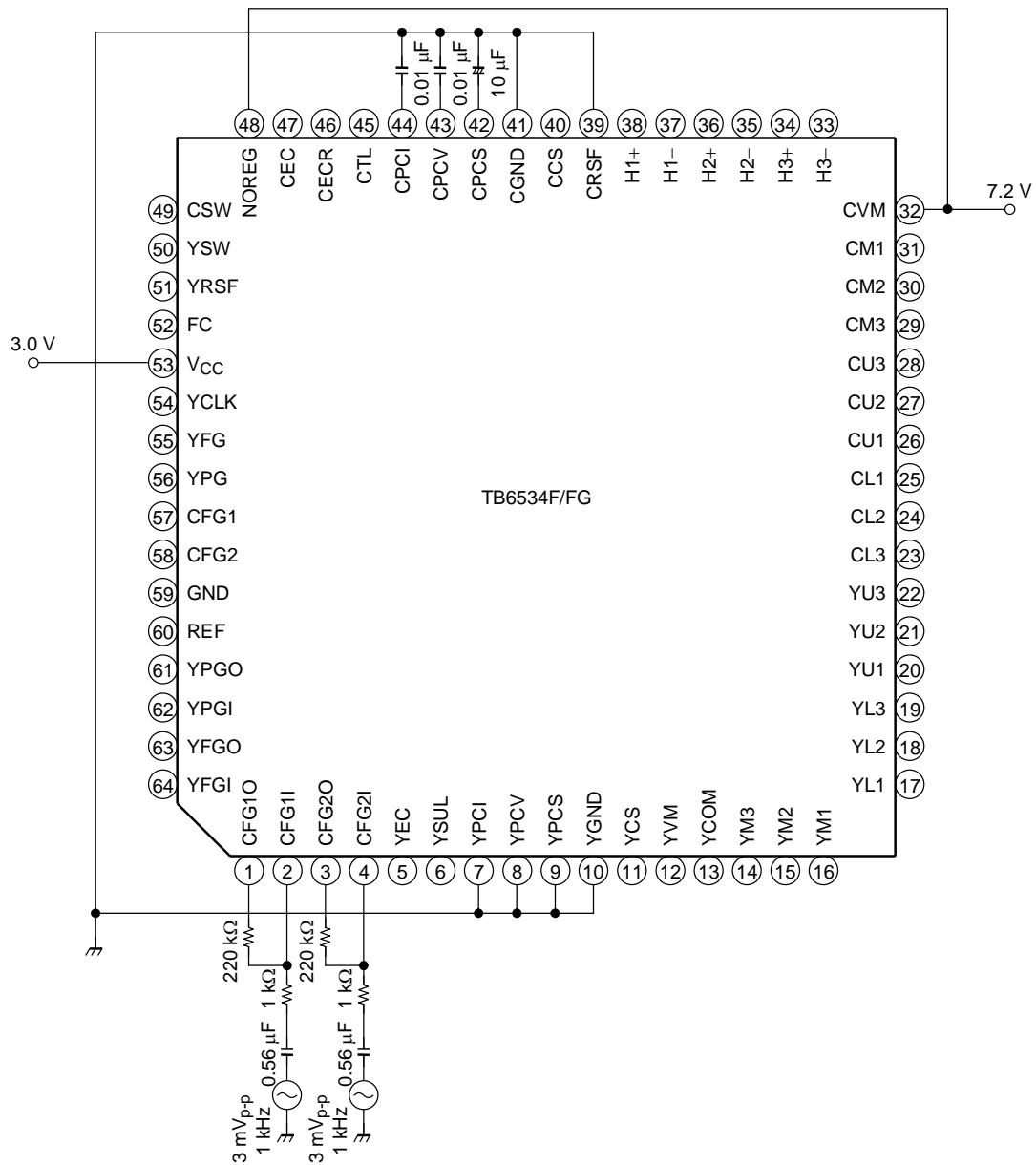
Set FC = 1.7 V, CEC = 0 V, and CM1 = 7.2 V, and measure the current to the pin CSW.

## No.62 CSWEC

Apply 10 mA to the pin CSW, and apply voltage to pin CEC to acquire the characteristic as shown below.



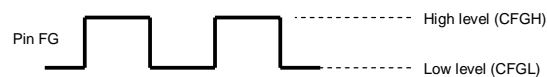
Test Circuit 22 CGFG, CFGH, CFGL



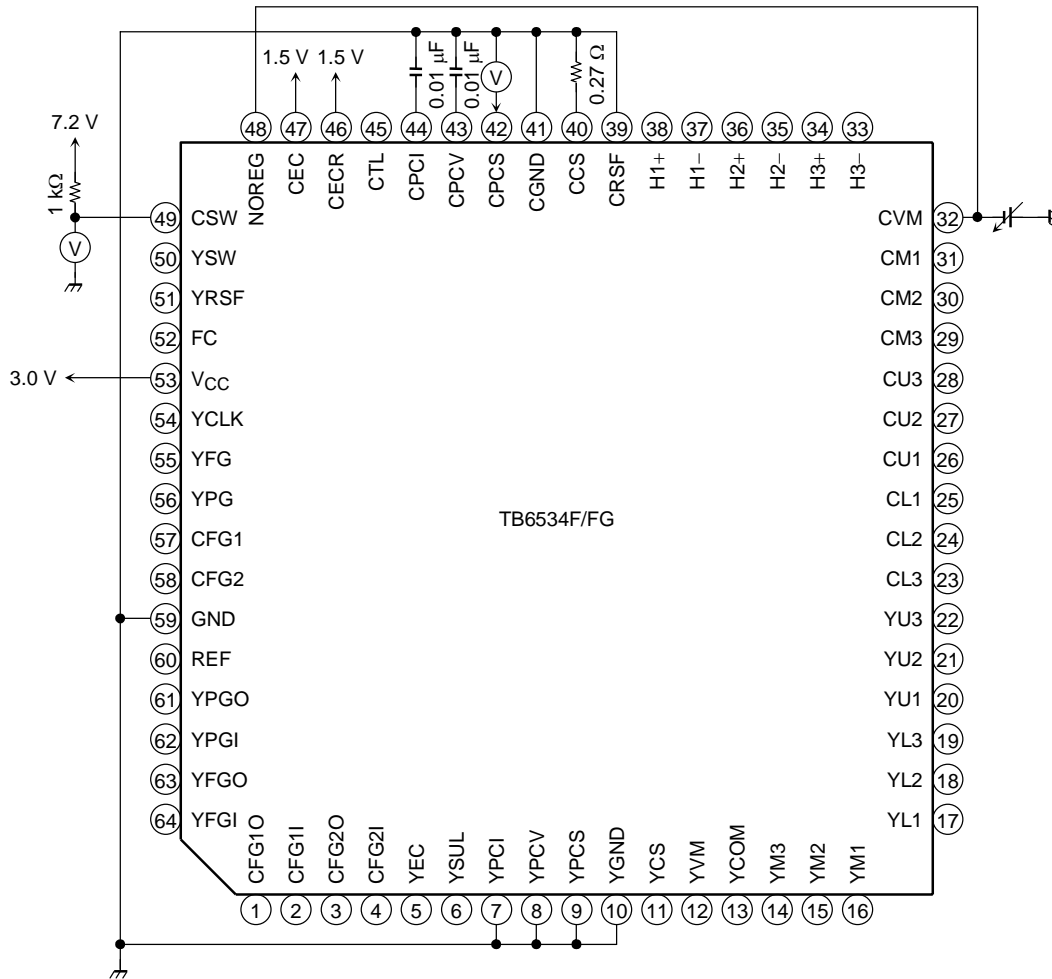
No.57 CGFG, No.58 CFGH, No.59 CFGL

Set  $CFG_{out} = V_o$ , and measure  $V_o$  when  $V_{in} = 3\text{ mV}_{p-p}, 1\text{ kHz}$  to acquire  $CGFG = 20 \log \frac{V_o}{V_{in}}$ .

Also, acquire the characteristic as shown below, and measure the potential of High and Low levels of the pin CFG output waveform.

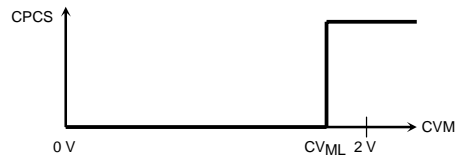


Test Circuit 23  $CV_{ML}$ ,  $CV_{MS}$



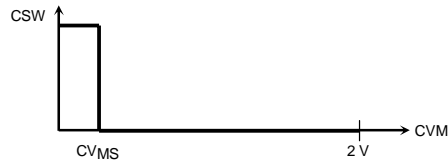
No.60  $CV_{ML}$

Change CVM from 2 V to 0 V, and acquire the characteristics as shown below.

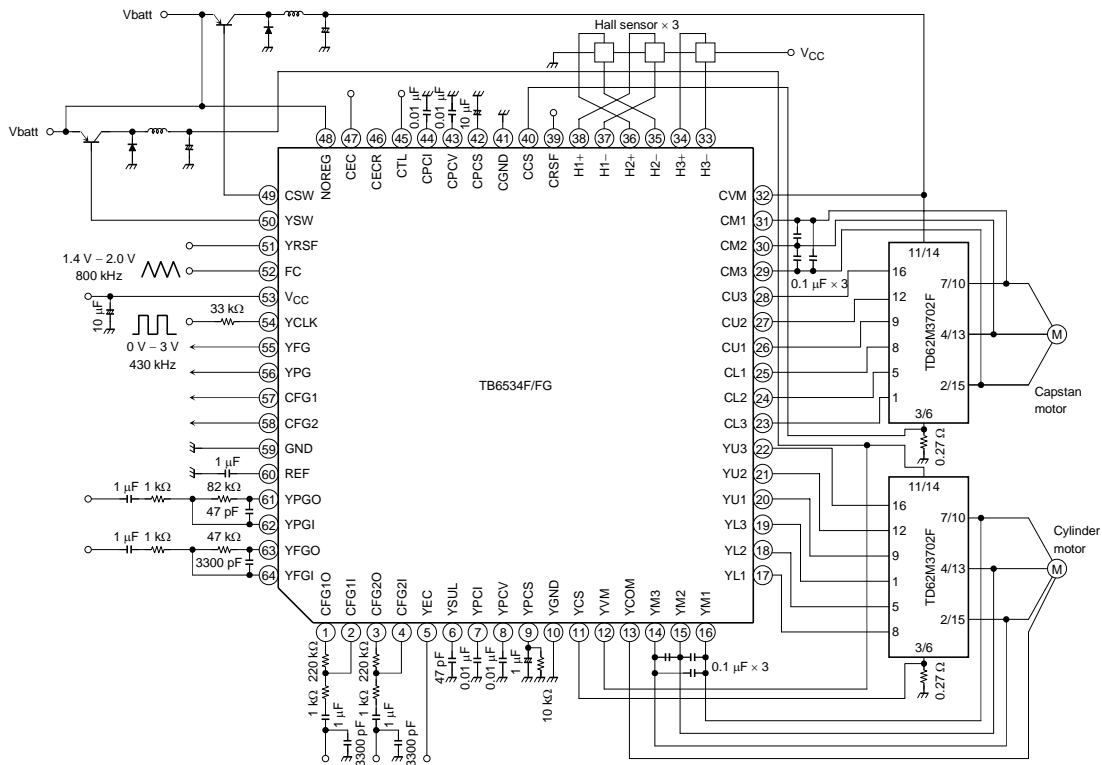


No.61  $CV_{MS}$

Change CVM from 2 V to 0 V, and acquire the characteristics as shown below.



Typical Application Diagram

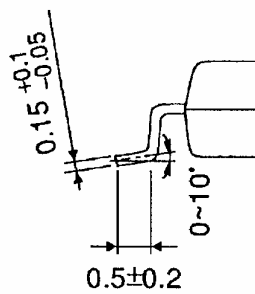
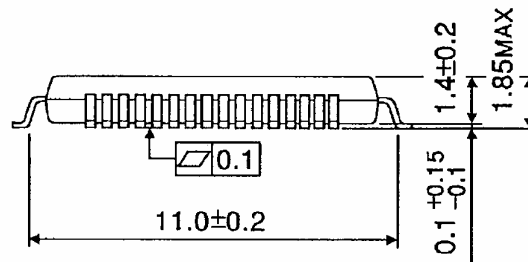
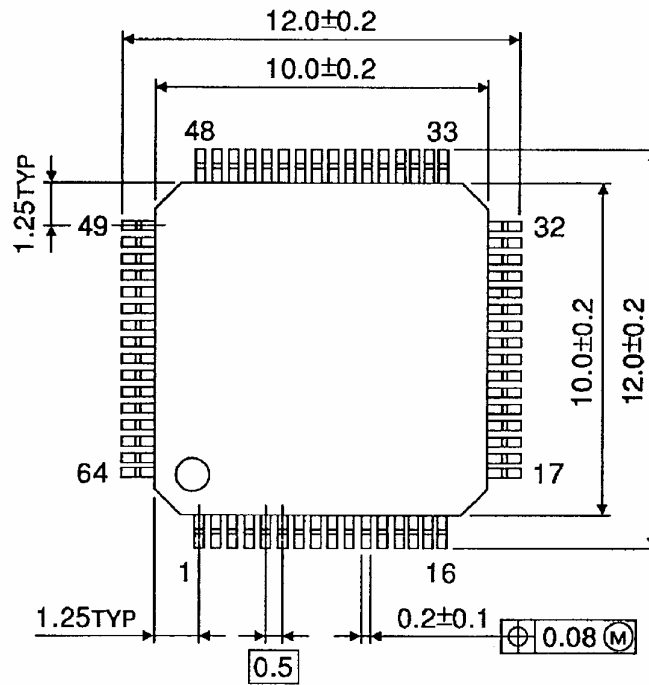




## Package Dimensions

LQFP64-P-1010-0.50A

Unit : mm



Weight: 0.34 g (typ.)

## Notes on Contents

### 1. Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

### 2. Equivalent Circuits

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

### 3. Timing Charts

Timing charts may be simplified for explanatory purposes.

### 4. Application Circuits

The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.

Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

### 5. Test Circuits

Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

## IC Usage Considerations

### Notes on handling of ICs

- [1] The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.  
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result in injury by explosion or combustion.
- [2] If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.  
Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.
- [3] Do not insert devices in the wrong orientation or incorrectly.  
Make sure that the positive and negative terminals of power supplies are connected properly. Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result in injury by explosion or combustion.  
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

**Points to remember on handling of ICs****(1) Thermal Shutdown Circuit**

Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

**(2) Back-EMF**

When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

**RESTRICTIONS ON PRODUCT USE**

060116EBA

- The information contained herein is subject to change without notice. 021023\_D
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.  
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc. 021023\_A
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk. 021023\_B
- The products described in this document shall not be used or embedded to any downstream products of which manufacture, use and/or sale are prohibited under any applicable laws and regulations. 060106\_Q
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of TOSHIBA or others. 021023\_C
- The products described in this document are subject to the foreign exchange and foreign trade laws. 021023\_E