



THE DATASHEET OF LR36689

SHARP

Integrated Circuit
Catalog

Integrated Circuits 2006

■ CMOS Image Sensors / CCDs ■ LSIs for LCDs ■ System LSIs ■ Smart Card Systems
■ Flash Memories / Combination Memories ■ Power Devices / Analog ICs ■ Packages



Guide to SHARP Semiconductors

1. Semiconductor Documents

See the following documents to obtain information on SHARP devices.
(Confirm the latest device specification sheets before using any SHARP device.)

IC information brochure	SILICON
Catalogs	CCDs/CMOS Image Sensors LSIs for LCDs Analog ICs

2. SHARP Home Page

For information on SHARP's latest products, see the following URL :
<http://sharp-world.com/products/device/index.html>

Contents

- Data sheets
- Catalog
- New Product Information
- SHARP's devices for the future

NOTE : Package Descriptions
In this catalog, model numbers and corresponding package descriptions are shortened as shown below :

Example

Model No.	Package		Model No.	Package
IR3C08 IR3C08N	P-SDIP024-0300 P-SOP024-0450	⇒	IR3C08/N	P-SDIP024-0300/ P-SOP024-0450

(Short form)

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CMOS Image Sensors/ CCDs

Camera Modules

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CMOS Camera Modules

CMOS Camera Modules

Module configuration : CMOS image sensor, CDS/AGC/10-bit ADC, timing generator, DSP, lens (for UXGA/SXGA/VGA)
 CMOS image sensor, CDS/AGC/8-bit ADC, timing generator, DSP, lens (for CIF)
 Color filter : R, G, B primary color mosaic filters
 Operating temperature : -20 to 60°C

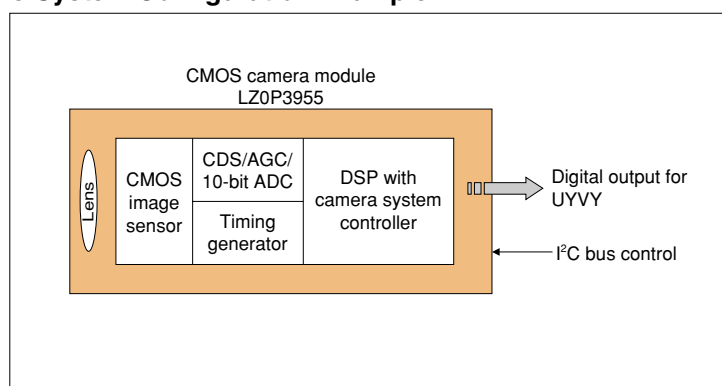
Optical format	Image format	Optical function	Model No.	Features	Output pixels (H x V) MAX.	Lens			Output signal	Supply voltage (V)	Power consumption (mW) TYP.	Package	
						F No.	Con-figuration	Horizontal viewing angle (°)					
1/3.2 type	UXGA	Macro function	LZ0P3955	• UXGA to SubQCIF • 15 fps at UXGA/ 30 fps at SVGA • 5x electronic zoom at QVGA size (MAX.) • Image inversion function (right and left)	1 600 x 1 200	F3.4		53	UYVY	2.8/1.8 (I/O : 1.8 or 2.8 V)	290 (at 7.5 fps)	28LCC type (Can be socket-mounted)	
		Auto focus function	★LZ0P3954			F2.8		57			240 (at 7.5 fps)		
1/3 type	SXGA	Macro function	LZ0P393E	• SXGA to SubQCIF • 15 fps at SXGA/ 30 fps at QSXGA • 4.2x electronic zoom at QVGA size (MAX.) • Image inversion function (right and left)	1 280 x 1 024	F2.8	3 pcs.	58			150 (at 15 fps)		
		—	LZ0P3936										
1/4 type		Macro function	LZ0P393D			• SXGA to SubQCIF • 15 fps at SXGA/ 30 fps at QSXGA • 4.2x electronic zoom at QVGA size (MAX.) • Image inversion function (right and left)		F3.2			56		220 (at 15 fps)
			LZ0P393M					F3.4					
1/6 type	VGA	—	★LZ0P394U	• VGA to SubQCIF • 30 fps at VGA • 2x electronic zoom at QVGA size (MAX.) • Image inversion function (right and left)	640 x 480	F2.8	2 pcs.	52			110 (at 30 fps)		24LCC type (Can be socket-mounted)
			LZ0P394K					54					
1/7 type	CIF		LZ0P392N	• CIF/QCIF • 30 fps at CIF • Image inversion function (right and left)	352 x 288	F3.2	Single	58			2.5 (I/O : 2.8 V)	35 (at 15 fps)	
			LZ0P392L					65					
			★LZ0P396D					56			1.8 (I/O : 1.8 or 2.8 V)	12 (at 30 fps)	
1/11 type													

Outline Dimensions

Model No.	Outline dimensions (mm) TYP.	Package
LZ0P3955	9.5 x 9.5 x (H) 7.0	28LCC type (Can be socket-mounted)
★LZ0P3954	12.0 x 12.0 x (H) 7.2	
LZ0P393E	9.0 x 9.0 x (H) 6.6	24LCC type (Can be socket-mounted)
LZ0P3936	9.0 x 9.0 x (H) 6.4	
LZ0P393D	8.4 x 8.4 x (H) 5.3	
LZ0P393M	8.0 x 8.0 x (H) 4.9	
★LZ0P394U	5.8 x 5.8 x (H) 3.7	
LZ0P394K	6.2 x 6.5 x (H) 4.3	
LZ0P392N	6.5 x 6.5 x (H) 4.5	
LZ0P392L	6.5 x 6.5 x (H) 3.8	
★LZ0P396D	5.5 x 5.5 x (H) 2.4	

(H) : Module height

System Configuration Example





CCD Camera Modules

■ CCD Camera Modules

Module configuration : CCD, CDS/AGC/10-bit ADC, timing generator, V driver, DSP*, lens, peripheral components
 Color filter : R, G, B primary color mosaic filters
 Operating temperature : -20 to 60°C

* External DSP is required for LZ0P375D/LZ0P3758.

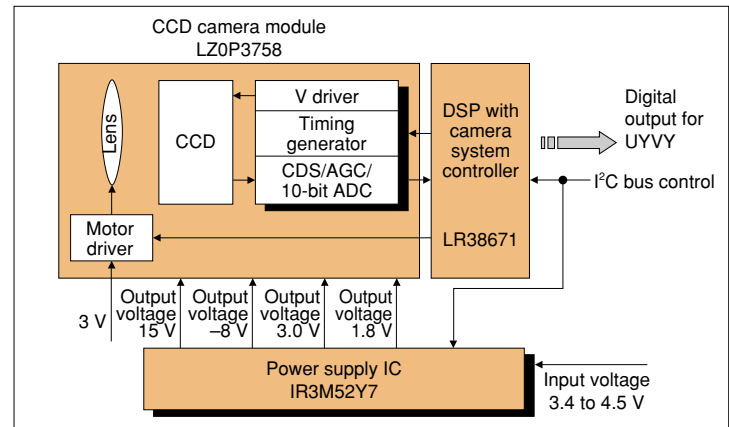
Optical format	Total pixels	Optical function	Model No.	Features	Output pixels (H x V) MAX.	Lens			Output signal	Supply voltage (V)	Power consumption (mW) TYP.	Package
						F number	Con-figuration	Horizontal viewing angle (°)				
1/2.5 type	3.37 M	Auto focus function	LZ0P375D	• 2 048 x 1 536 to SubQCIF • 4.5 fps at 2 048 x 1 536/ 10 fps at VGA • 6.4x electronic zoom at QVGA size (MAX.) • Image inversion function (right and left)	2 048 x 1 536	F2.8	3 pcs.	54	RGB Bayer	1.8, 3.0, 15, -8	400 (at 4.5 fps)	52LCC type
		2x optical zoom/auto focus function	LZ0P3758			F2.8 to 4.1	6 pcs.	Wide : 61 Tele : 33			400 (at 4.5 fps)/ 900 (at motor operation)	40FPC type
1/4 type	1.36 M	Macro function	LZ0P374R	• 1 280 x 960 to SubQCIF • 7.5 fps at 1 144 x 880/ 15 fps at QVGA • 4x electronic zoom at QVGA size (MAX.) • Image inversion function (right and left)	1 280 x 960	F3.4	3 pcs.	60	UYVY	1.8, 3.0, 15, -8 (I/O : 1.8 or 3.0 V)	370 (at 7.5 fps)	64LCC type
			LZ0P374P					54LCC type				
		Auto focus function	LZ0P374H			F2.8		46				48LCC type
1/7 type	350 k	—	LZ0P371K	• VGA/CIF/QVGA/ QCIF/SubQCIF • 15 fps • 2x electronic zoom at QVGA size (MAX.) • Image inversion function (right and left)	640 x 480	F2.4	2 pcs.	58		1.8, 3.0, 15, -8 (I/O : 3.0 V)	240 (at 12 fps)	36LCC type
			LZ0P371L									

● Outline Dimensions

Model No.	Outline dimensions (mm) TYP.	Package
LZ0P375D	22.0 x 13.5 x (H) 9.9	52LCC type
LZ0P3758	20.0 x 10.0 x (H) 23.2	40FPC type
LZ0P374R	19.5 x 11.9 x (H) 5.2	64LCC type
LZ0P374P	10.4 x 12.9 x (H) 6.2	54LCC type
LZ0P374H	20.3 x 14.9 x (H) 7.4	48LCC type
LZ0P371K	10.0 x 13.0 x (H) 4.3	36LCC type
LZ0P371L	10.4 x 8.0 x (H) 5.2	

(H) : Module height

● System Configuration Example



■ Peripheral LSI for CCD Camera Modules

Model No.	Function	Features	Package
LR38671	DSP for 3.37-Mpixel CCD camera modules	CCD signal processing circuit, YUV digital output, RGB bayer data output, processing circuit for AWB/AE control, auto white defect detection, stepless electronic zoom, motor driver control, timing generator serial control	TFBGA152-0808

■ Power Supply ICs for CCD Camera Modules

Model No.	Function	Output voltage 1 (V)[for CCD]	Output voltage 2 (V)[for CCD]	Output voltage 3 (V)[for CCD]	Output voltage 4 (V)[for DSP]	Output voltage 5 (V)[for I/O]	Input voltage (V)	Package
IR3M48U6	Multi-output power supply for 1/7-type 350-kpixel CCD camera modules	15	-8	—	1.8	—	2.7 to 3.2	P-VQFN032-0505
IR3M52Y7	Multi-output power supply for 1/2.5-type 3.37-Mpixel, 1/4-type 1.36-Mpixel CCD camera modules			2.5 to 3.3	1.2/1.8	2.5 to 3.3	2.7 to 5.5*1	41WL-CSP*2

*1 Since output voltages 3, 4 and 5 are outputs for LDO, an input voltage 0.2 to 0.3 V higher than the output voltages is required.

*2 3.97 mm x 3.97 mm x 0.82 mm (TYP.)



CCDs and Peripheral ICs/LSIs

Higher-resolution CCDs

Optical format	Total pixels	Color filter	Model No.	30 fps VGA movie	Resolution	Pixel size H x V (μm ²)	Sensitivity (mV) TYP.	Smear ratio (dB) TYP.	Package
					Image pixels (H x V)				
1/1.7 type	10 540 k	R,G,B primary color mosaic filters	RJ21W3BA0ET	○ (25 fps VGA movie)	3 704 x 2 784	2.05 x 2.05	80	-88	P-SOP032-0525
			RJ21W3CA0ET	—					
1/1.8 type	8 500 k		RJ21V3BC0ET	○	3 320 x 2 496	2.2 x 2.2	105		
			RJ21V3CC0ET	—					
1/2.5 type	5 190 k		RJ23S3BC0ET	○	2 600 x 1 944	2.2 x 2.2	80	-85	P-SOP028-0400
			RJ23S3CC0ET	—					
	6 360 k		RJ23T3BA0ET	○	2 872 x 2 160	2.05 x 2.05	100		
			RJ23T3CA0ET	—					
			★RJ23T3BB0ET	○					
			★RJ23T3CB0ET	—					
	7 400 k		★RJ23U3BA0ET	○	3 096 x 2 328	1.9 x 1.9	80		
			★RJ23U3CA0ET	—					

1/3-type CCDs

Total pixels			Standard	Model No.	Electronic shutter (s)	Resolution		Pixel size H x V (μm ²)	Sensitivity (mV) TYP.	Smear ratio (dB) TYP.	Package
Horizontal TV lines		Image pixels (H x V)									
270 k	Color	NTSC	RJ2311AA0PB	1/60 to 1/10 000	330	512 x 492	9.6 x 7.5	1 300	−120	P-DIP016-0500C	
320 k		PAL	RJ2321AA0PB	1/50 to 1/10 000		512 x 582	9.6 x 6.3				
410 k		NTSC	RJ2351AA0BB	1/60 to 1/10 000	480	768 x 494	6.4 x 7.5	800	−105	N-DIP016-0450	
			★RJ2351BA0AB					1 200	−120		
470 k		PAL	RJ2361AA0BB	1/50 to 1/10 000		752 x 582	6.5 x 6.3	750	−105		
			★RJ2361BA0AB				6.53 x 6.39	1 100	−120		

1/4-type CCDs

Total pixels	Standard		Model No.	Electronic shutter (s)	Resolution		Pixel size H x V (μm ²)	Sensitivity (mV) TYP.	Smear ratio (dB) TYP.	Package
					Horizontal TV lines	Image pixels (H x V)				
270 k	Color	NTSC	RJ2411AA0PB*	1/60 to 1/10 000	330	512 x 492	7.2 x 5.6	800	−105	P-DIP014-0400A
			RJ2411AB0PB					1 200	−120	
			RJ2411BA0PB*							
			RJ2411BB0PB							
320 k		PAL	RJ2421AB0PB	1/50 to 1/10 000	512 x 582	7.2 x 4.7	720	−105		
			★RJ2421BB0PB			7.2 x 4.73	1 100	−120		
410 k		NTSC	RJ2451AA0PB	1/60 to 1/10 000	480	768 x 494	4.9 x 5.6	400	−90	
470 k		PAL	RJ2461AA0PB	1/50 to 1/10 000		752 x 582	5.0 x 4.7			

* Suitable for intense light exposure.

1/3-type CCDs with Dual-power-supply (5 V/12 V) Operation*¹

Total pixels	Standard	Model No.	Electronic shutter (s)	Resolution		Pixel size H x V (μm ²)	Sensitivity (mV) TYP.	Smear ratio (dB) TYP.	Package
				Horizontal TV lines	Image pixels (H x V)				
270 k	B/W	LZ2316A3	1/60 to 1/10 000	380	512 x 492	9.6 x 7.5	3 300* ²	-110	N-DIP016-0500C
320 k		LZ2326A3	1/50 to 1/10 000		512 x 582	9.6 x 6.3	3 000* ²		

*¹ With mirror image function

*² When IR cut-off filter is not used.

■ CCD Peripheral ICs/LSIs

Description	Model No.	Features		Package
Single-chip driver (Timing generator + Synchronous signal generator)	LR385851	For 270-k/320-kpixel CCDs with dual-power-supply operation (5 V/12 V)	Electronic shutter, electronic exposure, mirror image function, for B/W CCDs, level shifter, smooth shutter, line lock function	P-QFP048-0707
Signal processor	IR3Y30M2	Available for signal processing from CCD output to 75 Ω video output, for B/W CCDs, comparator for electronic exposure, high-speed S/H circuit, H aperture, LPF, AGC		P-QFP048-0707
V driver	LR366851	Vertical pulse driver for CCDs, 2-level output x 2, 3-level output x 4, 2-level output circuit for electronic shutter		P-SSOP024-0275
	LR36687U/Y	Vertical pulse driver for CCDs, 2-level output x 10, 3-level output x 10, 2-level output circuit for electronic shutter		P-VQFN064-0808/ TFBGA068-0606
	LR36689U	Vertical pulse driver for CCDs, 2-level output x 4, 3-level output x 8, 2-level output circuit for electronic shutter		P-VQFN036-0505
CDS/PGA/ADC	IR3Y48A3/A5	Low power consumption [80 mW (TYP.)], high-speed S/H circuit, high-gain PGA circuit, 10-bit ADC (18 MHz)		P-QFP048-0707/ P-VQFN052-0707
	IR3Y60U6	Low power consumption [69 mW (TYP.)], high-speed S/H circuit, high-gain PGA circuit, 10-bit ADC (20 MHz)		P-VQFN032-0505
	IR3Y50U6	Low power consumption [75 mW (TYP.)], high-speed S/H circuit, high-gain PGA circuit, 12-bit ADC (25 MHz)		P-VQFN036-0606
Timing generator + V driver + CDS/PGA/ADC	LR38667	For 1/2.5 type 5 190-kpixel CCDs with/without movie function	<Timing generator> Monitoring mode/still mode <V driver> Vertical pulse driver for CCDs, 2-level output x 10, 3-level output x 10, 2-level output circuit for electronic shutter <CDS/PGA/ADC> 30 MHz (LR38667)/ 36 MHz (LR38675/LR38678/LR38674/LR38677), high-speed S/H circuit, high-gain PGA circuit, 12-bit ADC	LFBGA192-1010
	LR38675	For 1/2.5 type 6 360-kpixel CCDs with/without movie function		
	LR38678	For 1/2.5 type 7 400-kpixel CCDs with/without movie function		
	LR38674	For 1/1.8 type 8 500-kpixel CCDs with/without movie function		
	LR38677	For 1/1.7 type 10 540-kpixel CCDs with/without movie function		
V driver + DSP	★LRS5753	For 270-k/320-k/410-k/ 470-kpixel CCDs	<V driver> Vertical pulse driver for CCDs, 2-level output x 2, 3-level output x 2, 2-level output circuit for electronic shutter <DSP> YUV digital output, NTSC/PAL analog output, mirror image function, 9-bit DAC, synchronous signal generation circuit, CCD drive timing generator, processing circuit for AWB/AE control, Y/C separation analog output, line lock function	LFBGA144-0808
V driver + CDS/PGA/ADC + DSP	LR386431/33	For 270-k/320-k/410-k/ 470-kpixel CCDs	<V driver> Vertical pulse driver for CCDs, 2-level output x 2, 3-level output x 2, 2-level output circuit for electronic shutter <CDS/PGA/ADC> 18 MHz, high-speed S/H circuit, high-gain PGA circuit, 10-bit ADC <DSP> YUV digital output, NTSC/PAL analog output, mirror image function, 9-bit DAC, synchronous signal generation circuit, CCD drive timing generator, processing circuit for AWB/AE control, supports monitoring output	LFBGA168-1212/ LFBGA171-0811
	★LR38653		<V driver> Vertical pulse driver for CCDs, 2-level output x 2, 3-level output x 2, 2-level output circuit for electronic shutter <CDS/PGA/ADC> 25 MHz, high-speed S/H circuit, high-gain PGA circuit, 12-bit ADC <DSP> YUV digital output, NTSC/PAL analog output, mirror image function, 10-bit DAC, synchronous signal generation circuit, CCD drive timing generator, processing circuit for AWB/AE control	LFBGA171-0811

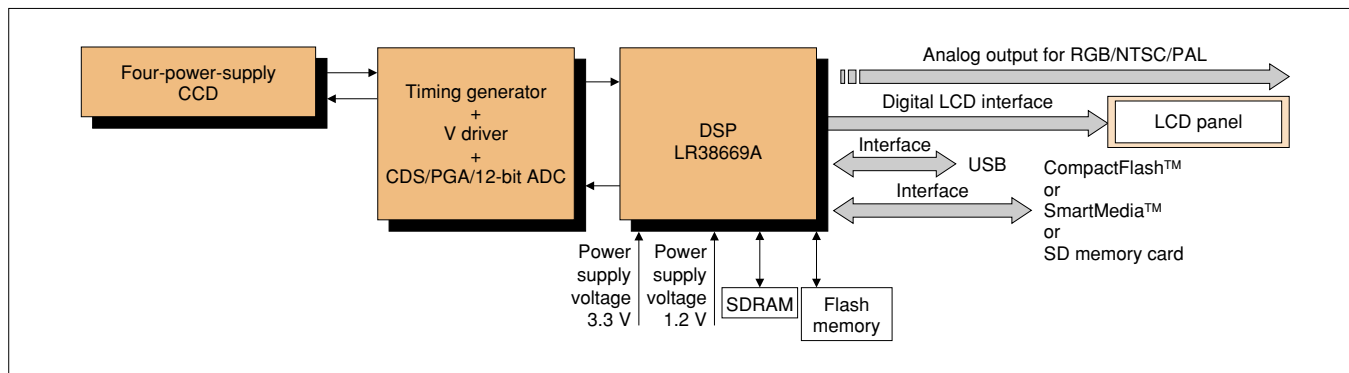
■ CCD Peripheral ICs/LSIs (cont'd)

Description	Model No.	Features		Package
DSP + Flash memory + SDRAM	LR38682	For 6 000-kpixel-class CCDs (MAX.)	<DSP> CCD signal processing circuit, ARM core, JPEG (hardware), memory controller, video encoder (NTSC/PAL), USB line driver, supports CompactFlash™/SmartMedia™/ SD memory card interfaces, supports several types of LCD digital interfaces, support for CCDs with movie function <Flash memory> Capacity : 32 Mbits Bit configuration : x 16 Access time : 100 ns (MAX.) 4-Kword reprogramming time (Program + erase) : 0.42 s (Program 0.06 s + Erase 0.35 s) <SDRAM> Capacity : 256 Mbits (LR38682) 256 Mbits x 2 (LR38683) Burst length (BL) : 1, 2, 4, 8, full page CAS latency (CL) : 2, 3 Frequency : 100 MHz (MAX.)	FBGA424-1414
	LR38683	For 10 000-kpixel-class CCDs (MAX.)		
DSP	LR386032	For 270-k/320-k/410-k/ 470-kpixel CCDs	YUV digital output, NTSC/PAL analog output, mirror image function, 9-bit DAC, synchronous signal generation circuit, CCD drive timing generator, processing circuit for AWB/AE control, supports monitoring output of IR3Y48A3	P-LQFP080-1212
	LR386071		YUV digital output, NTSC/PAL analog output, mirror image function, 9-bit DAC, synchronous signal generation circuit, CCD drive timing generator, processing circuit for AWB/AE control, Y/C separation analog output, line lock function, supports monitoring output of IR3Y48A3	P-LQFP100-1414
	LR38669A	For 1 300-k to 10 000-kpixel-class CCDs	CCD signal processing circuit, ARM core, JPEG (hardware), memory controller, video encoder (NTSC/PAL), USB line driver, supports CompactFlash™/SmartMedia™/ SD memory card interfaces, supports several types of LCD digital interfaces, support for CCDs with movie function	TFBGA260-1313
Power supply IC for CCDs and peripheral ICs/LSIs	IR3M55U*	For 270-k/320-kpixel CCDs	Input voltage range : 4.5 to 16 V, PWM control + charge pump system, output voltage : three outputs (15 V/12 V, -8 V/-5 V, 3.3 V), power sequencing circuit, overheat protection circuit	P-VQFN032-0505
	IR3M59U			
	★IR3M61U*		Input voltage range : 4.5 to 10 V, PWM control + charge pump system, output voltage : four outputs (15 V, -8 V, 3.3 V, 1.8 V), power sequencing circuit, overheat protection circuit	
	★IR3M63U			

* For in-vehicle use

● System Configuration Examples

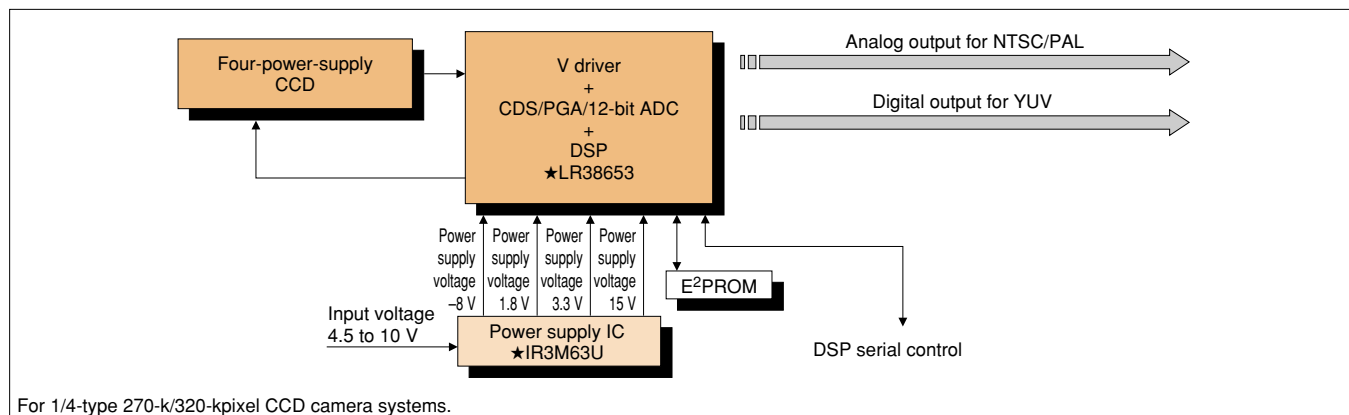
● High-resolution Digital Camera System with Three-chip Configuration



Four-power-supply CCDs and peripheral LSIs

CCD				30 fps VGA movie	Timing generator + V driver + CDS/PGA/ADC	DSP	
Interlace	1/1.7 type	10 540 k pixels	RJ21W3BA0ET	○ (25 fps VGA movie)	LR38677	LR38669A	
			RJ21W3CA0ET	—			
	1/1.8 type	8 500 k pixels	RJ21V3BC0ET	○	LR38674		
			RJ21V3CC0ET	—			
	1/2.5 type	5 190 k pixels	RJ23S3BC0ET	○	LR38667		
			RJ23S3CC0ET	—			
			6 360 k pixels	RJ23T3BA0ET	○		LR38675
				RJ23T3CA0ET	—		
		★RJ23T3BB0ET		○			
		★RJ23T3CB0ET		—			
		7 400 k pixels	★RJ23U3BA0ET	○	LR38678		
			★RJ23U3CA0ET	—			

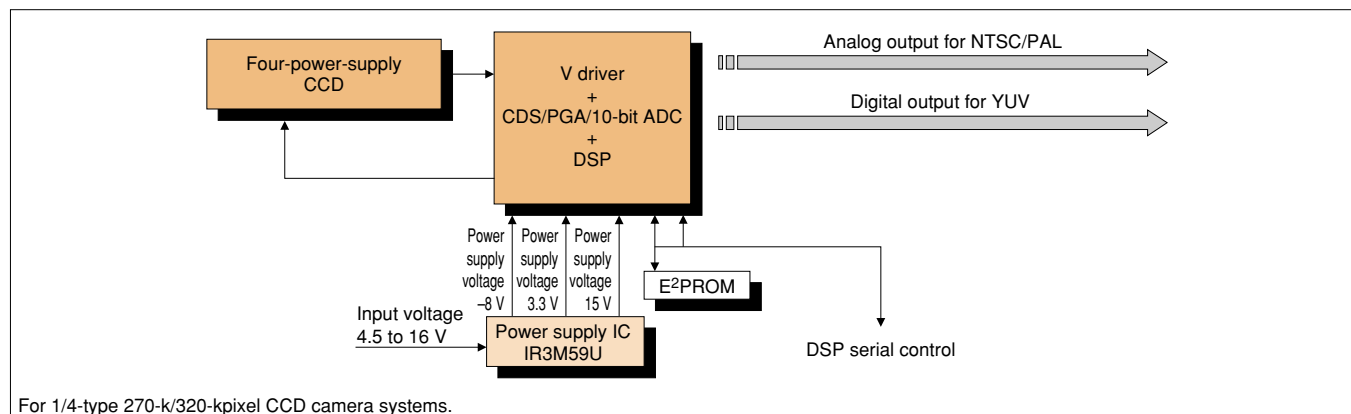
● Color Security Camera System with Two-chip Configuration [Low Power Consumption Type]



Four-power-supply CCDs and peripheral IC/LSIs

CCD			V driver + CDS/PGA/ADC + DSP	Power supply IC
1/3 type	270 k pixels	RJ2311AA0PB	★LR38653	—
	320 k pixels	RJ2321AA0PB		
	410 k pixels	RJ2351AA0BB		
		★RJ2351BA0AB		
	470 k pixels	RJ2361AA0BB		
		★RJ2361BA0AB		
1/4 type	270 k pixels	RJ2411AA0PB		★IR3M63U
		RJ2411AB0PB		
		RJ2411BA0PB		
		RJ2411BB0PB		
		RJ2421AB0PB		
		★RJ2421BB0PB		
	410 k pixels	RJ2451AA0PB		—
	470 k pixels	RJ2461AA0PB		

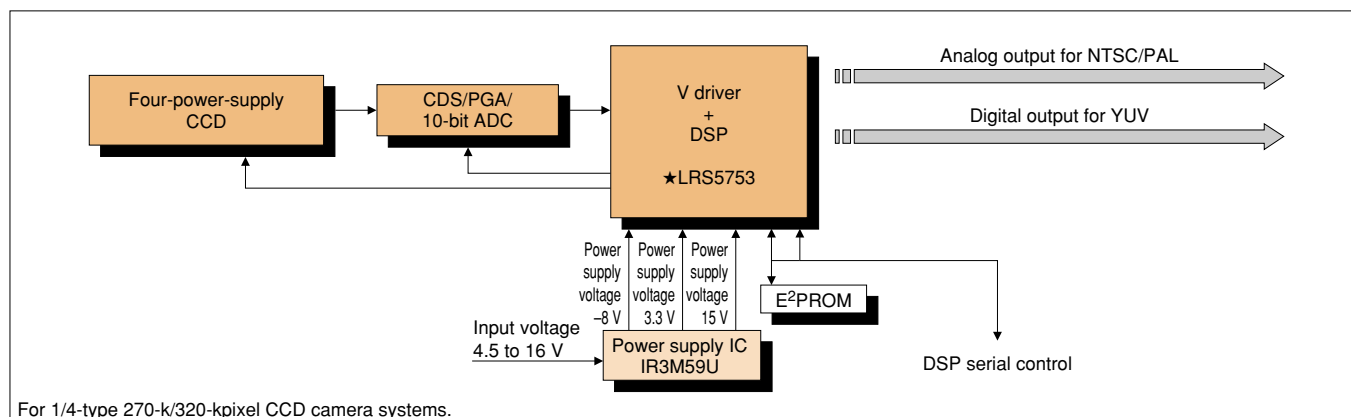
● Color Security Camera System with Two-chip Configuration



Four-power-supply CCDs and peripheral IC/LSIs

CCD			V driver + CDS/PGA/ADC + DSP	Power supply IC
1/3 type	270 k pixels	RJ2311AA0PB	LR386431/LR386433	—
	320 k pixels	RJ2321AA0PB		
	410 k pixels	RJ2351AA0BB		
		★RJ2351BA0AB		
	470 k pixels	RJ2361AA0BB		
1/4 type		★RJ2361BA0AB		IR3M59U
		RJ2411AA0PB		
		RJ2411AB0PB		
		RJ2411BA0PB		
		RJ2411BB0PB		
	270 k pixels	RJ2421AB0PB		
		★RJ2421BB0PB		
	320 k pixels	RJ2451AA0PB		
	410 k pixels	RJ2461AA0PB		
	470 k pixels	RJ2461AA0PB		—

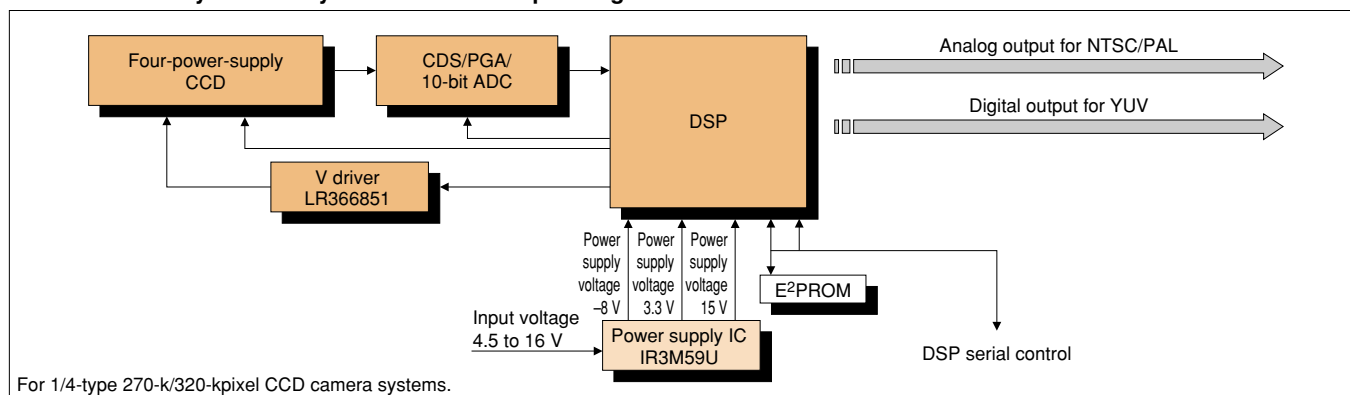
● Color Security Camera System with three-chip Configuration



Four-power-supply CCDs and peripheral ICs/LSI

CCD			CDS/PGA/ADC	V driver + DSP	Power supply IC
1/3 type	270 k pixels	RJ2311AA0PB	IR3Y60U6/IR3Y48A3	★LRS5753	—
	320 k pixels	RJ2321AA0PB			
	410 k pixels	RJ2351AA0BB			
		★RJ2351BA0AB			
	470 k pixels	RJ2361AA0BB			
1/4 type		★RJ2361BA0AB			IR3M59U
		RJ2411AB0PB			
		RJ2411BB0PB			
		RJ2421AB0PB			
		★RJ2421BB0PB			
	270 k pixels	RJ2451AA0PB			
	320 k pixels	RJ2461AA0PB			
	410 k pixels	RJ2461AA0PB			
	470 k pixels	RJ2461AA0PB			—

● Color Security Camera System with Four-chip Configuration



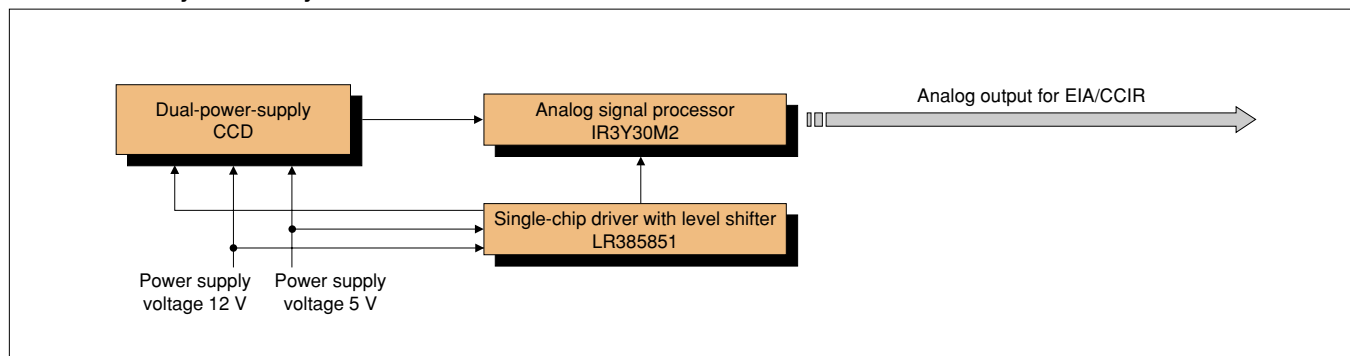
Four-power-supply CCDs and peripheral ICs/LSIs (1)

CCD			V driver	CDS/PGA/ADC	DSP	Power supply IC
1/3 type	270 k pixels	RJ2311AA0PB	LR366851	IR3Y60U6/IR3Y48A3	LR386071	—
	320 k pixels	RJ2321AA0PB				
	410 k pixels	RJ2351AA0BB				
		★RJ2351BA0AB				
	470 k pixels	RJ2361AA0BB				
1/4 type		★RJ2361BA0AB				IR3M59U
	270 k pixels	RJ2411AB0PB				
		RJ2411BB0PB				
	320 k pixels	RJ2421AB0PB				
		★RJ2421BB0PB				
	410 k pixels	RJ2451AA0PB				
	470 k pixels	RJ2461AA0PB				

Four-power-supply CCDs and peripheral ICs/LSIs (2)

CCD			V driver	CDS/PGA/ADC	DSP	Power supply IC
1/3 type	270 k pixels	RJ2311AA0PB	LR366851	IR3Y48A3	LR386032	—
	320 k pixels	RJ2321AA0PB				
	410 k pixels	RJ2351AA0BB				
		★RJ2351BA0AB				
	470 k pixels	RJ2361AA0BB				
1/4 type		★RJ2361BA0AB				IR3M59U
	270 k pixels	RJ2411AB0PB				
		RJ2411BB0PB				
	320 k pixels	RJ2421AB0PB				
		★RJ2421BB0PB				
	410 k pixels	RJ2451AA0PB				
	470 k pixels	RJ2461AA0PB				

● B/W Security Camera System



Dual-power-supply CCDs and peripheral IC/LSI for analog interface

CCD			Single-chip driver (Timing generator + Synchronous signal generator)	Signal processor
1/3 type	270 k pixels	LZ2316A3	LR385851	IR3Y30M2
	320 k pixels	LZ2326A3		

LSIs for LCDs

TFT-LCD

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STN-LCD

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LSIs for LCDs

For Notebook PCs, PC Monitors and LCD TVs

TFT-LCD Drivers

Drive function		Model No.	Gray scale	No. of LCD drive outputs	Display voltage (V) MAX.	Clock frequency (MHz) MAX.	Supply voltage (V)	Description	Package
Source driver	Dot inversion drive	LH16AM	64 levels	384	13.5	85	2.7 to 3.6	Low EMI*1 using RSDS™*2 interface, built-in reference voltage generation circuit, R-DAC system	SOF
		LH16B6		414/420/432			2.3 to 3.6		
		LH16AD		480/504/516/528			2.7 to 3.6		
		LH16B0		600			2.3 to 3.6		
		LH16B1		618					
		LH16B2		630					
		LH16B3		642					
		★LH16B5		630/642					
	Line inversion drive	LH168R	256 levels	384	13	65	2.7 to 3.6	2-port data input, built-in reference voltage generation circuit, R-DAC system	TCP/SOF
		LH16AE			15	85		Low EMI*1 using RSDS™*2 interface, built-in reference voltage generation circuit, R-DAC system	SOF
		LH16AW		384/414/420	16				
		LH168V		480	13	65	2.5 to 3.6	Selectable clock single-edge (2-port input) or clock dual-edge (1-port input) (built-in data sampling switching function), built-in reference voltage generation circuit, R-DAC system	TCP/SOF
		LH16AF			15	85	2.7 to 3.6	Low EMI*1 using RSDS™*2 interface, built-in reference voltage generation circuit, R-DAC system	SOF
		LH16A1		64 levels	384	5.5		57	2-port data input, built-in reference voltage generation circuit, R-DAC system
Gate driver	LH1691	—	240	33	0.1	3.0 to 5.5	Selectable 1-pulse (normal) or 2-pulse (continuous/jumping) scanning, usable with both positive/negative power supplies	TCP/SOF/COG	
	LH1694		256	42		2.7 to 3.6	Output signal masking function, usable with both positive/negative power supplies, enables chain connection	TCP/SOF	
	LH169G		202/242/258/263/272	45	0.2	2.4 to 4.2	Output signal masking function, enable constructing the module without substrate	SOF	

*1 EMI : Electro-Magnetic Interference

*2 RSDS™ : Reduced Swing Differential Signaling

For Mobile Equipment

TFT-LCD Drivers

Drive function	Model No.	Gray scale	No. of LCD drive outputs	Display voltage (V) MAX.	Clock frequency (MHz) MAX.	Supply voltage (V)	Description	Package
Source driver	Dot inversion drive	★LH16AV	402/480/516	13.5	65	2.7 to 3.6	Built-in reference voltage generation circuit, R-DAC system, power saving function	COG
	Line inversion drive	LH168Y	240	5.5	35	2.5 to 5.5	Built-in reference voltage generation circuit, R-DAC system, power saving function, polarity inversion of input data	
		LH16AR	480			2.5 to 3.6	Built-in R-DAC system, power saving function, polarity inversion of input data	
		LH1687	240		12.5	3.0 to 5.5	Selectable three-point simultaneous or normal sampling (Sampling frequency : 25 MHz), power saving function, 3 V drive (MIN.), prechargeless output	TCP/SOF/COG
Gate driver		LH1691	240	33	0.1	2.5 to 3.6	Selectable 1-pulse (normal) or 2-pulse (continuous/jumping) scanning, usable with both positive/negative power supplies	COG
		★LH169H	240/244/258	40			Output signal masking function, enables chain connection	

STN-LCD Drivers

Drive technology	Drive function	Model No.	No. of LCD drive outputs	Duty ratio	Display voltage (V) MAX.	Data input	Clock frequency (MHz) MAX.	Supply voltage (V)	Package
New drive technology* ¹	Segment	LH1583	160	to 1/240	+5.5	4/8-bit parallel	12 (at 2.4 V) / 20 (at 5 V)	2.4 to 5.5	TCP/SOF
		LH1580	240	to 1/480		8/12-bit parallel	30 (at 2.5 V) / 55 (at 5 V)	2.5 to 5.5	
	Common	LH1537	200/240	1/200, 1/240	+45	—	3 (at 2.4 V) / 4 (at 5 V)	2.4 to 5.5	
		LH1538	120/128	to 1/480	+80		3 (at 2.5 V) / 4 (at 5 V)		
Conventional drive technology* ²	Segment	LH1542	80	to 1/240	+30	4-bit parallel	8	2.5 to 5.5	
		LH1549	160	to 1/480	+42	4/8-bit parallel	12 (at 2.5 V) / 20 (at 5 V)		
		LH1548	240			8/12-bit parallel	12 (at 2.5 V) / 25 (at 5 V)		
	Common	LH1530	120	to 1/480	+42	—	3 (at 2.5 V) / 4 (at 5 V)		
	Segment or Common (Pin-selectable)	LH1565	160	to 1/240	+30	4/8-bit parallel (at segment drive)	[Segment mode] 8 [Common mode] 4		
		LH1560		to 1/480	+42		[Segment mode] 8 (at 2.5 V) / 14 (at 5 V) [Common mode] 4		
		LH1562	240				[Segment mode] 12 (at 2.5 V) / 20 (at 5 V) [Common mode] 4		

*1 New drive technology : A drive technology which drives LCDs with low voltage of 5 V on segment side and drives LCDs with high voltage on common side.

Driving with low voltage on segment side enables LCDs to reduce power consumption and shadowing.

*2 Conventional drive technology : A drive technology which drives LCDs with high voltage on both segment and common sides.

Power Supply IC for STN-LCD Drivers

Model No.	Description	Supply voltage (V)	Package
LR3697A	For STN LCD drivers with new drive technology* DC-DC converter for LCD drive power supply, built-in bias voltage generation circuit for LCD drive, electronic volume control circuit	2.4 to 3.3 (V _{DD} , V _P)	P-QFP072-1010

* New drive technology : A drive technology which drives LCDs with low voltage of 5 V on segment side and drives LCDs with high voltage on common side.

Driving with low voltage on segment side enables LCDs to reduce power consumption and shadowing.

For Cellular Phones

■ TFT-LCD Controller/Driver with Two-chip Configuration (LR38825 + LH169C)

Model No.	No. of LCD drive outputs		Display colors MAX.	Display RAM capacity (bit)	a-Si	Function	CPU interface	External image interface	Supply voltage (V)			Package
	Source	Gate							Core	Host I/F	Display	
LR38825	528	—	262 144 colors	240 x 176 x 18	○	- Versatile graphic functions - Window display function - Write mask function - Bit built function - Built-in gray-scale control circuit - Built-in timing generator	80-family (8/16/18-bit parallel, serial)	RGB : respective 6-bit parallel	1.65 to 1.95	1.65 to 3.6	4.75 to 5.25	COG
LH169C	—	240		—	○	Built-in DC-DC converter, VCOM generation circuit	—	—	2.75 to 3.3		26.5 (MAX.)	

■ Single-chip TFT-LCD Controller/Driver

Model No.	No. of LCD drive outputs		Display colors MAX.	Display RAM capacity (bit)	a-Si	Function	CPU interface	External image interface	Supply voltage (V)			Package
	Source	Gate							Core	Host I/F	Display	
LR38826	396	176	262 144 colors	176 x 132 x 18	○	- Versatile graphic functions - Window display function - Write mask function - Bit built function - Built-in gray-scale control circuit - Built-in timing generator, DC-DC converter, VCOM generation circuit	80-family (8/16/18-bit parallel, serial)	RGB : respective 6-bit parallel, YUV format	1.65 to 1.95	1.65 to 3.6	2.75 to 3.3 (Using built-in power supply *Source : 4.0 to 5.5 *Gate : 20 to 27.5)	COG

■ TFT-LCD Controllers

Model No.	LCD interface (pixel) MAX.	Display colors MAX.	Display RAM capacity (bit)	a-Si	Function	CPU interface	External image interface	Supply voltage (V)		Package
								Core	Host I/F	
LR38822A	176 x 240	65 536 colors	176 x 240 x 16	○	Built-in timing generator, clock generator	80-family (8/16-bit parallel, serial)	RGB : respective 6-bit parallel	2.25 to 2.75	3.0 to 3.6	TFBGA112-1010
LR38869A	240 x 400	262 144 colors	240 x 400 x 18	○	- MDDI* compliant - Main/sub LCD controller - Graphic processing - Parallel bus host interface	MDDI* for MSM series/ 80-family (8/9/16/18-bit parallel)	—	1.65 to 1.95	1.65 to 3.6	TFBGA176-0909

* MDDI (Mobile Display Digital Interface) : The serial interface standard developed by QUALCOMM.

■ TFT-LCD Driver

Model No.	No. of LCD drive outputs		LTSPS*	Function	External image interface	Supply voltage (V)		Package
	Source	Gate				Core	Display MAX.	
LH16AP	240	○	○	Built-in timing generator, DC-DC converter, VCOM generation circuit	RGB : respective 6-bit parallel	2.2 to 3.6	5.5	COG/SOF

* LTSPS : Low Temperature Poly-Silicon

■ Color STN-LCD Controllers/Drivers

Display colors MAX.	Drive function	Model No	No. of LCD drive outputs		Display RAM capacity (bit)	Duty ratio	Display voltage (V) MAX.	Data input	Clock frequency (MHz) MAX.	Supply voltage (V)	Package
			Segment	Common							
256 colors	Segment and Common	LH15H1	288	66	96 x 66 x 8	1/10, 1/18, 1/26, 1/34, 1/42, 1/50, 1/58, 1/66	+13.2	8/16-bit parallel, serial	4 (at 3 V)	1.8 to 3.3	TCP/SOF
4 096 colors		LH15JA	396	132	132 x 132 x 12	1/33, 1/39, 1/68, 1/74, 1/133, 1/139	+18	8-bit parallel, serial	3 (at 2.5 V)	1.65 to 3.3	COG
65 536 colors		LH15KA		176	132 x 176 x 16	to 1/176 (Selectable per 1 line)	+18.6	8/16-bit parallel, serial	4 (at 3 V)	1.8 to 3.3	COG/SOF
262 144 colors		★LH15LA		162	132 x 162 x 18	to 1/162 (Selectable per 1 line)	±18		6.25 (at 1.65 to 1.95)	Core : 1.65 to 1.95 Host I/F : 1.65 to 3.6	COG

■ Color STN-LCD Controller

Model No.	LCD interface (pixel) MAX.	Display colors MAX.	Function/Feature		CPU interface	Display RAM capacity (bit)	Supply voltage (V) TYP.	Package
LR38844A	128 x 164	65 536 colors	- High-speed host access - Display colors selectable : 256/4 096/65 536 colors - Power saving function reduces the power consumption in standby mode - Built-in CPU interface, LCD interface, clock generator, display memory	Recommended to be used together with LH15H1	68-family/ 80-family (8/16 bits)	128 x 164 x 16	2.5	TFBGA081-0808

Peripheral ICs for LSIs for LCDs

Video Interface ICs for TFT-LCDs

Model No.	Input signal				Color decode	LCD panel				Serial data control	Supply voltage (V) TYP.	Power consumption (mW) TYP.	Package
	Composite video	Y/color difference	Analog RGB	OSD (Digital)		± power source	+ power source	Low voltage source	Digital input				
IR3Y18A1	○				NTSC/PAL	○	○				4.5/12 or 4.5/-7.5	130	P-QFP048-0707
IR3Y26A2/A6			○*3		—			○			5/7.5	140	P-QFP048-1010/ P-QFP048-0707
IR3Y29A1/B1	○		○		NTSC/PAL			○				190	P-QFP048-0707
IR3Y31M1	○		○		NTSC/PAL	○	○				4.5/12 or 4.5/-7.5	160	
IR3Y34M1		○	○	○	—		○				3/12	88	
IR3Y37A1		○(Common terminal)		○	—			○			3/6.5	106/88*4	
RB5P0010M2			○*3	○	—	○	○			○	3/12 or 3/4.5/-7.5	92	P-QFP048-1010
RB5P0020M2		○(Common terminal)		○	—			○			3/5	70/57*4	
RB5P0050M2		○(Common terminal)		○	—			○		○	3/5/13	95/80*4	
RB5P0060M2	○		○		NTSC/PAL			○		○		120	
RB5P006AM2	○		○		NTSC/PAL			○		○			
RB5P0070M*1	○		○	○	NTSC/PAL				○	○	3/7	330	P-QFP072-1010
RB5P0090M	○		○*3		NTSC/PAL (automatic identification)			○		○	5/13	250	P-QFP048-1010
LRS5751*2	○		○		NTSC/PAL			○			3.3/5/7.5	197	P-LQFP100-1414
LRS5752*2	○		○*3		NTSC/PAL (automatic identification)			○		○	3.3/5/13	257	

*1 For digital signal input panels *2 Built-in timing generator *3 Two inputs *4 At analog input for RGB

Power Supply ICs for TFT-LCDs

Model No.	Application/Function	Oscillation frequency (kHz)	Supply voltage (V)	Package
IR3M16U	For small TFT-LCD panels, charge pump system DC-DC converter (15.3 V, 5.1 V, -10.2 V)	100	2.6 to 3.6	P-HQFN020-0404
IR3M30M/U	For small/medium TFT-LCD panels, PWM switching system DC-DC converter (Output voltage (3ch) : External setting)	70 to 1 000	2.7 to 5.5	P-QFP048-0707/ P-VQFN036-0505
★IR3M58M/U		70 to 500	4.5 to 28	

Gray-scale ICs for TFT-LCDs

Model No.	Panel type	Function	No.of output circuits	Output current (mA) MAX.	Common output current (mA) MAX.	Supply voltage (V)	Package
IR3E2015	• Small panels • Line inversion drive	γ correction, gray-scale voltage generator for LCD drivers, built-in dividing resistors	10	± 1	± 1	4.5 to 5.5	P-MFP018
IR3E2045			5			4.6 to 5.5	P-SSOP012-0225/ P-HQFN020-0404
IR3E3XX*							
IR3E11P1	• Large panels • Up to 20-inch panels • SXGA/UXGA • Dot inversion drive	γ correction, gray-scale voltage generator for LCD drivers	10	± 15	± 150	7 to 14	P-QFP048-0707
IR3E11A1						7 to 15	P-TQFP048-0707
IR3E11M1						7 to 14	
IR3E12M1			18			7 to 15	
IR3E13N/U			6			± 50	5 to 15

* SHARP can offer semi-custom-made gray-scale ICs in accordance with the characteristics of LCD panels.

System LSIs

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ARM RISC Core LSIs

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System LSIs

Special-function LSIs

Model No.	Function	Features	Supply voltage (V)	Package
LR35501/Y	Home & amusement processor	- Capable of moving picture play/record, thanks to real-time image compression and extension technology - Real images, backgrounds and sprites can be superimposed - Built-in sprite processor - Built-in color object detector - Built-in Bluetooth interface - Built-in sound generator (ADPCM/PSG) - Built-in CMOS camera module interface - Built-in video encoder : NTSC/PAL compatible signal output - Analog RGB signal output - CPU : Z80 compatible - PIO, UART, SIO, MMU, NAND flash memory I/F, ADC, etc.	Core : 1.8 ± 0.18 I/O : 3.3 ± 0.3	P-QFP128-1420/ TFBGA160-1212
★LR38886	Image detection engine	- High-speed image processing : 960 MOPS (MAX.) - Built-in camera interface : 8-bit digital input (UYVY etc.) - Built-in SDRAM interface : 512 Mbits (MAX.) - Universal I/O : 32 bits (MAX.) - Serial interface (SPI) - Bus interface (Bus Master/Slave) - Built-in PLL - Low power consumption : 250 mW (at 15 fps/VGA)	Core : 1.8 (TYP.) I/O : 3.3 (TYP.)	P-LQFP176-2424
LR38875	RSDS transmitter	- RSDS^{TM*1} spec. V095 compliant - Low EMI^{*2} generation - Low current consumption : 50 mA (MAX. at 85 MHz) - High noise rejection - Data rate : 50 to 180 Mbps (CLK : at 25 to 90 MHz) - Clock delay timing of RSDS^{TM*1} output can be controlled by external register - RSDS^{TM*1} swing output voltage can be controlled by external load resistor	3.3 ± 0.3	P-TQFP100-1414
LR38888	H. 264 decoding signal processor	- Built-in video (H. 264) and audio (MP3/AAC/AAC + SBR) decoding functions - Low current consumption : 125 mA (at 1.3 V) - Fast play - Built-in memory (DRAM) - Input signal : MPEG2-TS - Image size : QVGA - Frame rate : 15 frames/s - Output signal format : Image UYVY/RGB for video, I²S for audio - Output interface : CPU bus, camera interface	Core : 1.3 (TYP.) I/O : 1.8 (TYP.)	TFBGA208-1010
LR38669A	DSP for 1 300-k to 10 000-kpixel-class CCDs	- Built-in CCD signal processing circuit, ARM core, JPEG (hardware), memory controller, video encoder (NTSC/PAL), USB line driver - Supports CompactFlashTM/SmartMediaTM/SD memory card interfaces - Supports several types of LCD digital interfaces - Support for CCDs with movie function	Core : 1.2 (TYP.) I/O : 3.3 (TYP.)	TFBGA260-1313
LR38682	System LSI for digital cameras (for 6 000-kpixel-class CCDs [MAX.])	<DSP> - Built-in CCD signal processing circuit, ARM core, JPEG (hardware), memory controller, video encoder (NTSC/PAL), USB line driver - Supports CompactFlashTM/SmartMediaTM/SD memory card interfaces - Supports several types of LCD digital interfaces - Support for CCDs with movie function <Flash memory> - Capacity : 32 Mbits - Bit configuration : x 16 - Access time : 100 ns (MAX.) 4-Kword reprogramming time (Program + erase) : 0.42 s (Program 0.06 s + Erase 0.35 s) <SDRAM> - Capacity : 256 Mbits (LR38682), 256 Mbits x 2 (LR38683) - Burst length (BL) : 1, 2, 4, 8, full page - CAS latency (CL) : 2, 3 - Frequency : 100 MHz (MAX.)	<DSP> Core : 1.2 (TYP.) I/O : 3.3 (TYP.) <Flash memory> 3.3 (TYP.) <SDRAM> 3.3 (TYP.)	FBGA424-1414
LR38683	System LSI for digital cameras (for 10 000-kpixel-class CCDs [MAX.])	<DSP> - Built-in CCD signal processing circuit, ARM core, JPEG (hardware), memory controller, video encoder (NTSC/PAL), USB line driver - Supports CompactFlashTM/SmartMediaTM/SD memory card interfaces - Supports several types of LCD digital interfaces - Support for CCDs with movie function <Flash memory> - Capacity : 32 Mbits - Bit configuration : x 16 - Access time : 100 ns (MAX.) 4-Kword reprogramming time (Program + erase) : 0.42 s (Program 0.06 s + Erase 0.35 s) <SDRAM> - Capacity : 256 Mbits (LR38682), 256 Mbits x 2 (LR38683) - Burst length (BL) : 1, 2, 4, 8, full page - CAS latency (CL) : 2, 3 - Frequency : 100 MHz (MAX.)	<DSP> Core : 1.2 (TYP.) I/O : 3.3 (TYP.) <Flash memory> 3.3 (TYP.) <SDRAM> 3.3 (TYP.)	FBGA424-1414
LR388733	USB On-The-Go controller	- USB2.0 supplemental standard OTG1.0 compliant - Connectable to a product whose data transfer speed (12 Mbps and 1.5 Mbps) conforms to USB2.0 - Built-in 2-ch USB line driver (2-port root HUB function) - Asynchronous SRAM-compatible interface - Supports 4 transfer modes (control, bulk, interrupt and isochronous)	Core : 3.3 (TYP.) I/O (USB) : 5 (TYP.)	P-QFP072-1010

*1 RSDSTM : Reduced Swing Differential Signaling

*2 EMI : Electro-Magnetic Interference

ARM RISC Core LSIs

ARM RISC Core ASSPs for Mobile Equipment

Model No.	Core CPU	Configuration	Operating frequency (MHz) MAX.	Supply voltage (V)	Power consumption (mW) MAX.	Package	Remarks
LH79532A/Y	ARM7TDMI	Cache memory (4 Kbytes) + UART + PIT + RTC + PWM + INTIC + PIO + WDT + RPC + Color LCDC + DMAC + SDRAMC + PLL	50	Core : 2.35 to 2.75 I/O : 3.0 to 3.6	325 (at 50 MHz)	P-LQFP176-2424/ TFBGA180-1212	- ASSP for color and B/W LCDs - LCDC : Supports TFT/STN/STN, single/dual scanning, SVGA [800 x 600 pixels] (MAX.)
LH79533A	ARM7TDMI	UART + PIT + RTC + PWM + INTIC + PIO + WDT + RPC + Color LCDC + DMAC + SDRAMC + PLL + SRAM (16 Kbytes)	50	Core : 1.62 to 1.98 I/O : 3.0 to 3.6	200 (at 50 MHz)	P-LQFP144-2020	- ASSP for color and B/W LCDs - LCDC : Supports STN/STN, VGA [640 x 480 pixels] (MAX.)

Startup Kit for ARM Embedded Linux™* (LH0E776)

The LH0E776 is a startup kit which facilitates the evaluation and debugging of the ARM RISC core ASSP, LH79532A and ARM embedded Linux™. It incorporates the LH79532A as a CPU, memories (including a flash memory and SDRAMs) and communication ports (including Ethernet and RS-232C), as well as a JTAG port for debugging. SHARP is also able to provide an embedded Linux™ source.

Features

Simple operability

Simply applying power enables evaluation of Linux™ and LH79532A.

Compact board

A7 size

Mounting devices

CPU : LH79532A (ARM7TDMI core)

Flash memory : 4 Mbytes (2 Mwords x 16 bits)

SDRAM : 32 Mbytes (8 Mwords x 32 bits)

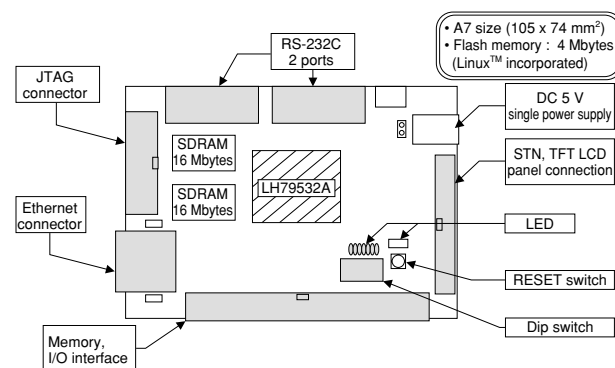
Ethernet communication port : 1 ch

RS-232C communication port : 2 ch

JTAG connector

* Joint development with AXE Inc.

Board Configuration



Development Environment for ARM Microprocessors

In order to ensure the functionality of a system LSI based on a RISC processor and speedy development of the products, an advanced software development environment, a real-time OS and middleware are required.

The required development environment and tools, such as software, real-time OS and middleware can be obtained by customers from third party vendors.

Software Environment

RealView v2.0	ARM Ltd.
MULTI-2000 IDE	Green Hills Software Inc.

Emulator

RealView, Multi-ICE	ARM Ltd.
MAJIC, JEENI	Embedded Performance Inc.
advicePLUS	Yokogawa Digital Computer Corporation

Real Time OS

μITRON 4.0	eSOL Corporation, ACCESS Corporation, Elmic Systems Inc.
Linux™, Embedded Linux™	Lineo Inc., Red Hat Inc., Montavista Software Inc., AXE Inc., ELT Inc.

Middleware

TCP/IP, PPP, IPv6	ACCESS Corporation, eSOL Corporation
Graphics, File system	Elmic Systems Inc., AXE Inc.

■ ARM Universal Microcontroller

Model No.	Core CPU	Configuration	Operating frequency (MHz) MAX.	Supply voltage (V)	Power consumption (mW) Typical	Power consumption (mW) MAX.	Package	Remarks
LH75400	ARM7TDMI	SRAM (32 Kbytes) + LCDC + CAN + 10-bit ADC + UART + Timer + RTC + PMC + WDT + DMAC	84	Core : 1.7 to 1.98 I/O : 3.0 to 3.6	149 (At 84 MHz)	209 (At 84 MHz)	144LQFP	• ASSP for B/W LCDs • LCDC : Supports STN, XGA [1 024 x 768 pixels] (MAX.) • CAN-Ver 2.0B
LH75401	ARM7TDMI		84	Core : 1.7 to 1.98 I/O : 3.0 to 3.6	149 (At 84 MHz)	209 (At 84 MHz)	144LQFP	• ASSP for color and B/W LCDs • LCDC : Supports XGA [1 024 x 768 pixels] (MAX.), 4 K colors (MAX.) • CAN-Ver 2.0B
LH75410	ARM7TDMI	SRAM (32 Kbytes) + LCDC + 10-bit ADC + UART + DMAC + Timer + RTC + PMC + WDT	84	Core : 1.7 to 1.98 I/O : 3.0 to 3.6	149 (At 84 MHz)	209 (At 84 MHz)	144LQFP	• ASSP for B/W LCDs • LCDC : Supports STN, XGA [1 024 x 768 pixels] (MAX.)
LH75411	ARM7TDMI		84	Core : 1.7 to 1.98 I/O : 3.0 to 3.6	149 (At 84 MHz)	209 (At 84 MHz)	144LQFP	• ASSP for color and B/W LCDs • LCDC : Supports XGA [1 024 x 768 pixels] (MAX.), 4 K colors (MAX.)
LH79520	ARM720T	Cache memory (8 Kbytes) + MMU + SRAM (32 Kbytes) + LCDC + DMAC + UART + Timer + RTC + PWM + PMC + WDT	77.4	Core : 1.62 to 1.98 I/O : 3.0 to 3.6	92 (At 77.4 MHz)	128 (At 77.4 MHz)	176LQFP	• ASSP for color and B/W LCDs • LCDC : Supports SVGA [800 x 600 pixels] (MAX.), 64 K colors
LH79524	ARM720T	Cache memory (8 Kbytes) + MMU + SRAM (16 Kbytes) + LCDC + USB + Ethernet MAC + DMAC + 10-bit ADC + UART + Timer + RTC + PWM + PMC + WDT	76.2	Core : 1.7 to 1.9 I/O : 3.0 to 3.6	181 (At 76.2 MHz)	247 (At 76.2 MHz)	208CABGA	• ASSP for color and B/W LCDs • LCDC : Supports SVGA [800 x 600 pixels] (MAX.), 4 K colors (LH79525)/ 64 K colors (LH79524) • USB 2.0 (Device, Full speed) • Ethernet MAC
LH79525	ARM720T		76.2	Core : 1.7 to 1.9 I/O : 3.0 to 3.6	181 (At 76.2 MHz)	247 (At 76.2 MHz)	176LQFP	
LH7A400	ARM922T	ICache memory (8 Kbytes) + DCache memory (8 Kbytes) + MMU + SRAM (80 Kbytes) + LCDC + RTC + DMAC + USB + UART + Timer + SmartCard + MMC + WDT + PMC	200 250	<At 200 MHz> Core : 1.71 to 1.89 I/O : 3.0 to 3.6 <At 250 MHz> Core : 2.0 to 2.2 I/O : 3.0 to 3.6	247 (At 200 MHz) 561 (At 250 MHz)	417 (At 200 MHz) 728 (At 250 MHz)	256PBGA 256CABGA	• ASSP for color multimedia and portable applications. • LCDC : Supports XGA [1 024 x 768 pixels] (MAX.), 64 K colors • USB 2.0 (Device, Full speed)
LH7A404	ARM922T	ICache memory (8 Kbytes) + DCache memory (8 Kbytes) + MMU + SRAM (80 Kbytes) + LCDC + RTC + DMAC + USB (Device/Host) + UART + Timer + SmartCard + MMC + WDT + PMC + 10-bit ADC	200 266	<At 200 MHz> Core : 1.7 to 1.98 I/O : 3.0 to 3.6 <At 266 MHz> Core : 2.0 to 2.2 I/O : 3.0 to 3.6	287 (At 200 MHz) 443 (At 266 MHz)	565 (At 200 MHz) 1 015 (At 266 MHz)	324CABGA	• ASSP for color multimedia and portable applications. • LCDC : Supports XGA [1 024 x 768 pixels] (MAX.), 64 K colors • USB 2.0 (Device, Full speed) • USB 2.0 (Host, Full speed)

Sales Contact

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■ Development Environment for ARM Microprocessors

● Compilers/Assemblers

ARM Developer Suite, ADS v1.2	ARM Ltd.
ARM RealView Developer Suite	ARM Ltd.
MULTI IDE	Green Hills Software Inc.
EWARM	IAR Systems Inc.
GCC	GNU

● JTAG Debuggers

Multi-ICE	ARM Ltd.
Slingshot, Probe	Green Hills Software Inc.
BDI 2000	Abatron Inc.
Vitra, Genia, Opella, PathFinder	Ashling Microsystems Ltd.
JTAGjet-ARM	Signum Systems Corporation
TRACE32 In-Circuit Debugger	Lauterbach Inc.
EMUL-ARM	Nohau a DBA of Knowit LLC
MAJIC-ICE	Embedded Performance Inc.

● Evaluation Boards/Single Board Computers

Zoom Starter Kits, Integrated	Logic Product Development Inc.
Developers Kit, Card Engines	
Single Board Computers	Revely Microsystems
Single Board Computers	Cogent Computer Systems Inc.
Evaluation Boards	Yokogawa Digital Computer Corporation

● RTOS/OS/BSP

Windows CE .NET	Microsoft Corporation
Windows CE .NET 4.2 BSP	BSQUARE Corporation
Windows CE .NET 5.0 BSP, Linux	Logic Product Development Inc.
Windows CE 5.0 BSP	Sharp Microelectronics of the Americas
Linux 2.4 BSP	Metrowerks V2.4
Linux 2.6 BSP	Sharp Microelectronics of the Americas
ThreadX	Express Logic Inc.
Nucleus+	Accelerated Technologies Inc.
VxWorks	Wind River Systems Inc.

● Design Services

Full service, Mechanical, Industrial, Electrical, Systems & Software, PCB Design & Layout, FPGA	Logic Product Development Inc.
Full service, Mechanical, Industrial, Electrical, Systems & Software, PCB Design & Layout, FPGA	Wind River Systems Inc.

IPs

The IPs contribute to shorter development time, effective use of existing software and improvement in reliability. SHARP is promoting a comprehensive range of IPs to provide support for top-down design using logic synthesis.

CPU Cores

IP	Macro	Function	Data type	
			Hard	Soft
ARM	ARM7TDMI	32-bit RISC ARM7TDMI CPU Core (16-bit Ins. mode supported)	○	○
	ARM720T	ARM7TDMI + MMU + 8-Kbyte Cache	○	
	ARM922T	ARM9TDMI + MMU + 8-Kbyte I-cache + 8-Kbyte D-cache	○	
	ARM946E-S	ARM9E + PU + I-cache (configurable) + D-cache (configurable) + TCM (configurable)		○
	ARM926EJ-S	ARM9E + MMU + I-cache (configurable) + D-cache (configurable) + TCM (configurable) + Java		○

Peripherals

IP	Macro	Function	Data type	
			Hard	Soft
Bus Interface				
PCMCIA	PCMCIA1	PCMCIA PC card interface		○
	82365SL	PCMCIA card interface controller		○
IEEE1284	1284	IEEE 1284 host parallel port		○
I2C	I2C	I ² C bus interface		○
FDD-cntl	FDC78	High performance PC compatible floppy disk controller system (82078SL)		○
	765A78	Extended features floppy disk controller core for FM and MFM formats		○
Microcontroller & Microprocessor				
8-bit-cntl	8051	High performance industry compatible 8-bit microcontroller with 2 timers		○
Microprocessor Peripheral				
SDRAMC		Synchronous DRAM Controller		○
DMA	8237A	General purpose programmable 4-channel DMA controller		○
LCDC		Color LCD Controller (TFT, HR-TFT, CSTN, STN, DMTN)		○
PIT	8254	Extended feature 3-channel Programmable Interval Timer (PIT)		○
RTC	146818	Ultra-low-power real time clock with up to 114 bytes of RAM		○
PIC	8259A	8-channel cascable Programmable Interrupt Controller (PIC)		○
PPI	8255	General purpose Programmable Peripheral Interface (PPI)		○
INTC		Interrupt Controller		○
Serial Communication				
USB-OTG		Universal Serial Bus On The Go Controller Full Speed (12 MHz)/ Low Speed (1.5 MHz)/High Speed (480 MHz)		○
USART	8251A	Universal Synchronous/Asynchronous Receiver/Transmitter (USART)		○
SSP		Synchronous Serial Port		○
SCC	85C30	SCC 2-channel Serial Communications Controller with FIFOs		○
UART	16550A	Universal Asynchronous Receiver/Transmitter (UART) with FIFO		○
	6402	Compact Universal Asynchronous Receiver/Transmitter (UART)		○

Analog Cells

IP	Macro	Function	Data type	
			Hard	Soft
ADC	High Speed ADC	8-bit AD (80 MHz), 10-bit AD (80 MHz), 6-bit AD (80 MHz)	○	
	Voice ADC	12-bit AD/14-bit AD (8 to 32 kHz)	○	
	Audio ADC	20-bit AD (44.1 kHz)	○	
DAC	High Speed DAC	8-bit DA/9-bit DA (30 MHz)	○	
	Voice DAC	10-bit DA (8 to 32 kHz)	○	
	Audio DAC	20-bit DA (44.1 kHz)	○	

Analog PLL (Phase Locked Loop)

IP	Macro	Function	Data type	
			Hard	Soft
PLL	PLL	Fout : 100 to 200 MHz	○	
		Fout : 200 to 400 MHz	○	
		Fout : 400 to 800 MHz	○	
		Fin : 32 kHz, Fout : 33 to 134 MHz	○	

Others

IP	Macro	Function	Data type	
			Hard	Soft
LVDS	LVDS Receiver	Input signal : 7-bit 3 ch (6 bits for RGB), 85 MHz (MAX.)	○	
		Input signal : 7-bit 4 ch (8 bits for RGB), 85 MHz (MAX.)	○	
RSDS	RSDS Transmitter	Input signal : 8 bits for RGB, 90 MHz (MAX.)	○	

Contact a SHARP sales office about applicable series. A use-fee and license-fee are required for use of the above IPs.

Smart Card Systems

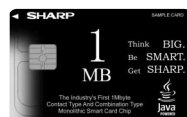
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Reader/Writer for Smart Cards	25
Software Development Kit for Smart Cards	25



Smart Card Systems

Smart Cards/LSI Modules for Smart Cards

Type		Communication standards	Protocol	Transmission speed (kbps) MAX.	Nonvolatile memory capacity	Cycling capability	CPU	Security system
SJCard 211	Contact	ISO/IEC7816	T = 1	19.2	1 Mbyte (Flash memory)	100 000 times	16 bits	RSA, DES, T-DES, etc. high-speed cryptographic authentication with built-in coprocessor, hardware-based random number generator
	Contactless	ISO/IEC14443 Type B	ISO/IEC14443-4	424				
★JCOP*	Contact	ISO/IEC7816	T = 0, 1	76.8	1 Mbyte (Flash memory)	100 000 times	16 bits	(Under development)
	Contactless	ISO/IEC14443 Type B	ISO/IEC14443-4	424				
(Under development)	Contact	ISO/IEC7816	T = 0, 1	76.8	1 Mbyte (Flash memory)	100 000 times	32-bit MIPS	(Under development)
	Contactless	ISO/IEC14443 Type B	ISO/IEC14443-4	424				



SJCard 211

- Java Card™ 2.1.1 compliance
- Capable of developing applications using Java language



★JCOP* card

- Java Card™ 2.2 compliance
- GP (Global Platform) 2.1.1 compliance
- EMV 2000 compliance
- With built-in USIM interface
- Capable of developing applications using Java language



★32-bit MIPS card

- With built-in 32-bit MIPS on CPU
- High security thanks to incorporation of secure MIPS32™ 4KSd™ controller

*JCOP : JCOP means IBM's Java Card Open Platform, which was developed by IBM Corporation as an embedded Operating System (OS) for smart cards which conforms to the standards of Java and Global Platform. This platform ensures the security of applications working on various mobile terminals, such as a USB key and a smart card suitable for multiple applications.

■ Reader/Writer for Smart Cards

Type	Model No.	Communication standard	Host interface	Transmission speed between smart card and RW (kbps)	Smart card operation method	Outline dimensions W x H x D (mm)	Mass (g)	Power supply
Contact type	RW4040	ISO/IEC7816 (T = 0, 1)	USB1.1 (Included driver soft)	9.6 to 153.6	Manual insertion/ejection	70.4 x 14.1 x 60.5	Approx. 65	DC 5 V (USB connector)
	LR550R03	ISO/IEC7816 (T = 0, 1)	PC card interface Type II	10.8 to 344.1		54 x 5 x 85.6	Approx. 30	DC 5 V (PC card connector)



Contact type reader/writer (RW4040)

- High-speed data communication
- Conforms to PC/SC standard
- USB interface



Contact type reader/writer (LR550R03)

- High-speed data communication
- PC card interface Type II

■ SDK (Software Development Kit) for Smart Cards

SDK type	Contents
For SJCARD 211	Development kit CD for SJCARD SJCARD simulator Contact type reader/writer (1 set)

Flash Memories/ Combination Memories

Flash Memories

[Highly Functional Type]

Boot Block Type 3 V Page Mode 27, 29

[Standard Type]

Boot Block Type 3 V 27, 29

System-Flash

For PCs 28, 30

For Digital Equipment 28, 30

For Amusement Products 28, 30

Combination Memories

Boot Block Type Flash Memory +
Pseudo SRAM 31



Flash Memories

Highly Functional Flash Memories

Boot Block Type 3 V Page Mode Flash Memories : LH28FXXXBF Series

Capacity (bit)	Bit configuration	Erasable block size		Operating temp. (°C)	Model No.	Remarks
32 M	x 16	4 Kwords x 8, 32 Kwords x 63	Top boot	0 to 70	LH28F320BF-PTTL	- Built-in dual work function - Built-in OTP function [4 words (factory area) + 4 words (user area)]
				-40 to 85	LH28F320BFH-PTTL	
			Bottom boot	0 to 70	LH28F320BF-PBTL	
				-40 to 85	LH28F320BFH-PBTL	
64 M	x 16	4 Kwords x 8, 32 Kwords x 127	Top boot	0 to 70	LH28F640BF-PTTL	
				-40 to 85	LH28F640BFH-PTTL	
			Bottom boot	0 to 70	LH28F640BF-PBTL	
				-40 to 85	LH28F640BFH-PBTL	
128 M	x 16	4 Kwords x 8, 32 Kwords x 255	Top boot	0 to 70	LH28F128BF-PTTL	
				-40 to 85	LH28F128BFH-PTTL	
			Bottom boot	0 to 70	LH28F128BF-PBTL	
				-40 to 85	LH28F128BFH-PBTL	

Standard Flash Memories

Boot Block Type 3 V Flash Memories : LH28FXXXBJ Series

Capacity (bit)	Bit configuration	Erasable block size		Operating temp. (°C)	Model No.	Remarks
8 M	x 8	8 Kbytes x 8, 64 Kbytes x 15	Top boot	0 to 70	LH28F008BJ-TTL	-
			Bottom boot	0 to 70	LH28F008BJ-BTL	
	x 8/ x 16	4 Kwords x 8, 32 Kwords x 15 (or 8 Kbytes x 8, 64 Kbytes x 15)	Top boot	0 to 70	LH28F800BJ-PTTL	Built-in OTP function [4 words (factory area) + 3 963 words (user area)]
				-40 to 85	LH28F800BJH-PTTL	
			Bottom boot	0 to 70	LH28F800BJ-PBTL	
				-40 to 85	LH28F800BJH-43	
16 M	x 8/ x 16	4 Kwords x 8, 32 Kwords x 31 (or 8 Kbytes x 8, 64 Kbytes x 31)	Top boot	-40 to 85	LH28F160BJH-PTTL	-
				-40 to 85	LH28F160BJH-PBTL	
			Bottom boot	-40 to 85	LH28F160BJH-PTTL	
				-40 to 85	LH28F160BJH-PBTL	

System-Flash

FWH* Interface System-Flash for PCs

Capacity (bit)	Bit configuration	Erased block size		Operating temp. (°C)	Model No.
8 M	x 8	8 Kbytes x 8, 64 Kbytes x 15	Top boot	0 to 85	LHF00L04
	x 8	64 Kbytes x 16	Symmetrical block	0 to 85	LHF00L21

* FWH : Firmware Hub

Fast-Reprogramming System-Flash for Digital Equipment

Capacity (bit)	Bit configuration	Erased block size		Operating temp. (°C)	Model No.	Remarks
16 M	x 16	4 Kwords x 8 + 32 Kwords x 1, 64 Kwords x 15	Top boot	-40 to 85	LHF00L24	• Fast-reprogramming (4-Kword blocks) • Built-in OTP function [4 words (factory area) + 4 words (user area)]
			Bottom boot	-40 to 85	LHF00L28	
					LHF00L25	
					LHF00L29	
32 M	x 16	4 Kwords x 8 + 32 Kwords x 1, 64 Kwords x 31	Top boot	-40 to 85	LHF00L08	
					LHF00L10	
					LHF00L14	
			Bottom boot	-40 to 85	LHF00L09	
					LHF00L11	
					LHF00L15	

System-Flash for Amusement Products

Capacity (bit)	Bit configuration	Erased block size		Operating temp. (°C)	Model No.	Remarks
256 M	x 16	16 Kwords x 4, 64 Kwords x 255	Top boot	0 to 85	LH28F256BF-PTSL	• 70 SSOP industry standard package
512 M	x 16	(16 Kwords x 4, 64 Kwords x 255) x 2	Top/Top boot	0 to 70	LH28F512BF-PTSL	• Compact FBGA (CSP) package

Highly Functional Flash Memories

Boot Block Type 3 V Page Mode Flash Memories : LH28FXXXBF Series

Supply voltage		32 M : V _{CC} = 2.7 to 3.6 V, V _{PP} = 2.7 to 3.6 V or 11.7 to 12.3 V 64 M : V _{CC} = 2.7 to 3.6 V, V _{PP} = 1.65 to 3.6 V or 9.0 to 10.0 V 128 M : V _{CC} = 2.7 to 3.6 V, V _{PP} = 2.7 to 3.6 V or 9.0 to 10.0 V								
Capacity (bit)	Bit configuration	Erasable block size		Model No.	Access time (ns) MAX.	Page mode access time (ns) MAX.	Read current (mA) MAX. f = 5 MHz (CMOS)	Standby current (μA) MAX. (CMOS)	Operating temp. (°C)	Package
32 M	x 16	Parameter : 4 Kwords x 8 Main : 32 Kwords x 63	Top boot	LH28F320BFE/B-PTTL70	70	25	25	20	0 to 70	P-TSOP048-1220 (Normal bend)/ TFBGA048-0808
				LH28F320BFHE/B-PTTL70					-40 to 85	
				LH28F320BFHG-PTTLZK	80	35			TFBGA048-0707	
			Bottom boot	LH28F320BFE/B-PBTL70	70	25	25	20	0 to 70	P-TSOP048-1220 (Normal bend)/ TFBGA048-0808
				LH28F320BFHE/B-PBTL70					-40 to 85	
				LH28F320BFHG-PBTLZL	80	35			TFBGA048-0707	
64 M	x 16	Parameter : 4 Kwords x 8 Main : 32 Kwords x 127	Top boot	LH28F640BFE-PTTLHDA	70	30	25	20	0 to 70	P-TSOP048-1220 (Normal bend) TFBGA060-0811
				LH28F640BFB-PTTL70A					-40 to 85	
				LH28F640BFHE-PTTLHFA						P-TSOP048-1220 (Normal bend) TFBGA060-0811
				LH28F640BFHB-PTTL70A						
			Bottom boot	LH28F640BFE-PBTLHEA	70	30	25	20	0 to 70	P-TSOP048-1220 (Normal bend) TFBGA060-0811
				LH28F640BFB-PBTL70A					-40 to 85	
				LH28F640BFHE-PBTLHGA						P-TSOP048-1220 (Normal bend) TFBGA060-0811
				LH28F640BFHB-PBTL70A						
128 M	x 16	Parameter : 4 Kwords x 8 Main : 32 Kwords x 255	Top boot	LH28F128BFT/B-PTTL75A	75	25	35	40	0 to 70	P-TSOP056-1420 (Normal bend)/ LFBGA072-0811
				LH28F128BFHT/B-PTTL75A					-40 to 85	
			Bottom boot	LH28F128BFT/B-PBTL75A	75	25	35	40	0 to 70	
				LH28F128BFHT/B-PBTL75A					-40 to 85	

Contact a SHARP sales office for other packages and top boot/bottom boot models other than those listed above.

Standard Flash Memories

Boot Block Type 3 V Flash Memories : LH28FXXXBJ Series

Supply voltage		V _{CC} = 2.7 to 3.6 V, V _{CCW} = 2.7 to 3.6 V or 11.7 to 12.3 V											
Capacity (bit)	Bit configuration	Erasable block size		Model No.	Access time (ns) MAX.	Read current (mA) MAX. f = 5 MHz (CMOS)	Standby current (μA) MAX. (CMOS)	Operating temp. (°C)	Package				
8 M	x 8	Boot : 8 Kbytes x 2 Parameter : 8 Kbytes x 6 Main : 64 Kbytes x 15	Top boot	LH28F008BJT-TTLZ2	100	25	15	0 to 70	P-TSOP040-1020 (Normal bend)				
			Bottom boot	LH28F008BJT-BTLZ1	100	25	15	0 to 70					
	x 8/ x 16	Boot : 4 Kwords (8 Kbytes) x 2 Parameter : 4 Kwords (8 Kbytes) x 6 Main : 32 Kwords (64 Kbytes) x 15	Top boot	LH28F800BJE-PTTL90	90	25	15	0 to 70	P-TSOP048-1220 (Normal bend)				
			LH28F800BJHE-PTTL90	−40 to 85									
			Bottom boot	LH28F800BJE-PBTL70	70 (At 2.97 to 3.63 V)	25	15	0 to 70					
				LH28F800BJE-PBTL90									
				LH28F800BJHB-43	90				−40 to 85	TFBGA048-0608			
				LH28F800BJHE-PBTL90					P-TSOP048-1220 (Normal bend)				
				16 M	x 8/ x 16	Boot : 4 Kwords (8 Kbytes) x 2 Parameter : 4 Kwords (8 Kbytes) x 6 Main : 32 Kwords (64 Kbytes) x 31	Top boot	LH28F160BJHE-PTTL70	70	25	15	−40 to 85	P-TSOP048-1220 (Normal bend)
				Bottom boot			LH28F160BJHE-PBTL70	70	25	15	−40 to 85		

Contact a SHARP sales office for other packages and top boot/bottom boot models other than those listed above.

System-Flash

FWH* Interface System-Flash for PCs

Supply voltage		$V_{CC} = 3.0$ to 3.6 V							
Capacity (bit)	Bit configuration	Erasable block size		Model No.	Operating frequency (MHz)	Read current (mA) MAX. $f = 33$ MHz (CMOS)	Standby current (μ A) MAX. (CMOS)	Operating temp. ($^{\circ}$ C)	Package
8 M	x 8	Boot : 8 Kbytes x 8 Main : 64 Kbytes x 15	Top boot	LHF00L04	33	15	15	0 to 85	P-TSOP040-1020 (Normal bend)
		64 Kbytes x 16	Symmetrical block	LHF00L21	33	15	15	0 to 85	P-TSOP032-0813 (Normal bend)

* FWH : Firmware Hub

Contact a SHARP sales office for other packages and top boot/bottom boot models other than those listed above.

Fast-Reprogramming System-Flash for Digital Equipment

Supply voltage		V _{CC} = 2.7 to 3.6 V, V _{PP} = 11.7 to 12.3 V								
Capacity (bit)	Bit configuration	Erasable block size		Model No.	Access time (ns) MAX.	4-Kword reprogramming time (s)	Read current (mA) MAX. f = 5 MHz (CMOS)	Standby current (μA) MAX. (CMOS)	Operating temp. (°C)	Package
16 M	x 16	Parameter : 4 Kwords x 8 + 32 Kwords x 1 Main : 64 Kwords x 15	Top boot	LHF00L24	70	0.31	17	10	−40 to 85	TFBGA048-0608
			LHF00L28	P-TSOP048-1220 (Normal bend)						
			Bottom boot	LHF00L25	70	0.31	17	10	−40 to 85	TFBGA048-0608
				LHF00L29						P-TSOP048-1220 (Normal bend)
32 M	x 16	Parameter : 4 Kwords x 8 + 32 Kwords x 1 Main : 64 Kwords x 31	Top boot	LHF00L08	90	0.31	17	10	−40 to 85	TFBGA048-0608
			LHF00L10	TFBGA048-0707						
			LHF00L14	P-TSOP048-1220 (Normal bend)						
			Bottom boot	LHF00L09	90	0.31	17	10	−40 to 85	TFBGA048-0608
				LHF00L11						TFBGA048-0707
				LHF00L15						P-TSOP048-1220 (Normal bend)

Contact a SHARP sales office for other packages and top boot/bottom boot models other than those listed above.

System-Flash for Amusement Products

Supply voltage		V _{CC} = 1.7 to 1.95 V, V _{CCQ} = 2.7 to 3.6 V, V _{PP} = 0.9 to 1.95 V or 8.5 to 9.5 V								
Capacity (bit)	Bit configuration	Erasable block size		Model No.	Access time (ns) MAX.	Page mode access time (ns) MAX.	Read current (mA) MAX. f = 5 MHz (CMOS)	Standby current (μA) MAX. (CMOS)	Operating temp. (°C)	Package
256 M	x 16	Parameter : 16 Kwords x 4 Main : 64 Kwords x 255	Top boot	LH28F256BFN-PTSLZ2	100	25	22	60	0 to 85	P-SSOP070-0500
512 M	x 16	(Parameter : 16 Kwords x 4 Main : 64 Kwords x 255)	x 2 Top/ Top boot	LH28F512BFBD-PTSLZ2	90	25	22	120	0 to 70	LFBGA072-0811

Contact a SHARP sales office for other packages and top boot/bottom boot models other than those listed above.



Combination Memories

■ Boot Block Type Flash Memory + Pseudo SRAM

● 1.8 V models with 1.8 V I/O voltage

Model No.	Flash memory block configuration	Capacity (bit) [Bit configuration]		Access time (ns) MAX.						Supply voltage (V)			Package
		Flash memory	Pseudo SRAM	Flash memory			Pseudo SRAM			Flash memory core voltage	Pseudo SRAM core voltage	I/O voltage	
				Random mode	Page mode	Synchronous burst mode	Random mode	Page mode	Synchronous burst mode				
LRS18AC	Bottom boot	128 M [x 16]	32 M [x 16]	85	25	54 MHz	70	20	—	1.7 to 1.95	1.7 to 1.95	1.7 to 1.95	LFBGA088-0811
LRS1890A		256 M [x 16]	64 M [x 16]	85	25	—	70	20	—	1.7 to 1.95	1.7 to 1.95	1.7 to 1.95	LFBGA072-0811
LRS1887B			256 M [x 32]			80 MHz			80 MHz				LFBGA107-0912
LRS18A6			128 M [x 16]			—			—				LFBGA072-0811
LRS1897	Bottom/Top boot	512 M [x 16]	128 M [x 16]	85	25	—	70	20	—	1.7 to 1.9	2.7 to 3.1	1.7 to 1.9	LFBGA072-0811
LRS18CC	Bottom/Top/Bottom boot	740 M [x 16]	256 M [x 16]	93	25	52 MHz	70	20	83 MHz	1.7 to 1.95	1.7 to 1.95	1.7 to 1.95	LFBGA088-0912

● 1.8 V models with 3 V I/O voltage

Model No.	Flash memory block configuration	Capacity (bit) [Bit configuration]		Access time (ns) MAX.						Supply voltage (V)			Package
		Flash memory	Pseudo SRAM	Flash memory			Pseudo SRAM			Flash memory core voltage	Pseudo SRAM core voltage	I/O voltage	
				Random mode	Page mode	Synchronous burst mode	Random mode	Page mode	Synchronous burst mode				
LRS18BK	Top boot	128 M [x 16]	32 M [x 16]	85	25	54 MHz	65	20	—	1.7 to 1.95	2.7 to 3.1	2.7 to 3.1	LFBGA088-0811
LRS18BL	Bottom boot					—							LFBGA072-0811
LRS18C8A						54 MHz							LFBGA088-0811
LRS18BN			64 M [x 16]			—							LFBGA088-0811
LRS18AZ*	Bottom boot	256 M [x 16]	64 M [x 16]	85	25	54 MHz	65	20	—	1.7 to 1.95	2.7 to 3.1	2.7 to 3.1	LFBGA088-0811
LRS18B0*						—							LFBGA072-0811

* This flash memory is divided into two banks, each including an enable signal.

● 3 V models with 3 V I/O voltage

Model No.	Flash memory block configuration	Capacity (bit) [Bit configuration]		Access time (ns) MAX.						Supply voltage (V)			Package	
		Flash memory	Pseudo SRAM	Flash memory			Pseudo SRAM			Flash memory core voltage	Pseudo SRAM core voltage	I/O voltage		
				Random mode	Page mode	Synchronous burst mode	Random mode	Page mode	Synchronous burst mode					
LRS18BT	Bottom boot	32 M [x 16]	8 M [x 16]	85	—	—	85	—	—	2.7 to 3.1	2.7 to 3.1	2.7 to 3.1	LFBGA072-0811	
LRS1871A	Top boot	64 M [x 16]	16 M [x 16]	85	35	—	85	—	—	2.7 to 3.3	2.7 to 3.1	2.7 to 3.1	LFBGA072-0811	
LRS1872A	Bottom boot													
LRS18BP	Top boot		32 M [x 16]		65	25	—	65	20	—	2.7 to 3.1	2.7 to 3.1	2.7 to 3.1	LFBGA088-0811
LRS18BR	Bottom boot													
LRS18831	Top boot													
LRS18841	Bottom boot						70	35	—	60	—	—	2.7 to 3.1	2.7 to 3.1

Power Devices/ Analog ICs

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Low Power-loss Voltage Regulators

TO-220 type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings				Electrical characteristics			Built-in functions					Lead forming available	Package								
		Output current Io (A)	Input voltage Vin (V)	Power dissipation (W)		Output voltage Vo*3 (V) TYP.	Output voltage precision (%)	Dropout voltage Vi-o*5 (V)	Overheat protection	Overcurrent protection	ON/OFF control	Low dissipation current at OFF state	Variable output voltage		Package shape type*7								
				Pd*1	Pd*2																		
PQxxRD08J00H series	ASO protection function	0.8	20	1.25	10	5, 9, 12	±3	0.5	○	○	○				TO-220	A							
PQ3RD083J00H						3.3										A							
PQ6RD083J00H						6.3										A							
PQxxRA11J00H series	Low dissipation current at OFF state (Iqs : 1μA (MAX.))	1	35	1.5	15	5, 9, 12	±2.5	0.5	○	○	○	○		○		B							
PQxxRD11J00H series	ASO protection function		20	1.4		5, 9, 12	±3									○	A						
PQxxxRDA1SZH series	ASO protection function, low dissipation current at OFF state (Iqs : 5 μA (MAX.))		24			5, 8, 9, 12										○	A						
PQxxxRDA2SZH series		2	20	—	—	3.3, 5, 9, 12	±2.5	0.5	○	○	○	○				A							
PQ3RD13J000H	ASO protection function	1	10	1.4	15	3.3	±3									○	A						
PQxxxEF01SZH series	Minimum operating input voltage : 2.35 V (4 terminals)	2					1.5, 1.8, 2.5, 3.3									±2.5	○	A					
PQxxxEF02SZH series																							
PQxxRF11J00H series	General purpose	1	35	1.5	18	5, 9, 12	±2.5	0.5	○	○	○			○		B							
PQxxRH11J00H series		1.5															○	B					
PQ3RD23J000H	ASO protection function	2	20	1.4	15	3.3	±3									○	A						
PQxxRD21J00H series																							
PQxxRF21J00H series	General purpose		35	1.5	18	5, 9, 12	±2.5	0.5	○	○	○			○		B							
PQ3RF23J000H	High output current	3.5	10	1.8		3.3										±2.5	○	B					
PQ3RF33J000H																							
PQ070XF01SZH	Minimum operating input voltage : 2.35 V (4 terminals)	1	10	1.4	15	1.5 to 7	±2*4	0.5	○	○			○			A							
PQ070XF02SZH		2																					
PQ070VK01FZH	Minimum operating input voltage : 2.35 V (5 terminals)	1	10	1.4	15	1.5 to 7	±2*4									○	○	○	○	○	○		E
PQ070VK02FZH		2																					
PQ15RW08J00H	ASO protection function, minimum operating input voltage : 3.5 V	0.8	20	1.25	10	3.0 to 15	±2.5*4	0.5	○	○			○			A							
PQ15RW11J00H		1		1.4	15												○	A					
PQ15RW21J00H		2		—	—												○	A					
PQ150RWA2SZH	ASO protection function															○	○		○				A
PQ20RX05J00H	Variable output voltage, output ON/OFF control	0.5	24	1.25	10	3.0 to 20	±2.5*4	0.5	○	○	○		○	○		C							
PQ20RX11J00H		1														C							
PQ150VB01FZH	Overheat shutdown circuit, minimum operating input voltage : 2.35 V (5 terminals)	2	17	12.5	1.5 to 15											○	○		○	○			E
PQ150VB02FZH																							
PQ30RV11J00H	Variable output voltage	1	35	1.5	15	1.5 to 30	±2*4	0.5	○	○	△*6		○	○		B							
PQ30RV21J00H		2		18												○	B						
PQ30RV31J00H		3		20												○	B						
PQ7RV4J0000H		4.6		18												○	B						

*1 At self-cooling

*2 With infinite heat sink attached

*3 The xx/xxx in the model No. refer to the output voltage values of the model (e.g. 05/050 for 5 V, 12/120 for 12 V, 015 for 1.5 V).

*4 Reference voltage accuracy

*5 Current ratings are defined individually.

*6 △ : Available by adding circuit

*7 Refer to page 55

● High output current type [TO-220 high heat radiation type, TO-3P type]

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings				Electrical characteristics			Built-in functions				Package
		Output current I _o (A)	Input voltage V _{in} (V)	Power dissipation (W)		Output voltage V _o (V)	Output voltage precision (%)	Dropout voltage V _{i-o} *4 (V)	Overheat protection	Overcurrent protection	ON/OFF control	Variable output voltage	
				Pd*1	Pd*2								
PQ5EV3J0000H	High output current, minimum operating input voltage : 2.35 V	3.5	7	1.6	45	1.5 to 5	±1*3	0.5	○	○	○	○	TO-220 (heat sink exposure)
PQ5EV5J0000H		5							○	○	○	○	
PQ5EV7J0000H		7.5							○	○	○	○	
PQ7DV5J0000H	High output current, minimum operating input voltage : 3 V	5	10	2.2	60	1.5 to 7	±2*3		○	○	○	○	TO-3P
PQ7DV10J0000H		10							○	○	○	○	

*1 At self-cooling

*2 With infinite heat sink attached

*3 Reference voltage accuracy

*4 Current ratings are defined individually.

● Low output current type [TO-92 type]

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings			Electrical characteristics			Built-in functions		Package
		Output current I _o (A)	Input voltage V _{in} (V)	Power dissipation P _d *1 (W)	Output voltage V _o (V) TYP.	Output voltage precision (%)	Dropout voltage V _{i-o} (V)	Overheat protection	Overcurrent protection	
PQ033ES1MXPQ	Low output current type with general purpose TO-92 package (for auxiliary power supply)	0.15	16	0.52	3.3	±2	0.4 (I _o = 150 mA)	○	○	TO-92
PQ050ES1MXPQ					5					
PQ033ES3MXPQ		0.3	9		3.3		0.7 (I _o = 300 mA)	○	○	
PQ050ES3MXPQ					5					

*1 At self-cooling

■ Surface Mount Type Low Power-loss Voltage Regulators

● SOT-23-5 type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings			Electrical characteristics			Built-in functions				Package
		Input voltage Vin (V)	Power dissipation Pd*1 (W)	Output current Io (A)	Output voltage Vo*2 (V) TYP.	Output voltage precision (%)	Dropout voltage Vi-o (V)	Overheat protection	Overcurrent protection	ON/OFF control	Low dissipation current at OFF state	
PQ1Uxx1M2ZPH series	Compact, low output current	16	0.35	0.18	1.8, 2.5, 2.8, 3.0, 3.3, 3.5, 5.0	± 2.0 (3.0 V output)	0.26 (Io = 60 mA)	○	○	○	○	SOT-23-5
PQ1Xxx1M2ZPH series	Compact, ceramic capacitor compatible	9			*3			○	○	○	○	

*1 When mounted on a board

*2 The xx in the model No. refer to the output voltage values of the model (e.g. 50 for 5.0 V, 18 for 1.8 V).

*3 1.5, 1.8, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.3, 3.5, 3.7, 4.0, 4.5, 5.0

● SOT-23L type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings			Electrical characteristics				Built-in functions				Package
		Output current I _o (A)	Input voltage V _{in} (V)	Power dissipation P _d *1 (W)	Output current I _o (A)	Output voltage V _o *2 (V) TYP.	Output voltage precision (%)	Dropout voltage V _{i-o} (V)	Overheat protection	Overcurrent protection	ON/OFF control	Low dissipation current at OFF state	
PQ1RxxJ0000H series	Compact, surface mount type, low dissipation current at OFF state (I _{qs} : 0.1 μA (MAX.))	—	16	0.4	0.18	*3	± 2.7 (3.0 V output)	0.26 (I _o = 60 mA)	○	○	○	○	SOT-23L
PQ1Kxx3M2ZPH series	Compact, surface mount type, high ripple rejection, output current of up to 300 mA	0.3	9		—	1.8, 2.5, 3.0, 3.3, 3.6, 5.0	± 2.0 (3.0 V output)	0.7 (I _o = 300 mA)	○	○	○	○	
PQ1KAxx3MZPH series	Compact, surface mount type, output current of up to 300 mA, ceramic capacitor compatible		15			1.5, 1.8, 2.5, 3.3, 5.0, 9.0	○	○	○	○			

*1 When mounted on a board

*2 The xx in the model No. refer to the output voltage values of the model (e.g. 25 for 2.5 V, 47 for 4.7 V, 50 for 5.0 V).

*3 1.8, 2.0, 2.3, 2.5, 2.7, 2.8, 2.9, 3.0, 3.2, 3.3, 3.4, 3.5, 3.7, 3.8, 4.0, 4.2, 4.4, 4.7, 4.9, 5.0, 5.2

● SOT-89 type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings			Electrical characteristics			Built-in functions					Package	
		Output current Io (A)	Input voltage Vin (V)	Power dissipation Pd*1 (W)	Output voltage Vo*2 (V) TYP.	Output voltage precision (%)	Dropout voltage Vi-o*3 (V)	Overheat protection	Overcurrent protection	ON/OFF control	Low dissipation current at OFF state	Variable output voltage		
PQ1Lxx3M2SPQ	Compact, high radiation package, low dissipation current at OFF state (Iqs : 1 μA (MAX.))	0.3	16	0.9	1.5, 1.8, 2.5, 3.0, 3.2, 3.3, 5.0	± 2.0 (3.0 V output)	0.7	○	○	○	○	SOT-89		
PQ1LAXx3MSPQ	Compact, high radiation package, low dissipation current at OFF state (Iqs : 1 μA (MAX.)), ceramic capacitor compatible		15		1.5, 1.8, 2.5, 3.3, 5.0, 9.0			○	○	○	○			
PQ1LAX95MSPQ	Ceramic capacitor compatible, variable output voltage	0.5	9		1.5 to 9.0	± 2.0*6	0.7	○	○	○	○			
PQ1Mxx5M2SPQ	Compact, high output current, ceramic capacitor compatible	0.5			1.8, 2.5, 3.3, 5.0	± 2.0 (5.0 V output)		○	○	○	○			
PQ1MX55M2SPQ	Ceramic capacitor compatible, variable output voltage				1.3 to 5.0	± 2.0*6		○	○	○	○			
PQ1Nxx3MxSPQ	Reset signal output function*4, ceramic capacitor compatible	0.35			2.5, 3.3	± 2.0	0.4	○	○	○	○			
PQ2Lxxx2MSPQ	Compact, high radiation package, 2 outputs	0.25/ch	9		*5	—		○	○	○	○			

*1 When mounted on a board

*2 The xx in the model No. refer to the output voltage values of the model (e.g. 25 for 2.5 V, 50 for 5.0 V). [Except PQ2Lxxx2MSPQ]

*3 Current ratings are defined individually.

*4 Reset detection voltage : 4.2 V, 3.8 V

*5 Output voltage combination : 3.3/3.3 V, 3.3/2.5 V, 3.3/1.8 V, 3.3/1.5 V, 2.5/1.8 V, 2.5/1.5 V

*6 Reference voltage accuracy

● SC-63 type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings				Electrical characteristics			Built-in functions						Taped package	Package						
		Output current I _O (A)			Input voltage V _{IN} (V)	Power dissipation Pd*1 (W)	Output voltage V _O *2 (V) TYP.	Output voltage precision (%)	Dropout voltage V _{I-O} *5 (V)	Overheat protection	Overcurrent protection	ON/OFF control	Low dissipation current at OFF state	Variable output voltage		Package shape type*6						
		0.5	1	1.5																		
PQ07VR5MAPH series	Reset signal generation function (input voltage drop detection)	○			10	8	1.5 to 7	±2.0*3	0.5	○	○			○	○	SC-63	F					
PQ3DZ53J000H	ASO protection function, low dissipation current at OFF state (I _{qs} : 5 μA (MAX.))	○					3.3			○	○	○	○		○		F					
PQ3DZ13J000H			○							○	○	○	○		○		F					
PQxxDZ51J00H series		○					5, 9, 12			○	○	○	○		○		F					
PQxxDZ11J00H series			○		24					○	○	○	○		○		F					
PQxxxDNA1ZPH series		Ceramic capacitor compatible, ASO protection function, low dissipation current at OFF state (I _{qs} : 5 μA (MAX.)), solder dip compatible lead shape			○			3.3, 5, 8, 9, 12				○	○	○	○			○	G			
PQxxxDZ01ZPH series	Low dissipation current at OFF state (I _{qs} : 5 μA (MAX.))		○		9, 10		3.3, 5				○	○	○	○			○	F				
PQxxxEZ5MZPH series	Minimum operating input voltage : 2.35 V	○			10		1.5, 1.8, 2.5, 3.0, 3.3	±2.5*4			○	○	○	○			○	F				
PQxxxEZ01ZPH series			○								○	○	○	○			○	F				
PQxxxEEN01ZPH series	Minimum operating input voltage : 2.35 V, solder dip compatible lead shape		○								○	○	○	○			○	G				
PQxxxEEN1ZPH series	Minimum operating input voltage : 2.35 V, ceramic capacitor compatible, solder dip compatible lead shape		○				1.5, 1.8, 2.5, 3.3	±2.5			○	○	○	○			○	G				
PQxxxEENAHZPH series				○				—		—	○	○	○	○			○	G				
PQxxxEZ1HZPH series	Minimum operating input voltage : 2.35 V			○	3.7		1.5, 1.8, 2.5, 3.0, 3.3	±2.5*4		1.0	○	○	○	○			○	F				
PQxxxEZ02ZPH series				○ (2 A)								0.5	○	○	○		○		○	F		
PQxxxFZ5MZPH series	Minimum operating input voltage : 1.7 V	○					1.0, 1.2	±30 mV			○	○	○	○			○	F				
PQxxxFZ01ZPH series	(Dual power supply type)		○								○	○	○	○			○	F				
PQxxxEEN01ZPH series	Minimum operating input voltage : 1.7 V (Dual power supply type), ceramic capacitor compatible, solder dip compatible lead shape			○			5.5	0.8, 1.0, 1.2		—	—	○	○					○	G			
PQxxxEEN1HZPH series					○								○	○						○	G	
PQ070XZ5MZPH series	Minimum operating input voltage : 2.35 V	○			10		1.5 to 7	±2.0*3		0.5	○	○	○	○	○		○		F			
PQ070XZ01ZPH				○									○	○	○		○	○	○		F	
PQ070XN01ZPH	Minimum operating input voltage : 2.35 V, solder dip compatible lead shape			○									○	○	○		○	○	○		G	
PQ070XNA1ZPH	Minimum operating input voltage : 2.35 V, ceramic capacitor compatible, solder dip compatible lead shape			○										○	○		○	○	○	○		G
PQ070XNAHZPH											○		—	—	○		○	○	○	○	○	
PQ070XZ1HZPH	Minimum operating input voltage : 2.35 V			○	3.7		1.0 to 1.5	±3.0*3		—	○	○					○	○	F			
PQ070XZ02ZPH				○ (2 A)					±2.0*3		1.0	○	○	○	○	○	○		F			
PQ015YZ5MZPH	Reference voltage (V _{ref}) : 1.0 V, minimum operating input voltage : 1.7 V (Dual power supply type)	○										○	○				○	○	F			
PQ015YZ01ZPH			○									○	○				○	○	F			
PQ035ZN01ZPH	Reference voltage (V _{ref}) : 0.6 V, minimum operating input voltage : 1.7 V (Dual power supply type), ceramic capacitor compatible, solder dip compatible lead shape			○		5.5			0.8 to 3.5		±30 mV	—	○	○				○	○	G		
PQ035ZN1HZPH					○			○		○							○	○	G			
PQ20VZ51J00H	Minimum operating input voltage : 4.5 V	○			24	1.5 to 20	±2.0*3	0.5	○	○	○	○	○	○	○	F						
PQ20VZ11J00H				○							○	○	○	○	○	○	○	F				
PQ20WZ51J00H	Minimum operating input voltage : 3.5 V, ASO protection function, low dissipation current at OFF state (I _{qs} : 5 μA (MAX.))	○										○	○	○	○	○	○	F				
PQ20WZ11J00H			○									○	○	○	○	○	○	F				
PQ200WNA1ZPH	Minimum operating input voltage : 3.5 V, ASO protection function, low dissipation current at OFF state (I _{qs} : 5 μA (MAX.)) ceramic capacitor compatible, solder dip compatible lead shape			○						3.0 to 20	±2.5*3		○	○	○	○	○	○	G			

*1 With infinite heat sink attached

*2 The xx/xxx in the model No. refer to the output voltage values of the model (e.g. 033 for 3.3 V, 05/050 for 5 V, 12/120 for 12 V).

*3 Reference voltage accuracy

*4 The value is defined as ± 50 mV in some models.

*5 Current ratings are defined individually.

*6 Refer to page 56

● SOT-263 type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings			Electrical characteristics			Built-in functions						Taped package	Package
		Output current I _o (A)	Input voltage V _{in} (V)	Power dissipation P _d *1 (W)	Output voltage V _o *2 (V) TYP.	Output voltage precision (%)	Dropout voltage V _{i-o} *4 (V)	Overheat protection	Overcurrent protection	ON/OFF control	Low dissipation current at OFF state	Variable output voltage			
PQxxxY053ZPH	High output current (minimum operating input voltage : 2.35 V)	5.0	7	35	1.5, 2.5, 3.3	1.0	0.5	○	○	○	○		○	TO-263	
PQ05VY053ZPH					1.5 to 5	1.0*3		○	○	○	○	○	○		
PQxxxY3H3ZPH		3.5			1.5, 2.5, 3.3	1.0		○	○	○	○		○		
PQ05VY3H3ZPH					1.5 to 5	1.0*3		○	○	○	○	○	○		
★PQxxxEHS2ZPH	2 A output (minimum operating input voltage : 2.35 V), built-in soft start function	2.0	10		1.2, 1.5, 1.8, 2.5, 3.3	±2.5		0.5	○	○	○	○			○
PQxxxEH02ZPH	2 A output (minimum operating input voltage : 2.35 V)				1.5, 1.8, 2.5				○	○	○	○			○
PQ070XH02ZPH					1.5 to 7	±2.0*3			○	○	○	○	○		○
PQxxxEH01ZPH	1 A output (minimum operating input voltage : 2.35 V)	1.0			1.5, 1.8, 2.5	±2.5			0.5	○	○	○	○		
PQ070XH01ZPH				1.5 to 7	±2.0*3	○	○			○	○	○	○		

*1 With infinite heat sink attached

*2 The xxx in the model No. refer to the output voltage values of the model (e.g. 015 for 1.5 V, 025 for 2.5 V, 033 for 3.3 V).

*3 Reference voltage accuracy

*4 Current ratings are defined individually.

● SOP-8 type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings			Electrical characteristics		Built-in functions		Taped package	Package
		Output current I _o (A)	Input voltage V _{in} (V)	Power dissipation Pd*1 (W)	Output voltage V _o (V) TYP.	Output voltage precision (mV)	Overheat protection	Overcurrent protection		
★PQ1DX095MZPQ	Built-in sink source function (For DDR II memory)	±0.8	6	0.6	V _{DD} X 1/2 (V _{DDQ} : 1.5 V (MIN.))	—	○	○	○	SOP-8
PQ1DX125MZPQ	Built-in sink source function (For DDR memory)				V _{DD} X 1/2 (V _{DDQ} : 2.3 V (MIN.))	± 35	○	○		

*1 When mounted on a board

■ Surface Mount Type Chopper Regulators (DC-DC Converters)

(Ta = 25°C)

Model No.	Features	No. of output circuits	Output type			Built-in SW Tr	Input voltage range Vin (V)	Switch current Isw (A)	Output voltage Vo (V)	Oscillation frequency fo (Hz) TYP.	Package	
			Step-down	Step-up	Inversion							
PQ6CU11X1APQ	• High voltage CMOS output : 30 V (MAX.) • White LED driver for back light • Output ON/OFF control function • Overvoltage/overcurrent protection circuits • Soft start function	1		○		○	up to 5.5	0.25*1	—	1.2 M	SOT-23-6	
PQ6CB11X1AP	• High voltage CMOS output : 30 V (MAX.) • White LED driver for back light (Capable of driving up to 4 LEDs in series connection) • Output ON/OFF control function • Overvoltage/overcurrent protection circuits • Soft start function			○		○	2.7 to 5.5		up to 30		USB-6	
PQ6CB11X1CP	• High voltage CMOS output : 30 V (MAX.) • White LED driver for back light (Capable of driving up to 6 LEDs in series connection) • Output ON/OFF control function • Overvoltage/overcurrent protection circuits • Soft start function			○		○						
PQ6CU12X2APQ	• High switching voltage : 40 V (MAX.) • For tuner power supply • Output ON/OFF control function			○		○	3.0 to 5.5		up to 36	300 k to 800 k*6	SOT-23-6W	
★PQ7L2010BP	• Possible to correspond also to operation in the minute lighting mode • High frequency PWM control for brightness adjustment • Output ON/OFF control function			○		○	2.7 to 5.5		up to 30	2 M	USB-10	
PQ1CZ38M2ZPH series	• PWM chopper regulator (high oscillation frequency) • Output ON/OFF control function • Overcurrent/overheat protection circuits • For light load			○		○	up to 40	0.8*1	VREF*2 to 35*4 (step-down type)/ -VREF*2 to -30*4 (inverting type)	300 k	SC-63	
PQ1CZ21H2ZPH	• PWM chopper regulator • Output ON/OFF control function • Overcurrent/overheat protection circuits • Low dissipation current at OFF state (Standby current <Isd> : 1 μA (MAX.))			○		○		1.5*1	100 k			
PQ1CZ41H2ZPH	• PWM chopper regulator (high oscillation frequency) • Output ON/OFF control function • Overcurrent/overheat protection circuits			○		○		300 k				
PQ1CX12H2ZPQ	• Bootstrap system for high efficiency (Efficiency 90% (TYP.)) • Low dissipation current			○			○	up to 33	2.5*1	VREF*3 to 24*4 (step-down type)	150 k	SOP-8
PQ1CX22H2ZPQ	• Bootstrap system for high efficiency (Efficiency 90% (TYP.)) • Low dissipation current • Low voltage output : 1.2 V (MIN.)			○			○					
PQ1CY1032ZPH	• PWM chopper regulator • Output ON/OFF control function • Overheat protection/overcurrent shutdown circuits • High output current type			○		○	○	up to 40	3.5*1	VREF*2 to 35*4 (step-down type)/ -VREF*2 to -30*4 (inverting type)	150 k	TO-263
PQ1CYxx3HZPH series PQ1CYxx3LZPH series	• PWM chopper regulator • Fixed output voltage : 3.3 V or 5 V • Output ON/OFF control function • Overheat protection circuit			○			○			3.3, 5.0*5 (TYP.)		
IR3M18N	• Soft start function • Undervoltage protection circuit • Timer latch short-circuit protection circuit • Standby function			○			2.2 to 6.0	(Determined by external Tr)	(Determined by external Tr)	100 k to 1 M*6	P-SSOP008-0150	
IR3M19N	• High transient load characteristics from built-in current control circuit • Soft start function • Overcurrent/overvoltage/undervoltage protection circuits • Internal reference voltage accuracy (±1%)			○			4.5 to 22		1.24 to input voltage	220 k		
★IR3M56N	• High efficiency synchronous rectified step-down converter • Current mode control • Soft start function • Overcurrent/overvoltage/undervoltage/overheat protection circuits			○			4.5 to 36		0.8 to 6.3	200 k/300 k/ 400 k/500 k/ external sync.		P-TSSOP016-0225
IR3M17U	• Standby function (output ON/OFF control function for each channel) • Soft start function • Undervoltage protection circuit		2		○				2.2 to 6.5	(Determined by external Tr)		100 k to 500 k*6/ external sync.
			○	○	○							

*1 Peak current (absolute maximum ratings) *2 V_{REF} nearly equal to 1.26 V (TYP.) *3 V_{REF} nearly equal to 1 V (TYP.) *4 Output voltage variable range

*5 The xx in the model No. refer to the output voltage values of the model (e.g. 33 for 3.3 V, 50 for 5.0 V). *6 Selectable oscillation frequency range

■ Surface Mount Type Chopper Regulators (DC-DC Converters) (cont'd)

(Ta = 25°C)

Model No.	Features	No. of output circuits	Output type			Built-in SW Tr	Input voltage range Vin (V)	Switch current Isw (A)	Output voltage Vo (V)	Oscillation frequency fo (Hz) TYP.	Package		
			Step down	Step up	Inversion								
★PQ5CAD1xxxP series	• 2-ch output (Chopper output + Low-loss regulator) • CMOS synchronous rectified step-down converter • Independent regulator input terminal • Reset circuit • Ceramic capacitor compatible	2	○			○	2.9 to 5.5 (4.0 to 5.5 ^{*2})	0.8 ^{*3} (Chopper regulator output) Io : 0.2 (MAX.) (Series regulator output)	1.5, 3.3 ^{*2} (TYP.)	1.2 M	LNC-8		
			○			—				—			
★IR3M57N	• High efficiency two channel synchronous rectified step-down converter • Current mode control • Soft start function • Overcurrent/overvoltage/undervoltage/overheat protection circuits		○				External	4.5 to 36	(Determined by external Tr)	0.8 to 6.3	200 k/ 300 k/ 400 k/ 500 k/ external sync.	P-TSSOP028-0225	
			○										
IR3M30M/U	• ON/OFF sequence setting • Timer latch short-circuit protection circuit • Soft start function • Overcurrent/undervoltage/overheat protection circuits	3	○	○			△ ^{*1}	2.7 to 5.5	1 ^{*4} (when using internal Tr)	External setting	70 k to 1M ^{*5}	P-QFP048-0707/ P-VQFN036-0505	
			○	○	○		External		External setting				
			○	○	○		External						
★IR3M58M/U	• ON/OFF sequence setting without external control • Timer latch phase fault protection circuit • Soft start function • Overcurrent/undervoltage/overheat protection circuits		○	○			△ ^{*1}	4.5 to 28	0.4 ^{*4} (when using internal Tr)		70 k to 500 k ^{*5}		
			○				External		External setting				

*1 Built-in SW Tr can be used in step-up mode ; external SW Tr is required in step-down or inverting mode.

*2 For model PQ5CAD1B3CP (chopper output voltage : 1.5 V, output voltage of series regulator unit : 3.3 V)

*3 Peak current (absolute maximum ratings)

*4 Constant current (MAX.)

*5 Selectable oscillation frequency range

■ Chopper Regulators (DC-DC Converters)

● TO-220 type

(Ta = 25°C)

Model No.	Features	Absolute maximum ratings			Electrical characteristics			Package	
		Switch current Isw (A)	Input voltage Vin (V)	Power dissipation Pd*1 (W)	Output voltage Vo*2 (V)	Oscillation frequency fo (kHz) TYP.	Output saturation voltage Vsat (V) TYP.		
PQ1CG38M2FZH	• PWM chopper regulator (high oscillation frequency) • Built-in overcurrent/overheat protection circuits • Output ON/OFF control function • For light load	0.8*3	40	14	VREF*4 to 35 (step-down type)/ -VREF*4 to -30 (inverting type)	300	0.9	TO-220	E
PQ1CG38M2RZH									D
PQ1CG21H2FZH	• PWM chopper regulator • Built-in overcurrent/overheat protection circuits • Output ON/OFF control function	1.5*3				100	1.0		E
PQ1CG21H2RZH									D
PQ1CG41H2FZH	• PWM chopper regulator (high oscillation frequency) • Built-in overcurrent/overheat protection circuits • Output ON/OFF control function	1.5*3				300	0.9		E
PQ1CG41H2RZH									D
PQ1CG2032FZH	• PWM chopper regulator • Built-in overcurrent/overheat protection circuits • Output ON/OFF control function	3.5*3				70	1.4		E
PQ1CG2032RZH									D
PQ1CG3032FZH	• PWM chopper regulator (high oscillation frequency) • Built-in overcurrent/overheat protection circuits • Output ON/OFF control function	3.5*3				150	1.4		E
PQ1CG3032RZH									D
PQ2CF1J0000H	• PWM chopper regulator • Built-in overcurrent/overheat protection circuits	2.5*3	35	15	4.5 to 35 (step-up type)	50	0.6	E	

*1 With infinite heat sink attached

*2 Output voltage variable range

*3 Peak current

*4 V_{REF} nearly equal to 1.26 V (TYP.)

*5 Refer to page 55

Power Supply ICs for CCDs/CCD Camera Modules

Model No.	No. of output circuits	Input voltage range (V)	Output voltage (V)	System	Switching frequency (Hz)	SW Tr	Switching current (mA) [Built-in SW Tr]	Drive capacity (pF) [External SW Tr]	Package
IR3M52Y7	5	2.7 to 5.5	15	Step-up type PWM + REG	1 M	Built-in	20 (DC)	—	41WL-CSP ^{*2}
			—8	Inverting type PWM		External	—	1 000	
			2.5 to 3.3	REG	—	—	100 (DC)	—	
			2.5 to 3.3	REG			100 (DC)	—	
			1.8/1.2	REG			100 (DC)	—	
IR3M61U ^{*1} /63U	4	4.5 to 10	15	Charge pump	200 k	—	1.2 (DC)	—	P-VQFN032-0505
			—8	Negative charge pump			2.5 (DC)	—	
			3.3	Step-down type PWM + REG	1 M	Built-in	120 (DC)	—	
			1.8	Step-down type PWM + REG			50 (DC)	—	
IR3M49U6	4	2.7 to 5.5	15	Step-up type PWM + REG	1 M	Built-in	600 (DC)	—	P-VQFN036-0505 ⁽⁺³⁾
			External setting	Step-up, step-down, step-up/down type PWM		External	—	1 000	
				Inverting type PWM			—	1 000	
			REG	—	—	—	170 (DC)	—	
IR3M55U ^{*1} /59U	3	4.5 to 16	15/12	Charge pump	200 k	—	10/20 (DC)	—	P-VQFN032-0505
			—8/—5	Negative charge pump			2/5 (DC)	—	
			3.3	Step-down type PWM + REG	1 M	Built-in	150 (DC)	—	
IR3M48U6	3	2.7 to 3.2	15	Charge pump + REG	300 k	—	6 (DC)	—	P-VQFN032-0505 ⁽⁺³⁾
			—8	Negative charge pump + REG			7 (DC)	—	
			1.8	REG	—	—	50 (DC)	—	

*1 For in-vehicle use

*2 3.97 mm x 3.97 mm x 0.82 mm (TYP.)

*3 Contact a SHARP sales office regarding a wafer-level CSP.

Power Supply ICs for TFT-LCDs

Model No.	No. of output circuits	Input voltage range (V)	Output voltage (V)	System	Switching frequency (Hz)	SW Tr	Switching current (mA) [Built-in SW Tr]	Drive capacity (pF) [External SW Tr]	Package
★IR3M58M/U		4.5 to 28	External setting	Step-up (20 V (MAX.)) / step-down type PWM	70 k to 500 k	Built-in (Step-up type)	400	1 000	P-QFP048-0707/ P-VQFN036-0505
				Step-down type PWM		External	—		
				Step-up, step-down type PWM		External	—		
IR3M30M/U	3	2.7 to 5.5	External setting	Step-up, step-down, step-up/down type PWM	70 k to 1 M	Built-in (Step-up type)	1 000	—	
				Step-up, step-down, step-up/down, inverting type PWM		Built-in (Step-up type)	1 000	—	
				Step-up, step-down, step-up/down, inverting type PWM		External	—	1 000	
IR3M16U		2.6 to 3.6	15.3	Charge pump	100 k	—	0.1 (DC)	—	P-HQFN020-0404
			5.1	Charge pump + REG		—	5 (DC)	—	
			—10.2	Negative charge pump		—	0.1 (DC)	—	

■ LED drivers

● Built-in step up circuit

Model No.	Function	Features	No. of output circuits	Number of LEDs	Booster method	Built-in constant current circuit	Built-in SW Tr	Input voltage range (V)	Output current (mA) MAX.	Oscillation frequency fo (Hz) TYP.	Package
PQ6CU11X1APQ	White LED driver for back light (For small panel)	• High voltage CMOS output : 30 V (MAX.) • Output ON/OFF control function • Overcurrent/overvoltage protection circuits • Soft start function	1	3 (Series connection)	PWM	*1	○	Up to 5.5	250*2	1.2 M	SOT-23-6
PQ6CB11X1AP				4 (Series connection)		*1	○	2.7 to 5.5			USB-6
PQ6CB11X1CP				6 (Series connection)		*1	○				
★PQ7L2010BP		• Possible to correspond also to operation in the minute lighting mode • High frequency PWM control for brightness adjustment • Output ON/OFF control function		4 (Series connection)		*1	○		2.0 M	USB-10	
IR2E46U6*/Y6	RGB LED driver for picture lights and illuminations	• I²C bus control • Illumination mode (64 levels/ch) • Picture light mode (32 levels/ch) • Brightness adjustment • Standby function/soft start function • Overcurrent/undervoltage/overheat protection circuits	3	3		○	○	2.7 to 4.5	155/ch*3 (in picture light mode)	1.2 M	33WL-CSP*5
IR2E47U6	White LED driver for back light (for small panels)	• Independent current control for two systems (4 outputs and 2 outputs) • LED non-connected judging function • Brightness adjustment • Undervoltage/overheat protection circuits	6	4 + 2	Charge pump	○	—	2.7 to 5.5	20/ch*3	1 M	P-HQFN024-0404
★IR2E49U	White LED driver for back light (for medium panels)	• Built-in 150 mA driver for each channel • Step-up DC-DC output short-circuit protection function • Current driver output open detection • Capable of external brightness adjustment using PWM input signal • Overcurrent/overvoltage/undervoltage/overheat protection circuits	5	35	PWM	○	External	6 to 28	150/ch*3 (600 mA in total)	100 k to 1 M*4	P-VQFN036-0606
★IR2E50Y6	LED driver for back light and call alert display LED driver (auto brightness adjustment)	• Capable of direct connection of ambient light sensor • Brightness adjustment by ambient illuminance feedback (16-step ambient illuminance/128-level illuminance) (for main LCDs) • Non-external coil thanks to charge pump drive • Capable of driving 4 main-LEDs, 2 sub-LEDs, and 3 call alert LEDs with a single device. • I²C interface • Standby function/power on reset function/soft start function	9	4 + 2 + 3	Charge pump	○	—	3.0 to 4.5 (for drive)/ 2.3 to 3.2 (for control)	25/ch*3	500 k	33WL-CSP*5

*1 LED constant current value can be set by external resistors.

*2 Peak switch current

*3 Constant current (MAX.)

*4 Selectable oscillation frequency range

*5 3.57 mm x 3.57 mm x 0.82 mm (TYP.)

● External power supply for LEDs

Model No.	Function	Features	Supply voltage (V)	Package
IR2D20U	24-dot LED panel driver with constant-current sink outputs	- Output current (constant current sink output) : 30 mA (MAX.) (setup by external resistor) - Gradation function (clock cycle setting or external synchronization) - Independent current control for three systems (for RGB LED) - LED drive voltage : 15 V - Rated output voltage : 20 V (MAX.) - f_{CLK} : 20 MHz (MAX.)/16.6 MHz (MAX.) (at cascade connection)	4.5 to 5.5	P-HQFN052-0707
IR2D07N1	16-dot LED panel driver with constant current sink outputs	- Output current (constant-current sink output) : 60 mA (MAX.) (setup by external resistor) - Rated output voltage : 7 V (MAX.) - f_{CLK} : 20 MHz (MAX.)/16.6 MHz (MAX.) (at cascade connection)	3.0 to 5.5	P-SSOP040-0300



Analog ICs

Video Interface ICs for TFT-LCDs

Model No.	Input signal				Color decode	LCD panel				Serial data control	Supply voltage (V) TYP.	Power consumption (mW) TYP.	Package
	Composite video	Y/color difference	Analog RGB	OSD (Digital)		± power source	+ power source	Low voltage source	Digital input				
IR3Y18A1	○				NTSC/PAL	○	○				4.5/12 or 4.5/-7.5	130	P-QFP048-0707
IR3Y26A2/A6			○*3		—			○			5/7.5	140	P-QFP048-1010/ P-QFP048-0707
IR3Y29A1/B1	○		○		NTSC/PAL			○				190	P-QFP048-0707
IR3Y31M1	○		○		NTSC/PAL	○	○				4.5/12 or 4.5/-7.5	160	
IR3Y34M1		○	○	○	—		○				3/12	88	
IR3Y37A1		○(Common terminal)		○	—			○			3/6.5	106/88*4	
RB5P0010M2			○*3	○	—	○	○			○	3/12 or 3/4.5/-7.5	92	
RB5P0020M2		○(Common terminal)		○	—			○			3/5	70/57*4	
RB5P0050M2		○(Common terminal)		○	—			○		○		95/80*4	
RB5P0060M2	○		○		NTSC/PAL			○		○	3/5/13	120	P-QFP048-1010
RB5P006AM2	○		○		NTSC/PAL			○		○			
RB5P0070M*1	○		○	○	NTSC/PAL				○	○	3/7	330	P-QFP072-1010
RB5P0090M	○		○*3		NTSC/PAL (automatic identification)			○		○	5/13	250	P-QFP048-1010
LRS5751*2	○		○		NTSC/PAL			○			3.3/5/7.5	197	P-LQFP100-1414
LRS5752*2	○		○*3		NTSC/PAL (automatic identification)			○		○	3.3/5/13	257	

*1 For digital signal input panels

*2 Built-in timing generator

*3 Two inputs

*4 At analog input for RGB

Power Amplifiers for Wireless LAN

Model No.	Application	Operating frequency (GHz)	Supply voltage (V) TYP.	Output power (dBm) TYP.	Supply current (mA) TYP.	Gain (dB) TYP.	Detection function	Matching circuit	Package	
IRM046U7	For 2.4 GHz wireless LAN (IEEE 802.11b/g)	2.4 to 2.5	3.3	18 (at EVM 3%)	105	30	○	—	P-HQFN024-0404	
	For 5 GHz wireless LAN (IEEE 802.11a)	4.9 to 5.9		18 (at EVM 2%)	140	25	○	—		
IRM046U8	For 2.4 GHz wireless LAN (IEEE 802.11b/g)	2.4 to 2.5		18 (at EVM 3%)	105	30	○	—		P-HQFN024-0305
	For 5 GHz wireless LAN (IEEE 802.11a)	4.9 to 5.9		18 (at EVM 2%)	140		○	—		
IRM054U7	For 2.4 GHz wireless LAN (IEEE 802.11b/g)	2.4 to 2.5		18 (at EVM 3%)	120	29	○	Built-in (IN/OUT)	P-HQFN024-0305	
	For 5 GHz wireless LAN (IEEE 802.11a)	4.9 to 5.9		18 (at EVM 2%)	150	21	○	Built-in (IN/OUT)		
★IRM062U6	For 2.4 GHz wireless LAN (IEEE 802.11b/g)	2.4 to 2.5		16	75	27	○	Built-in (IN/OUT)		P-HQFN024-0404/ P-HQFN016-0303
	For 5 GHz wireless LAN (IEEE 802.11a)	4.9 to 5.9		15	100	30	○	Built-in (IN/OUT)		
IRM047U7/U8*	For 2.4 GHz wireless LAN* (IEEE 802.11b/g)	2.4 to 2.5		18 (at EVM 3%)	105	30	○	—	P-HQFN016-0303	
IRM049U6				16 (at 802.11 b)/ 16 (at 802.11 g)	65 (at 802.11 b)/ 90 (at 802.11 g)	28/31	—	—		
★IRM060U6	For 2.4 GHz wireless LAN (IEEE 802.11b/g)			16 (at EVM 2%)	75	27	○	Built-in (IN/OUT)		
IRM052U6				18 (at EVM 3%)	120	29	○	Built-in (IN/OUT)		
IRM048U6	For 5 GHz wireless LAN (IEEE 802.11a)	4.9 to 5.9		18 (at EVM 2%)	140	30	○	—	P-HQFN024-0404	
IRM048U7						25	○	—		
IRM053U6				15 (at EVM 3%)	150	31	○	Built-in (IN/OUT)	P-HQFN016-0303	
★IRM061U6					100	30	○	Built-in (IN/OUT)		

* Can be used as a power amp for PHS and DECT (1.9 GHz band), or as a driver amp for FWA (1.9 to 2.6 GHz band).

Power Amplifier for Cordless Phones

Model No.	Application	Operating frequency (GHz)	Supply voltage (V) TYP.	Output power (dBm) TYP.	Supply current (mA) TYP.	Gain (dB) TYP.	Operating temp. (°C)	Package
★IRM050U6	For 5.8 GHz cordless phones	5.725 to 5.85	3.3	25	220	20	–25 to 85	P-HQFN016-0303

■ Laser Diode Drivers

Model No.	Application	Function	Drive mode	Maximum output current (mA) MIN.	Applicable SHARP diode type	Supply voltage (V)	Package
IR3C14N1	For Mini Disc players	Built-in 100 mA driver, APC function	DC mode	100	—	2.4 to 3.5	P-SSOP008-0150
IR3C22N	For CD/DVD players	Built-in APC function, with inhibit input pin	—	150	P (Single power supply)	4.5 to 5.5	

■ IC for Cameras

Model No.	Function	Output/input element	Supply voltage (V)	Package
IR3S881	AF/AE/thermometry/AD (10-bit serial output for each datum), AF lens/shutter/IX magnetic head driver, zoom/film pre-driver, battery check, DC-DC converter	AF : Infrared LED, PSD* ¹ (active type, 1 beam), AE : SPD* ² (available for 2-part SPD)	2.2 to 6.0	P-QFP048-0707

*1 PSD : Position Sensitive Detector

*2 SPD : Silicon Photo Diode

■ Compandor

Model No.	Function/Feature	Supply voltage (V)	Operating current (mA) TYP.	Output dynamic range (mVrms) TYP.	Package
IR3N74A1	Compression and expansion of speech signal, small package	2.4 to 5.5	3.4	900	P-SSOP012-0225

■ ICs for Audio Equipment

Model No.	Description	Function	Supply voltage (V)	Package
IR3R55M1	RF amp IC for Mini Disc players	Built-in RF amp, ADIP detection circuit, connectable to hologram pickup	2.4 to 3.3	P-TQFP048-0707
IR3R58M1		Built-in 2x speed RF amp, ADIP detection circuit, connectable to hologram pickup		
IR3R61U	Audio amp IC	Built-in serial control input ATT and mike amp	±2.0 to ±3.25	P-HQFN020-0404
IR3R59N1		Built-in serial control input ATT and filter amp	±1.2 to ±3.25	P-SSOP024-0275
IR3M17U	Power supply IC	Two outputs (step-up, step-up/down type PWM, and step-up, step-down, step-up/down, inverting type PWM), switching frequency : 500 kHz (MAX.), external synchronization	2.2 to 6.5	P-HQFN020-0404
IR3C14N1	Laser diode driver for Mini Disc players	Built-in 100 mA driver, APC function	2.4 to 3.5	P-SSOP008-0150

Packages

CSP

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CSP

■ CSP (Chip Size Package)

The FBGA (commonly known as CSP) has an area array terminal structure with solder balls on the bottom, to give it a near chip-size footprint. This high-density, compact and low-profile package technology will greatly help in the design of compact mobile equipment, such as cellular phones and digital cameras.



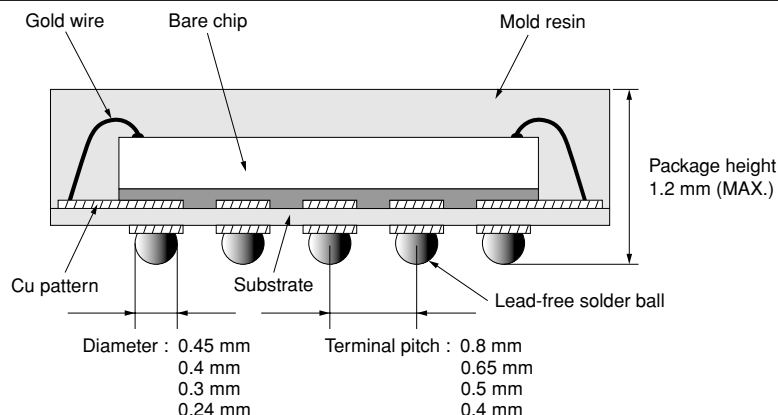
FBGA (CSP)

Features

- **Compact and lightweight**
Ability to create a near-chip size and lighter-weight package in comparison with conventional plastic packages.
- **High reliability**
Comparable high reliability with that of conventional plastic packages.
- **Mountability**
Conventional mounting system is available for CSP. SOP and QFP can be mounted together with CSP.

Terminal pitch	0.8 mm	0.65 mm	0.5 mm	0.4 mm
Maximum terminal counts	288 (16 mm x 16 mm)	352 (16 mm x 16 mm)	424 (14 mm x 14 mm)	264 (10 mm x 10 mm)
Nominal dimensions	6 mm x 6 mm to 16 mm x 16 mm			5 mm x 5 mm to 10 mm x 10 mm

Cross section example



■ Wafer-level CSP

The wafer-level CSP (WL-CSP) is a kind of chip-size package which is manufactured by assembling directly onto the finished wafer.

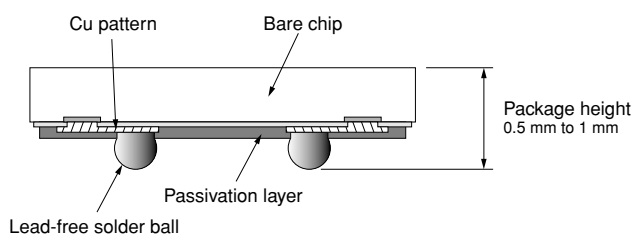
Features

- **Compact and thinner size**
It makes it possible to create an almost bare-chip-size and lighter-weight package.
- **Mountability**
The conventional CSP mounting system can be also used in that of wafer-level CSP, which facilitates chip mounting more than bare-chip mounting does. It can be mounted together with other existing packages and passive components. (The use of underfill is recommended to improve the reliability of assembly.)

Chip size*	4 mm x 4 mm		3.5 mm x 3.5 mm		3 mm x 3 mm		2.5 mm x 2.5 mm	
Pad pitch	0.5 mm	0.4 mm	0.5 mm	0.4 mm	0.5 mm	0.4 mm	0.5 mm	0.4 mm
Maximum terminal counts	49 (7 x 7)	81 (9 x 9)	36 (6 x 6)	49 (7 x 7)	25 (5 x 5)	36 (6 x 6)	16 (4 x 4)	25 (5 x 5)

* Rectangular chip form is also available.

Cross section example

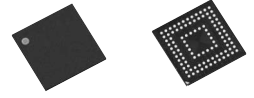




LGA

■ LGA (Land Grid Array Package)

The LGA package has basically the same structure as the CSP, enabling a thin package by removing the solder balls from the bottom of the package. The LGA package contributes to the compact and thinner design of applications, such as cellular phones and digital cameras.



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Packages

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Features

- **Lower package height**

Achieves 0.5 mm Max. in package height.

- **High reliability**

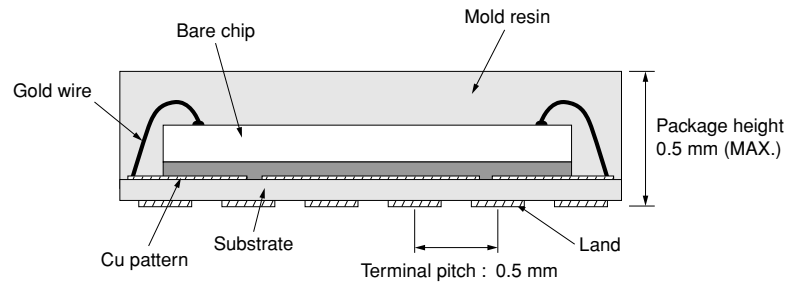
Comparable high reliability with that of conventional plastic package.

- **Excellent mountability**

Conventional mounting system is available for LGA. SOP and QFP can be mounted together with LGA.

Terminal pitch	0.5 mm
Maximum terminal count	216 (10 mm x 10 mm)
Nominal dimensions	6 mm x 6 mm ~ 10 mm x 10 mm

Cross section example





SiP (System in Package)

System in Package is an original SHARP high-density mounting technology that achieves high-density memory capacity and multiple functions by stacking multiple bare chips or multiple packages. This technology has two major streams. One method refers to a chip-stacked package technology that can achieve up to 5-chip mounting by stacking chips in a single package. The other method refers to a package stack technology with which it is possible to stack a package of over 5 chips, by stacking multiple packages in which 1 to 2 chips are stacked. The System in Package technology contributes to higher functionality of applications, such as cellular phones and digital cameras, as well as to reduction in size and weight.

■ Chip Stacked CSP

Features

- **Wide variety of lineup**

It is possible to provide a wide lineup of stacked CSPs, including 2-chip, 3-chip, 4-chip and 5-chip stacked CSPs, to respond to customer needs.

- **Compact and thinner size**

Encapsulating multiple bare chips into an existing plastic package contributes to decreasing the mounting area. In addition, SHARP's wafer thinning technology makes it possible to achieve 1.4 mm package height.

- **Multiple functions**

Multiple bare chips of different sizes and functions, such as logic LSIs and memories, can be incorporated in a single package, making possible multiple functions.

- **Same-size chip stacking technology**

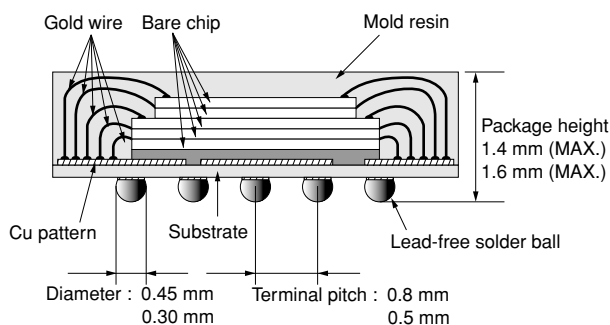
SHARP's stacking technology enables stacking of multiple same-size bare chips, contributing to higher memory density.

(4-chip stacked CSP)

When using a SHARP four-chip stacked CSP, the mounting area and weight of a package can be decreased by half in comparison with using two 2-chip stacked CSPs, or a 3-chip stacked CSP and a conventional CSP.

Cross section example

(5-chip stacked CSP)



■ Chip Stacked TSOP/QFP* / VQFN / HQFN

Features

- **Decreased mounting area**

By encapsulating two identical or different types of bare chips into a single conventional plastic package, the mounting area of the package can be decreased.

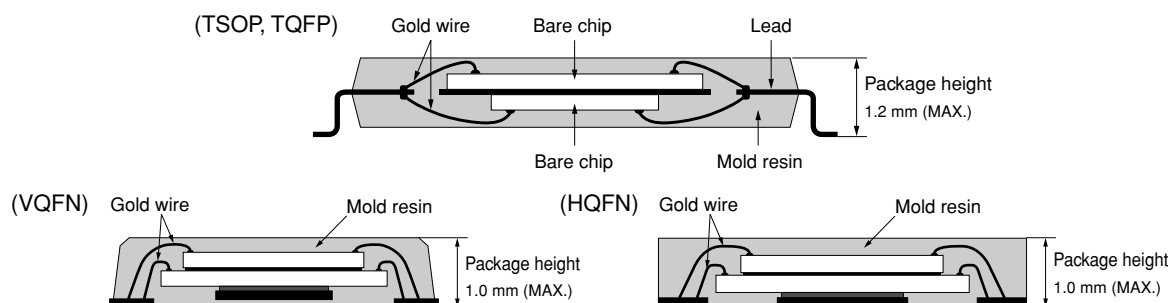
- **Multiple functions**

Thanks to the incorporation of different sizes and functions of multiple bare chips, such as logic LSIs and memories, the functionality increases.

- **Higher memory density**

When incorporating two identical memory bare chips into a single package, memory density doubles on the same mounting area.

Cross section example



* Including TQFP and LQFP.

■ Package Stacked

Features

• Multi stacking

The package stacking technology makes it possible to increase the memory capacity and create a combined system with memory and logic LSI. In the case of combination memories, memory capacity can be increased by stacking multiple 0.5 mm height packages in which 1 to 2 chips are stacked.

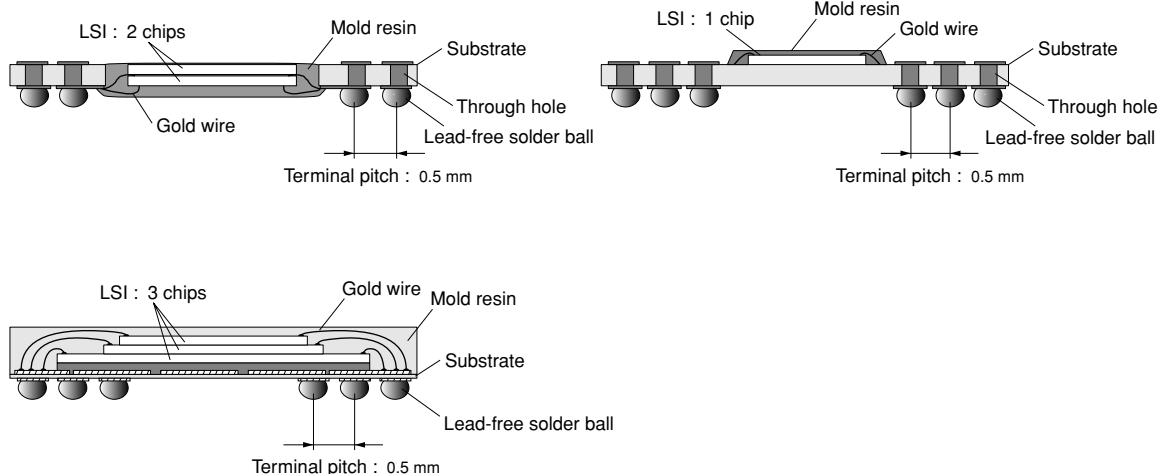
• Decreased mounting area and height

The package stacked technology makes it possible to decrease the mounting area by stacking multiple packages in which 1 to 2 chips are stacked, also achieving 1.5 mm height when six chips are stacked.

• Multiple functions

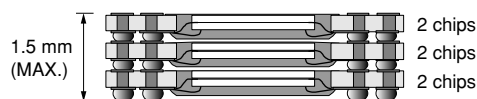
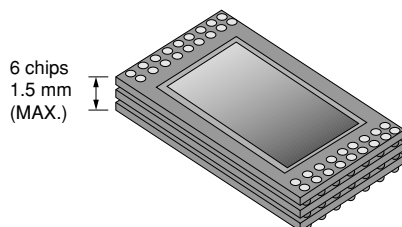
Thanks to the combination of packages in which various kinds of LSIs are mounted, such as a memory and ASIC, achieving an increase in and enhancement of functionality is easy.

Cross section example

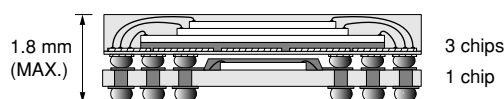
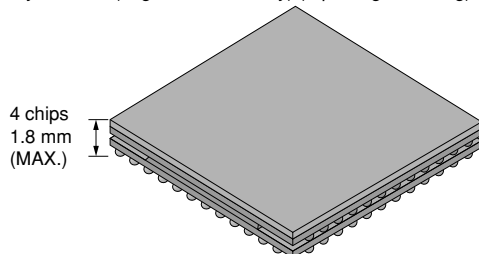


Examples of 3D-SiP composition

- High-density combination memory (3-package stacking)



- System LSI (Logic LSI + Memory) (2-package stacking)



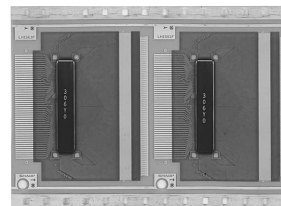


SOF

■ SOF (System On Film)

SOF is a highly flexible thin film package, created from SHARP's TCP technologies. It can be easily bent, and contributes to thin and compact design of products.

Peripheral circuit components can also be mounted.



Features

- **Highly flexible and thin film package**

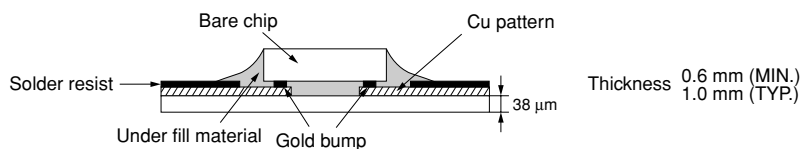
By using highly flexible and thin film, SOF contributes to creating thin and compact products.

It can also achieve finer terminal pitches and multiple outputs easily, and pattern layout on a film under the chip makes it possible to improve the flexibility of the pattern layout.

- **Multiple chip mounting**

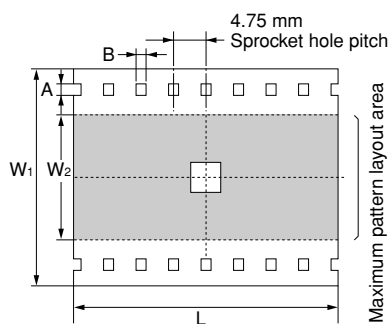
Plural bare chip mounting and incorporation of peripheral components contribute to the higher functionality of products.

Cross section example



Film specifications

Film width : W ₁	35 mm super wide	48 mm super wide	70 mm wide
Maximum pattern layout area : W ₂	28.6 mm	41.6 mm	59.0 mm
Maximum device pitch : L	15 sprockets		
Copper foil thickness	8 μm		
Copper foil type	Rolled or electrolytic		
Copper foil plating	Tin (Sn)		
Minimum pattern pitch	0.029 mm		
Sprocket hole : A	1.981 mm (wide) / 1.42 mm (super wide)		
Sprocket hole : B	1.981 mm (wide) / 1.42 mm (super wide)		



Other components

Bare chips and peripheral circuit components can be mounted on the film.

* In addition to the SOF described above, a conventional TCP (Tape Carrier Package) is also available.



Package Lineup

■ Surface-mount Type

Package type	Appearance (Package material)	Package code	No. of terminals	Terminal pitch mm	Nominal dimensions mm	Package width & length x (seated height [MAX.]) mm
FBGA (CSP)		TFBGA048-0608	48	0.8	6 x 8	6.0 x 8.0 x (1.2)
		TFBGA048-0808			8 x 8	8.0 x 8.0 x (1.2)
		TFBGA060-0811	60 (48)*		8 x 11	8.0 x 11.0 x (1.2)
		TFBGA064-0811	64			
		TFBGA072-0811	72 (64)*		8 x 8	8.0 x 11.0 x (1.4) / (1.6)
		LFBGA072-0811				
		TFBGA081-0808	81		8 x 11	8.0 x 8.0 x (1.2)
		LFBGA085-0811	85			
		LFBGA087-0811	87		9 x 12	8.0 x 11.0 x (1.4) / (1.6)
		LFBGA088-0811	88			
		LFBGA088-0912			8 x 11	9.0 x 12.0 x (1.4) / (1.6)
		LFBGA090-0811	90		10 x 10	8.0 x 11.0 x (1.4) / (1.6)
		TFBGA096-1010	96		10 x 10	10.0 x 10.0 x (1.2)
		LFBGA107-0912	107		9 x 12	9.0 x 12.0 x (1.4) / (1.6)
		TFBGA112-1010	112		10 x 10	10.0 x 10.0 x (1.2)
		LFBGA115-0914	115		9 x 14	9.0 x 14.0 x (1.4) / (1.6)
		LFBGA116-1010	116		10 x 10	10.0 x 10.0 x (1.4) / (1.6)
		LFBGA130-1013	130		10 x 13	10.0 x 13.0 x (1.4) / (1.6)
		TFBGA160-1212	160		12 x 12	12.0 x 12.0 x (1.2)
		LFBGA168-1212	168			12.0 x 12.0 x (1.4) / (1.6)
		TFBGA180-1212	180		14 x 14	12.0 x 12.0 x (1.2)
		TFBGA184-1212	184			
		TFBGA240-1414	240		14 x 14	14.0 x 14.0 x (1.2)
		LFBGA280-1616	280		16 x 16	16.0 x 16.0 x (1.4) / (1.6)
		TFBGA064-0606	64	0.65	6 x 6	6.0 x 6.0 x (1.2)
		LFBGA160-1010	160		10 x 10	10.0 x 10.0 x (1.4) / (1.6)
		LFBGA192-1010	192		12 x 12	12.0 x 12.0 x (1.4) / (1.6)
		LFBGA208-1212	208			
		LFBGA224-1313	224		13 x 13	13.0 x 13.0 x (1.4) / (1.6)
		TFBGA260-1313	260			13.0 x 13.0 x (1.2)
		TFBGA068-0606	68	0.5	6 x 6	6.0 x 6.0 x (1.2)
		TFBGA100-0707	100		7 x 7	7.0 x 7.0 x (1.2)
		TFBGA108-0707	108			
		TFBGA120-0707	120		8 x 8	8.0 x 8.0 x (1.4) / (1.6)
		LFBGA144-0808	144			
		TFBGA152-0808	152		8 x 11	8.0 x 8.0 x (1.2)
		LFBGA171-0811	171			8.0 x 11.0 x (1.4) / (1.6)
		TFBGA176-0909	176		9 x 9	9.0 x 9.0 x (1.2)
		TFBGA180-0909	180			
		TFBGA188-0909	188		10 x 10	10.0 x 10.0 x (1.2)
		TFBGA208-1010	208			
		FBGA424-1414	424		14 x 14	14.0 x 14.0 x (1.8)
		WFBGA144-0606	144	0.4	6 x 6	6.0 x 6.0 x (0.75)
		TFBGA168-0707	168		7 x 7	7.0 x 7.0 x (1.2)
		TFBGA204-0808	204		8 x 8	8.0 x 8.0 x (1.2)

* Figures in brackets indicate available terminal counts.

CMOS Image Sensors/
CCDs

LSIs for LCDs

System LSIs

Smart Card Systems

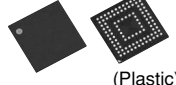
Flash Memories/
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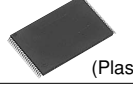
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■ Surface-mount Type (cont'd)

Package type	Appearance (Package material)	Package code	No. of terminals	Terminal pitch mm	Nominal dimensions mm	Package width & length x (seated height [MAX.]) mm
FBGA (CSP)		TFBGA ~~XXX~~ -0606	to 36	0.8	6 x 6	6.0 x 6.0 x (1.2)
		TFBGA ~~XXX~~ -0707	to 49		7 x 7	7.0 x 7.0 x (1.2)
		TFBGA ~~XXX~~ -0808	to 81		8 x 8	8.0 x 8.0 x (1.2)
		TFBGA ~~XXX~~ -0909	to 100		9 x 9	9.0 x 9.0 x (1.2)
		TFBGA ~~XXX~~ -1010	to 121		10 x 10	10.0 x 10.0 x (1.2)
		TFBGA ~~XXX~~ -1111	to 144		11 x 11	11.0 x 11.0 x (1.2)
		TFBGA ~~XXX~~ -1212	to 196		12 x 12	12.0 x 12.0 x (1.2)
		TFBGA ~~XXX~~ -1313	to 216		13 x 13	13.0 x 13.0 x (1.2)
		TFBGA ~~XXX~~ -1414	to 240		14 x 14	14.0 x 14.0 x (1.2)
		TFBGA ~~XXX~~ -1515	to 280		15 x 15	15.0 x 15.0 x (1.2)
		TFBGA ~~XXX~~ -1616	to 352		16 x 16	16.0 x 16.0 x (1.2)
		TFBGA ~~XXX~~ -0606	to 49	0.65	6 x 6	6.0 x 6.0 x (1.2)
		TFBGA ~~XXX~~ -0707	to 81		7 x 7	7.0 x 7.0 x (1.2)
		TFBGA ~~XXX~~ -0808	to 121		8 x 8	8.0 x 8.0 x (1.2)
		TFBGA ~~XXX~~ -0909	to 144		9 x 9	9.0 x 9.0 x (1.2)
		TFBGA ~~XXX~~ -1010	to 196		10 x 10	10.0 x 10.0 x (1.2)
		TFBGA ~~XXX~~ -1111	to 224		11 x 11	11.0 x 11.0 x (1.2)
		TFBGA ~~XXX~~ -1212	to 256		12 x 12	12.0 x 12.0 x (1.2)
		TFBGA ~~XXX~~ -1313	to 272		13 x 13	13.0 x 13.0 x (1.2)
		TFBGA ~~XXX~~ -1414	to 304		14 x 14	14.0 x 14.0 x (1.2)
		TFBGA ~~XXX~~ -1515	to 320		15 x 15	15.0 x 15.0 x (1.2)
		TFBGA ~~XXX~~ -1616	to 352		16 x 16	16.0 x 16.0 x (1.2)
		TFBGA ~~XXX~~ -0606	to 100	0.5	6 x 6	6.0 x 6.0 x (1.2)
		TFBGA ~~XXX~~ -0707	to 132		7 x 7	7.0 x 7.0 x (1.2)
		TFBGA ~~XXX~~ -0808	to 164		8 x 8	8.0 x 8.0 x (1.2)
		TFBGA ~~XXX~~ -0909	to 192		9 x 9	9.0 x 9.0 x (1.2)
		TFBGA ~~XXX~~ -1010	to 216		10 x 10	10.0 x 10.0 x (1.2)
		TFBGA ~~XXX~~ -1111	to 244		11 x 11	11.0 x 11.0 x (1.2)
		TFBGA ~~XXX~~ -1212	to 268		12 x 12	12.0 x 12.0 x (1.2)
		TFBGA ~~XXX~~ -1313	to 296		13 x 13	13.0 x 13.0 x (1.2)
		TFBGA ~~XXX~~ -1414	to 320		14 x 14	14.0 x 14.0 x (1.2)
		TFBGA ~~XXX~~ -1515	to 348		15 x 15	15.0 x 15.0 x (1.2)
		TFBGA ~~XXX~~ -1616	to 372		16 x 16	16.0 x 16.0 x (1.2)
		TFBGA ~~XXX~~ -0505	to 100	0.4	5 x 5	5.0 x 5.0 x (1.2)
		TFBGA ~~XXX~~ -0606	to 144		6 x 6	6.0 x 6.0 x (1.2)
		TFBGA ~~XXX~~ -0707	to 168		7 x 7	7.0 x 7.0 x (1.2)
		TFBGA ~~XXX~~ -0808	to 204		8 x 8	8.0 x 8.0 x (1.2)
		TFBGA ~~XXX~~ -0909	to 228		9 x 9	9.0 x 9.0 x (1.2)
		TFBGA ~~XXX~~ -1010	to 264		10 x 10	10.0 x 10.0 x (1.2)
FLGA (LGA)	 (Plastic)	XFLGA100-0707	100	0.5	7 x 7	7.0 x 7.0 x (0.5)

XXX : Terminal counts

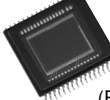
■ Surface-mount Type (cont'd)

Package type	Appearance (Package material)	Package code	No. of terminals	Terminal pitch mm (mil)	Nominal dimensions mm (mil)	Package width & length x (seated height [MAX.]) mm	Lead frame material		
							Alloy42	Copper alloy	
SOP		P-SOP044-0600	44	1.27 (50)	15.2 (600)	13.2 x 28.2 x (3.1)	○	○	
SSOP		P-SSOP008-0150	8	0.65	4.5 (150)	3.0 x 3.0 x (1.1)	—	○	
		P-SSOP012-0225	12	0.75	5.7 (225)	4.4 x 5.0 x (1.8)	○	—	
		P-SSOP024-0275	24	0.65	7.0 (275)	6.0 x 7.8 x (1.27)	—	○	
		P-SSOP040-0300	40		7.6 (300)	6.3 x 13.5 x (1.8)	—	○	
		P-SSOP070-0500	70	0.8	12.7 (500)	12.7 x 28.6 x (3.05)	—	○	
MFP		(Plastic)	P-MFP018	18	0.8	—	6.0 x 7.5 x (1.8)	○	—
		P-MFP020	20	0.75			○	—	
TSOP		P-TSOP040-1020	40	0.5	10 x 20	10.0 x 18.4 x (1.2)	○	○	
		P-TSOP048-1220	48		12 x 20	12.0 x 18.4 x (1.2)	○	○	
		P-TSOP056-1420	56		14 x 20	14.0 x 18.4 x (1.2)	○	○	
QFP		P-QFP048-0707	48	0.5	7 x 7	7.0 x 7.0 x (1.65)	○	—	
		P-QFP048-1010		0.75		10.0 x 10.0 x (1.82)	○	—	
		P-QFP064-1010	64	0.5	10 x 10	10.0 x 10.0 x (1.8)	○	—	
		P-QFP072-1010	72				○	—	
		P-QFP128-1420	128				○	—	
		P-QFP156-1420	156	0.4	14 x 20	14.0 x 20.0 x (2.3)	○	—	
LQFP		P-LQFP080-1212	80	0.5	12 x 12	12.0 x 12.0 x (1.7)	○	—	
		P-LQFP100-1414	100		14 x 14	14.0 x 14.0 x (1.7)	○	—	
		P-LQFP144-2020	144		20 x 20	20.0 x 20.0 x (1.7)	—	○	
		P-LQFP176-2424	176		24 x 24	24.0 x 24.0 x (1.7)	—	○	
		★P-LQFP256-2828	256	0.4	28 x 28	28.0 x 28.0 x (1.7)	—	○	
TQFP		(Plastic)	P-TQFP048-0707	48	0.5	7 x 7	7.0 x 7.0 x (1.2)	○	—
		P-TQFP100-1414	100	14 x 14		14.0 x 14.0 x (1.2)	○	—	
		P-TQFP128-1414	128		0.4		○	—	
VQFN		P-VQFN020-0404	20	0.5	4 x 4	4.2 x 4.2 x (1.0)	—	○	
		P-VQFN028-0505	28		5 x 5	5.2 x 5.2 x (1.0)	—	○	
		P-VQFN032-0505	32				—	○	
		P-VQFN036-0606	36		6 x 6	6.2 x 6.2 x (1.0)	—	○	
		P-VQFN048-0707	48	0.4	7 x 7	7.2 x 7.2 x (1.0)	—	○	
		P-VQFN036-0505	36		5 x 5	5.2 x 5.2 x (1.0)	—	○	
		P-VQFN052-0707	52		7 x 7	7.2 x 7.2 x (1.0)	—	○	
		P-VQFN064-0808	64		8 x 8	8.2 x 8.2 x (1.0)	—	○	
HQFN*		(Plastic)	P-HQFN016-0303	16	0.5	3 x 3	3.0 x 3.0 x (0.85)	—	○
		P-HQFN016-0404	0.65		4 x 4	4.0 x 4.0 x (1.0)	—	○	
		P-HQFN020-0404			20	3 x 5	3.0 x 5.0 x (0.85)	—	○
		★P-HQFN024-0305	24	0.5			4.0 x 4.0 x (0.85)	—	○
		P-HQFN024-0404		4 x 4	4.2 x 4.2 x (1.0)	—	○		
		P-HQFN028-0505		28	0.4	5 x 5	5.0 x 5.0 x (1.0)	—	○
		P-HQFN052-0707	52	7 x 7		7.2 x 7.2 x (1.0)	—	○	

* HQFN is a higher heat dissipation package of VQFN.

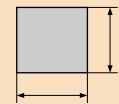
100 mil = 2.54 mm

■ For CCDs

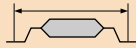
Package type	Appearance (Package material)	Package code	No. of terminals	Terminal pitch mm	Nominal dimensions mm (mil)	Package width & length x (seated height) mm
DIP	 (Plastic)	P-DIP014-0400A	14	1.27	10.16 (400)	10.0 x 10.0
		P-DIP016-0500C	16	1.78	12.7 (500)	12.4 x 14.0
		P-DIP020-0400	20	1.00	10.16 (400)	10.0 x 10.0
	 (Ceramic)	N-DIP016-0450	16	1.27	11.43 (450)	11.4 x 12.2
		N-DIP016-0500C		1.78	12.7 (500)	12.4 x 14.0
SOP	 (Plastic)	P-SOP028-0400	28	0.69	10.16 (400)	10.0 x 10.0 x (3.5)
		P-SOP032-0525	32	0.78	13.3 (525)	12.0 x 13.8 x (3.9)
LCC	 (Ceramic)	N-LCC028-S450B	28	0.80	11.5	11.5 x 11.5 x (1.62)
		N-LCC032-R543	32	0.80	13.8	12.9 x 13.8 x (1.35)

100 mil = 2.54 mm

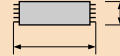
Nominal dimensions



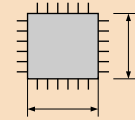
FBGA (CSP)
FLGA (LGA)



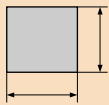
SOP
SSOP
MFP



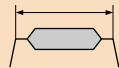
TSOP



QFP
LQFP
TQFP



VQFN
HQFN



DIP

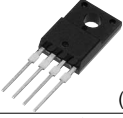
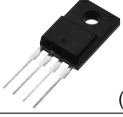
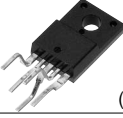


LCC

FBGA : fine-pitch ball grid array package
 FLGA : fine-pitch land grid array package
 SOP : small outline package
 SSOP : shrink small outline package
 MFP : mini flat package
 TSOP : thin small outline package
 QFP : quad flat package

LQFP : low profile quad flat package
 TQFP : thin quad flat package
 VQFN : very thin quad flat non-leaded package
 HQFN : heat sink quad flat non-leaded package
 DIP : dual inline package
 LCC : leadless chip carrier

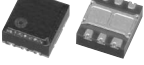
■ Lead-inserting Type Packages [For regulators : PQ series]

Package type	Appearance (Package material)	No. of terminals	Terminal pitch mm	Outline dimensions (Width x Thickness x Height) mm	Lead frame material
TO-3P	 (Plastic)	5	2.54	17 (MAX.) x 4.5 x 39 ^{*2}	Cu
TO-220 (Heat sink exposure) [Lead forming type]	 (Plastic)	5	(1.7) ^{*1}	10.2 (MAX.) x 3.5 x 25.2 ^{*2}	Cu
TO-220 A	 (Plastic)	4	2.54	10.2 (MAX.) x 4.5 x 29.1 ^{*2}	Cu
TO-220 B (Full mold)	 (Plastic)	4	2.54	10.2 (MAX.) x 4.5 x 29.1 ^{*2}	Cu
TO-220 C (Full mold) [Lead forming type]	 (Plastic)	5	(1.7) ^{*1}	10.2 (MAX.) x 4.5 x 24.6 ^{*2}	Cu
TO-220 D [Lead forming type]	 (Plastic)	5	(1.7) ^{*1}	10.2 (MAX.) x 4.5 x 24.6 ^{*2}	Cu
TO-220 E [Lead forming type]	 (Plastic)	5	(1.7) ^{*1}	10.2 (MAX.) x 4.5 x 24.6 ^{*2}	Cu
TO-92	 (Plastic)	3	2.5	5.2 (MAX.) x 4.2 (MAX.) x 18.2 (MAX.) ^{*2}	Cu

*1 The figure in parentheses indicates reference value.

*2 Including lead length

■ Surface-mount Type Packages [For regulators/LED drivers : PQ series]

Package type	Appearance (Package material)	No. of terminals	Terminal pitch mm	Outline dimensions (Width x Height x Thickness) mm	Lead frame material
TO-263	 (Plastic)	5 (Heat sink not included)	(1.7)* ¹	10.6 (MAX.) x 13.7 (MAX.)* ² x 3.5	Cu
SC-63	 (Plastic)	5 (Heat sink not included)	(1.27)* ¹	6.6 (MAX.) x 9.7 (MAX.)* ² x 2.3	Cu
SC-63	 (Plastic)	5 (Heat sink included)	(1.27)* ¹	6.6(MAX.) x 9.7 (MAX.)* ² x 2.1	Cu
SOP-8	 (Plastic)	8	1.27	5 x 6.2* ² x 1.55* ²	Cu
SOT-89	 (Plastic)	6	1.5	4.5 x 4.3* ² x 1.5	Cu
SOT-23-6	 (Plastic)	6	0.95	2.9 x 2.8* ² x 1.3	Cu
SOT-23-6W	 (Plastic)	6	0.95	2.9 x 2.8* ² x 1.3	Cu
SOT-23-L	 (Plastic)	6	(0.95)* ¹	(3.4)* ¹ x 3.3* ² x 1.4 (MAX.)	Cu
SOT-23-5	 (Plastic)	5	(0.95)* ¹	(2.9)* ¹ x 2.8* ² x 1.3 (MAX.)	Cu
USB-6		6	0.5	2.0 x 1.8 x 0.8	Cu (Terminal material)/ Au plating (Terminal finish)
USB-10		10	0.5	2.8 x 2.0 x 0.8	—
LNC-8		8	0.65	2.85 x 2.45 x 0.75	Cu (Terminal material)/ Au plating (Terminal finish)

*1 The figure in parentheses indicates reference value.

*2 Including lead length

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