

2SK2596

Silicon N-Channel MOS FET UHF Power Amplifier

REJ03G0207-0400

Rev.4.00

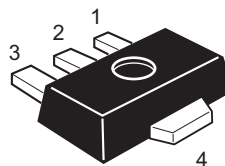
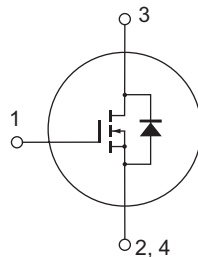
Nov 08, 2007

Features

- High power output, High gain, High efficiency
PG = 12.2 dB, Pout = 1.05 W, $\eta_D = 45\%$ min. (f = 836.5 MHz)
- Compact package capable of surface mounting

Outline

RENESAS package code: PLZZ0004CA-A
(Package name: UPAK®)



1. Gate
2. Source
3. Drain
4. Source

Note: Marking is "BX".

*UPAK is a trademark of Renesas Technology Corp.

Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Ratings	Unit
Drain to source voltage	V_{DS}	17	V
Gate to source voltage	V_{GS}	± 10	V
Drain current	I_D	0.4	A
Drain peak current	$I_{D(pulse)}$ ^{Note1}	1	A
Channel dissipation	P_{ch} ^{Note2}	3	W
Channel temperature	T_{ch}	150	°C
Storage temperature	T_{stg}	-45 to +150	°C

Notes: 1. $PW \leq 10 \mu s$, duty cycle $\leq 1\%$

2. Value at $T_c = 25^\circ C$

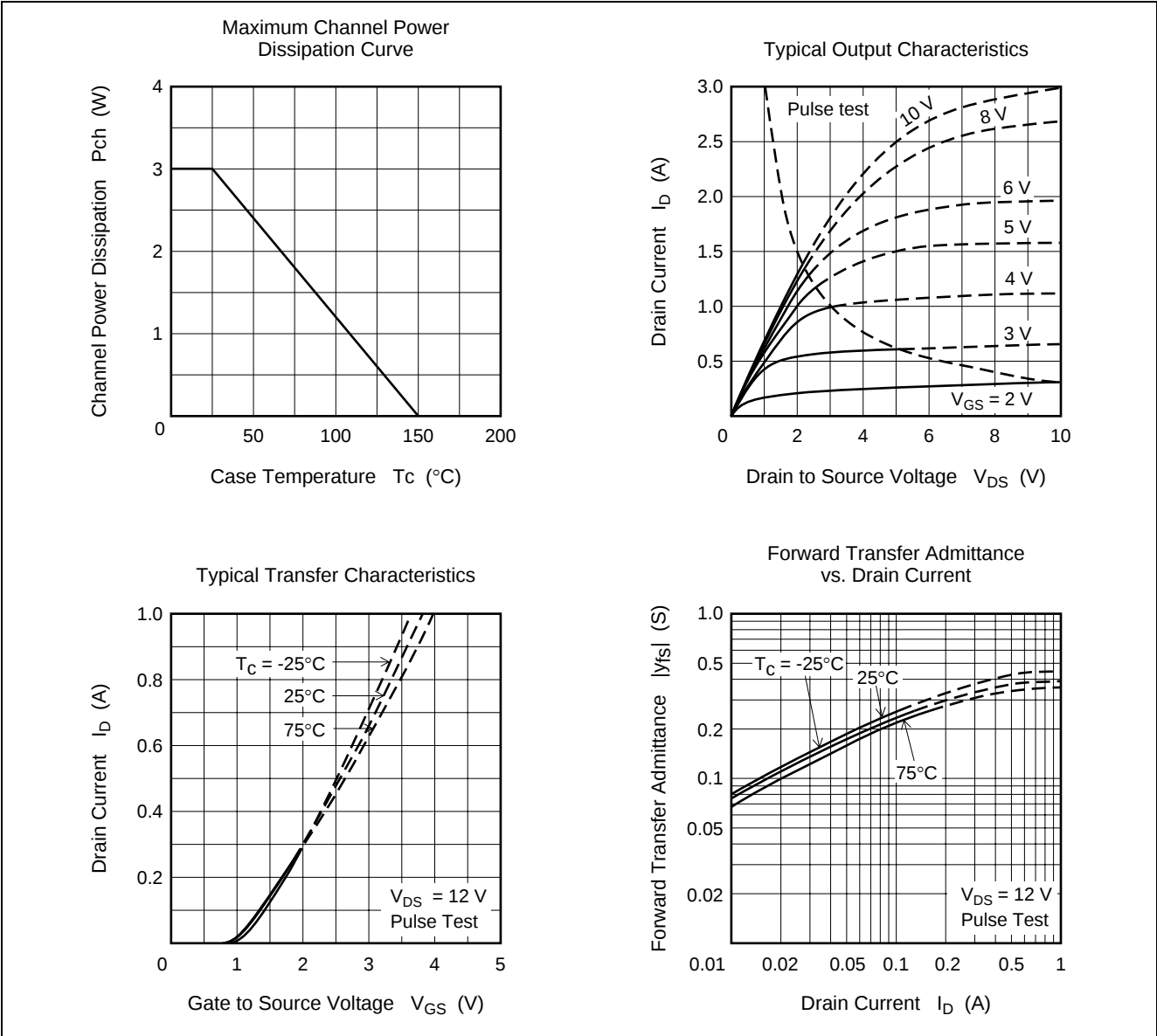
This device is sensitive to electro static discharge. An adequate careful handling procedure is requested.

Electrical Characteristics

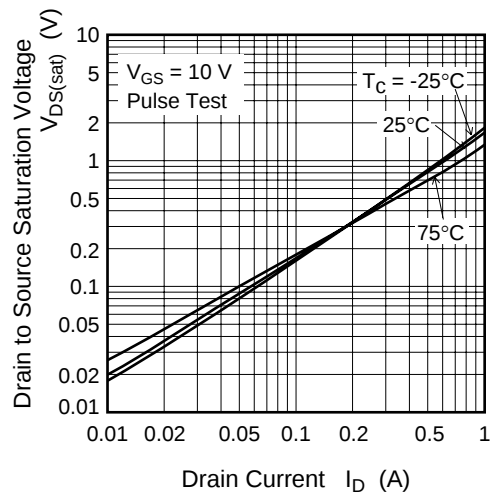
(Ta = 25°C)

Item	Symbol	Min.	Typ	Max.	Unit	Test Conditions
Zero gate voltage drain current	I_{DSS}	—	—	10	μA	$V_{DS} = 12 V, V_{GS} = 0$
Gate to source leak current	I_{GSS}	—	—	± 5.0	μA	$V_{GS} = \pm 10 V, V_{DS} = 0$
Gate to source cutoff voltage	$V_{GS(off)}$	0.4	—	1.1	V	$V_{DS} = 12 V, I_D = 2 mA$
Input capacitance	C_{iss}	—	22	—	pF	$V_{GS} = 5 V, V_{DS} = 0, f = 1 MHz$
Output capacitance	C_{oss}	—	10.5	—	pF	$V_{DS} = 12 V, V_{GS} = 0, f = 1 MHz$
Output Power	P_{out}	30.2	31.5	—	dBm	$V_{DS} = 12 V, I_{DQ} = 50 mA$
		1.05	1.4	—	W	$f = 836.5 MHz, P_{in} = 63 mW$
Drain Efficiency	η_D	45	55	—	%	

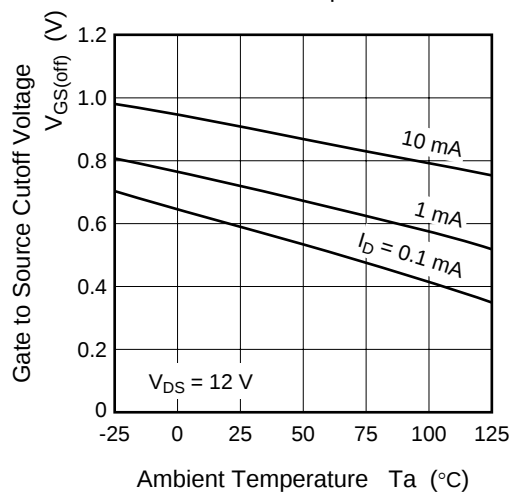
Main Characteristics



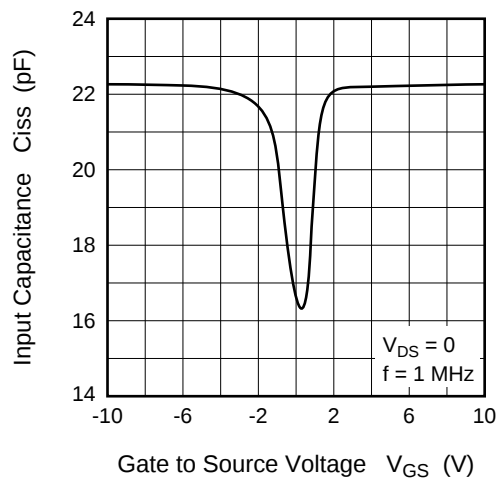
Drain to Source Saturation Voltage
vs. Drain Current



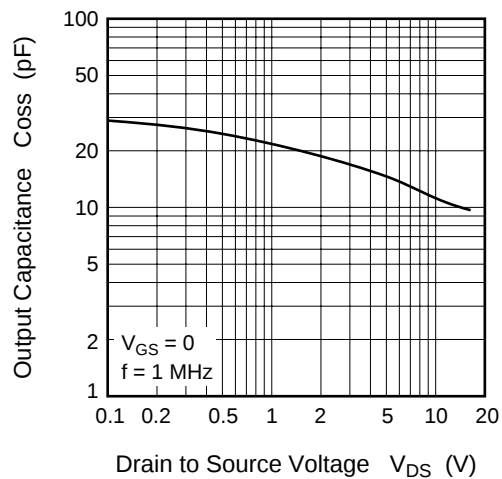
Gate to Source Cutoff Voltage vs.
Ambient Temperature



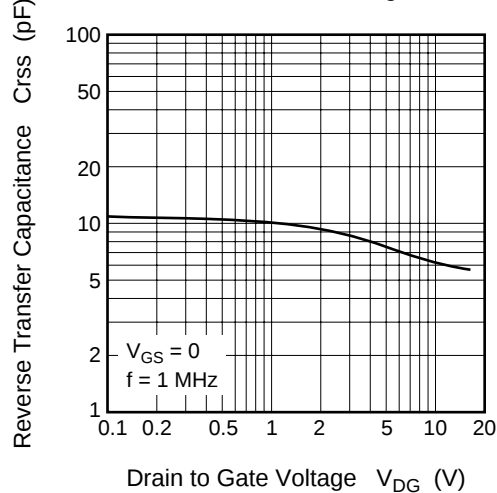
Input Capacitance vs.
Gate to Source Voltage



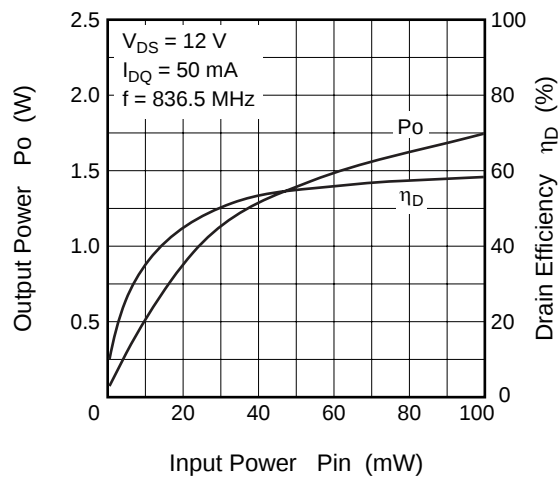
Output Capacitance vs.
Drain to Source Voltage

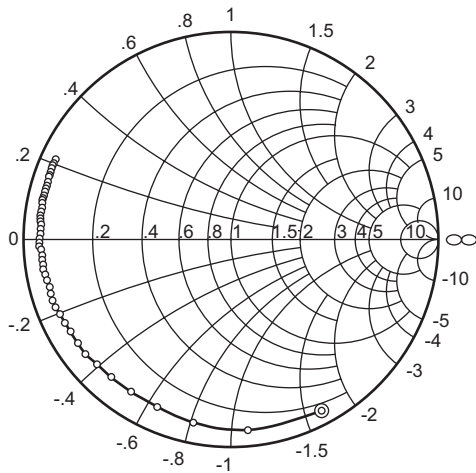


Reverse Transfer Capacitance vs.
Drain to Gate Voltage

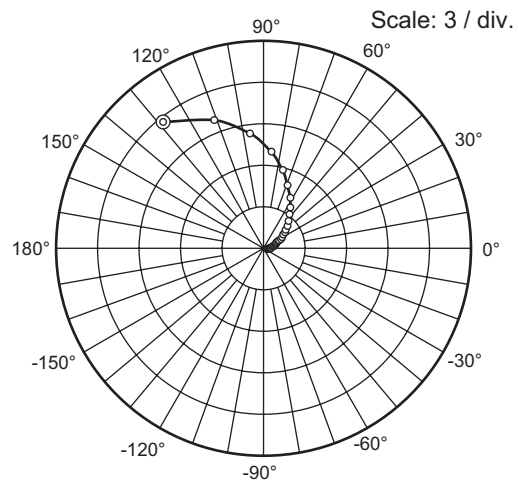


Output Power, Drain Efficiency
vs. Input Power

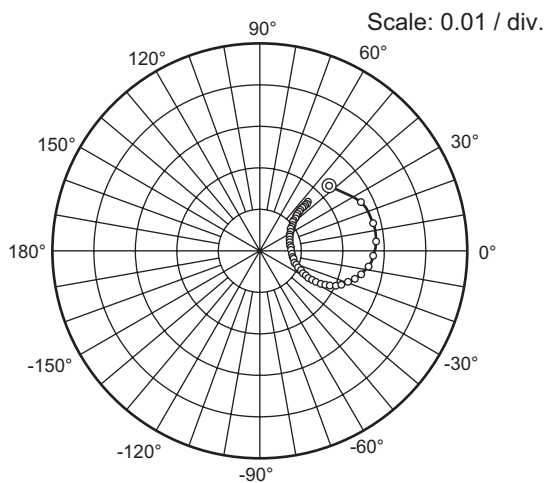


S₁₁ Parameter vs. Frequency

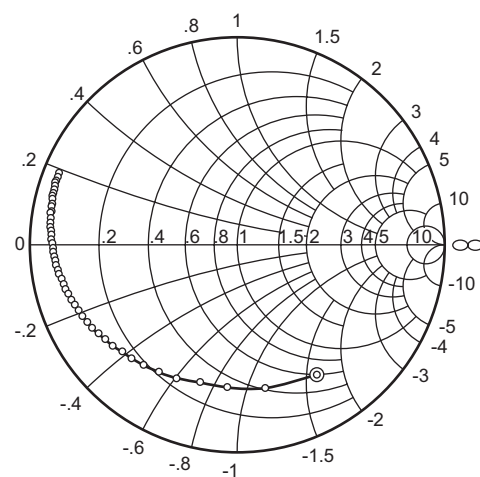
Test condition: $V_{DS} = 12\text{ V}$, $I_{DQ} = 50\text{ mA}$, $Z_O = 50\ \Omega$
100 to 2500 MHz (50 MHz step)

S₂₁ Parameter vs. Frequency

Test condition: $V_{DS} = 12\text{ V}$, $I_{DQ} = 50\text{ mA}$, $Z_O = 50\ \Omega$
100 to 2500 MHz (50 MHz step)

S₁₂ Parameter vs. Frequency

Test condition: $V_{DS} = 12\text{ V}$, $I_{DQ} = 50\text{ mA}$, $Z_O = 50\ \Omega$
100 to 2500 MHz (50 MHz step)

S₂₂ Parameter vs. Frequency

Test condition: $V_{DS} = 12\text{ V}$, $I_{DQ} = 50\text{ mA}$, $Z_O = 50\ \Omega$
100 to 2500 MHz (50 MHz step)

S Parameter

(V_{DS} = 3.8 V, I_{DQ} = 50 mA, Z_O = 50 Ω)

f (MHz)	S11		S21		S12		S22	
	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)
100	0.875	-71.1	7.24	121.4	0.0440	28.8	0.646	-97.9
150	0.825	-95.7	6.41	100.9	0.0474	12.2	0.662	-118.6
200	0.807	-110.8	5.28	86.8	0.0471	1.8	0.677	-130.6
250	0.806	-121.1	4.27	76.7	0.0454	-6.9	0.711	-139.0
300	0.811	-129.1	3.46	68.9	0.0440	-12.7	0.731	-145.0
350	0.824	-135.7	2.85	62.4	0.0416	-17.6	0.746	-149.9
400	0.840	-141.1	2.39	56.8	0.0393	-21.4	0.764	-153.5
450	0.853	-145.4	2.03	52.1	0.0374	-24.9	0.774	-156.9
500	0.860	-149.1	1.75	48.1	0.0352	-27.0	0.788	-159.6
550	0.868	-152.6	1.52	44.6	0.0334	-29.7	0.800	-162.1
600	0.874	-155.8	1.34	41.4	0.0316	-31.1	0.808	-164.1
650	0.883	-158.6	1.19	38.5	0.0301	-32.5	0.817	-166.0
700	0.890	-160.9	1.06	35.9	0.0289	-33.7	0.818	-167.9
750	0.895	-163.1	0.96	33.4	0.0273	-34.7	0.827	-169.6
800	0.895	-165.1	0.87	31.0	0.0259	-35.2	0.834	-171.3
850	0.897	-167.1	0.79	28.9	0.0247	-36.1	0.835	-172.7
900	0.900	-169.1	0.72	26.9	0.0233	-36.8	0.839	-174.1
950	0.904	-170.8	0.67	25.1	0.0224	-36.7	0.843	-175.5
1000	0.908	-172.3	0.62	23.2	0.0214	-37.0	0.849	-176.8
1050	0.908	-173.8	0.57	21.3	0.0204	-36.6	0.853	-178.0
1100	0.909	-175.3	0.53	19.4	0.0197	-37.0	0.858	-179.3
1150	0.910	-176.8	0.50	17.6	0.0187	-36.6	0.858	-179.5
1200	0.911	-178.1	0.47	16.1	0.0179	-35.9	0.864	-178.3
1250	0.915	-179.3	0.44	14.6	0.0172	-34.9	0.866	-177.2
1300	0.918	-179.6	0.41	13.0	0.0165	-34.9	0.870	-176.2
1350	0.918	-178.4	0.39	11.4	0.0157	-33.1	0.873	-175.1
1400	0.915	-177.1	0.37	9.8	0.0150	-32.4	0.871	-174.0
1450	0.916	-175.9	0.35	8.4	0.0144	-30.6	0.874	-173.1
1500	0.918	-174.7	0.33	6.9	0.0139	-29.2	0.876	-172.0
1550	0.919	-173.6	0.32	5.6	0.0131	-27.5	0.878	-170.7
1600	0.921	-172.8	0.30	4.2	0.0128	-25.5	0.883	-169.8
1650	0.923	-171.8	0.29	3.0	0.0122	-23.1	0.882	-169.0
1700	0.923	-170.8	0.27	1.6	0.0120	-22.0	0.885	-167.9
1750	0.923	-169.6	0.26	0.1	0.0119	-18.9	0.887	-166.9
1800	0.925	-168.5	0.25	-1.2	0.0116	-16.6	0.892	-165.8
1850	0.926	-167.6	0.24	-2.6	0.0114	-13.7	0.893	-164.7
1900	0.925	-166.9	0.23	-3.8	0.0111	-10.7	0.893	-163.5
1950	0.923	-165.9	0.22	-5.3	0.0111	-7.1	0.896	-163.3
2000	0.923	-164.9	0.21	-6.4	0.0109	-6.1	0.898	-161.9
2050	0.923	-163.9	0.20	-7.5	0.0110	-3.0	0.898	-161.0
2100	0.923	-162.9	0.20	-8.6	0.0111	0.8	0.899	-160.1
2150	0.924	-161.9	0.19	-9.9	0.0111	3.0	0.903	-159.1
2200	0.927	-160.8	0.18	-11.0	0.0115	5.6	0.901	-158.6
2250	0.927	-159.9	0.18	-12.2	0.0114	7.9	0.905	-157.5
2300	0.927	-158.9	0.17	-13.1	0.0116	9.9	0.905	-156.5
2350	0.929	-157.9	0.16	-14.4	0.0120	12.4	0.908	-155.6
2400	0.930	-157.0	0.16	-15.4	0.0123	13.2	0.909	-155.1
2450	0.931	-156.2	0.15	-16.4	0.0124	15.0	0.905	-154.1
2500	0.930	-155.2	0.15	-17.4	0.0130	16.2	0.903	-153.2

S Parameter

(V_{DS} = 6.0 V, I_{DQ} = 50 mA, Z_O = 50 Ω)

f (MHz)	S11		S21		S12		S22	
	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)
100	0.883	-68.6	9.10	123.1	0.0371	33.6	0.675	-83.2
150	0.851	-92.2	7.85	104.4	0.0411	15.6	0.668	-105.0
200	0.836	-108.2	6.46	89.9	0.0410	4.6	0.672	-118.6
250	0.828	-119.0	5.26	79.3	0.0405	-3.2	0.699	-128.4
300	0.829	-127.4	4.28	71.1	0.0388	-10.1	0.715	-135.6
350	0.839	-134.4	3.54	64.2	0.0369	-15.2	0.732	-141.2
400	0.852	-139.9	2.97	58.4	0.0352	-19.6	0.751	-145.8
450	0.863	-144.3	2.53	53.4	0.0332	-22.8	0.763	-149.4
500	0.869	-148.1	2.18	49.3	0.0315	-25.2	0.778	-152.7
550	0.875	-151.8	1.90	45.5	0.0299	-27.6	0.787	-155.6
600	0.880	-155.0	1.68	42.2	0.0283	-29.4	0.796	-158.2
650	0.887	-157.8	1.48	39.1	0.0269	-31.1	0.805	-160.5
700	0.894	-160.2	1.33	36.3	0.0255	-32.4	0.811	-162.6
750	0.897	-162.4	1.19	33.6	0.0245	-33.3	0.822	-164.4
800	0.898	-164.4	1.08	31.1	0.0230	-34.5	0.827	-166.4
850	0.900	-166.6	0.99	28.8	0.0218	-34.7	0.828	-167.9
900	0.902	-168.5	0.90	26.8	0.0208	-35.2	0.834	-169.8
950	0.906	-170.3	0.83	24.8	0.0195	-35.6	0.839	-171.3
1000	0.910	-171.8	0.77	22.7	0.0188	-35.8	0.846	-172.9
1050	0.910	-173.3	0.71	20.7	0.0178	-35.5	0.849	-174.3
1100	0.912	-174.8	0.66	18.8	0.0169	-34.7	0.854	-175.8
1150	0.911	-176.3	0.62	16.9	0.0160	-34.6	0.855	-176.9
1200	0.914	-177.6	0.58	15.2	0.0153	-33.8	0.861	-178.2
1250	0.918	-178.8	0.54	13.7	0.0144	-32.6	0.864	-179.4
1300	0.920	-179.9	0.51	12.1	0.0139	-31.3	0.868	-179.3
1350	0.920	-178.9	0.48	10.4	0.0133	-28.6	0.871	-178.3
1400	0.917	-177.5	0.45	8.8	0.0125	-28.2	0.873	-177.0
1450	0.918	-176.2	0.43	7.2	0.0121	-26.1	0.877	-176.0
1500	0.919	-175.0	0.41	5.6	0.0116	-23.4	0.877	-174.7
1550	0.921	-174.0	0.39	4.4	0.0110	-21.4	0.879	-173.5
1600	0.923	-173.1	0.37	2.9	0.0106	-17.6	0.883	-172.5
1650	0.925	-172.2	0.35	1.5	0.0103	-15.3	0.886	-171.5
1700	0.925	-171.1	0.33	0.1	0.0103	-12.9	0.889	-170.5
1750	0.925	-169.9	0.32	-1.5	0.0098	-8.7	0.894	-169.5
1800	0.927	-168.9	0.31	-2.8	0.0100	-5.4	0.897	-168.4
1850	0.928	-167.9	0.29	-4.2	0.0100	-1.3	0.901	-167.1
1900	0.926	-167.3	0.28	-5.5	0.0099	0.5	0.896	-165.9
1950	0.925	-166.2	0.26	-7.0	0.0100	5.7	0.897	-165.5
2000	0.924	-165.2	0.25	-8.2	0.0101	8.1	0.903	-164.1
2050	0.925	-164.2	0.24	-9.3	0.0102	10.3	0.900	-163.1
2100	0.925	-163.2	0.24	-10.5	0.0103	12.8	0.904	-162.0
2150	0.926	-162.1	0.23	-11.8	0.0106	15.5	0.906	-161.2
2200	0.929	-161.1	0.22	-13.0	0.0110	17.7	0.908	-160.4
2250	0.929	-160.2	0.21	-14.1	0.0114	20.0	0.904	-159.5
2300	0.929	-159.2	0.20	-15.2	0.0118	22.1	0.909	-158.2
2350	0.931	-158.2	0.20	-16.4	0.0123	24.2	0.915	-157.6
2400	0.934	-157.3	0.19	-17.5	0.0126	25.3	0.910	-156.8
2450	0.933	-156.5	0.18	-18.6	0.0128	26.1	0.909	-155.8
2500	0.932	-155.5	0.18	-19.7	0.0134	26.9	0.910	-154.8

S Parameter

(V_{DS} = 7.2 V, I_{DQ} = 50 mA, Z_O = 50 Ω)

f (MHz)	S11		S21		S12		S22	
	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)
100	0.895	-67.4	9.82	124.2	0.0332	37.0	0.689	-76.7
150	0.866	-90.5	8.41	106.1	0.0382	18.0	0.676	-98.7
200	0.850	-106.8	6.97	91.5	0.0385	6.6	0.673	-112.6
250	0.842	-117.9	5.71	80.7	0.0382	-1.9	0.697	-123.1
300	0.840	-126.6	4.66	72.3	0.0362	-8.4	0.715	-130.8
350	0.847	-133.6	3.87	65.3	0.0348	-13.8	0.728	-136.8
400	0.858	-139.3	3.25	59.2	0.0328	-17.8	0.746	-141.6
450	0.869	-143.8	2.77	54.2	0.0313	-21.7	0.760	-145.7
500	0.874	-147.7	2.40	49.8	0.0298	-24.2	0.772	-149.4
550	0.879	-151.3	2.09	46.0	0.0282	-26.4	0.782	-152.4
600	0.884	-154.6	1.84	42.6	0.0267	-28.9	0.793	-155.1
650	0.891	-157.5	1.63	39.4	0.0253	-30.6	0.802	-157.7
700	0.896	-159.9	1.46	36.5	0.0241	-31.3	0.810	-159.6
750	0.899	-162.1	1.31	33.7	0.0225	-32.9	0.816	-162.1
800	0.900	-164.1	1.19	31.1	0.0215	-33.2	0.822	-163.9
850	0.901	-166.3	1.08	28.8	0.0205	-34.3	0.827	-165.5
900	0.904	-168.3	0.99	26.6	0.0191	-34.5	0.834	-167.5
950	0.908	-170.0	0.91	24.5	0.0183	-34.5	0.839	-169.1
1000	0.912	-171.6	0.84	22.5	0.0173	-34.5	0.844	-170.6
1050	0.912	-173.0	0.78	20.4	0.0165	-34.1	0.851	-172.3
1100	0.913	-174.6	0.72	18.3	0.0155	-33.9	0.854	-173.8
1150	0.913	-176.0	0.68	16.5	0.0146	-33.2	0.857	-175.2
1200	0.915	-177.4	0.63	14.7	0.0139	-32.0	0.862	-176.4
1250	0.919	-178.6	0.59	13.1	0.0132	-30.1	0.866	-177.8
1300	0.921	-179.7	0.56	11.5	0.0126	-28.9	0.869	-178.9
1350	0.921	179.1	0.53	9.7	0.0119	-25.8	0.873	179.8
1400	0.918	177.7	0.49	8.1	0.0113	-23.4	0.876	178.5
1450	0.919	176.4	0.47	6.4	0.0108	-22.4	0.880	177.5
1500	0.920	175.3	0.44	4.9	0.0102	-19.1	0.878	176.3
1550	0.922	174.1	0.42	3.5	0.0101	-15.1	0.881	175.0
1600	0.923	173.3	0.40	2.0	0.0097	-12.4	0.885	173.8
1650	0.926	172.3	0.38	0.7	0.0093	-8.8	0.886	172.9
1700	0.927	171.3	0.36	-0.8	0.0093	-5.0	0.890	171.7
1750	0.926	170.1	0.35	-2.3	0.0094	-1.7	0.894	170.7
1800	0.928	169.1	0.33	-3.8	0.0091	1.6	0.897	169.3
1850	0.929	168.1	0.32	-5.2	0.0093	6.0	0.898	168.3
1900	0.928	167.4	0.30	-6.5	0.0095	8.8	0.900	166.9
1950	0.925	166.3	0.29	-8.1	0.0099	14.4	0.899	166.6
2000	0.926	165.3	0.27	-9.2	0.0100	15.8	0.904	165.1
2050	0.926	164.3	0.26	-10.4	0.0102	18.8	0.904	164.2
2100	0.926	163.3	0.25	-11.6	0.0104	20.4	0.907	162.9
2150	0.928	162.2	0.24	-12.9	0.0108	23.0	0.908	162.1
2200	0.929	161.2	0.24	-14.1	0.0114	25.2	0.912	161.6
2250	0.930	160.3	0.23	-15.3	0.0114	26.2	0.909	160.4
2300	0.930	159.3	0.22	-16.4	0.0121	27.4	0.913	159.2
2350	0.933	158.2	0.21	-17.6	0.0124	28.9	0.917	158.4
2400	0.935	157.4	0.20	-18.8	0.0131	29.6	0.911	157.6
2450	0.934	156.6	0.20	-19.7	0.0133	31.0	0.912	156.9
2500	0.934	155.6	0.19	-20.9	0.0134	31.5	0.912	155.8

S Parameter

(V_{DS} = 12 V, I_{DQ} = 50 mA, Z_O = 50 Ω)

f (MHz)	S11		S21		S12		S22	
	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)	MAG	ANG(deg.)
100	0.932	-62.1	11.71	128.4	0.0228	42.3	0.735	-59.0
150	0.921	-85.1	9.96	111.2	0.0270	25.0	0.709	-79.5
200	0.898	-101.9	8.40	96.8	0.0281	13.2	0.691	-94.0
250	0.882	-114.0	7.04	85.0	0.0282	4.1	0.694	-105.3
300	0.877	-123.5	5.80	76.1	0.0275	-3.0	0.714	-114.4
350	0.879	-131.1	4.86	68.7	0.0265	-8.9	0.723	-121.6
400	0.884	-137.2	4.11	62.1	0.0252	-13.4	0.738	-127.7
450	0.892	-141.9	3.53	56.6	0.0239	-17.1	0.753	-132.7
500	0.893	-146.0	3.06	52.0	0.0228	-20.2	0.765	-137.0
550	0.893	-150.2	2.68	47.7	0.0215	-23.0	0.776	-140.9
600	0.895	-153.4	2.37	43.7	0.0203	-25.1	0.788	-144.3
650	0.900	-156.4	2.10	40.3	0.0191	-27.0	0.799	-147.3
700	0.907	-158.8	1.88	37.0	0.0179	-27.9	0.808	-150.1
750	0.909	-161.1	1.70	33.9	0.0168	-29.4	0.816	-152.7
800	0.909	-163.2	1.53	30.9	0.0157	-30.1	0.825	-155.1
850	0.906	-165.4	1.40	28.3	0.0147	-30.2	0.831	-157.3
900	0.909	-167.5	1.28	25.8	0.0136	-30.2	0.837	-159.5
950	0.912	-169.4	1.18	23.3	0.0127	-29.4	0.845	-161.5
1000	0.917	-170.9	1.08	21.1	0.0119	-28.5	0.851	-163.5
1050	0.915	-172.3	1.00	18.9	0.0111	-26.8	0.857	-165.3
1100	0.916	-173.9	0.93	16.5	0.0103	-25.1	0.862	-167.1
1150	0.916	-175.3	0.87	14.3	0.0096	-22.8	0.866	-168.8
1200	0.917	-177.0	0.81	12.4	0.0090	-19.8	0.871	-170.4
1250	0.923	-178.0	0.75	10.8	0.0085	-15.8	0.876	-171.9
1300	0.925	-179.3	0.71	8.8	0.0080	-11.9	0.880	-173.4
1350	0.923	179.7	0.67	7.0	0.0078	-7.0	0.883	-174.8
1400	0.921	178.2	0.62	5.2	0.0074	-1.8	0.886	-176.2
1450	0.920	176.8	0.59	3.4	0.0074	3.6	0.889	-177.6
1500	0.920	175.5	0.56	1.9	0.0074	8.5	0.890	-178.9
1550	0.923	174.5	0.52	0.2	0.0075	13.5	0.893	179.7
1600	0.927	173.7	0.50	-1.4	0.0076	18.0	0.897	178.4
1650	0.928	172.7	0.47	-2.8	0.0079	23.3	0.899	177.2
1700	0.926	171.5	0.45	-4.5	0.0082	26.4	0.902	175.9
1750	0.926	170.3	0.43	-5.9	0.0086	29.8	0.905	174.7
1800	0.927	169.1	0.41	-7.5	0.0090	33.1	0.910	173.5
1850	0.929	168.2	0.39	-9.0	0.0095	35.5	0.912	172.2
1900	0.927	167.5	0.38	-10.4	0.0100	37.1	0.913	170.8
1950	0.927	166.6	0.36	-12.0	0.0105	40.0	0.911	170.2
2000	0.928	165.4	0.34	-13.4	0.0109	41.0	0.917	168.6
2050	0.927	164.5	0.33	-14.6	0.0115	41.8	0.916	167.6
2100	0.924	163.5	0.32	-15.9	0.0121	42.8	0.918	166.4
2150	0.925	162.4	0.30	-17.2	0.0126	43.1	0.921	165.3
2200	0.930	161.1	0.29	-18.3	0.0132	44.0	0.922	164.6
2250	0.928	160.4	0.28	-19.8	0.0137	44.4	0.921	163.4
2300	0.929	159.3	0.26	-20.9	0.0142	44.7	0.924	162.3
2350	0.931	158.3	0.26	-22.1	0.0148	44.5	0.927	161.4
2400	0.932	157.3	0.25	-23.4	0.0153	44.4	0.926	160.6
2450	0.931	156.6	0.24	-24.5	0.0158	44.6	0.924	159.4
2500	0.930	155.6	0.23	-25.7	0.0163	44.4	0.925	158.4

Package Dimensions

JEITA Package Code	RENESAS Code	Package Name	MASS[Typ.]	Unit: mm
SC-62	PLZZ0004CA-A	UPAK / UPAKV	0.050g	

The drawing shows three views of the package: a top view, a side view, and an end view. The top view shows a rectangular body with a central circular feature of diameter $\phi 1$. Dimensions include a total width of 4.5 ± 0.1 mm, a maximum width of 1.8 mm, a height of 0.4 mm, a maximum height of 2.5 ± 0.1 mm, a maximum height of 4.25 mm, a minimum height of 0.8 mm, and a maximum height of 0.53 mm. The side view shows a maximum width of 1.5 ± 0.1 mm, a maximum height of 0.44 mm, and a maximum height of 0.44 mm. The end view shows a maximum width of 1.5 mm, a maximum height of 2.5 mm, and a maximum height of 0.4 mm.

Ordering Information

Part Name	Quantity	Shipping Container
2SK2596BXTL-E	1000 pcs.	$\phi 178$ mm Reel, 12 mm Emboss taping

Note: For some grades, production may be terminated. Please contact the Renesas sales office to check the state of production before ordering the product.

Notes:

1. This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.
2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.
3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.
4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (<http://www.renesas.com>)
5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.
6. When using or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guarantees regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.
7. With the exception of products specified by Renesas as suitable for automobile applications, Renesas products are not designed, manufactured or tested for applications or otherwise in systems the failure or malfunction of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. If you are considering the use of our products for such purposes, please contact a Renesas sales office beforehand. Renesas shall have no liability for damages arising out of the uses set forth above.
8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below:
 - (1) artificial life support devices or systems
 - (2) surgical implantations
 - (3) healthcare intervention (e.g., excision, administration of medication, etc.)
 - (4) any other purposes that pose a direct threat to human lifeRenesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Technology Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.
9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.
10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.
12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.
13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.



RENESAS SALES OFFICES

<http://www.renesas.com>

Refer to "<http://www.renesas.com/en/network>" for the latest and detailed information.

Renesas Technology America, Inc.
450 Holger Way, San Jose, CA 95134-1368, U.S.A
Tel: <1> (408) 382-7500, Fax: <1> (408) 382-7501

Renesas Technology Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.
Tel: <44> (1628) 585-100, Fax: <44> (1628) 585-900

Renesas Technology (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd, Pudong District, Shanghai, China 200120
Tel: <86> (21) 5877-1818, Fax: <86> (21) 6887-7898

Renesas Technology Hong Kong Ltd.
7th Floor, North Tower, World Finance Centre, Harbour City, 1 Canton Road, Tsimshatsui, Kowloon, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2730-6071

Renesas Technology Taiwan Co., Ltd.
10th Floor, No.99, Fushing North Road, Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

Renesas Technology Singapore Pte. Ltd.
1 Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001

Renesas Technology Korea Co., Ltd.
Kukje Center Bldg. 18th Fl., 191, 2-ka, Hangang-ro, Yongsan-ku, Seoul 140-702, Korea
Tel: <82> (2) 796-3115, Fax: <82> (2) 796-2145

Renesas Technology Malaysia Sdn. Bhd
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No.18, Jalan Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: <603> 7955-9390, Fax: <603> 7955-9510