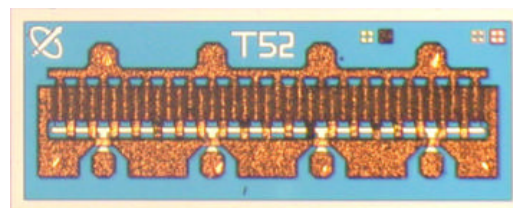


## 1W High Linearity and High Efficiency GaAs Power FETs

### FEATURES

- 1W Typical Power at 12 GHz
- Linear Power Gain:  $G_L = 9$  dB Typical at 12 GHz
- High Linearity:  $IP_3 = 40$  dBm Typical at 12 GHz
- Non-Via Hole Source for Single-Bias Application
- Suitable for High Reliability Application
- Breakdown Voltage:  $BV_{DGO} \geq 13.5$  V
- $L_g = 0.25$   $\mu$ m,  $W_g = 2.4$  mm
- High Power Added Efficiency: Nominal PAE of 43% at 12 GHz
- Tight  $V_p$  ranges control
- High RF input power handling capability
- 100 % DC Tested

### PHOTO ENLARGEMENT



### DESCRIPTION

The TC1504N is a GaAs Pseudomorphic High Electron Mobility Transistor (PHEMT) which has high linearity and high Power Added Efficiency. The device is processed without via-holes for single-bias applications. The short gate length enables the device to be used in circuits up to 20GHz. All devices are 100% DC tested to assure consistent quality. Bond pads are gold plated for either thermo-compression or thermo-sonic wire bonding. Backside gold plating is compatible with standard AuSn die-attach. Typical application include commercial and military high performance power amplifiers.

### ELECTRICAL SPECIFICATIONS ( $T_A=25$ ° C)

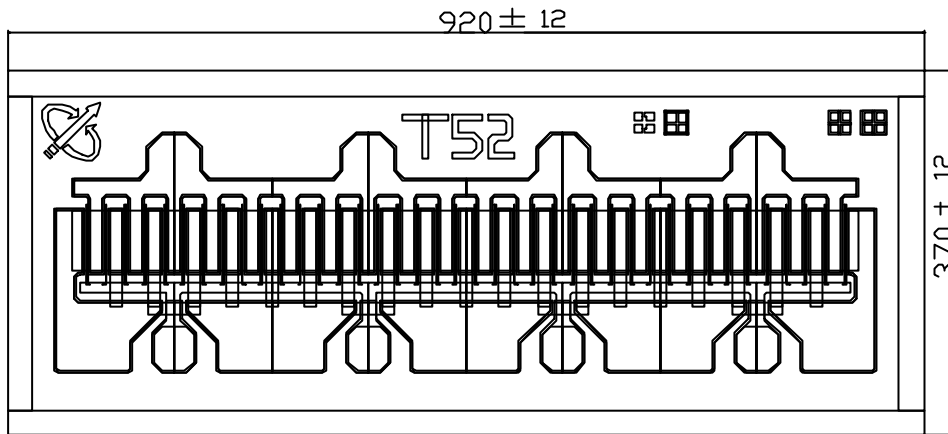
Symbol	Conditions	MIN	TYP	MAX	UNIT
$P_{1dB}$	Output Power at 1dB Gain Compression Point, $f = 12$ GHz $V_{DS} = 8$ V, $I_{DS} = 240$ mA	29.5	30		dBm
$G_L$	Linear Power Gain, $f = 12$ GHz $V_{DS} = 8$ V, $I_{DS} = 240$ mA		9		dB
$IP_3$	Intercept Point of the 3 <sup>rd</sup> -order Intermodulation, $f = 12$ GHz $V_{DS} = 8$ V, $I_{DS} = 240$ mA, * $P_{SCL} = 17$ dBm		40		dBm
PAE	Power Added Efficiency at 1dB Compression Power, $f = 12$ GHz		43		%
$I_{DSS}$	Saturated Drain-Source Current at $V_{DS} = 2$ V, $V_{GS} = 0$ V		720		mA
$g_m$	Transconductance at $V_{DS} = 2$ V, $V_{GS} = 0$ V		520		mS
$V_p$	Pinch-off Voltage at $V_{DS} = 2$ V, $I_D = 4.8$ mA		-1.7		Volts
$BV_{DGO}$	Drain-Gate Breakdown Voltage at $I_{DGO} = 1.2$ mA	13.5	15		Volts
$R_{th}$	Thermal Resistance		12		°C/W

#### Note:

\*  $P_{SCL}$ : Output Power of Single Carrier Level.

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub>=25 °C)**

Symbol	Parameter	Rating
V <sub>DS</sub>	Drain-Source Voltage	12 V
V <sub>GS</sub>	Gate-Source Voltage	-5 V
I <sub>DS</sub>	Drain Current	I <sub>DSS</sub>
P <sub>in</sub>	RF Input Power, CW	28 dBm
P <sub>T</sub>	Continuous Dissipation	3.8 W
T <sub>CH</sub>	Channel Temperature	175 °C
T <sub>STG</sub>	Storage Temperature	- 65 °C to +175 °C

**CHIP DIMENSIONS**


Units : Micrometer      Gate Pad : 45\*45  
 Chip Thickness : 76.2      Drain Pad : 55\*55

**CHIP HANDLING**

**DIE ATTACHMENT:** Conductive epoxy or eutectic die attach is recommended. Eutectic die attach can be accomplished with Au-Sn (80% Au-20% Sn) perform at stage temperature: 290°C ± 5°C; Handling Tool: Tweezers; Time: less than 1min.

**WIRE BONDING:** The recommended wire bond method is thermocompression bonding with 0.7 to 1.0 mil (0.018 to 0.025 mm) gold wire. Stage temperature: 220°C to 250°C; Bond Tip Temperature: 150°C; Bond Force: 20 to 30 gms depending on size of wire and Bond Tip Temperature.

**HANDLING PRECAUTIONS:** The user must operate in a clean, dry environment. Care should be exercised during handling avoid damage to the devices. Electrostatic Discharge (ESD) precautions should be observed at all stages of storage, handling, assembly, and testing. The static discharge must be less than 300V.

**TYPICAL SCATTERING PARAMETERS ( $T_A=25\text{ }^\circ\text{C}$ )  $V_{DS} = 8\text{ V}$ ,  $I_{DS} = 240\text{ mA}$** 

FREQUENCY (GHz)	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
0	0.99991	0	35.323	180	4.23E-07	0	0.10178	180
0.1	0.99314	-34.988	33.574	161.57	0.0090419	71.935	0.22271	-133.76
0.2	0.97875	-64.443	29.563	146.16	0.015924	56.902	0.36342	-136.56
0.3	0.96503	-86.781	25.217	134.57	0.020374	45.679	0.45786	-143.31
0.4	0.95479	-103.15	21.455	126.09	0.023113	37.57	0.51658	-149.11
0.5	0.94769	-115.21	18.431	119.81	0.024819	31.664	0.55334	-153.61
0.6	0.94281	-124.28	16.04	115.04	0.02592	27.261	0.57715	-157.05
0.7	0.93939	-131.27	14.141	111.3	0.026658	23.895	0.59318	-159.72
0.8	0.93696	-136.79	12.611	108.29	0.027173	21.257	0.6044	-161.82
0.9	0.93517	-141.24	11.363	105.81	0.027542	19.146	0.61251	-163.5
1	0.93382	-144.89	10.328	103.72	0.027815	17.425	0.61856	-164.87
1.1	0.9328	-147.93	9.4585	101.92	0.028022	15.999	0.6232	-166
1.2	0.93199	-150.51	8.7197	100.36	0.028182	14.801	0.62683	-166.94
1.3	0.93136	-152.72	8.0847	98.968	0.028307	13.784	0.62974	-167.73
1.4	0.93084	-154.63	7.5337	97.724	0.028408	12.91	0.63212	-168.41
1.5	0.93043	-156.3	7.0514	96.598	0.028489	12.154	0.63409	-168.99
1.6	0.93008	-157.77	6.626	95.567	0.028555	11.493	0.63576	-169.49
1.7	0.92979	-159.07	6.248	94.616	0.028609	10.913	0.63719	-169.92
1.8	0.92955	-160.24	5.9101	93.733	0.028654	10.4	0.63844	-170.3
1.9	0.92935	-161.29	5.6063	92.907	0.028692	9.9439	0.63954	-170.64
2	0.92917	-162.24	5.3318	92.129	0.028724	9.5367	0.64053	-170.93
2.1	0.92903	-163.1	5.0825	91.394	0.02875	9.1716	0.64142	-171.18
2.2	0.9289	-163.88	4.8552	90.695	0.028773	8.843	0.64224	-171.41
2.3	0.92879	-164.61	4.647	90.028	0.028792	8.5463	0.64299	-171.61
2.4	0.92869	-165.27	4.4558	89.389	0.028807	8.2776	0.64369	-171.79
2.5	0.92861	-165.88	4.2794	88.775	0.028821	8.0336	0.64436	-171.94
2.6	0.92853	-166.45	4.1163	88.183	0.028832	7.8116	0.64499	-172.08
2.7	0.92847	-166.97	3.9651	87.611	0.028841	7.6093	0.64559	-172.21
2.8	0.92841	-167.46	3.8244	87.056	0.028849	7.4244	0.64617	-172.31
2.9	0.92836	-167.92	3.6932	86.517	0.028855	7.2554	0.64674	-172.41
3	0.92832	-168.35	3.5706	85.992	0.02886	7.1007	0.64729	-172.5
3.1	0.92828	-168.75	3.4557	85.48	0.028863	6.9588	0.64783	-172.57
3.2	0.92825	-169.13	3.3479	84.98	0.028866	6.8287	0.64836	-172.64
3.3	0.92822	-169.49	3.2466	84.491	0.028868	6.7094	0.64888	-172.69
3.4	0.9282	-169.82	3.1511	84.012	0.028868	6.5998	0.6494	-172.74
3.5	0.92817	-170.14	3.0609	83.541	0.028868	6.4993	0.64992	-172.78
3.6	0.92816	-170.44	2.9757	83.079	0.028868	6.407	0.65043	-172.82
3.7	0.92814	-170.73	2.8951	82.625	0.028866	6.3224	0.65094	-172.85
3.8	0.92813	-171	2.8186	82.178	0.028865	6.2448	0.65146	-172.88
3.9	0.92812	-171.26	2.746	81.737	0.028862	6.1738	0.65197	-172.9
4	0.92811	-171.51	2.677	81.303	0.028859	6.1089	0.65249	-172.91
4.1	0.9281	-171.74	2.6113	80.874	0.028856	6.0496	0.65301	-172.92
4.2	0.9281	-171.97	2.5486	80.45	0.028852	5.9956	0.65353	-172.93
4.3	0.92809	-172.18	2.4889	80.032	0.028848	5.9466	0.65406	-172.94
4.4	0.92809	-172.39	2.4318	79.618	0.028843	5.9022	0.65459	-172.94
4.5	0.92809	-172.59	2.3773	79.209	0.028838	5.8622	0.65512	-172.94
4.6	0.92809	-172.78	2.325	78.803	0.028833	5.8263	0.65566	-172.93
4.7	0.92809	-172.96	2.275	78.402	0.028827	5.7942	0.65621	-172.93
4.8	0.9281	-173.14	2.227	78.004	0.028821	5.7657	0.65676	-172.92
4.9	0.9281	-173.31	2.181	77.61	0.028815	5.7407	0.65731	-172.91
5	0.92811	-173.47	2.1368	77.219	0.028808	5.719	0.65787	-172.89
5.1	0.92811	-173.63	2.0943	76.832	0.028802	5.7003	0.65843	-172.88
5.2	0.92812	-173.78	2.0534	76.447	0.028794	5.6845	0.65901	-172.86

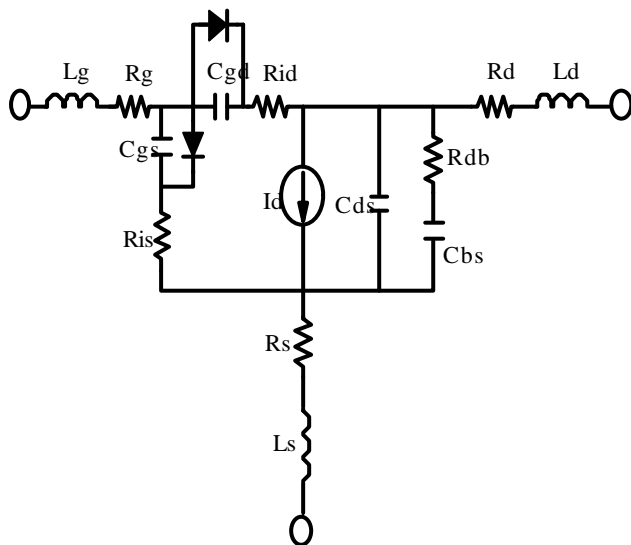
5.3	0.92813	-173.93	2.014	76.065	0.028787	5.6716	0.65958	-172.85
5.4	0.92814	-174.07	1.9761	75.686	0.02878	5.6613	0.66017	-172.83
5.5	0.92815	-174.2	1.9395	75.31	0.028772	5.6535	0.66075	-172.81
5.6	0.92816	-174.34	1.9042	74.935	0.028764	5.6482	0.66135	-172.79
5.7	0.92817	-174.47	1.8702	74.564	0.028756	5.6452	0.66195	-172.77
5.8	0.92818	-174.59	1.8373	74.194	0.028748	5.6444	0.66255	-172.74
5.9	0.92819	-174.71	1.8055	73.827	0.028739	5.6457	0.66317	-172.72
6	0.92821	-174.83	1.7747	73.462	0.02873	5.649	0.66378	-172.69
6.1	0.92822	-174.95	1.7449	73.099	0.028721	5.6543	0.66441	-172.67
6.2	0.92823	-175.06	1.7161	72.738	0.028712	5.6615	0.66504	-172.64
6.3	0.92825	-175.17	1.6882	72.379	0.028703	5.6705	0.66567	-172.62
6.4	0.92826	-175.27	1.6612	72.022	0.028694	5.6813	0.66631	-172.59
6.5	0.92828	-175.37	1.6349	71.666	0.028684	5.6938	0.66696	-172.56
6.6	0.92829	-175.47	1.6095	71.312	0.028675	5.7078	0.66761	-172.53
6.7	0.92831	-175.57	1.5848	70.96	0.028665	5.7235	0.66827	-172.51
6.8	0.92833	-175.67	1.5608	70.609	0.028655	5.7407	0.66894	-172.48
6.9	0.92835	-175.76	1.5375	70.26	0.028645	5.7594	0.66961	-172.45
7	0.92836	-175.85	1.5149	69.913	0.028635	5.7795	0.67028	-172.42
7.1	0.92838	-175.94	1.4929	69.567	0.028625	5.8011	0.67096	-172.39
7.2	0.9284	-176.02	1.4715	69.222	0.028615	5.8239	0.67165	-172.36
7.3	0.92842	-176.11	1.4506	68.879	0.028604	5.8481	0.67234	-172.33
7.4	0.92844	-176.19	1.4303	68.538	0.028594	5.8736	0.67303	-172.3
7.5	0.92846	-176.27	1.4106	68.197	0.028583	5.9004	0.67374	-172.27
7.6	0.92848	-176.35	1.3914	67.858	0.028572	5.9283	0.67444	-172.25
7.7	0.9285	-176.43	1.3726	67.52	0.028561	5.9575	0.67515	-172.22
7.8	0.92852	-176.51	1.3544	67.184	0.028551	5.9878	0.67587	-172.19
7.9	0.92854	-176.58	1.3366	66.849	0.02854	6.0192	0.67659	-172.16
8	0.92856	-176.65	1.3192	66.515	0.028529	6.0518	0.67731	-172.13
8.1	0.92858	-176.72	1.3022	66.182	0.028517	6.0855	0.67804	-172.1
8.2	0.92861	-176.79	1.2857	65.85	0.028506	6.1202	0.67878	-172.07
8.3	0.92863	-176.86	1.2695	65.52	0.028495	6.1559	0.67951	-172.04
8.4	0.92865	-176.93	1.2538	65.19	0.028484	6.1927	0.68026	-172.02
8.5	0.92867	-177	1.2384	64.862	0.028472	6.2305	0.681	-171.99
8.6	0.9287	-177.06	1.2233	64.535	0.028461	6.2693	0.68175	-171.96
8.7	0.92872	-177.13	1.2086	64.209	0.02845	6.309	0.68251	-171.93
8.8	0.92874	-177.19	1.1942	63.884	0.028438	6.3497	0.68327	-171.91
8.9	0.92877	-177.25	1.1802	63.56	0.028427	6.3913	0.68403	-171.88
9	0.92879	-177.31	1.1664	63.237	0.028415	6.4338	0.68479	-171.85
9.1	0.92881	-177.37	1.1529	62.915	0.028404	6.4772	0.68556	-171.83
9.2	0.92884	-177.43	1.1398	62.594	0.028392	6.5215	0.68634	-171.8
9.3	0.92886	-177.49	1.1269	62.275	0.02838	6.5667	0.68711	-171.77
9.4	0.92889	-177.55	1.1143	61.956	0.028369	6.6127	0.68789	-171.75
9.5	0.92891	-177.61	1.1019	61.638	0.028357	6.6596	0.68867	-171.72
9.6	0.92894	-177.66	1.0898	61.321	0.028345	6.7073	0.68946	-171.7
9.7	0.92896	-177.72	1.0779	61.005	0.028334	6.7558	0.69025	-171.68
9.8	0.92899	-177.77	1.0663	60.69	0.028322	6.8052	0.69104	-171.65
9.9	0.92901	-177.82	1.0549	60.376	0.02831	6.8553	0.69183	-171.63
10	0.92904	-177.88	1.0437	60.063	0.028299	6.9062	0.69263	-171.61
10.1	0.92906	-177.93	1.0328	59.751	0.028287	6.958	0.69343	-171.58
10.2	0.92909	-177.98	1.0221	59.44	0.028275	7.0104	0.69423	-171.56
10.3	0.92912	-178.03	1.0115	59.13	0.028264	7.0636	0.69504	-171.54
10.4	0.92914	-178.08	1.0012	58.82	0.028252	7.1176	0.69584	-171.52
10.5	0.92917	-178.13	0.99106	58.512	0.02824	7.1723	0.69665	-171.5
10.6	0.9292	-178.18	0.98111	58.204	0.028229	7.2278	0.69746	-171.48
10.7	0.92922	-178.23	0.97134	57.898	0.028217	7.2839	0.69827	-171.46
10.8	0.92925	-178.27	0.96175	57.592	0.028205	7.3408	0.69909	-171.44
10.9	0.92928	-178.32	0.95234	57.287	0.028194	7.3984	0.69991	-171.42

11	0.9293	-178.37	0.94309	56.983	0.028182	7.4567	0.70072	-171.4
11.1	0.92933	-178.41	0.93401	56.68	0.028171	7.5156	0.70154	-171.38
11.2	0.92936	-178.46	0.92509	56.377	0.028159	7.5752	0.70237	-171.36
11.3	0.92938	-178.5	0.91632	56.076	0.028148	7.6356	0.70319	-171.35
11.4	0.92941	-178.55	0.90771	55.775	0.028137	7.6965	0.70401	-171.33
11.5	0.92944	-178.59	0.89924	55.476	0.028125	7.7582	0.70484	-171.31
11.6	0.92947	-178.63	0.89092	55.177	0.028114	7.8205	0.70567	-171.3
11.7	0.9295	-178.68	0.88274	54.878	0.028103	7.8834	0.7065	-171.28
11.8	0.92952	-178.72	0.8747	54.581	0.028092	7.9469	0.70732	-171.27
11.9	0.92955	-178.76	0.86679	54.285	0.028081	8.0111	0.70815	-171.25
12	0.92958	-178.8	0.85901	53.989	0.02807	8.076	0.70899	-171.24
12.1	0.92961	-178.84	0.85135	53.694	0.028059	8.1414	0.70982	-171.22
12.2	0.92963	-178.88	0.84382	53.4	0.028048	8.2074	0.71065	-171.21
12.3	0.92966	-178.93	0.83642	53.107	0.028037	8.2741	0.71148	-171.2
12.4	0.92969	-178.97	0.82913	52.815	0.028026	8.3413	0.71232	-171.19
12.5	0.92972	-179.01	0.82195	52.523	0.028015	8.4092	0.71315	-171.17
12.6	0.92975	-179.04	0.81489	52.233	0.028005	8.4776	0.71399	-171.16
12.7	0.92978	-179.08	0.80794	51.943	0.027994	8.5466	0.71482	-171.15
12.8	0.9298	-179.12	0.80109	51.654	0.027984	8.6162	0.71566	-171.14
12.9	0.92983	-179.16	0.79435	51.365	0.027973	8.6863	0.7165	-171.13
13	0.92986	-179.2	0.78772	51.078	0.027963	8.757	0.71733	-171.12
13.1	0.92989	-179.24	0.78118	50.791	0.027953	8.8283	0.71817	-171.11
13.2	0.92992	-179.27	0.77474	50.505	0.027943	8.9001	0.719	-171.1
13.3	0.92995	-179.31	0.7684	50.22	0.027933	8.9724	0.71984	-171.1
13.4	0.92998	-179.35	0.76216	49.935	0.027923	9.0453	0.72068	-171.09
13.5	0.93	-179.38	0.756	49.652	0.027913	9.1187	0.72151	-171.08
13.6	0.93003	-179.42	0.74993	49.369	0.027904	9.1927	0.72235	-171.07
13.7	0.93006	-179.46	0.74396	49.087	0.027894	9.2672	0.72319	-171.07
13.8	0.93009	-179.49	0.73806	48.805	0.027884	9.3422	0.72402	-171.06
13.9	0.93012	-179.53	0.73226	48.525	0.027875	9.4177	0.72486	-171.06
14	0.93015	-179.56	0.72653	48.245	0.027866	9.4937	0.72569	-171.05
14.1	0.93018	-179.6	0.72089	47.966	0.027857	9.5702	0.72652	-171.05
14.2	0.9302	-179.63	0.71532	47.688	0.027848	9.6472	0.72736	-171.04
14.3	0.93023	-179.67	0.70984	47.41	0.027839	9.7246	0.72819	-171.04
14.4	0.93026	-179.7	0.70442	47.133	0.02783	9.8026	0.72902	-171.03
14.5	0.93029	-179.74	0.69909	46.857	0.027821	9.8811	0.72985	-171.03
14.6	0.93032	-179.77	0.69382	46.582	0.027813	9.96	0.73068	-171.03
14.7	0.93035	-179.8	0.68863	46.307	0.027804	10.039	0.73151	-171.03
14.8	0.93038	-179.84	0.68351	46.033	0.027796	10.119	0.73234	-171.02
14.9	0.93041	-179.87	0.67845	45.76	0.027788	10.2	0.73317	-171.02
15	0.93043	-179.9	0.67347	45.488	0.02778	10.28	0.73399	-171.02
15.1	0.93046	-179.93	0.66855	45.216	0.027772	10.361	0.73482	-171.02
15.2	0.93049	-179.97	0.66369	44.946	0.027764	10.443	0.73564	-171.02
15.3	0.93052	-180	0.6589	44.675	0.027756	10.525	0.73647	-171.02
15.4	0.93055	179.97	0.65417	44.406	0.027749	10.608	0.73729	-171.02
15.5	0.93058	179.94	0.6495	44.137	0.027742	10.691	0.73811	-171.02
15.6	0.93061	179.9	0.64489	43.869	0.027734	10.774	0.73893	-171.02
15.7	0.93063	179.87	0.64034	43.602	0.027727	10.858	0.73975	-171.03
15.8	0.93066	179.84	0.63585	43.335	0.02772	10.942	0.74057	-171.03
15.9	0.93069	179.81	0.63141	43.07	0.027714	11.026	0.74138	-171.03
16	0.93072	179.78	0.62703	42.805	0.027707	11.111	0.74219	-171.03
16.1	0.93075	179.75	0.6227	42.54	0.027701	11.197	0.74301	-171.04
16.2	0.93078	179.72	0.61843	42.276	0.027694	11.283	0.74382	-171.04
16.3	0.9308	179.69	0.61421	42.013	0.027688	11.369	0.74463	-171.04
16.4	0.93083	179.66	0.61004	41.751	0.027682	11.455	0.74544	-171.05
16.5	0.93086	179.63	0.60593	41.489	0.027676	11.542	0.74624	-171.05
16.6	0.93089	179.6	0.60186	41.229	0.027671	11.629	0.74705	-171.06

16.7	0.93092	179.57	0.59784	40.968	0.027665	11.717	0.74785	-171.06
16.8	0.93095	179.54	0.59387	40.709	0.02766	11.805	0.74865	-171.07
16.9	0.93097	179.51	0.58995	40.45	0.027655	11.893	0.74945	-171.08
17	0.931	179.48	0.58608	40.192	0.02765	11.982	0.75025	-171.08
17.1	0.93103	179.45	0.58225	39.934	0.027645	12.071	0.75104	-171.09
17.2	0.93106	179.42	0.57846	39.678	0.02764	12.16	0.75184	-171.1
17.3	0.93109	179.39	0.57472	39.422	0.027636	12.25	0.75263	-171.1
17.4	0.93111	179.36	0.57102	39.166	0.027631	12.34	0.75342	-171.11
17.5	0.93114	179.33	0.56737	38.911	0.027627	12.43	0.75421	-171.12
17.6	0.93117	179.3	0.56376	38.657	0.027623	12.521	0.75499	-171.13
17.7	0.9312	179.27	0.56018	38.404	0.027619	12.612	0.75578	-171.14
17.8	0.93122	179.25	0.55665	38.151	0.027616	12.703	0.75656	-171.14
17.9	0.93125	179.22	0.55316	37.899	0.027612	12.795	0.75734	-171.15
18	0.93128	179.19	0.54971	37.648	0.027609	12.886	0.75812	-171.16

\* The data does not include gate, drain and source bond wires.

### LARGE SIGNAL MODEL, $V_{DS} = 8\text{ V}$ , $I_{DS} = 240\text{ mA}$ SCHEMATIC



### TOM2 MODEL PARAMETERS

VTO	-1.768 V	VMAX	0.5 V
ALPHA	2.81	CGD	0.1805 pF
BETA	0.549	CGS	7.22 pF
GAMMA	0.0173	CDS	0.5364 pF
DELTA	0.0818	RIS	0.908 Ohm
Q	0.96	RID	0.0001 Ohm
NG	0.1	VBR	15 V
ND	0.01	RDB	46.517 Ohm
TAU	3.9 ps	CBS	9.6833 pF
RG	0.454 Ohm	TNOM	25 °C
RD	0.63 Ohm	LS	0.0101 nH
RS	0.394 Ohm	LG	0.0391 nH
IS	1E-11 mA	LD	0.008 nH
N	1	AFAC	1
VBI	1 V	NFING	1
VDELTA	0.2 V		