

SP4T 30 W/60 W_{peak} Power Switch 1 MHz to 5.0 GHz

Features

- Frequency Range 1 MHz to 5.0 GHz
- Low insertion loss:
0.25 dB @ 1.0 GHz
0.55 dB @ 3.0 GHz
0.90 dB @ 5.0 GHz
- High isolation:
25 dB @ 3.0 GHz
21 dB @ 5.0 GHz
- 30 W CW Power, 60 W_{peak} Peak Power
- Low power consumption, less than 1 mW
- No external DC blocking capacitors on RF lines
- All RF ports OFF state
- Versatile 2.6 V – 5.25 V power supply
- Charge pump disabled, -18 V supply needed
- Noise level better than -140 dBm kHz⁻¹

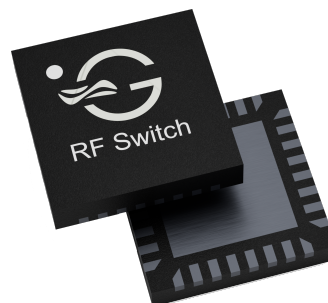


Figure 1: TS84410L in 4.0 x 4.0 mm² QFN 32-pin package.

Applications

- Private mobile and defense radios
- Public safety handsets
- Cellular infrastructure
- Satellite terminals
- Datalinks

General Description

The TS84410L is a 2nd Generation symmetrical reflective Single Pole Four Throw (SP4T) switch designed for medium power switching applications. The TS84410L covers 1 MHz to 5.0 GHz bandwidth and provides low insertion loss, high isolation, and high linearity within a small package size. With 30 W CW power handling and 60 W peak power capability, the TS84410L is well suited for applications requiring low insertion loss, high isolation, and high linearity. TS84410L has charge pump disabled and requires an external -18 V supply, offering a noise level better than -140 dBm/1 kHz.

The TS84410L is packaged into a compact Quad Flat No lead (QFN) 4.0x4.0 mm² 32 leads plastic package.

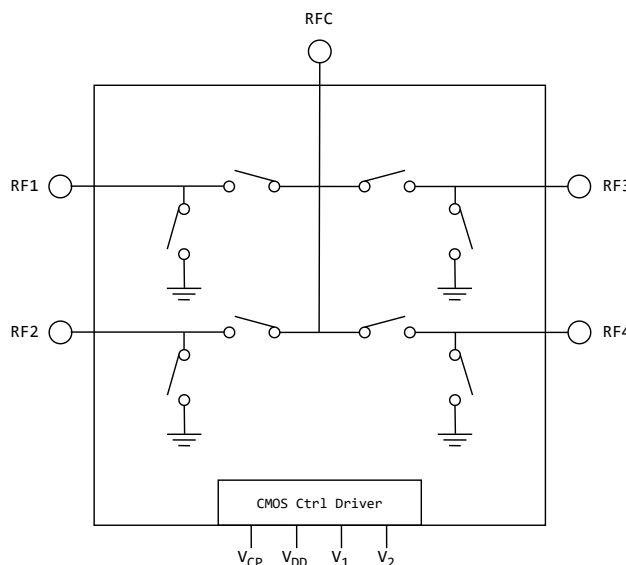


Figure 2: TS84410L functional diagram



RoHS/REACH/Halogen free

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Ordering information

Table 1: Ordering Information

Device Part Number	Package Type	Notes
TS84410L	32 Pin 4.0x4.0x0.75 mm ³ QFN	Core part number
TS84410L-EVB	Evaluation Board	
TS84410LMTRPBF ¹	330 mm reel, 3 000 pcs	Full reel

¹ MTRPBF - M: Manufacturing, TR: Tape and Reel, and PBF: lead free.

Table 2: Tape and Reel Information

Form	Quantity	Reel Diameter	Reel Width
Tape and Reel	3 000	13" (330mm)	18mm

Pin Assignment

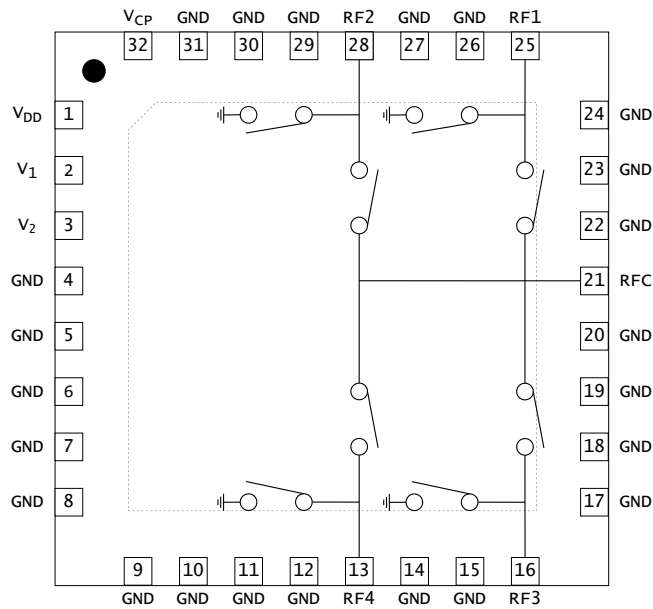


Figure 3: TS84410L pin assignment [top view]

Table 3: Pin Definition

Pin Number	Pin Name	Description
32	V _{CP}	Internal charge pump voltage disabled, -18 V supply needed on this pin.
1	V _{DD}	DC Power Supply
2	V ₁	Switch control input 1
3	V ₂	Switch control input 2
13	RF4	RF port 4
16	RF3	RF port 3
21	RFC	RF Common port / Antenna port
25	RF1	RF port 1
28	RF2	RF port 2
4,5,6,7,8,9,10,11,12 14,15,17,18,19,20 22,23,24,26,27 29,30,31	GND	Connect to ground ²
33 ¹	GND	Ground thermal pad, please connect to GND

¹ The backside ground (thermal) pad of the package must be grounded directly to the ground plane of PCB with multiple vias, and adequate heat sinking must be used to ensure proper operation and thermal management.

² These pins are NC pins inside the package. To avoid floating pins around RF lines, we request these to be connected to ground.

Absolute Maximum Ratings

Table 4: Absolute Maximum Ratings $T_A = +25^{\circ}\text{C}$ unless otherwise specified¹.

Parameter	Symbol	Value	Unit
Electrical Ratings			
Power Supply Voltage	V_{DD}	5.5	V
External bias voltage on V_{CP} pin	V_{CP}	-20	V
Storage Temperature Range	T_{st}	-55 – 125	$^{\circ}\text{C}$
Operating Temperature Range	T_{op}	-40 – 85	$^{\circ}\text{C}$
Maximum Junction Temperature	T_j	+140	$^{\circ}\text{C}$
Maximum RF CW input power (100MHz-5000MHz) ³	RFx/ANT	46	dBm
Maximum RF CW input power(30-100MHz) ³	RFx/ANT	45	dBm
Maximum RF peak input power, 1% duty cycle, 10 μs pulse ²	RFx/ANT	49	dBm
Thermal Ratings			
Thermal Resistance (junction-to-case) – Bottom side	$R_{\theta jc}$	9.0	$^{\circ}\text{C}/\text{W}$
Soldering Temperature	T_{solder}	+260	$^{\circ}\text{C}$
ESD Ratings			
Human Body Model (HBM)	Level 1B	500 – <1000	V
Charged Device Model (CDM)	Level C3	≥ 1000	V
Moisture Rating			
Moisture Sensitivity Level ⁴	MSL	1	

¹ Maximum ratings are absolute ratings. Exposure to absolute maximum rating conditions for extended periods may affect device reliability and can cause permanent damage to the device. Exceeding one or a combination of the absolute maximum ratings may cause permanent and irreversible damage to the device and/or to surrounding circuit. Functional operation of the device is not implied in any conditions above those indicated in the Electrical Specifications section.

² Test frequency 800MHz.

³ See Power De-rating table for low frequencies.

⁴ Tagore recommends to store part in moisture barrier bags to preserve solderability.

Electrical Specifications

Table 5: Electrical Specifications $T_A = +25^{\circ}\text{C}$; $V_{DD} = +3.3\text{V}$; 50Ω Source/Load.

Parameter	Condition	Minimum	Typical	Maximum	Unit
Operating frequency	f	1		5000	MHz
Insertion loss	30 MHz		0.20		dB
unmatched, upto 3.5 GHz	1.0 GHz		0.25	0.45	dB
RFC – RFx	2.0 GHz		0.35		dB
	3.0 GHz		0.55		dB
	3.5 GHz		0.80		dB
Insertion loss ¹	30 MHz		0.20		dB
matched upto 5.0 GHz	1.0 GHz		0.40		dB
RFC – RFx	3.0 GHz		0.70		dB
	4.0 GHz		0.70		dB
	5.0 GHz		0.90		dB
Isolation	30 MHz		50		dB
unmatched, upto 3.5 GHz	1.0 GHz		36		dB
RFC – RFx	2.0 GHz		30		dB
	3.0 GHz		25		dB
	3.5 GHz		23		dB
Isolation ¹	30 MHz		50		dB
matched upto 5.0 GHz	1.0 GHz		35		dB
RFC – RFx	3.0 GHz		23		dB
	4.0 GHz		22		dB
	5.0 GHz		21		dB

¹ Matched values are not guaranteed as they include performance of matching components. These components are beyond control of TagoreTech and therefore given values are indications, not guaranteed values.

Table 6: Electrical Specifications $T_A = +25^\circ\text{C}$; $V_{DD} = +3.3\text{V}$; 50Ω Source/Load.

Parameter	Condition	Minimum	Typical	Maximum	Unit
Operating frequency	f	1		5000	MHz
Return Loss	30 MHz		-30		dB
unmatched, upto 3.5 GHz	1.0 GHz		-25		dB
RFC – RFx	2.0 GHz		-20		dB
	3.0 GHz		-15		dB
	3.5 GHz		-12		dB
Return Loss ¹	30 MHz		-30		dB
matched upto 5.0 GHz	1.0 GHz		-17		dB
RFC – RFx	3.0 GHz		-14		dB
	4.0 GHz		-20		dB
	5.0 GHz		-17		dB

¹ Matched values are not guaranteed as they include performance of matching components. These components are beyond control of TagoreTech and therefore given values are indications, not guaranteed values.

Table 7: Electrical Specifications $T_A = +25^\circ\text{C}$; $V_{DD} = +3.3\text{V}$; 50Ω Source/Load.

Parameter	Condition	Minimum	Typical	Maximum	Unit
Operating frequency	f	1		5000	MHz
Harmonic Distortion					
H_2	800MHz, $P_{in} = 42\text{dBm}$		-80		dBc
H_3	800MHz, $P_{in} = 42\text{dBm}$		-77		dBc
IIP3	800MHz		70		dBm
Power and Compression point					
P_{maxCW}^2	Max RF CW Power		45		dBm
P_{maxpeak}	Max RF Peak Power		48		dBm
$P_{\text{maxhot RFX}}^5$	Max RF CW Power, hot switching		37		dBm
$P_{\text{maxhot RFC}}^5$	Max RF CW Power, hot switching		37		dBm
$P_{0.1\text{dB}}$	800MHz, CW		47		dBm
$P_{1\text{dB}}^1$	800MHz, CW		48		dBm
$P_{\text{peak}0.1\text{dB}}$	800MHz, 1% duty cycle, $10\mu\text{s}$ pulse		48		dBm
Noise					
Noise level ⁴	RBW=1 kHz		-140		dBm

¹ $P_{1\text{dB}}$ has been given for comparison reasons only. Please do not exceed Absolute Maximum ratings.

² See Power De-rating table

⁴ Internal charge pump is disabled; there is no charge pump switching noise. Noise level is valid over the whole operating frequency range.

⁵ Dependent on thermal design and surrounding circuits.

Table 8: Electrical Specifications $T_A = +25^\circ\text{C}$; $V_{DD} = +3.3\text{V}$; 50Ω Source/Load.

Parameter	Condition	Minimum	Typical	Maximum	Unit
Operating frequency	f	1		5000	MHz
Switching Time					
t_{ON}^8	Switch ON time		800		ns
t_{OFF}^8	Switch OFF time		800		ns
t_{RISE}^8	Switch RISE time		500		ns
t_{FALL}^8	Switch FALL time		500		ns
t_{WON}	Minimum Switch ON time		3.6		μs
t_{WOFF}	Minimum Switch OFF time		3.6		μs
$f_{PRR}, V_{CP} = -18\text{V}^6$	Maximum pulse repetition rate		>20		kHz
Power Supply, DC					
Control voltage	Power Supply V_{DD}	2.6	3.3	5.25	V
	All control pins high ⁷ , V_{ih}	1.0	3.3	5.25	V
	All control pins low, V_{il}	-0.3	0	0.5	V
Control current	All control pins high, I_{ih}			7.5	μA
	All control pins low, I_{il}		0		μA
Current consumption	I_{DD} , active mode (V_{DD} on)		160	260	μA

³ With internal charge pump and with C_{VCP} .⁶ External -18 V applied to V_{CP} pin.⁷ Control voltage V_{ih} cannot be higher than V_{DD} (to avoid forward biasing of ESD diode)⁸ Switching time characterization done at 30 Hz and 500 Hz pulse repetition rate (rate to change switch state, for example between RFC-RF1 and RFC-RF2).

Switching time definition

Example of the definition by using 10 W/40 dBm signal. We apply 10W signal to RF port, stabilized with isolator. Isolator is needed as our switch shows to RF port approximately 4Ω impedance. Let's assume that the switch insertion loss is 0.3 dB. Therefore 90% of the RF signal is 39.55 dBm and 10% of the RF signal is 1W/30dBm. We need to take into account 0.3dB insertion loss, therefore numbers are 39.25 dBm and 29.7 dBm respectively. We change the control from low to high and our time reference point is when our control signal exceeds lower threshold value V_{ihlow} . In certain measurements when control signal rise time is significantly shorter than RF output signal, we approximate start of the clock with 50% point of control signal.

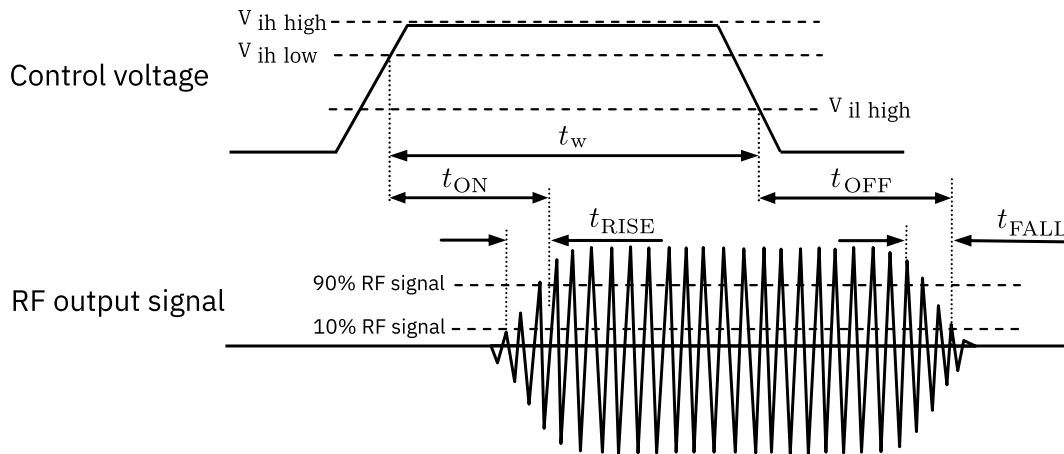


Figure 4: Switching time definition, t_{ON} , t_{OFF} , t_{RISE} , t_{FALL} . Minimum pulse width t_w .

In the TS84410L, the internal charge pump is disabled and an external -18 V supply to V_{CP} is required. Maximum pulse repetition rate f_{PRR} defines the maximum frequency for switching events. With the external -18 V supply, the switch can be driven at least to 20 kHz f_{PRR} . Expect current consumption of 10 mA from the -18 V supply.

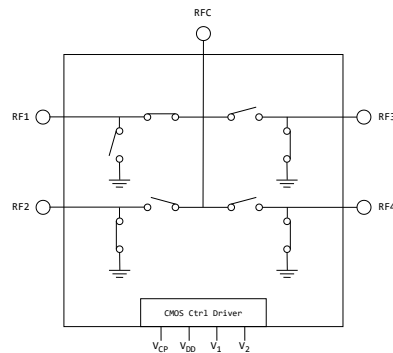
Switch Control table

Table 9: Switch Control Table

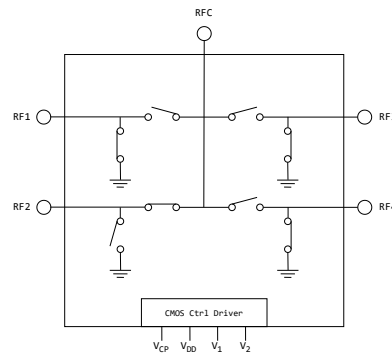
V_{DD}^1	V_2	V_1	Switch state
1	0	0	RFC – RF1 ON ²
1	0	1	RFC – RF2 ON
1	1	0	RFC – RF3 ON
1	1	1	RFC – RF4 ON
0	0	0	V_{DD} off (Isolation), all FETs are on, short shown to RFC and RFx ports

¹ V_{DD} should be applied first before V_1 and V_2 , otherwise may cause damage to the device.

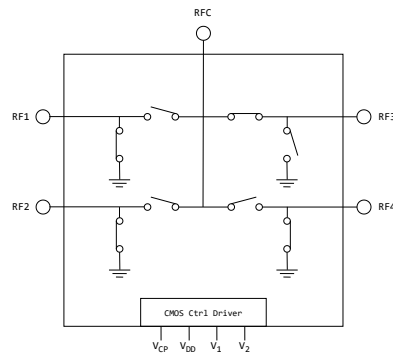
² There are internal pull-downs to ground on both V_1 and V_2 control pins, the state at start-up without any control voltage applied will be RFC – RF1 ON.



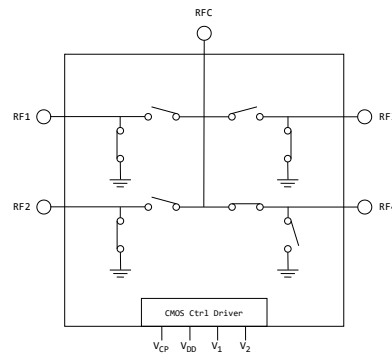
RFC-RF1 ON



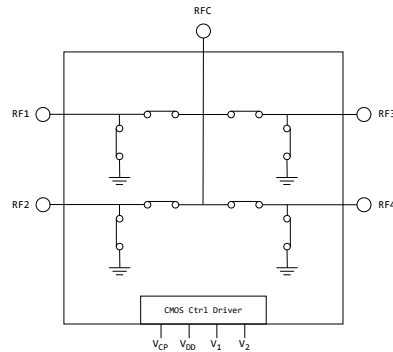
RFC-RF2 ON



RFC-RF3 ON



RFC-RF4 ON

 V_{DD} off state

Theory of Operation

Isolation modes

TS84410L has isolation mode when V_{DD} is turned off.

Device powered off

When V_{DD} is 0 V, all switch RF transistors are on, ie. every MOSFET is on. This means that series MOSFETs and shunt MOSFETs are conducting. Every RF port is essentially connected to ground, including RFC port. This is practical when device is directly connected to RFC, there is certain protection against induced electrical fields. This can partially protect radio equipment against electrical fields, when device is not in usage.

Feeding external V_{CP} voltage of -18 V

TS84410L requires external voltage supply to V_{CP} , as the internal charge pump is disabled. The external supply supports pulse repetition rate f_{PRR} of more than 20 kHz, in some cases even up to 100 kHz. In order to use external voltage, it is mandatory to supply first V_{DD} , have a delay of 1 ms and then apply -18 V to V_{CP} . Shutdown should be in opposite order.

Applications

TS84410L is offering 30 W/60 W_{peak} capability from 1 MHz to 5000 MHz frequency band. Applications include narrowband and multi-octave wideband radios, jammers, EMC testing, public mobile radios, industrial and scientific applications. In the past, such applications were covered with power hungry and complex PIN diodes, TS84410L significantly reduces design complexity for such RF switching needs. TS84410L works well upto 5 GHz frequency without external matching components, for frequency above 3.5 GHz, matching is recommended. Datasheet provides an example matching and its performance.

Schematics and Evaluation Board

S-parameters of the both presented EVBs can be downloaded from link: [Download TS84410L S-parameters](#)

Table 10: Port definitions in s-parameter files and plots.

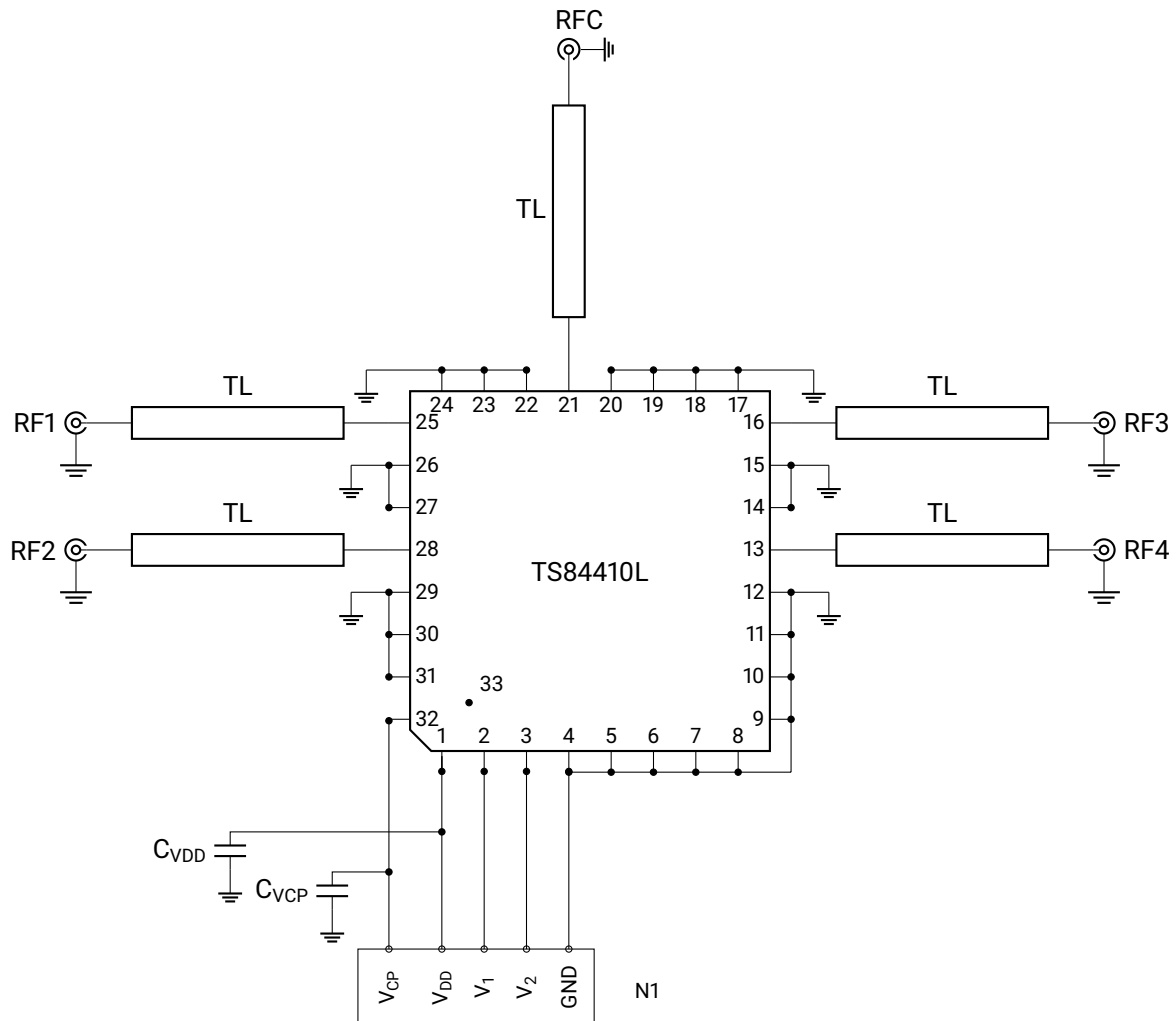
PIN name	Port numbers	S-parameters	Function
RFC	1	S11	
RF1	2	S22	
RF2	3	S33	
RF3	4	S44	
RF4	5	S55	
RF1ON	12	S21	RFC-RF1 ON
RF2ON	13	S31	RFC-RF2 ON
RF3ON	14	S41	RFC-RF3 ON
RF4ON	15	S51	RFC-RF4 ON

Content of s-parameter repository:

```
TS84410L.zip
├── TS84410L_IDX_00.....Directory for s-parameters without matching components
│   ├── Readme.txt
│   ├── TS84410L_RF1_ON_5PORT.s5p ..... S5P file for RFC-RF1ON mode
│   ├── TS84410L_RF2_ON_5PORT.s5p ..... S5P file for RFC-RF2ON mode
│   ├── TS84410L_RF3_ON_5PORT.s5p ..... S5P file for RFC-RF3ON mode
│   └── TS84410L_RF4_ON_5PORT.s5p ..... S5P file for RFC-RF4ON mode
├── TS84410L_IDX_01.....Directory for s-parameters with matching components, 5.0 GHz
│   ├── Readme.txt
│   ├── TS84410L_RF1ON_5PORT.s5p.....S5P file for RFC-RF1ON mode
│   ├── TS84410L_RF2ON_5PORT.s5p ..... S5P file for RFC-RF2ON mode
│   ├── TS84410L_RF3ON_5PORT.s5p.....S5P file for RFC-RF3ON mode
│   ├── TS84410L_RF4ON_5PORT.s5p ..... S5P file for RFC-RF4ON mode
│   └── TS84410L_OFF_5PORT.s5p.....S5P file for VDD OFF
```

Performance upto 3.5 GHz, unmatched

TS84410L shows best performance upto 3.5 GHz frequency without any matching components. Only two external components are recommended, 1 nF for V_{CP} and 10 nF for V_{DD} lines.



Schematics of TS84410L EVB

Table 11: Components used for TS84410L EVB

Reference	Part number / Value	Description	Notes
C_{VDD}	10 nF	Capacitor	
C_{VCP}	1 nF	Capacitor	

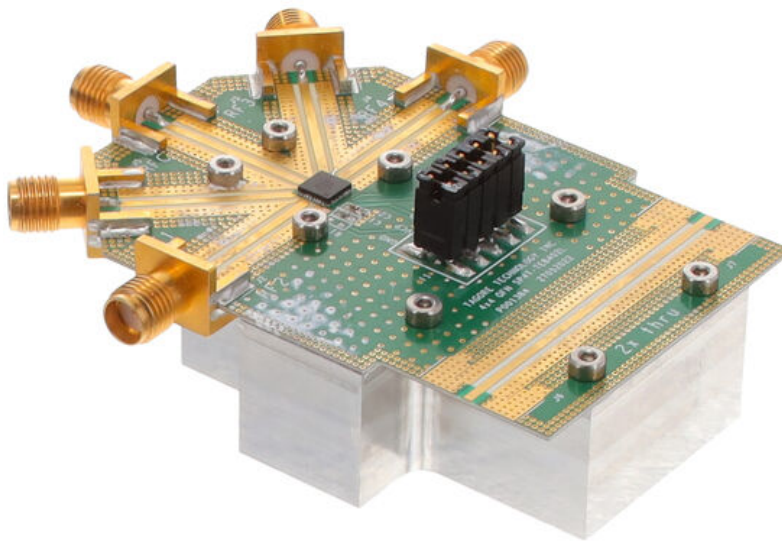


Photo of TS84410L EVB without matching components.

Performance upto 5.0 GHz, matched

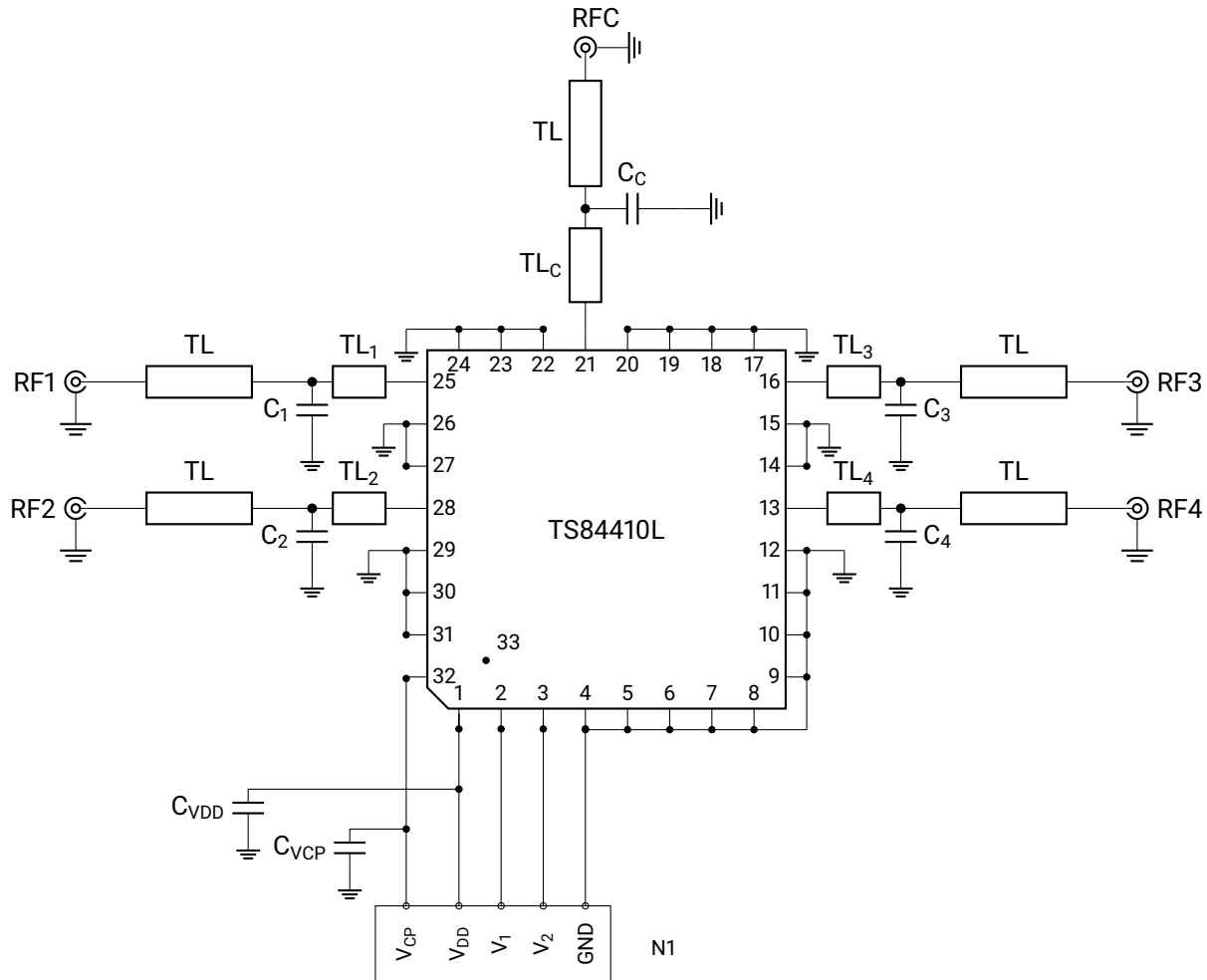


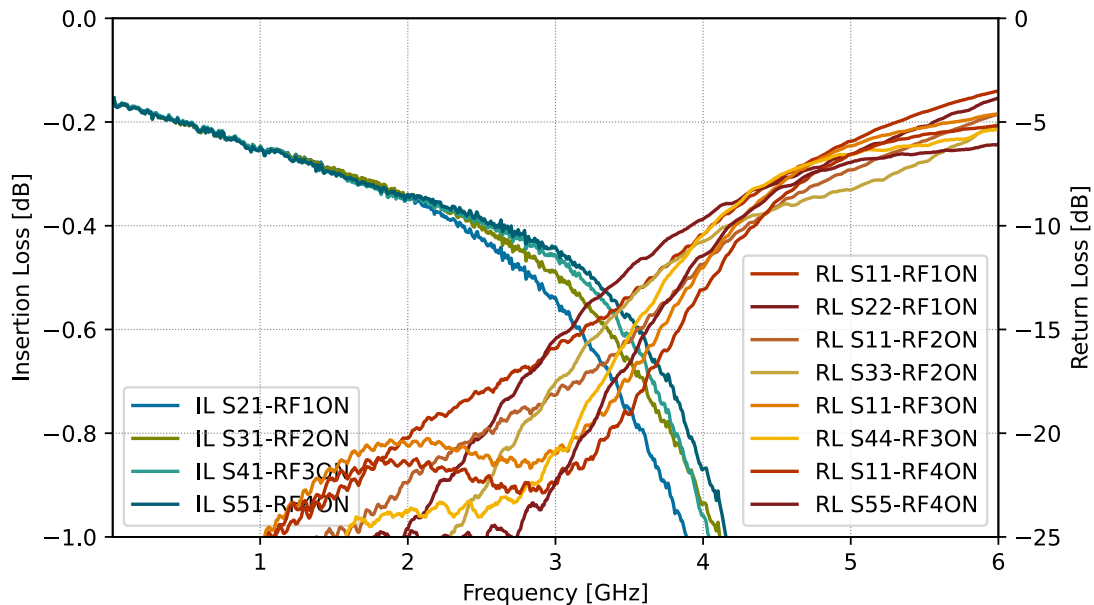
Table 12: Matching components used for 5.0 GHz matching

Reference	Part number / Value	Description	Notes
TL _C	2.2 mm	CPW length	Edge of SW to edge of capacitor
C _C	0603N0R3BW251	Ceramic capacitor	0.3 pF, 250 V, ± 0.1 pF
TL ₁	0.1 mm	CPW length	Edge of SW to edge of capacitor
C ₁	0603N0R4BW251	Ceramic capacitor	0.4 pF, 250 V, ± 0.1 pF
TL ₂	0.1 mm	CPW length	Edge of SW to edge of capacitor
C ₂	0603N0R4BW251	Ceramic capacitor	0.4 pF, 250 V, ± 0.1 pF
TL ₃	0.1 mm	CPW length	Edge of SW to edge of capacitor
C ₃	0603N0R4BW251	Ceramic capacitor	0.4 pF, 250 V, ± 0.1 pF
TL ₄	0.1 mm	CPW length	Edge of SW to edge of capacitor
C ₄	0603N0R4BW251	Ceramic capacitor	0.4 pF, 250 V, ± 0.1 pF
C _{VDD}	10 nF	Capacitor	
C _{VCP}	1 nF	Capacitor	

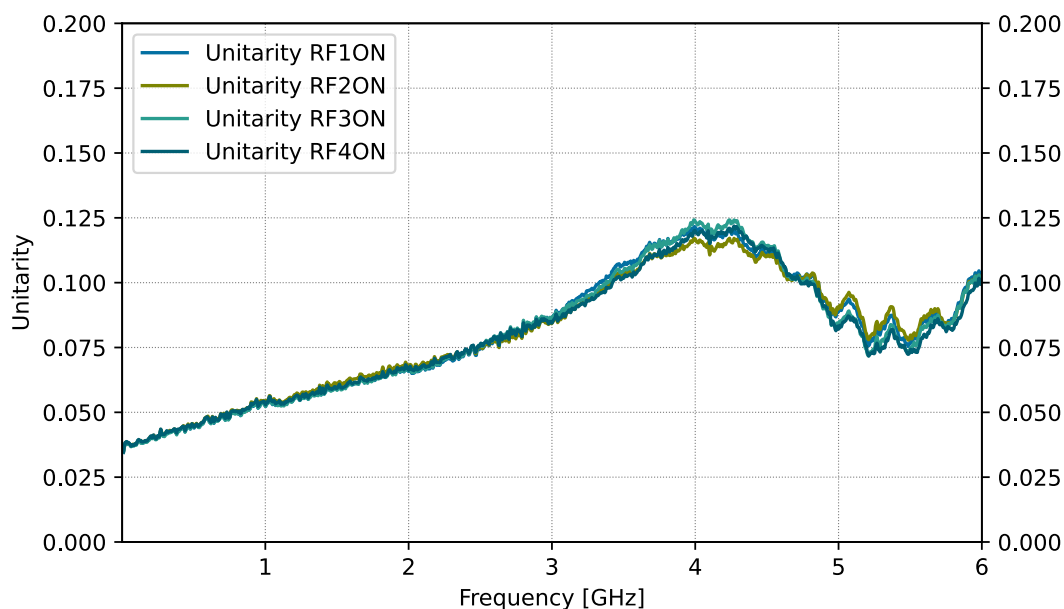
Typical characteristics

Performance up to 3.5 GHz, unmatched

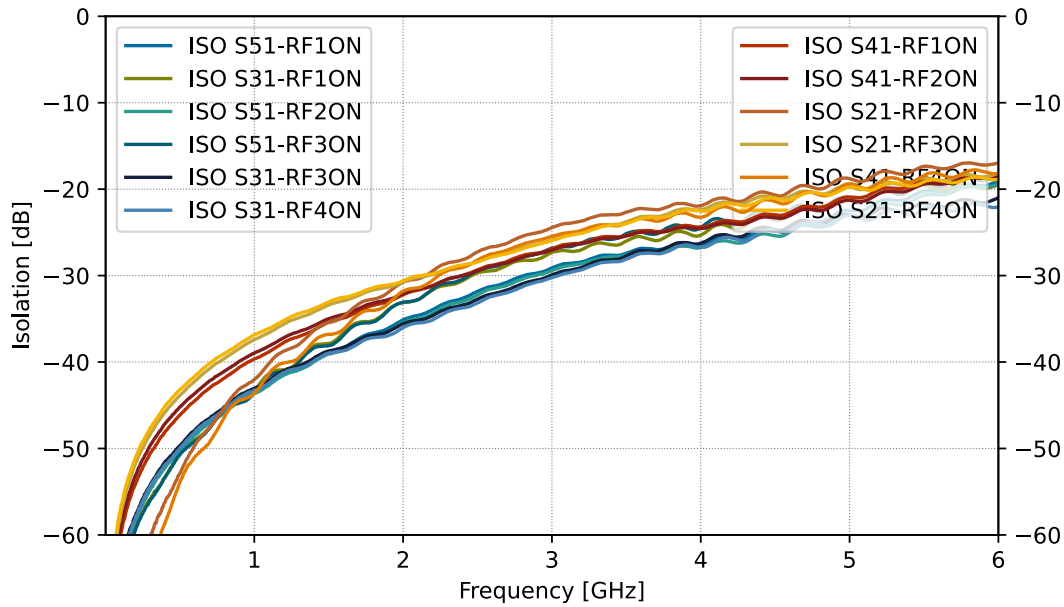
These measurements have been taken from TS84410L EVK, CPW losses have been de-embedded from the measurements. Device does not require any matching components for operation upto 3.5 GHz. Going above x.x GHz, performance can be improved by adding matching to ports. Our matching example shows excellent performance upto 5.0 GHz.



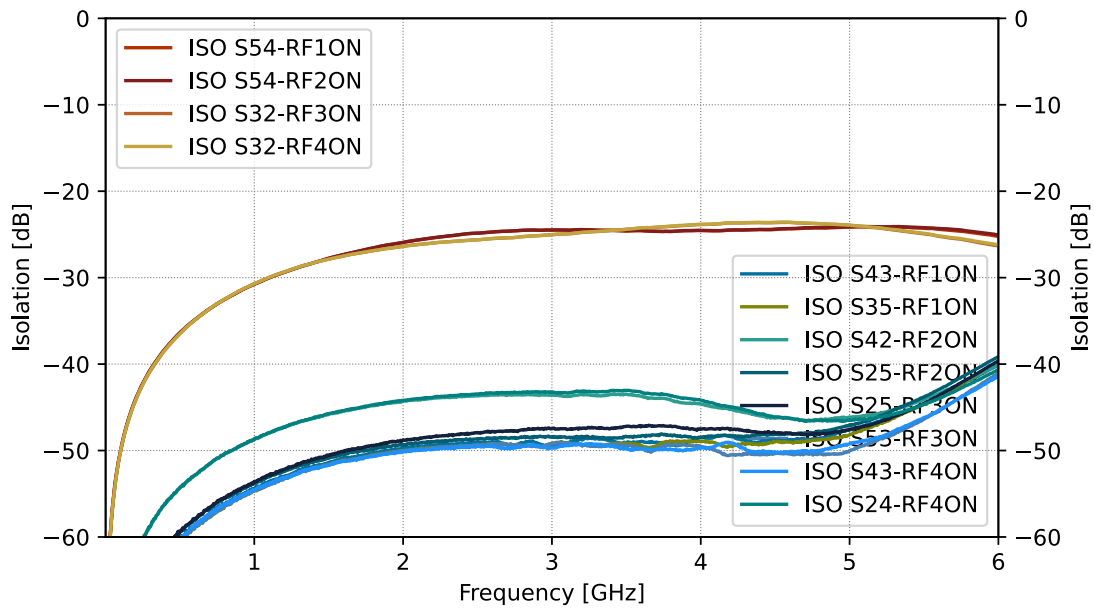
Insertion loss and Return loss, RFC – RFx.



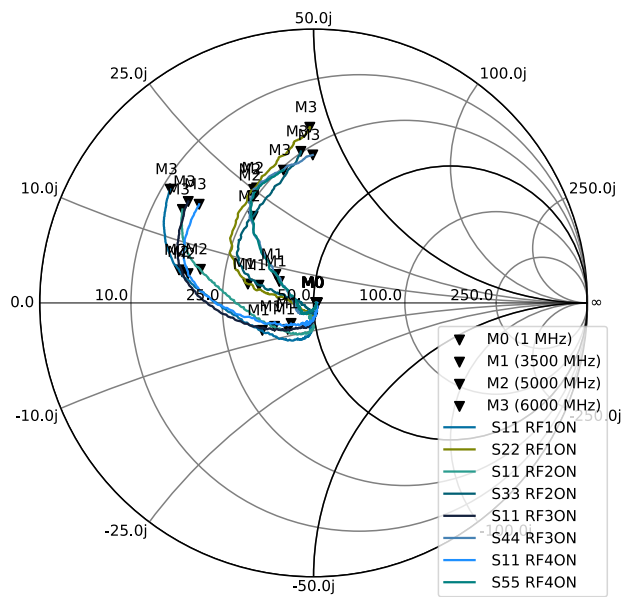
Power absorption of the switch $1 - |S_{11}|^2 - |S_{21}|^2 - |S_{31}|^2 - |S_{41}|^2 - |S_{51}|^2$, RFC – RFx.



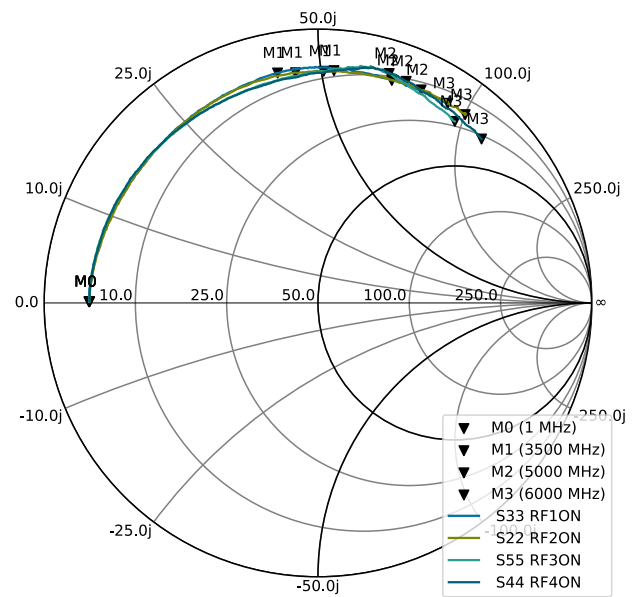
Isolation between RFC to non-active RFx and active RFx to non-active RFx.



RFx – RFx port isolation. Reddish curves present adjacent port to port isolation and blueish curves opposite side port to port isolations.



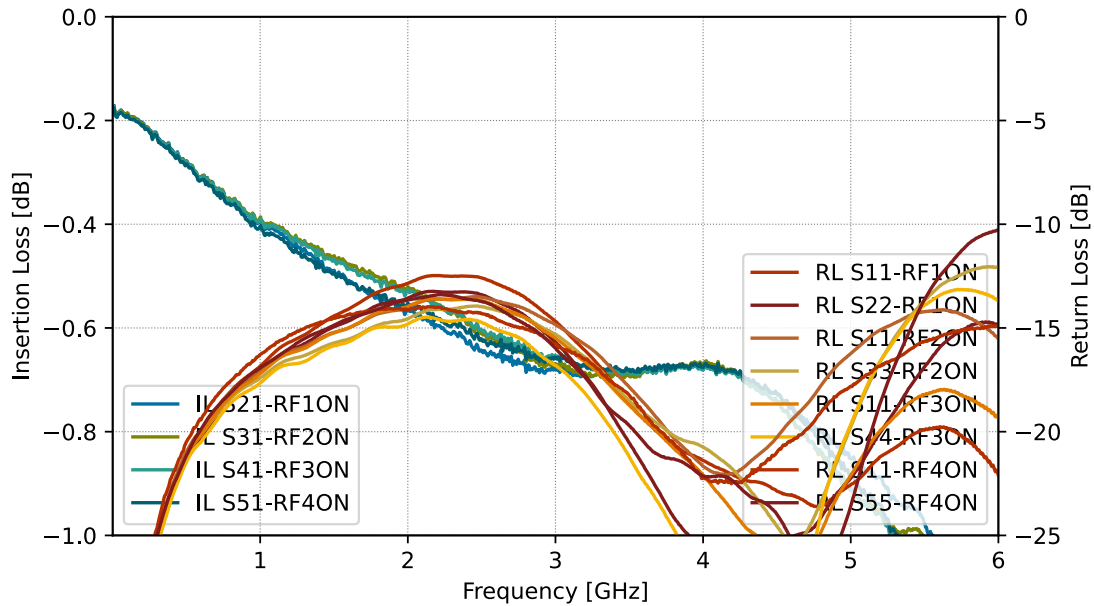
RFC and RFx matching at ON state.



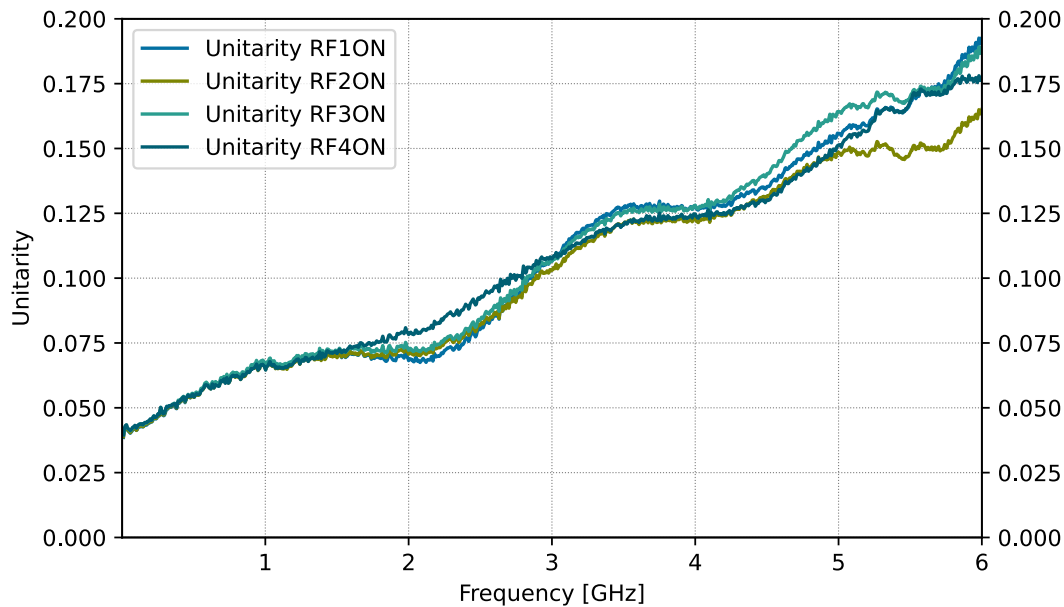
Non-active RFx port impedance. Low frequency starts from closed and circulates towards open at higher frequencies.

Performance up to 5.0 GHz, matching applied to EVK

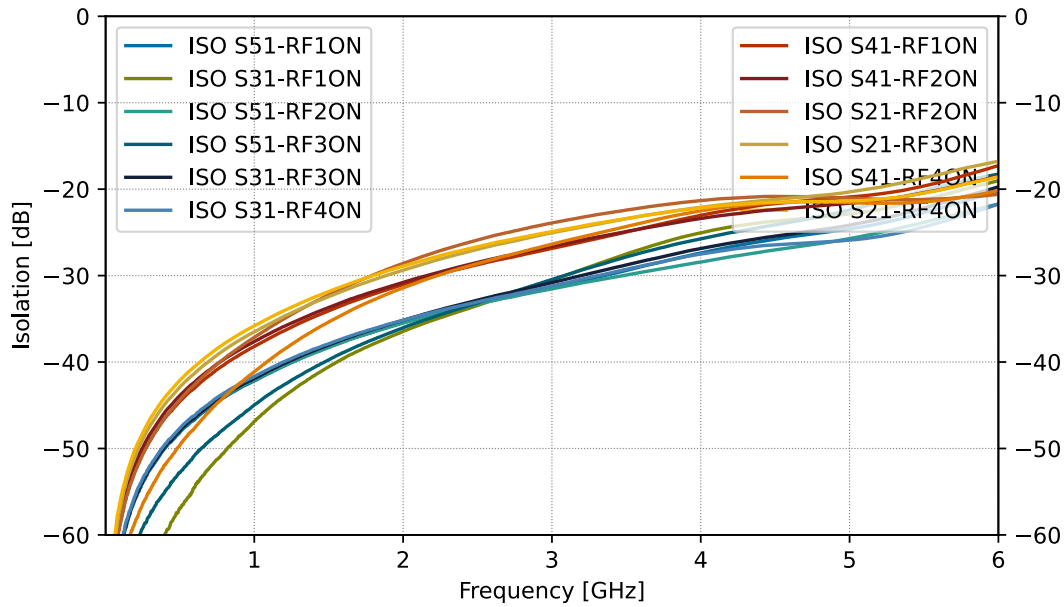
These measurements have been taken from TS84410L EVK, matching components applied. CPW losses have been de-embedded from the measurements, but matching component losses are present.



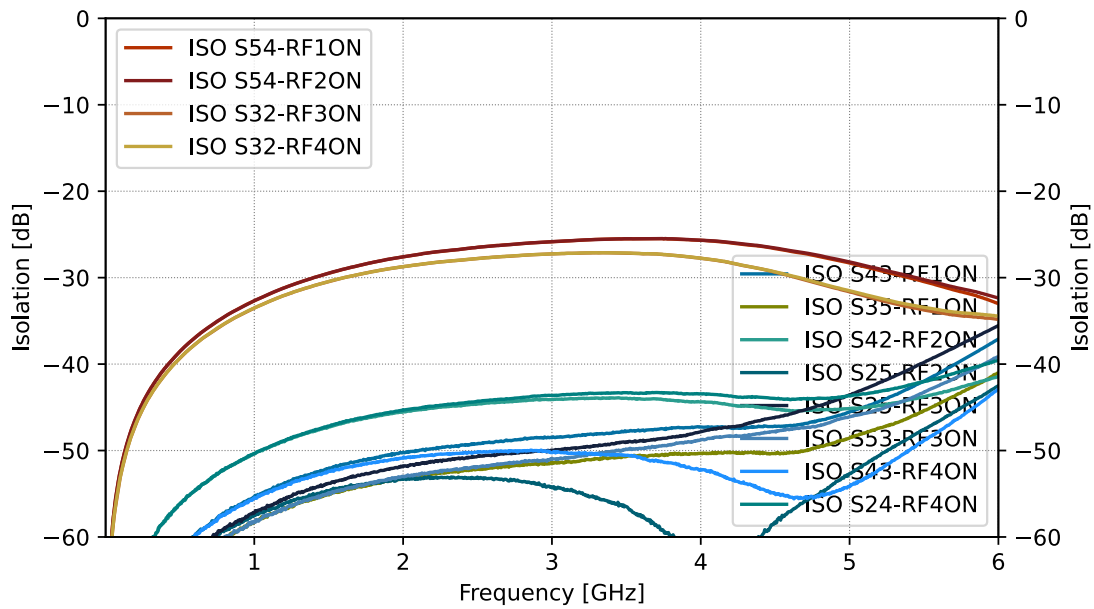
Insertion loss and Return loss, RFC – RFx.



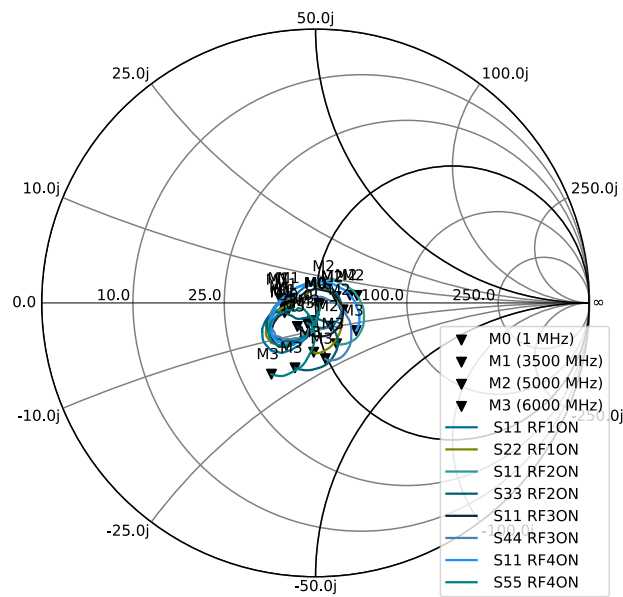
Power absorption of the switch $1 - |S_{11}|^2 - |S_{21}|^2 - |S_{31}|^2$, ANT – RFx.



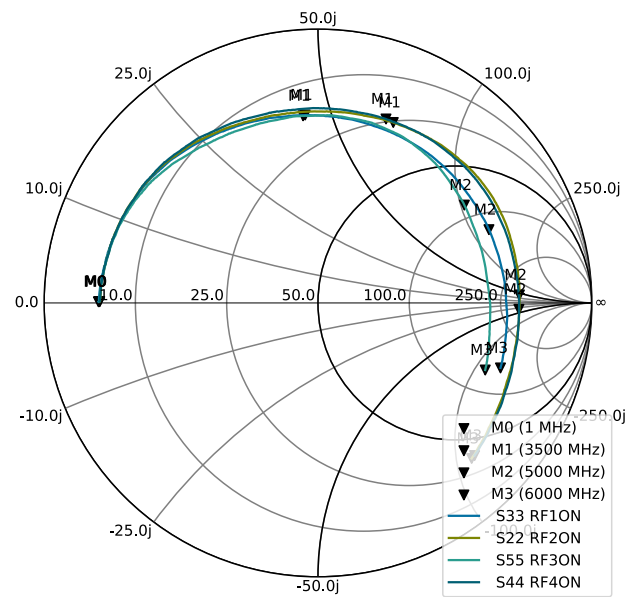
Isolation between RFC to non-active RFx and active RFx to non-active RFx.



RFC – RFx isolation and RFx – RFx isolation at ISO mode and V_{DD} off (Isolation).



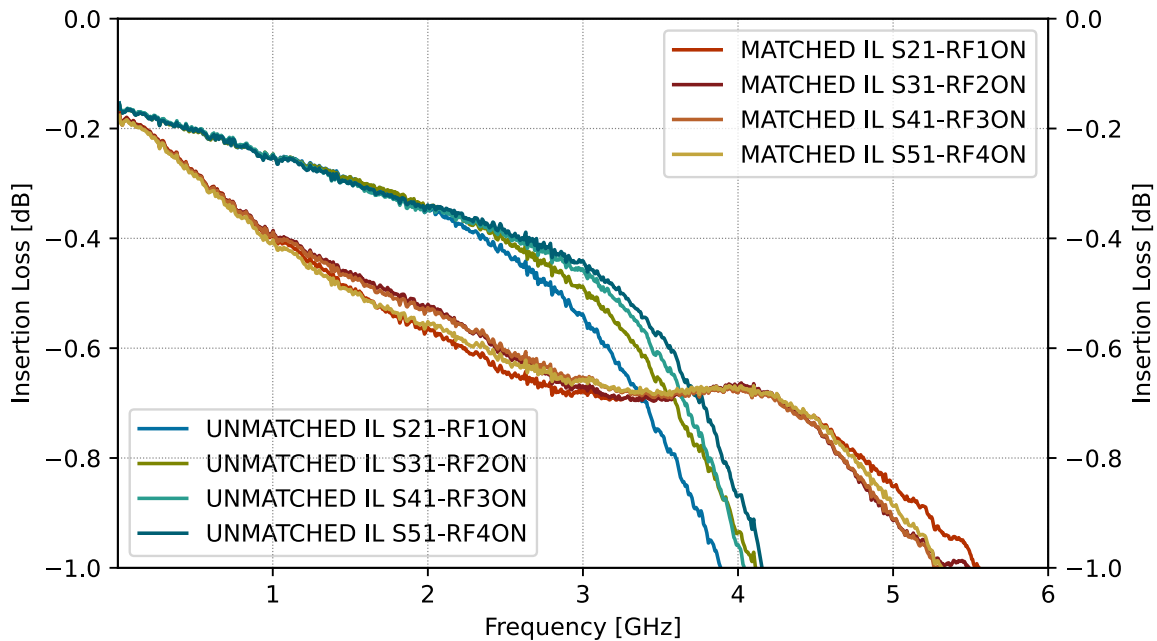
RFC and RFx matching at ON state.



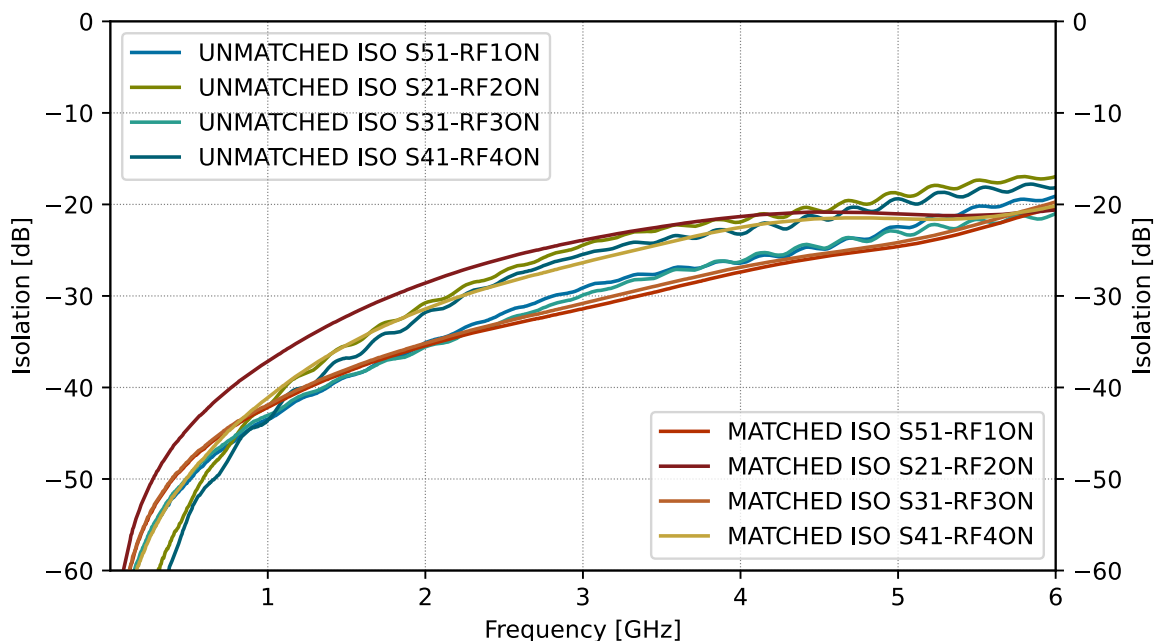
Non-active RFx port impedance. Low frequency starts from closed and circulates towards open at higher frequencies.

Comparison plots of matched and unmatched switch.

Below Insertion Loss and Isolation comparison plots of matched and unmatched switch. Matching extends frequency response to 5.0 GHz without affecting isolation.



Insertion loss comparison of matched to 5.0 GHz and unmatched switch.



Isolation comparison of matched to 5.0 GHz and unmatched switch.

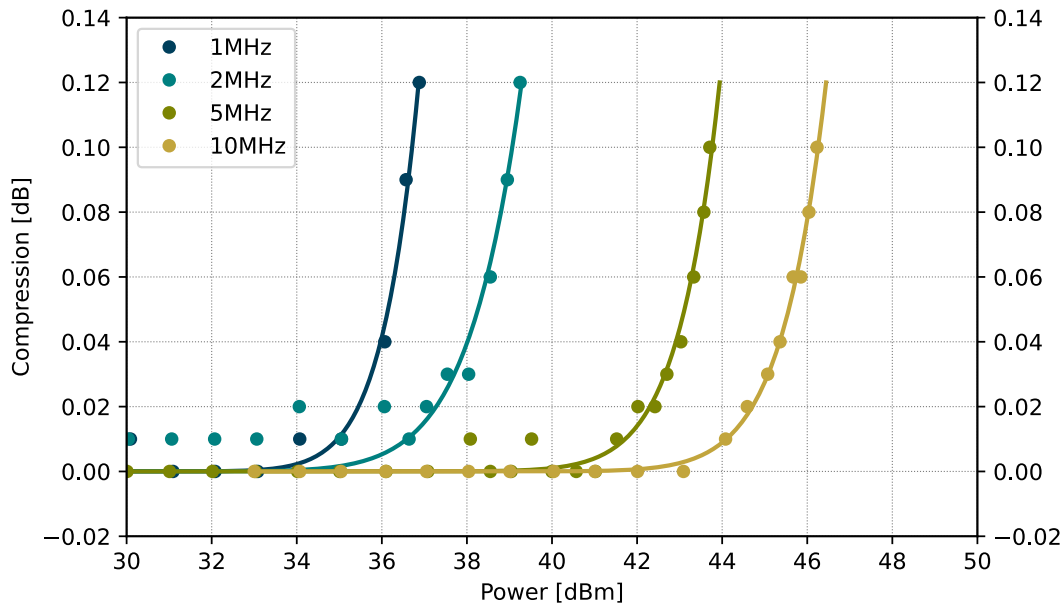
Power De-rating

TS84410L has power handling de-rating below 100 MHz. Power de-rating table has been defined for 50ohm environment.

Table 13: Power De-Rating table

Start f	Stop f	Max Power	Unit
1 MHz	2 MHz	34	dBm
2 MHz	5 MHz	37	dBm
5 MHz	10 MHz	41	dBm
10 MHz	30 MHz	43	dBm
30 MHz	100 MHz	44	dBm
100 MHz	$f_{\max}$	45	dBm

TS84410L Continuous Wave (CW) compression measurement are presented. Measurements are conducted in room temperature $T_A = +25^\circ\text{C}$. Values of De-Rating table takes into account manufacturing tolerances and margins. Measurements are presented as dot (•) and model and extrapolations presented as line (–).



TS84410L CW Compression measurement in room temperature $T_A = +25^\circ\text{C}$.

Device Package information

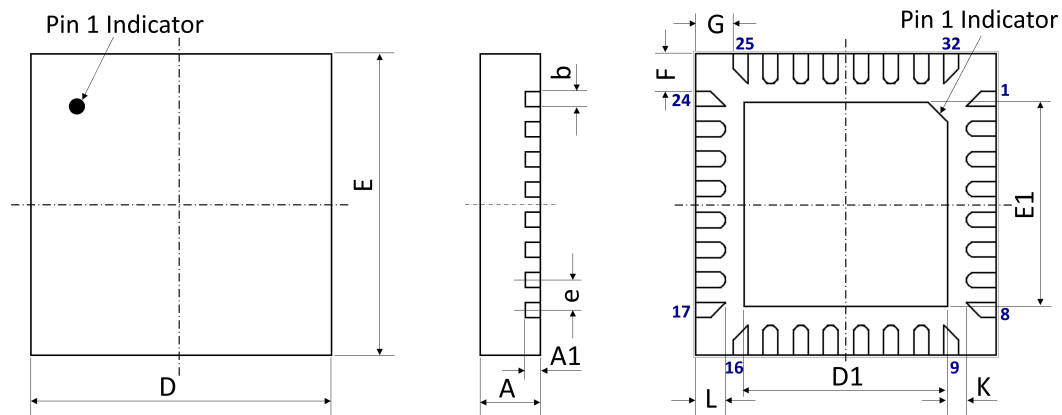


Figure 8: 32-pin QFN 4.0 x 4.0 x 0.75 mm³ package drawing.

Please refer to application notes TN-001 and TN-002 at TagoreTech web page for PCB and soldering guidelines.

Table 14: Device Package Dimensions

Dimension	Value [mm]	Tolerance [mm]	Dimension	Value [mm]	Tolerance [mm]
A	0.75	±0.05	E	4.00 BSC	±0.05
A1	0.203	±0.02	E1	2.70	±0.05
b	0.20	+0.05/-0.07	F	0.50	±0.05
D	4.00 BSC	±0.05	G	0.50	±0.05
D1	2.70	±0.05	L	0.40	±0.05
e	0.40 BSC	±0.05	K	0.25	±0.05

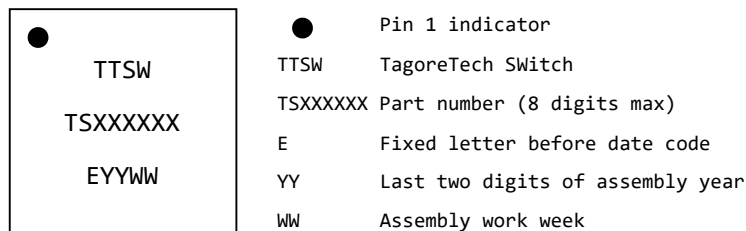


Figure 9: Part marking specification.

PCB Land Design

Notes:

- 4-layer PCB is recommended.
- Via diameter is recommended to be 0.3mm to prevent solder wicking inside the vias.
- Thermal vias shall only be placed on the center pad.
- The maximum via number for the center pad is $11(X) \times 11(Y) = 121$.

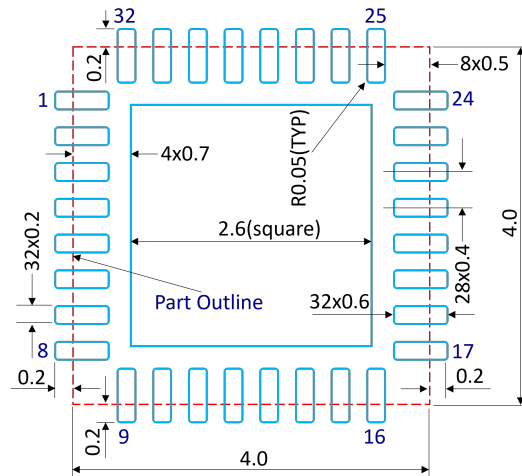


Figure 10: PCB land pattern, dimensions in [mm].

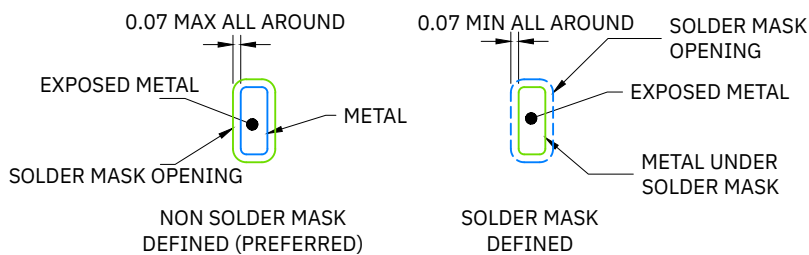


Figure 11: Solder mask opening, dimensions in [mm].

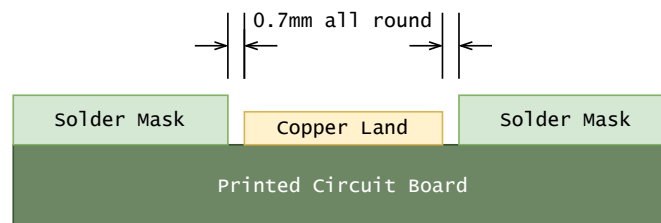


Figure 12: Preferred solder mask opening, side view, dimensions in [mm].

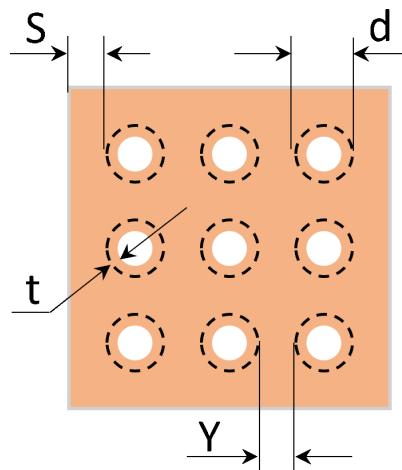
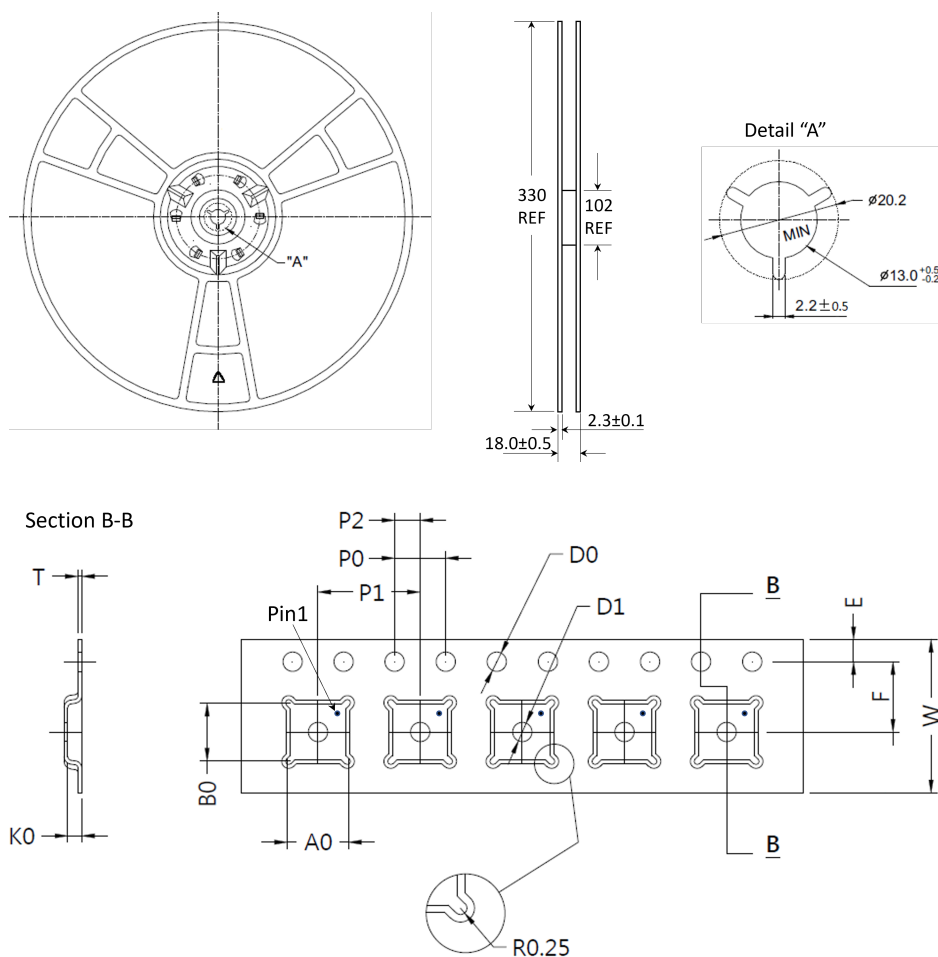


Figure 13: Thermal Via Pattern, Recommended Values: $S \geq 0.15$ mm; $Y \geq 0.20$ mm; $d = 0.2$ mm; Plating Thickness $t = 25\mu\text{m}$ or $50\mu\text{m}$.

Tape and Reel Information



A0[mm]	B0[mm]	D0[mm]	D1[mm]	E[mm]	F[mm]	K0[mm]	P0[mm]	P1[mm]	P2[mm]	T[mm]	W[mm]
4.35	4.35	1.50	1.50	1.75	5.50	1.10	4.00	8.00	2.00	0.30	12.00

Glossary

IL	Insertion loss
ISO	Isolation
RL	Return loss
VSWR	Voltage Standing Wave Ratio
RFC	RF Common port, sometimes referred as ANT
RFx	RF Port number x
Unitarity	Describes power absorption of the component, $1 - S_{11} ^2 - S_{21} ^2 - S_{31} ^2 - S_{41} ^2 - S_{51} ^2$

Changelog

Table 15: Changelog

Date	Revision	Notes
06/30/2026	3.0	New release with updated information, frequency range extended from 1 MHz to 5.0 GHz
09/20/2026	3.01	TS84410L datasheet created (charge pump disabled version), Legal Information page updated.

Legal Information and Resources

Published by

TagoreTech Inc.
601 Campus Drive, Suite B3
Arlington Heights, IL 60004, USA

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