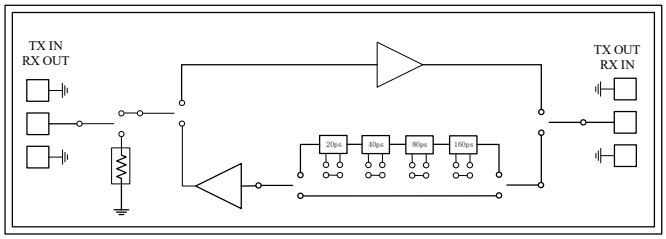
1. Description

- The M7109E(M) is a True-Time Delay (TDD) Multi-Function MMIC integrated Bi-Directional Amplifier, 4-bit TDD Circuit, Temperature Compensation Attenuator, SPDT Switch and Digital Control Circuit, which is fabricated on GaAs p-HEMT MMIC process.



M7109E(M)-PDS-F01

Figure 1. M7109E(M) Functional Block Diagram

2. Applications

- X-band T/R Modules

3. Features[1]

- Frequency Range: 5-13GHz
- T_X Small Signal Gain: 15dB
- T_X S11/S22: -20dB
- T_X Saturated Output Power: 8dBm
- T_X Quiescent Current: 36mA
- R_X Small Signal Gain: 6.5dB
- R_X S11/S22: -20dB/-15dB
- R_X Output P_{-1dB}: 18dBm
- R_X Quiescent Current: 100mA
- $\Delta Gain_{\text{Delay \& Non-Delay}}$: 1dB
- Time Delay Range: 0-300ps
- Time Delay Step: 20ps
- Delay Accuracy: 2%
- Die Size: 3.20 x 3.50 x 0.10mm

[1] On-wafer Test

4. Brief Typical Performance

Table 1. Brief Typical Performance

Parameter	5-13 GHz	Units
T_X Small Signal Gain	15	dB
T_X Saturated Output Power	8	dBm
T_X Quiescent Current	36	mA
R_X Small Signal Gain	6.5	dB
R_X Output P-1dB	18	dBm
R_X Quiescent Current	100	mA
Time Delay Range	0-300	ps
Time Delay Step	20	ps
Delay Accuracy	2	%

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5. Recommended Operating Conditions

Table 2. Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Units
Operating Temperature Range	-55	25	125	°C
Supply Voltage, VEE	-	-5	-	V
Control Voltage, SW1/SW2/Load	-	0/5	-	V
Control Voltage, V1-V4		0/5		V
R_X Supply Voltage, VR	-	5	-	V
T_X Supply Voltage, VT	-	5	-	V

6. RF Characteristics (T_C = 25˚C)

Table 3. RF Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
T_X Small Signal Gain	$S21_T_X$	14.8	15	15.2	dB
T_X S11	$S11_T_X$	-	-20	-18	dB
T_X S22	$S22_T_X$	-	-20	-	dB
T_X Saturated Output Power	$P_{SAT}_T_X$	7.8	8	8.4	dBm
T_X Quiescent Current	$I_{DQ}_T_X$	32	36	40	mA
R_X Small Signal Gain	$S21_R_X$	6	6.5	7	dB
R_X S11	$S11_R_X$	-	-20	-18	dB
R_X S22	$S22_R_X$	-	-15	-13	dB
R_X Output P_{-1dB}	$OP_{-1dB}_R_X$	17	18	19	dBm
R_X Quiescent Current	$I_{DQ}_R_X$	95	100	105	mA
Gain Difference Between Delay and Non-Delay States	$\Delta Gain_{\ Delay\ \&\ Non\text{-}Delay}$	-	1	-	dB
Time Delay Accuracy	A	-	-	2	%
Supply Current of Logic Circuit	I_{ss}	7	-	14	mA

• Typical performance at these conditions: Temp=+25°C，Vdd=+5V，50Ω system.

7. Typical Performance Curve

■ Small-signal Characteristics Curve

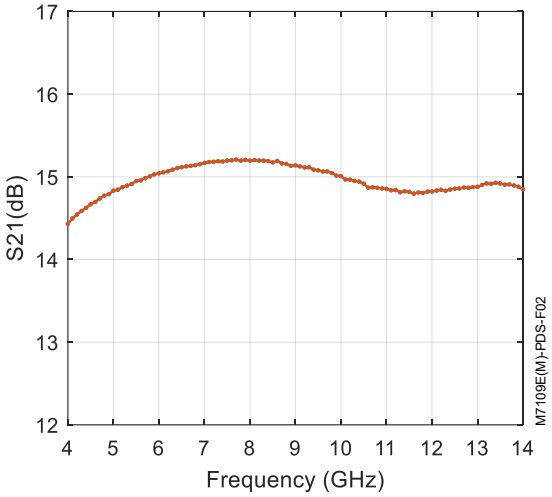


Figure 2. T_X Small-Signal Gain Characteristics

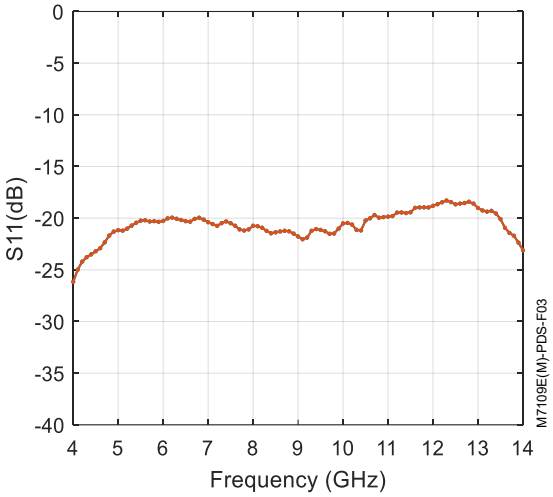


Figure 3. T_X Small-Signal S11 Characteristics

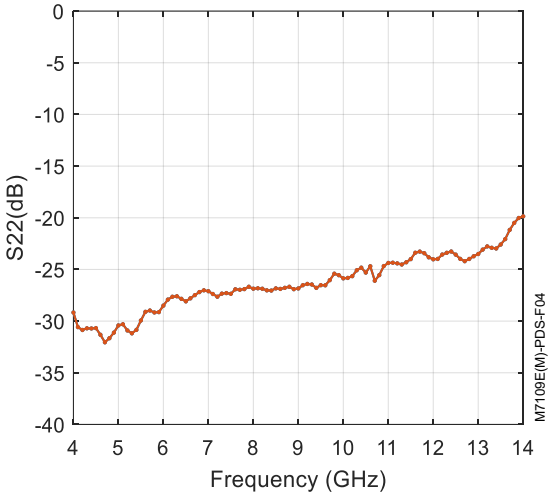


Figure 4. T_X Small-Signal S22 Characteristics

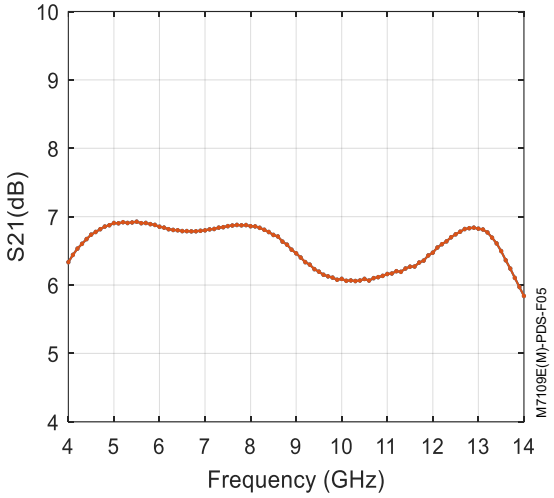


Figure 5. R_X Non-Delay-State Small-Signal Gain Characteristics

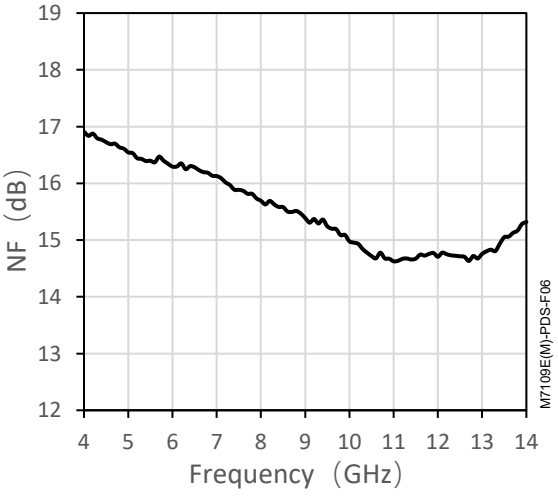


Figure 6. R_X Non-Delay-State NF Characteristics

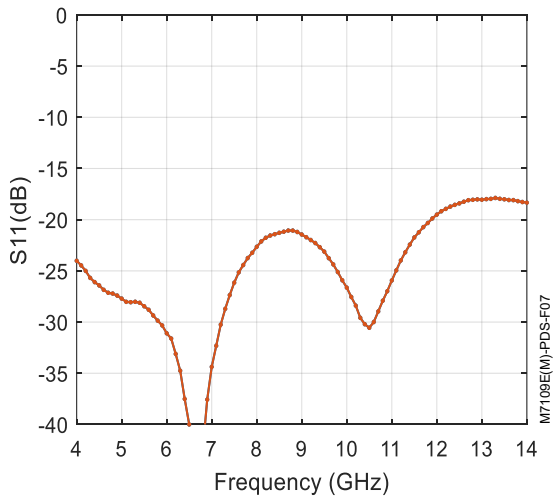


Figure 7. R_X Non-Delay-State S11 Characteristics

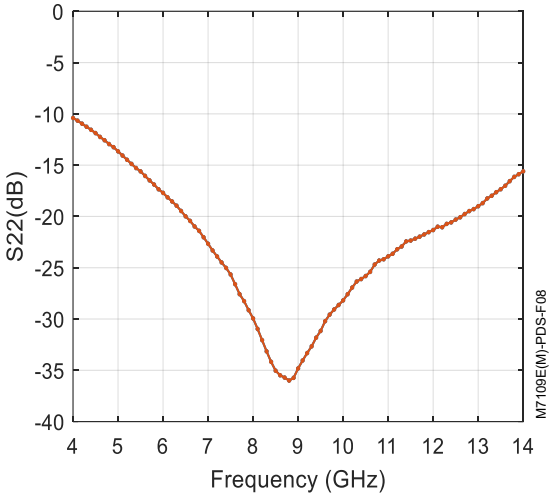


Figure 8. Rx Non-Delay-State S22 Characteristics

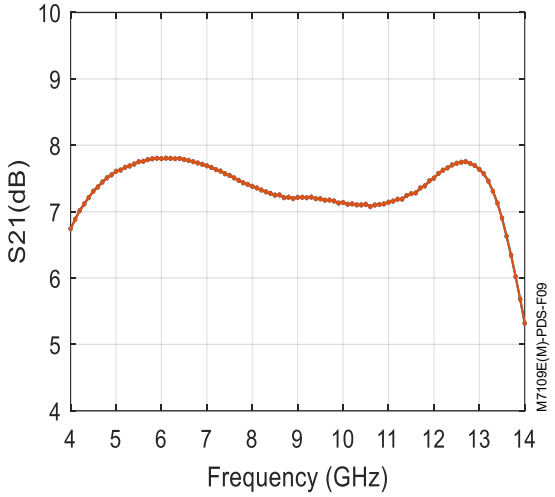


Figure 9. Rx Reference-State Small-Signal Gain Characteristics

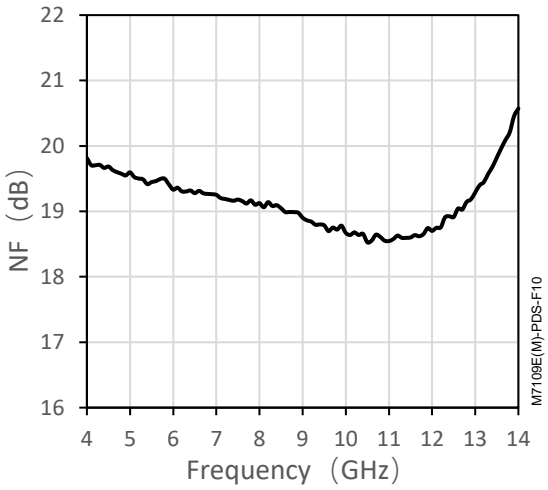


Figure 10. Rx Reference-State NF Characteristics

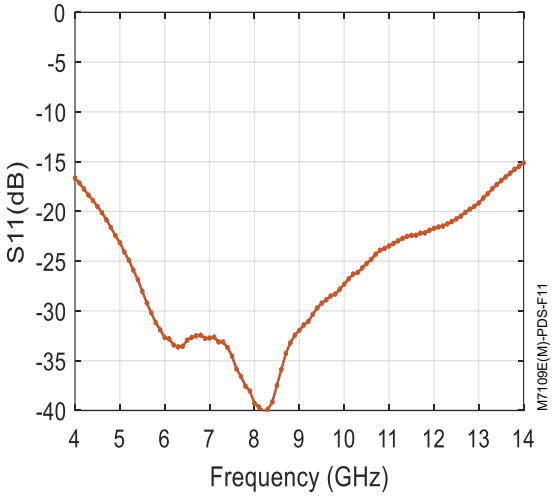


Figure 11. Rx Reference-State S11 Characteristics

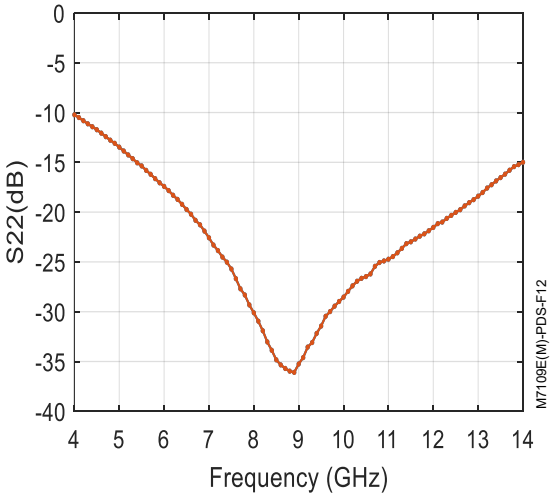


Figure 12. Rx Reference-State S22 Characteristics

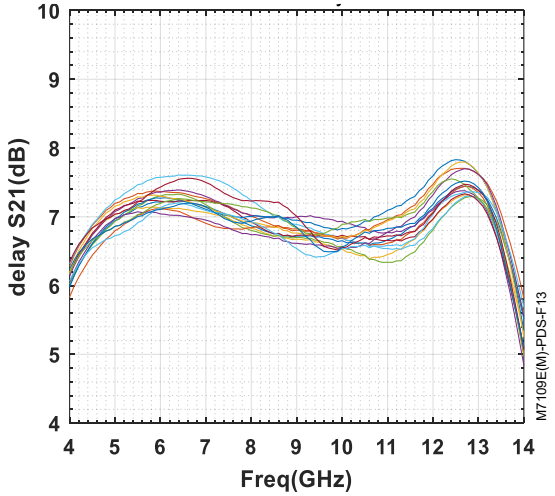
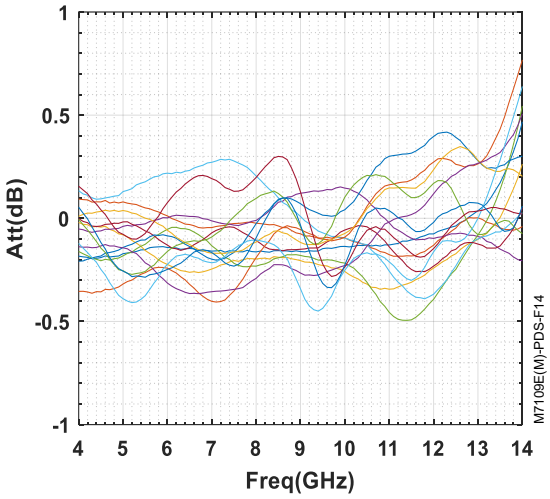


Figure 13. Rx Full-State Small-Signal Gain Characteristics



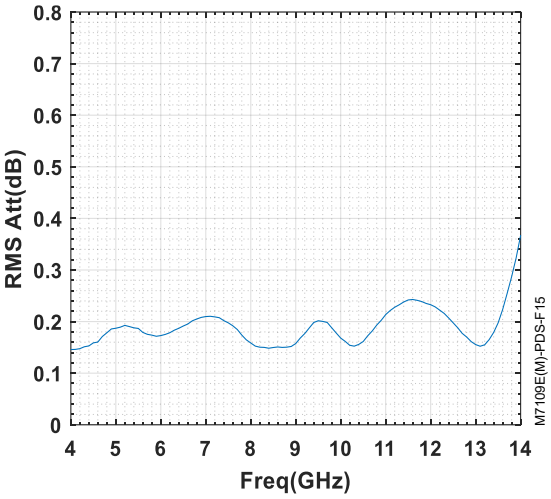


Figure 14. Rx Full-State Amplitude Error Characteristics **Figure 15. Rx Full-State Amplitude Error RMS Characteristics**

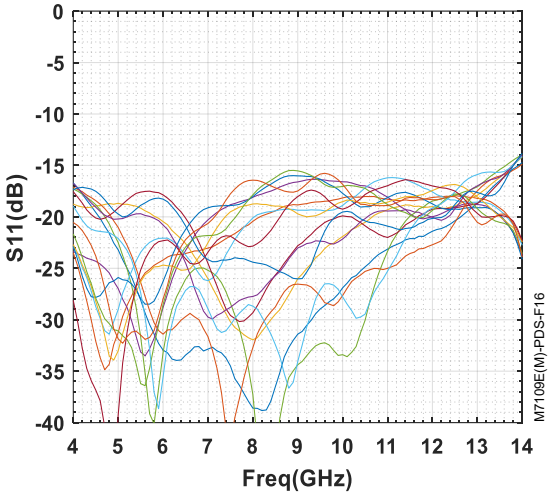


Figure 16. Rx Full-State S11 Characteristics

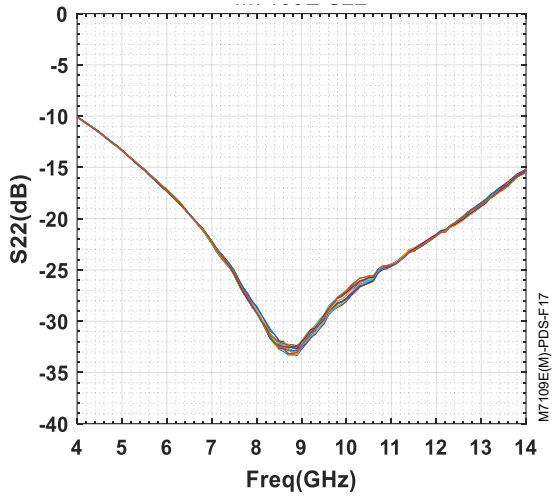


Figure 17. Rx Full-State S22 Characteristics

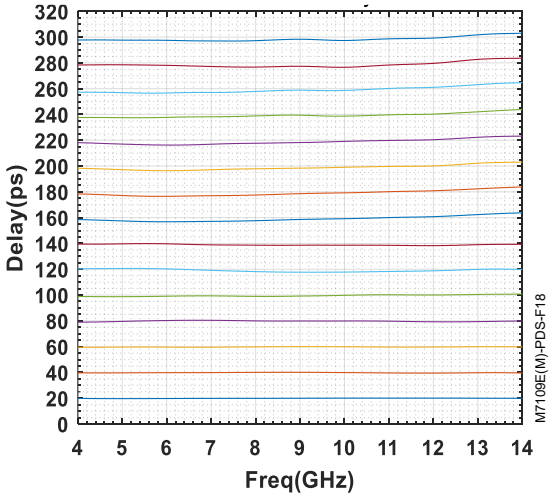


Figure 18. Rx Full-State Time Delay Characteristics

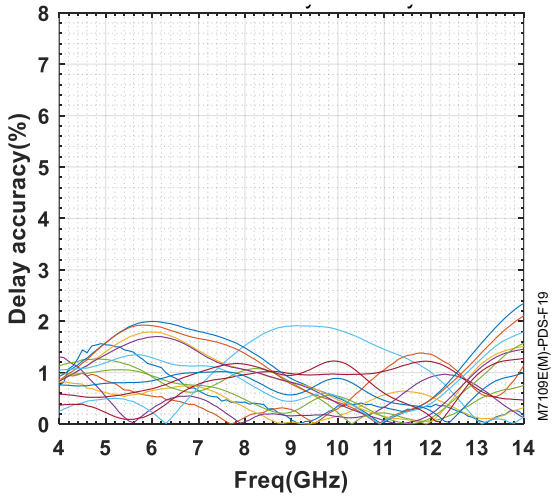


Figure 19. Rx Full-State Time Delay Accuracy Characteristics

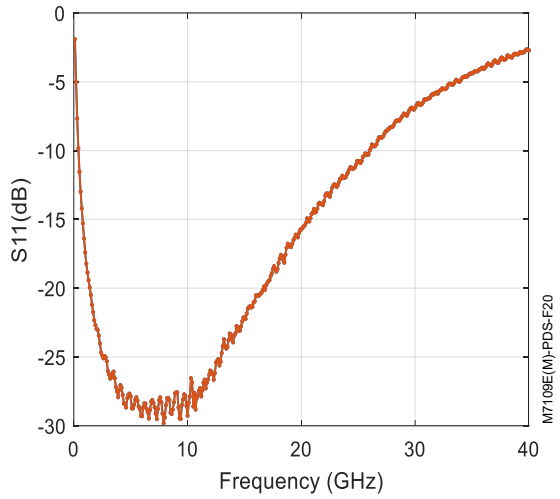


Figure 20. Load-State S11 Characteristics

■ Power Characteristic Curve

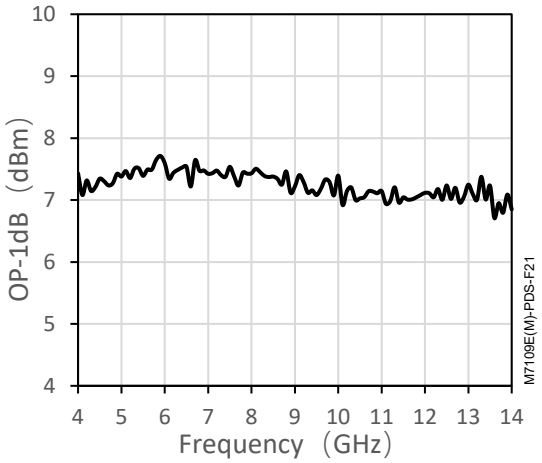


Figure 21. T_X OP_{-1dB} Characteristics

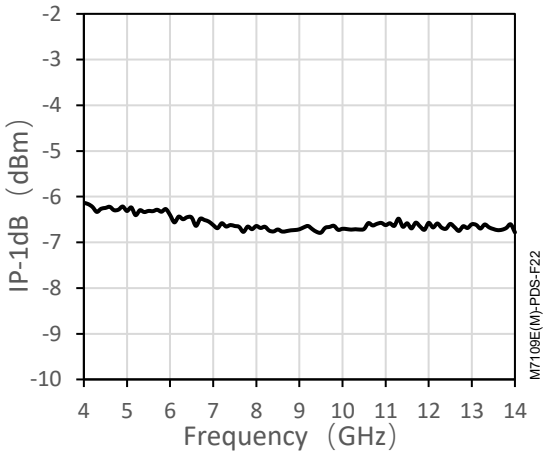


Figure 22. T_X IP_{-1dB} Characteristics

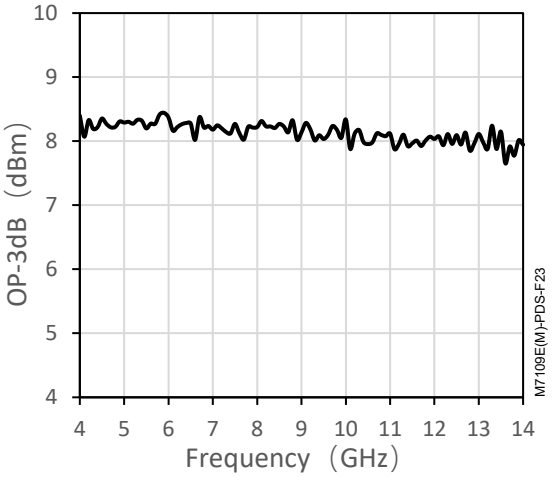


Figure 23. T_X OP_{-3dB} Characteristics

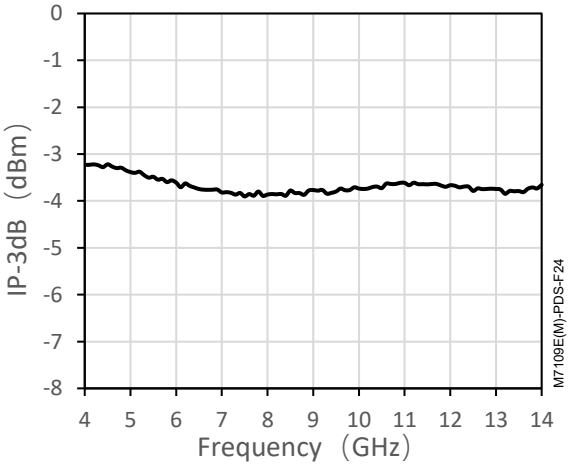


Figure 24. T_X IP_{-3dB} Characteristics

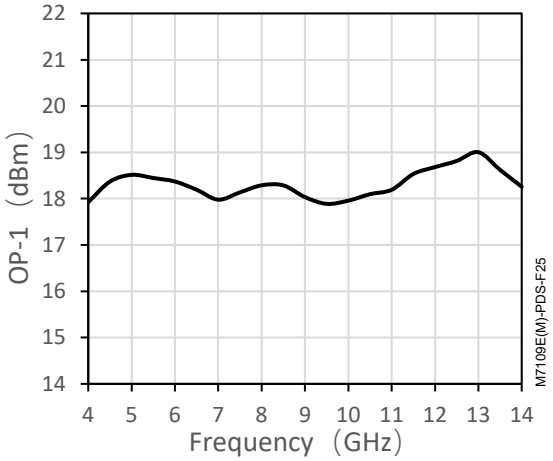


Figure 25. R_X Non-Delay-State OP_{-1dB} Characteristics

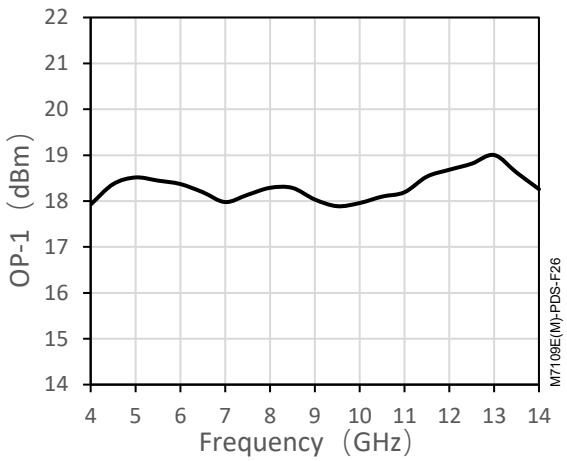
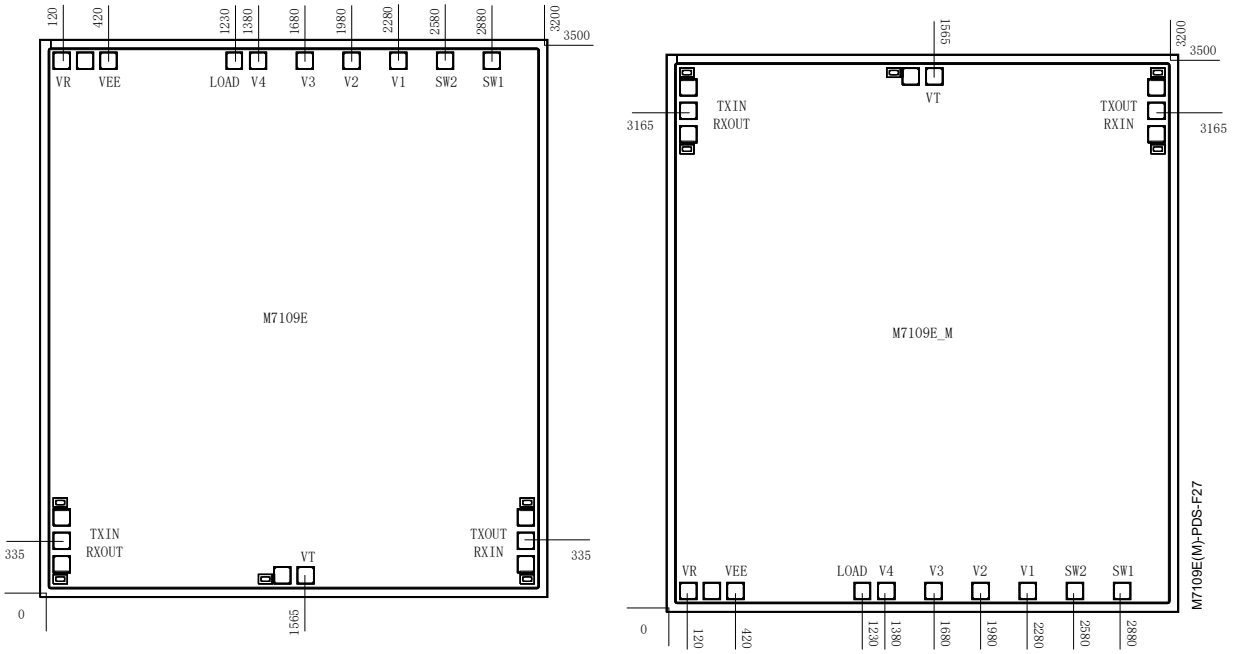


Figure 26. R_X Reference-State OP_{-1dB} Characteristics

8. Outline Dimensions



- Dimensions shown in micrometre

Figure 27. M7109E(M) Outline Dimensions

Table 4. Pad Description

Pad	Symbol	Description
1	TX_IN/RX_OUT	T_X Input / R_X Output
2	TX_OUT/RX_IN	T_X Output / R_X Input
3	VT	T_X Supply Voltage
4	VR	R_X Supply Voltage
5	VEE	Supply Voltage
6	SW1	Control Voltage of T_X State and R_X State
7	SW2	Control Voltage of Delay State and Non-Delay State
8	V1	Control Voltage of 20ps Delay
9	V2	Control Voltage of 40ps Delay
10	V3	Control Voltage of 80ps Delay
11	V4	Control Voltage of 160ps Delay
12	LOAD	Control Voltage of Load State and Working State

Table 5. Truth Table[1]

Control port			SW1	SW2	V1	V2	V3	V4	VEE	LOAD
Tx			1	-	-	-	-	-	-5V	1
Rx	Non-Delay		0	0	-	-	-	-	-5V	1
	Delay	0ps	0	1	0	0	0	0	-5V	1
		20ps	0	1	1	0	0	0	-5V	1
		40ps	0	1	0	1	0	0	-5V	1
		80ps	0	1	0	0	1	0	-5V	1
		160ps	0	1	0	0	0	1	-5V	1
Load			-	-	-	-	-	-	-5V	0

1. "0" for low voltage -0.5V~+0.5V, and "1" for high voltage +3V~+5.5V.

9. Assembly Information

■ Assembly Diagram

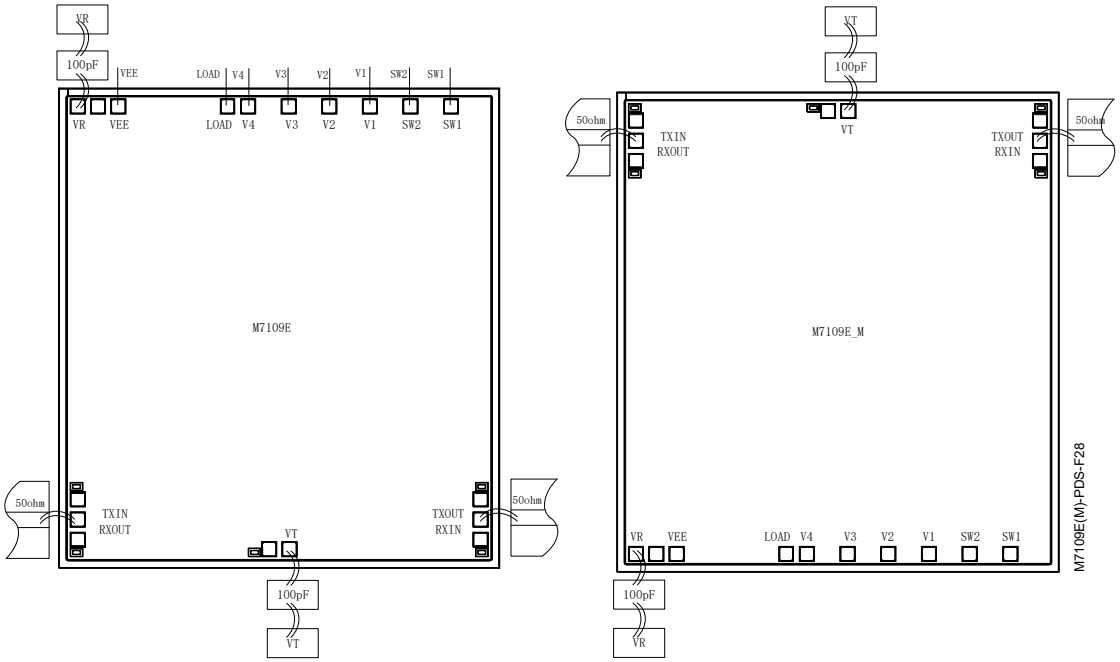


Figure 28. M7109E(M) Assembly Diagram

- **Eutectic Die Attach:** It is best to use an 80% Au/20% Sn preform. Do not expose the chip to a temperature greater than 300°C for more than 30sec.
- **Wire Bonding:** RF bonds made with 1mil gold wire are recommended for the RF ports. Keep all bonds as short as possible, less than 0.35mm.

10. Handling Precautions

- **Storage**
  All bare dies ship in either Waffle or Gel Pak, which is an ESD protective container, and then sealed in an ESD protective bag. After opening the sealed ESD protective bag, all dies must be stored in a dry nitrogen environment.
- **Cleanliness**
  Handle the dies in a clean environment. Never use liquid cleaning systems to clean the dies.
- **ESD Caution**
  ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore proper ESD precautions should be taken to avoid performance degradation or loss of functionality.



11. Contact Information

For the latest specifications, additional product information, technical support and sales support, please contact:

- **Email:** RF.support@raytrontek.com
- **Web:** www.raytrontek.com

12. Disclaimer

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