## 1. Description

- The M0059 is a wideband, 4-bit Digital Controlled True-Time Delay operating from 2 to 6GHz, which is fabricated using GaAs MMIC process. It provides true time delay (TTD) functionality with a precise minimum step of 80ps. The device maintains an insertion loss of -14dB and achieves return loss better than -15dB, making it an ideal solution for advanced RF and microwave systems requiring precise time control.

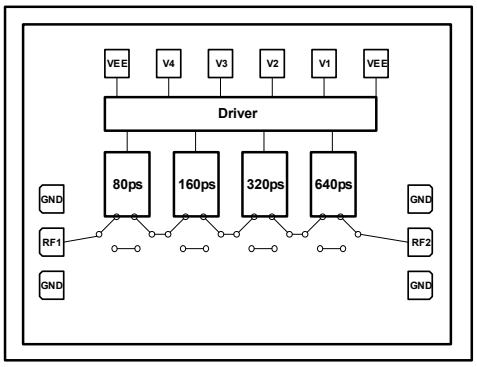



**Figure 1. M0059 Functional Block Diagram**

## 2. Applications

- TX/RX Modules
- Radar
- Defense

## 3. Features

- Frequency Range: 2 - 6GHz
- Insertion Loss: -14dB
- Input/Output Return Loss: -15dB
- Time Delay Step: 80ps
- Time Delay Range: 0 - 1200ps
- Time Delay Accuracy: <10%
- Amplitude Error RMS: 0.5dB
- Control Voltage: 0/+5V
- Die Size: 3.35 x 4.45 x 0.10mm

[1] On-wafer Test

## 4. Brief Typical Performance

**Table 1. Brief Typical Performance**

| Parameter | 2-6 GHz | Units |
|---|---|---|
| Insertion Loss | 14 | dB |
| Input/Output Return Loss | -15 | dB |
| Time Delay Step | 80 | ps |
| Time Delay Range | 0-1200 | ps |
| Time Delay Accuracy | <10 | % |
| Amplitude Error RMS | 0.5 | dB |

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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 |
| Control Voltage, V1-V4 | - | 0/5 | - | V |
| Reference Voltage, VEE | - | -5 | - | V |

## 6. RF Characteristics ($T_C$ = 25˚C)

**Table 3. RF Characteristics[1]**

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Insertion Loss | IL | 8.5 | - | 14 | dB |
| Input Return Loss | $RL_{IN}$ | - | -20 | -15 | dB |
| Output Return Loss | $RL_{OUT}$ | - | -20 | -15 | dB |
| Time Delay Error | Error | - | <10 | - | % |
| Amplitude Error RMS | ΔIL | - | 0.3 | 0.5 | dB |

[1]. Test condition: Input signal CW

## 7. Typical Performance Curve

### ■ Small-signal Characteristics Curve

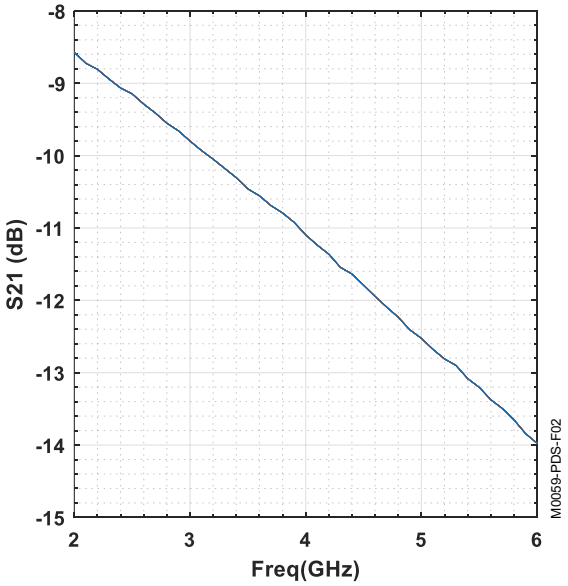



Figure 2. Reference State Insertion Loss Characteristics

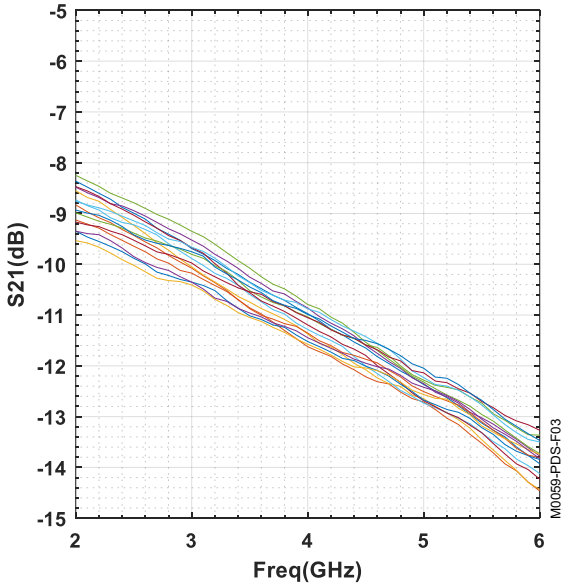



Figure 3. Full State Insertion Loss Characteristics

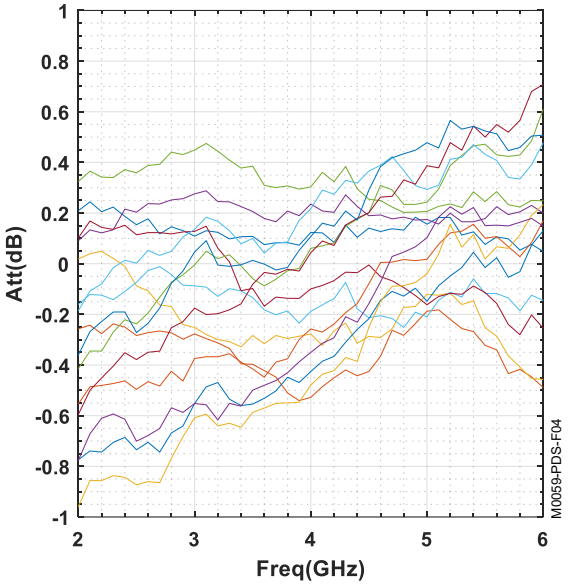



Figure 4. Full State Amplitude Error Characteristics

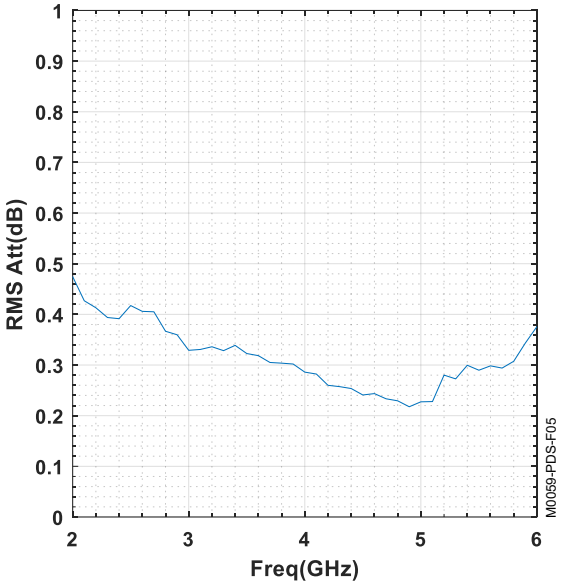



Figure 5. Amplitude Error RMS Characteristics

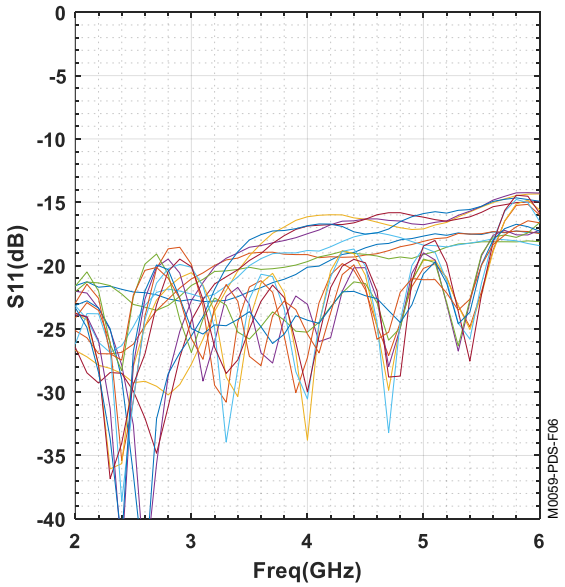



Figure 6. Full State Iuput Return Loss Characteristics

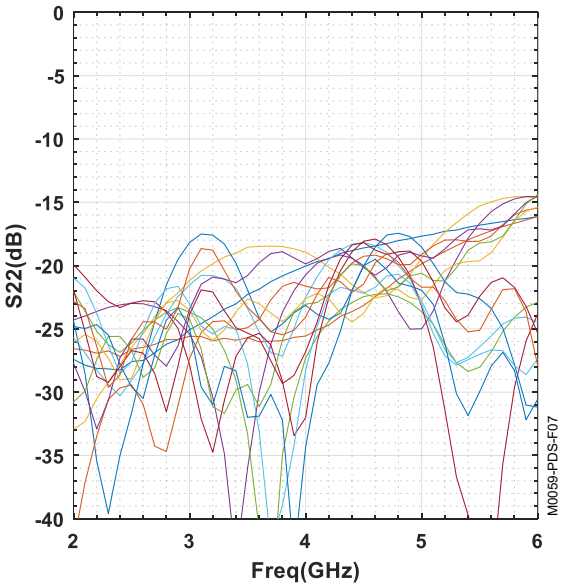



Figure 7. Full State Output Return Loss Characteristics

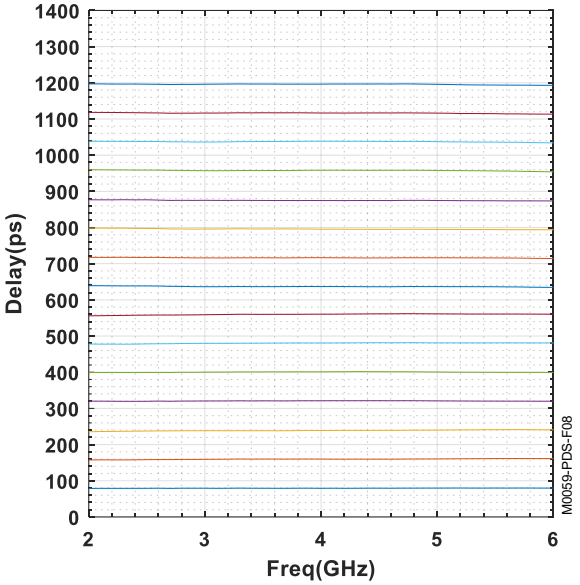



Figure 8. Full State Time Delay Characteristics

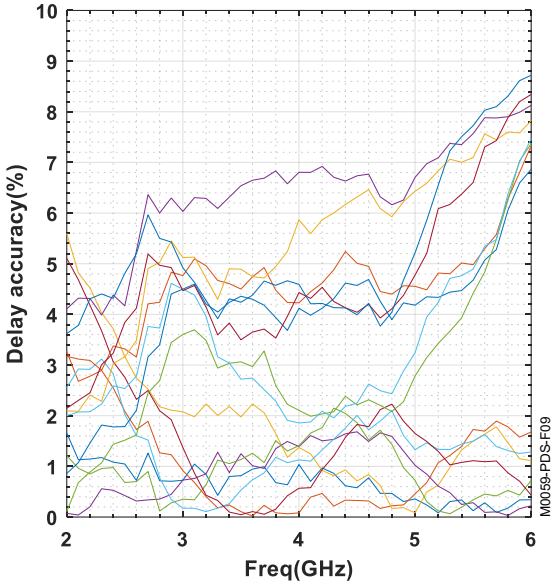
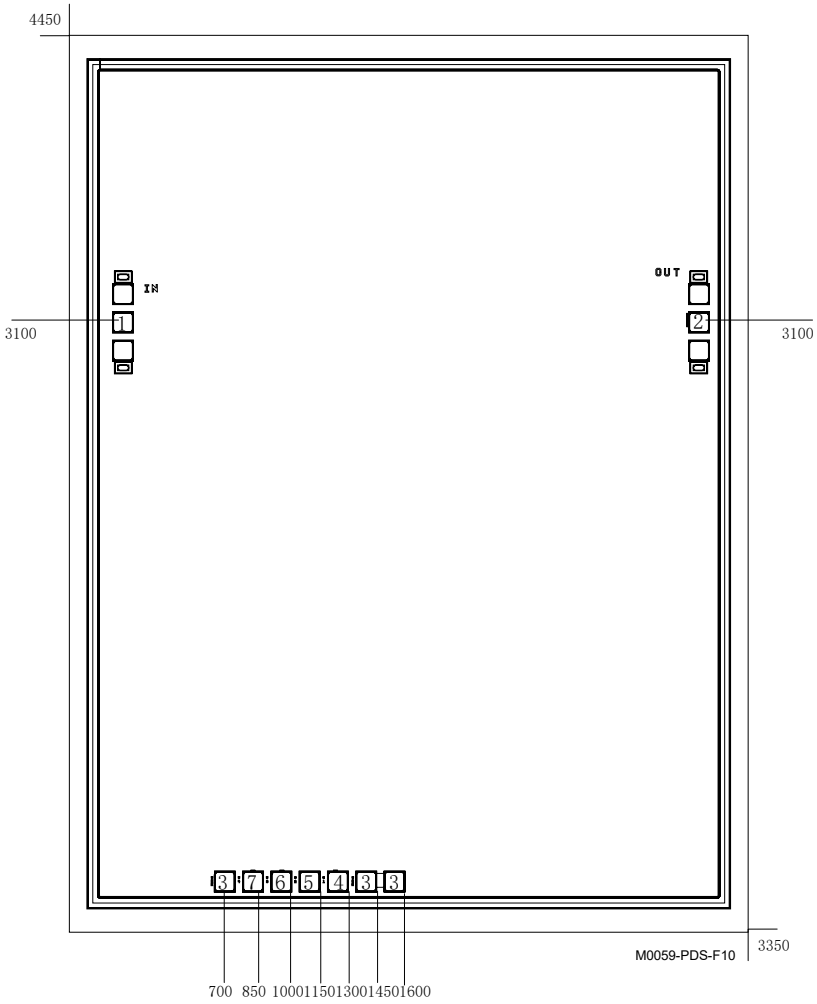



Figure 9. Full State Time Delay Error Characteristics

## 8. Outline Dimensions




- Dimensions shown in micrometre

Figure 10. M0059 Outline Dimensions

## Table 4. Pad Description

| Pad | Symbol | Description |
|---|---|---|
| 1 | RF1 | RF Input |
| 2 | RF2 | RF Output |
| 4-7 | V1-V4 | Control Voltage |
| 3 | VEE | Reference Voltage |

## Table 5. Truth Table (Logic "0" = 0V, Logic"1" = +5V)

| | V1 | V2 | V3 | V4 | VEE |
|---|---|---|---|---|---|
| 0(Reference) | 0 | 0 | 0 | 0 | -5 |
| 80ps | 1 | 0 | 0 | 0 | -5 |
| 160ps | 0 | 1 | 0 | 0 | -5 |
| 320ps | 0 | 0 | 1 | 0 | -5 |
| 640ps | 0 | 0 | 0 | 1 | -5 |
| 1200ps | 1 | 1 | 1 | 1 | -5 |

# 9. Assembly Information

## ■ Assembly Diagram

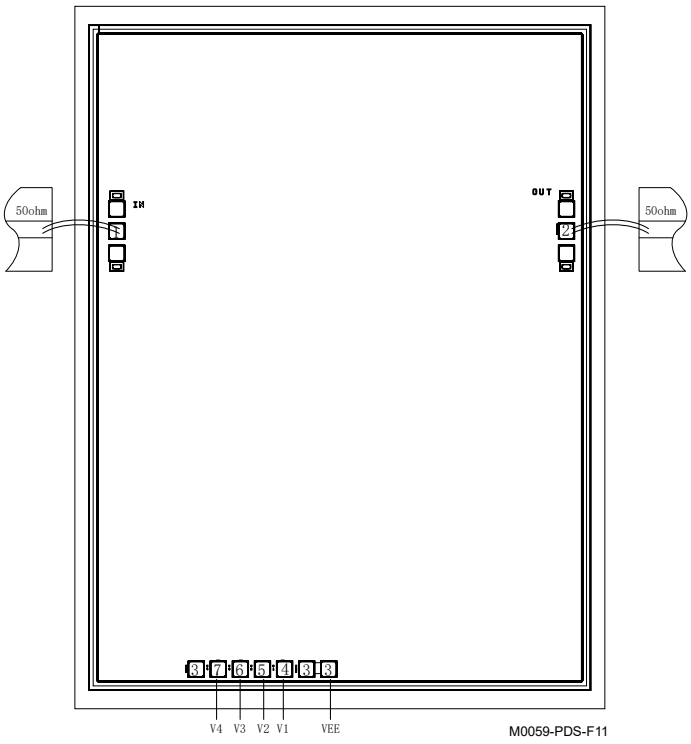



**Figure 11. M0059 Assembly Diagram**

- **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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