Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

By Michael Laemmlen and John Fisher

In recent years, Wi-Fi connectivity has penetrated most consumer electronic devices used for media reproduction. New TVs, satellite receivers and cable boxes, and streaming devices are built with Wi-Fi capabilities at multiple frequencies: 2.4 GHz and 5 GHz. One of the features of Vishay's newest IC generation is a general improvement in robustness to RF disturbances, particularly from Wi-Fi. The new Mneme IC (TSOP1xxxx series devices) and Cyllene IC (TSOP9xxxx series devices) show a reduction in spurious pulses over the previous generation IC series in all packages.

IR remote control receivers are built with highly sensitive wideband input stages and are able to detect signals near the noise level of their circuitry. In noisy environments, such as with both low and high frequency electromagnetic interference (EMI), the receiver may be noise-triggered, typically manifesting itself in the form of spurious pulses at its output. Most Vishay IR receiver packages are designed with internal metal shields to effectively guard the receiver against low frequency EMI. However, these metal shields have not proven entirely satisfactory against high frequency EMI in the GHz range used for Wi-Fi.

Empirical testing has shown that a number of factors play a role in the robustness of a package to RF noise. The internal shield design, differences in receiver IC design, the automatic gain control (AGC) setting programmed into the chip: all of these factors affect the receiver's sensitivity to RF. Metal holders may improve or worsen RF robustness, depending on their design. Adding RF capacitors between the supply and ground, and between the output and ground, is another proven - albeit expensive - method to improve the RF rejection. Such capacitors may serve as an emergency measure once an RF problem is detected when a design is already in an advanced stage. The primary design goal, however, is to not require them. The most significant factors governing whether an IR receiver exhibits RF triggered noise are the power level of the RF signal and the distance the receiver package is mounted away from the RF antenna. Lowering the power and increasing the distance both lower the chance of disturbance.

In this application note, the effects of all these factors are quantified as an aid to selecting the most appropriate Vishay IR receivers in Wi-Fi environments. Testing methodology and test data supporting the recommendations are presented.

TEST METHODOLOGY

Test Equipment

The RF signal source used for all the tests was an off the shelf WLAN router in combination with a USB network interface controller (NIC), fulfilling the IEEE 802.11ac specification for 5 GHz and IEEE 802.11n for 2.4 GHz. The USB NIC had a maximum output power of 200 mW and contained an integrated RF antenna. It was observed in all tests that the device under test (DUT) was more sensitive to noise at 5 GHz at a power level of 200 mW than to the less powerful noise at 2.4 GHz at 100 mW. A repeatable RF noise environment was created by placing the test board containing the DUT at a measured distance from the NIC antenna. A streaming routine was then initiated that sent a large file from the NIC to the router.

Fig. 1 - USB Adapter With WiFi Antenna Inside

Fig. 2 - Example: Minicast Receiver Mounted on PCB

Test Conditions

All measurements were performed in dark ambient. IR receivers contain an AGC that reacts to the ambient light levels. In dark ambient, the receiver's gain will settle to its maximum sensitivity level, thus providing a repeatable known state. This maximum gain level is also the operating condition most susceptible to seeing a disturbance from noise.

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Test PCB (Below for Side View Holders) and Location of Antenna

(Example pictures below: no metal holder, Minicast receiver mounted on test PCB)

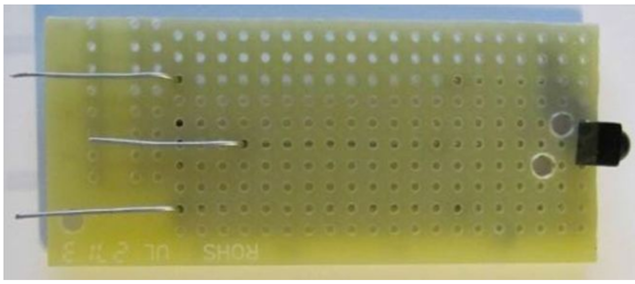


Fig. 3 - Front of PCB

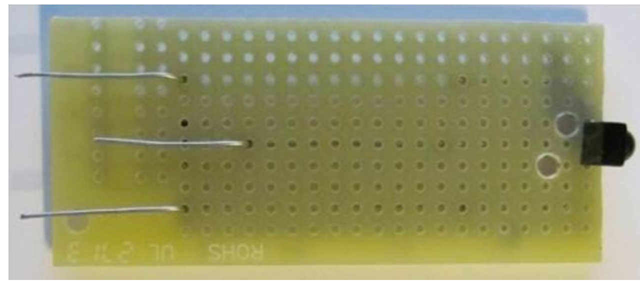


Fig. 4 - Back of PCB (with 1 kΩ pull-up resistor)

Length of supply wires and output line are each 0.5 m (no loops - to avoid coupling effects).

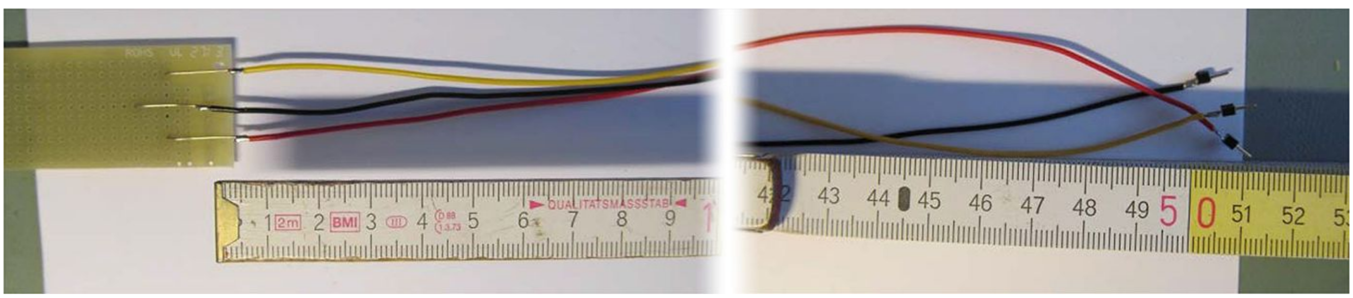


Fig. 5

Measurement 1: the DUT was mounted at a set distance from the RF antenna. The RF data transmission was then initiated from the NIC to the router, and any spurious pulses at the output of the IR receiver were counted within 60-second intervals. This procedure was repeated several times, and an average value was calculated. The test board was then moved to a new position from the antenna and the test was repeated.

Measurement 2: the distance between the DUT and the RF antenna was adjusted during data transmission to find the “threshold” distance. The threshold distance is defined as the minimum distance between the DUT and the antenna for which there is no significant disturbance to the IR receiver. At distances closer than the threshold, spurious pulses became a problem. At distances equal to and further than the threshold, no noise issues could be observed.

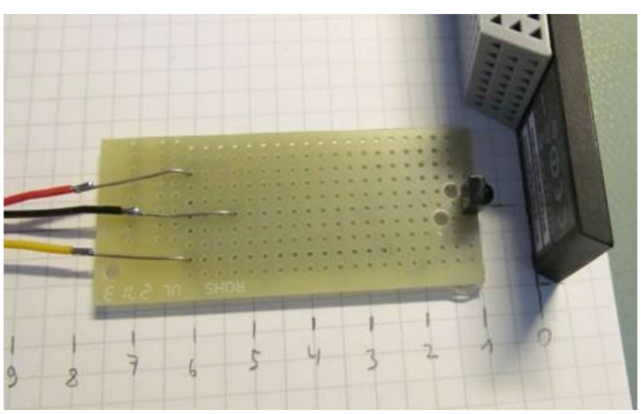


Fig. 6 - Antenna at 1 cm Distance

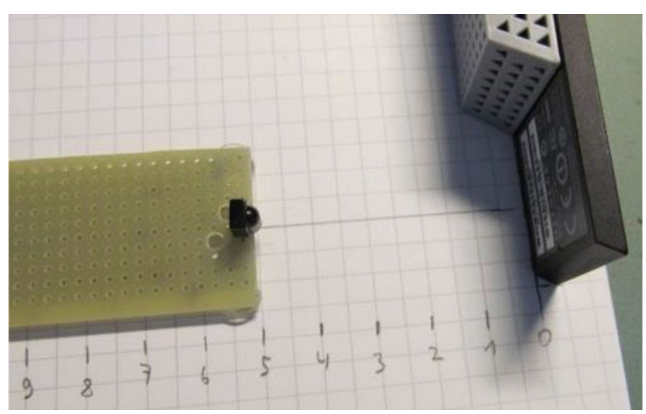


Fig. 7 - Antenna at 5 cm Distance

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

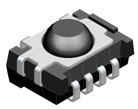
Test Results for Leaded Parts

For each device the number of unwanted output pulses at distances of 5 cm, 3 cm, 1 cm, and 0 cm from the antenna is shown in the table for 2.4 GHz and 5 GHz Wi-Fi interference. The last column contains the threshold antenna distance of the device without unwanted pulses.

SUMMARY OF TEST RESULTS: LEADED PACKAGES WITHOUT HOLDER

PACKAGE	FREQUENCY (GHz)	DUT	5 cm	3 cm	1 cm	0 cm	THRESHOLD (cm)
Minimold 	2.4	TSOP13338	0	0	0	0	0
		TSOP13438	0	0	0	0	0
		TSOP93338	0	0	0	20	1
		TSOP93438	0	0	0	10	1
	5.0	TSOP13338	0	0	0	0	0
		TSOP13438	0	0	0	0	0
		TSOP93338	0	0	0	> 20 000	1
		TSOP93438	0	0	0	1300	1
Mold 	2.4	TSOP14338	0	0	0	0	0
		TSOP14438	0	0	0	0	0
		TSOP94338	0	0	250	2000	2
		TSOP94438	0	0	20	800	2
	5.0	TSOP14338	0	0	0	10	1
		TSOP14438	0	0	0	0	0
		TSOP94338	15	650	2700	3000	6
		TSOP94438	0	160	200	200	5
Minicast 	2.4	TSOP18338	0	0	0	0	0
		TSOP18438	0	0	0	0	0
		TSOP98338	0	0	20	100	2
		TSOP98438	0	0	0	15	1
	5.0	TSOP18338	0	0	0	0	0
		TSOP18438	0	0	0	0	0
		TSOP98338	0	0	1500	8000	3
		TSOP98438	0	0	100	330	2
TVcast 	2.4	TSOP93338	0	0	0	30	1
		TSOP93438	0	0	0	1	0
	5.0	TSOP93338	0	5	900	3000	3
		TSOP93438	0	0	20	40	2
Cast 	2.4	TSOP11438	0	0	0	0	0
	5.0	TSOP11438	0	0	0	0	0

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

SUMMARY OF TEST RESULTS: SURFACE-MOUNT PACKAGES							
PACKAGE	**FREQUENCY (GHz)**	**DUT**	**5 cm**	**3 cm**	**1 cm**	**0 cm**	**THRESHOLD (cm)**
Heimdall 	2.4	TSOP95338	0	0	100	750	3
		TSOP95438	0	0	11	280	2
	5.0	TSOP95338	0	0	0	420	1
		TSOP95438	0	0	0	16	1
Panhead 	2.4	TSOP96338	0	0	8000	1700	3
		TSOP96438	0	0	300	400	2
	5.0	TSOP96338	3000	3500	3700	5000	9
		TSOP96438	140	150	200	400	7

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Wi-Fi MEASUREMENTS WITH METAL HOLDERS

The metal holders were always connected to GND potential.

Minicast (Holder CA1 / CE1)

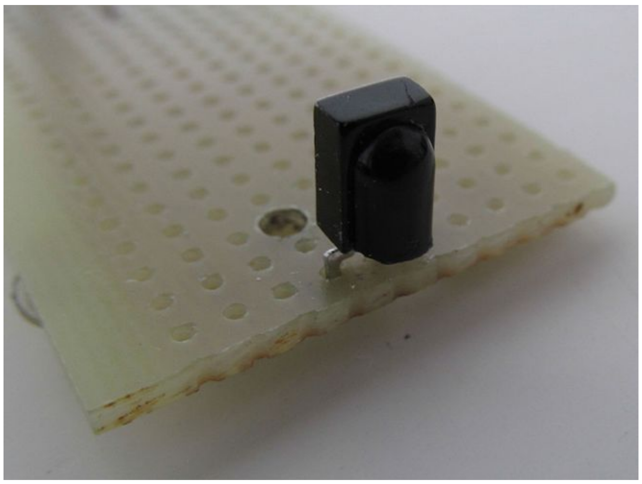


Fig. 8 - Minicast Without Holder

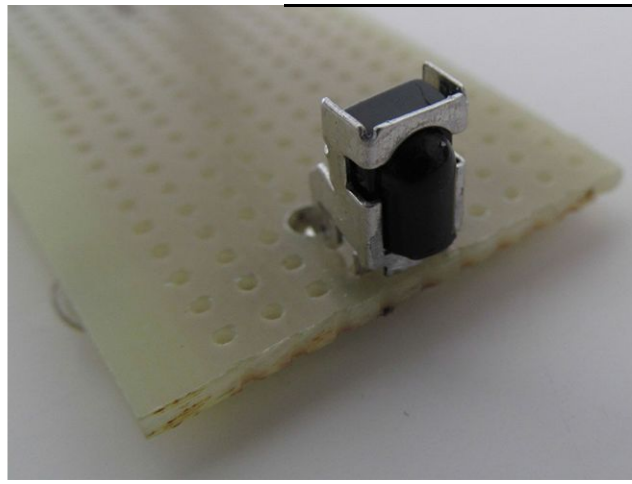


Fig. 9 - Minicast With Holder CA1 / CE1

For each device the number of unwanted output pulses at distances of 5 cm, 3 cm, 1 cm, and 0 cm from the antenna is shown in the table for 2.4 GHz and 5 GHz Wi-Fi interference. The last column contains the threshold antenna distance of the device without unwanted pulses.

SUMMARY OF TEST RESULTS

PACKAGE	FREQUENCY (GHz)	DUT	5 cm	3 cm	1 cm	0 cm	THRESHOLD (cm)
No Holder 	2.4	18338	0	0	0	0	0
		98338	0	0	15	100	2
	5	18338	0	0	0	0	0
		98338	0	20	4000	7000	4
Holder CA1 / CE1 	2.4	18338	0	0	0	0	0
		98338	0	0	10	100	2
	5	18338	0	0	0	0	0
		98338	0	20	4000	7000	4

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Minicast (Holder CB1 / CZ1)

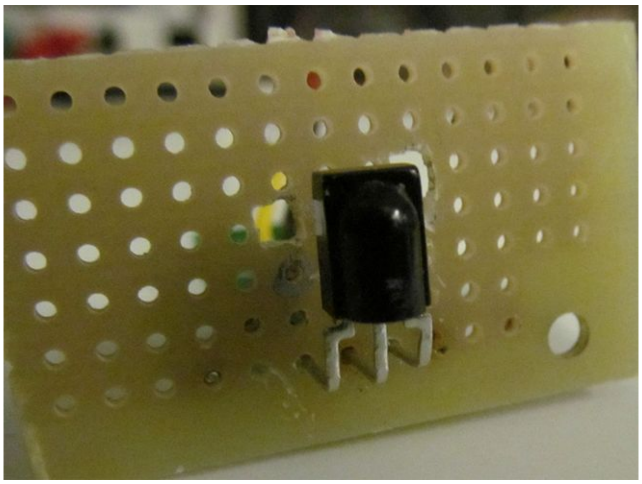


Fig. 10 - Minicast Without Holder

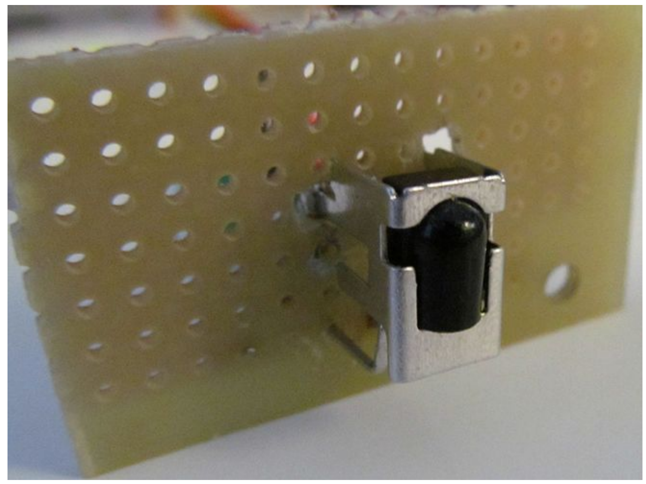
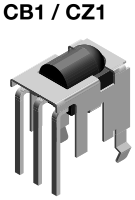


Fig. 11 - Minicast With Holder CB1 / CZ1

SUMMARY OF TEST RESULTS							
PACKAGE	**FREQUENCY (GHz)**	**DUT**	**5 cm**	**3 cm**	**1 cm**	**0 cm**	**THRESHOLD (cm)**
No Holder 	2.4	18338	0	0	0	0	0
		98338	0	0	0	0	0
	5	18338	0	0	0	0	0
		98338	0	0	300	1400	3
Holder CB1 / CZ1 	2.4	18338	0	0	0	0	0
		98338	0	0	0	0	0
	5	18338	0	0	0	0	0
		98338	0	0	30	300	2

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Minicast (Holder CC1)

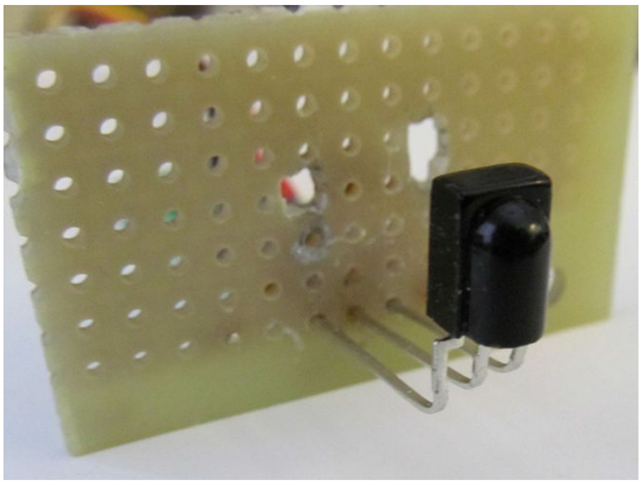


Fig. 12 - Minicast Without Holder

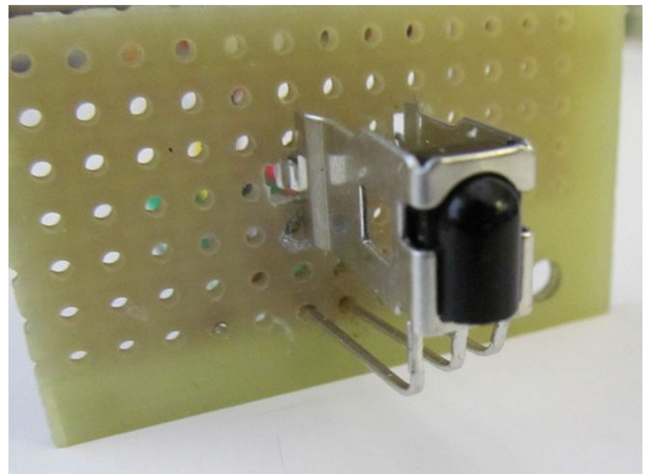
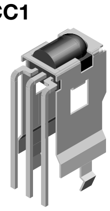


Fig. 13 - Minicast With Holder CC1

SUMMARY OF TEST RESULTS							
PACKAGE	**FREQUENCY (GHz)**	**DUT**	**5 cm**	**3 cm**	**1 cm**	**0 cm**	**THRESHOLD (cm)**
No Holder 	2.4	18338	0	0	0	0	0
		98338	0	0	0	0	0
	5	18338	0	0	0	0	0
		98338	0	0	0	1000	1
Holder CC1 	2.4	18338	0	0	0	0	0
		98338	0	0	0	0	0
	5	18338	0	0	0	0	0
		98338	0	0	0	800	1

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Minicast (Holder PA1)

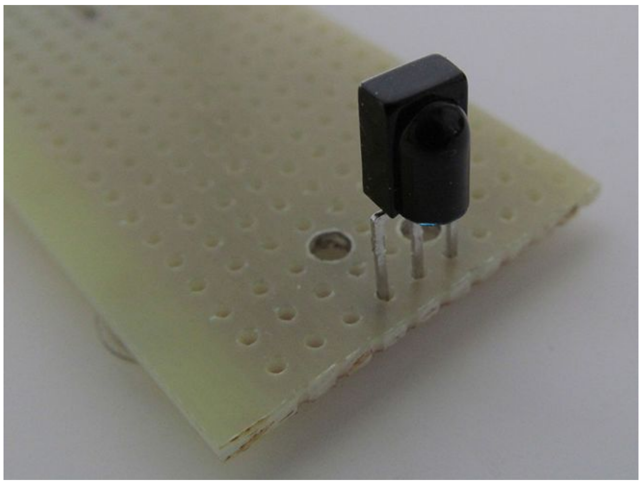


Fig. 14 - Minicast Without Holder

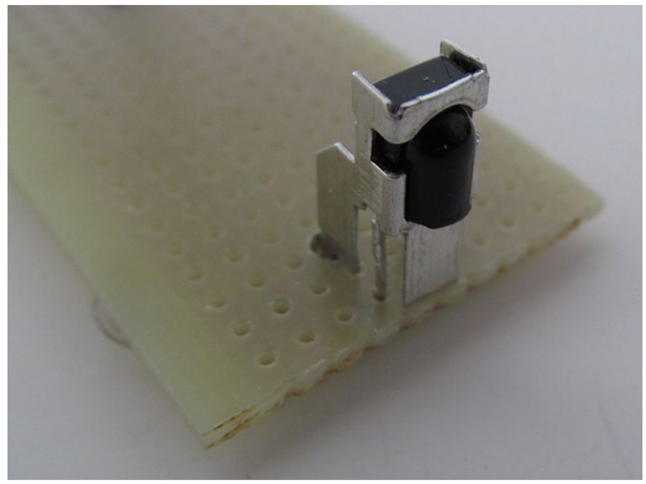
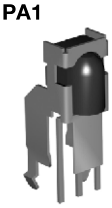


Fig. 15 - Minicast With Holder PA1

SUMMARY OF TEST RESULTS							
PACKAGE	**FREQUENCY (GHz)**	**DUT**	**5 cm**	**3 cm**	**1 cm**	**0 cm**	**THRESHOLD (cm)**
No Holder 	2.4	18338	0	0	0	0	0
		98338	0	0	0	130	1
	5	18338	0	0	0	0	0
		98338	0	0	1500	9000	3
Holder PA1 	2.4	18338	0	0	0	0	0
		98338	0	0	0	60	1
	5	18338	0	0	0	0	0
		98338	4	1400	6000	10 000	5

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Mold (Holder JH1 / JK1 / JL1)

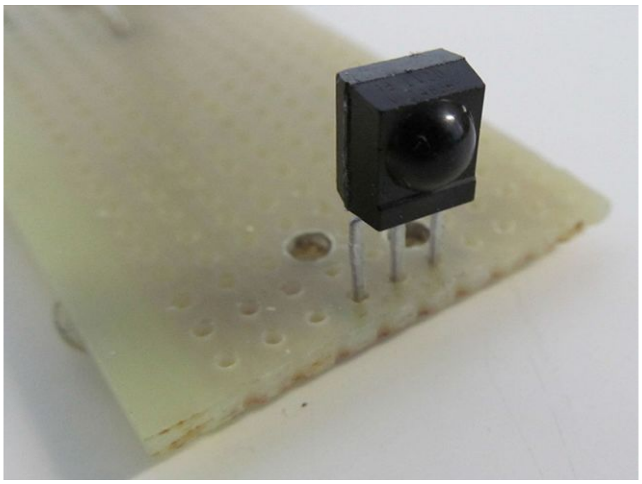


Fig. 16 - Mold Without Holder

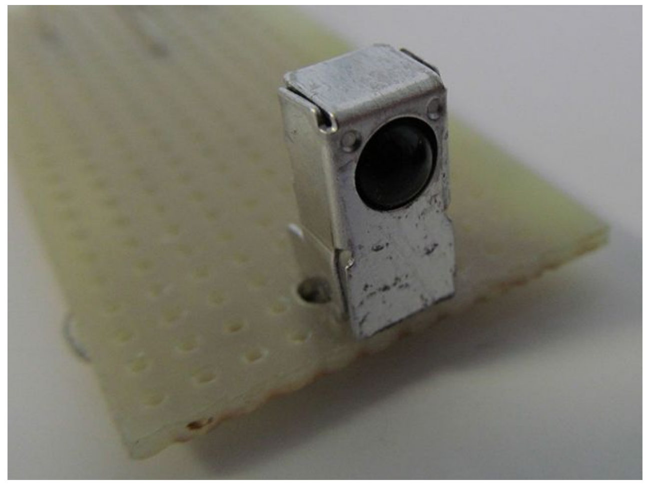
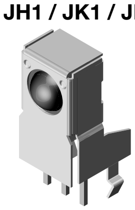


Fig. 17 - Mold With Holder JH1 / JK1 / JL1

SUMMARY OF TEST RESULTS							
PACKAGE	**FREQUENCY (GHz)**	**DUT**	**5 cm**	**3 cm**	**1 cm**	**0 cm**	**THRESHOLD (cm)**
No Holder 	2.4	14338	0	0	0	0	0
		94338	0	0	200	2000	2
	5	14338	0	0	0	1	0
		94338	10	2000	6000	9000	6
Holder JH1 / JK1 / JL1 	2.4	14338	0	0	0	0	0
		94338	0	0	0	60	1
	5	14338	0	0	0	0	0
		94338	10	400	2000	9000	6

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Mold (Holder CD1)

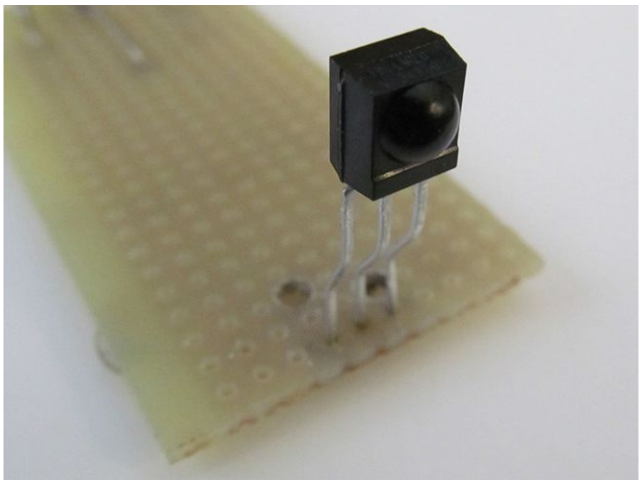


Fig. 18 - Mold Without Holder

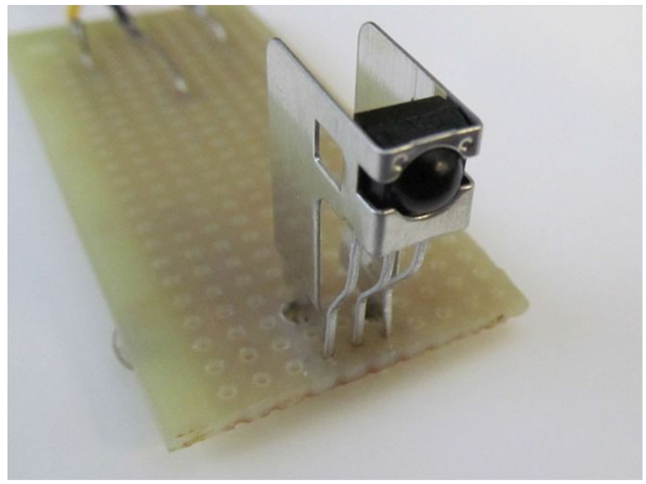
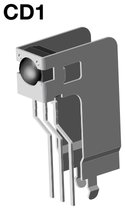


Fig. 19 - Mold With Holder CD1

SUMMARY OF TEST RESULTS							
PACKAGE	**FREQUENCY (GHz)**	**DUT**	**5 cm**	**3 cm**	**1 cm**	**0 cm**	**THRESHOLD (cm)**
No Holder 	2.4	14338	0	0	0	0	0
		94338	0	0	160	2000	2
	5	14338	0	0	0	0	0
		94338	0	100	1800	5000	4
Holder CD1 	2.4	14338	0	0	0	0	0
		94338	0	20	800	1600	4
	5	14338	0	0	0	10	1
		94338	0	1000	3500	> 20 000	5

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Mold (Holder PM1)

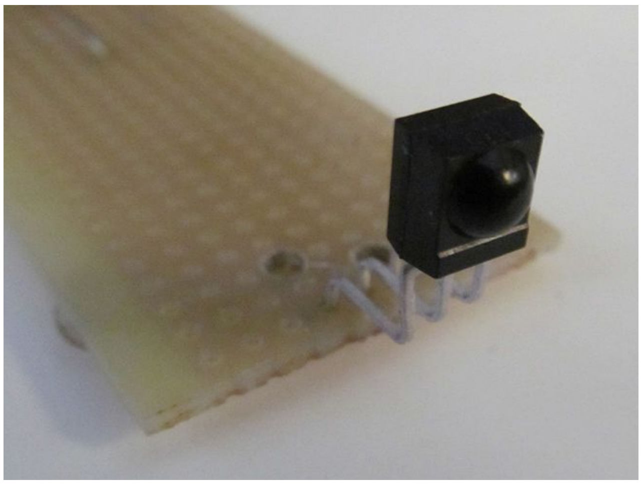


Fig. 20 - Mold Without Holder

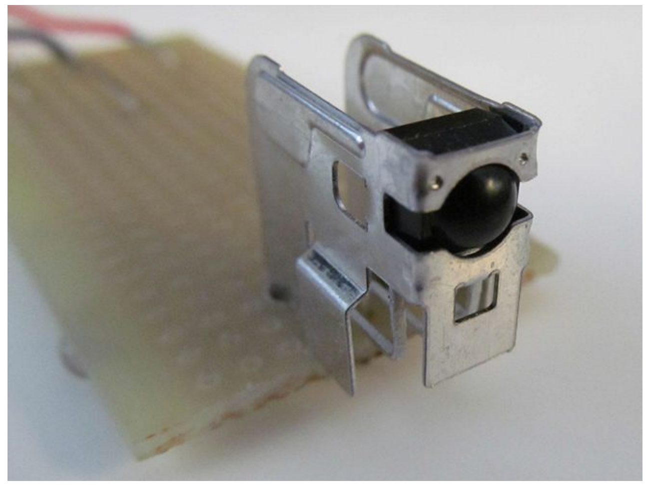
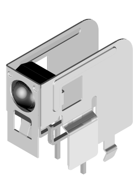


Fig. 21 - Mold With Holder PM1

SUMMARY OF TEST RESULTS

PACKAGE	FREQUENCY (GHz)	DUT	5 cm	3 cm	1 cm	0 cm	THRESHOLD (cm)
No Holder 	2.4	14338	0	0	0	0	0
		94338	0	0	10	150	2
	5	14338	0	0	0	0	0
		94338	0	0	2400	3000	3
Holder PM1 	2.4	14338	0	0	0	0	0
		94338	0	0	1000	2000	3
	5	14338	0	0	0	0	0
		94338	0	5	600	6000	3 to 4

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Mold (Holder CZ1)

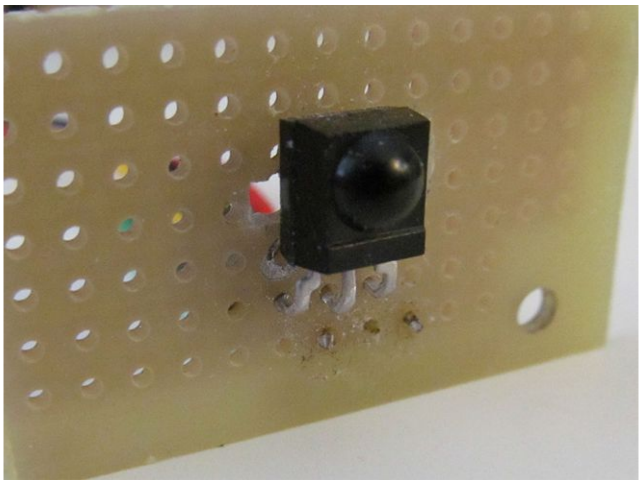


Fig. 22 - Mold Without Holder

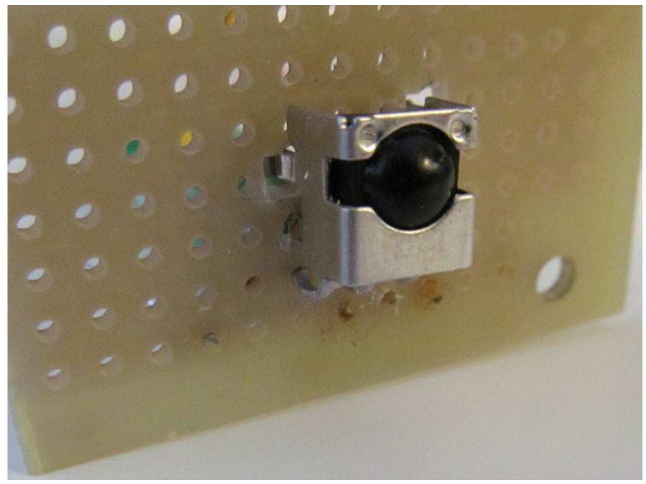


Fig. 23 - Mold With Holder CZ1

SUMMARY OF TEST RESULTS

PACKAGE	FREQUENCY (GHz)	DUT	5 cm	3 cm	1 cm	0 cm	THRESHOLD (cm)
No Holder 	2.4	14338	0	0	0	0	0
		94338	0	0	20	300	2
	5	14338	0	0	0	0	0
		94338	13	1500	3700	4000	6
Holder CZ1 	2.4	14338	0	0	0	0	0
		94338	0	0	0	30	1
	5	14338	0	0	0	0	0
		94338	0	10	600	850	4

Using Vishay Infrared Receivers in a Wi-Fi Environment: Mneme and Cyllene IC Series

Minimold (Holder CA1)

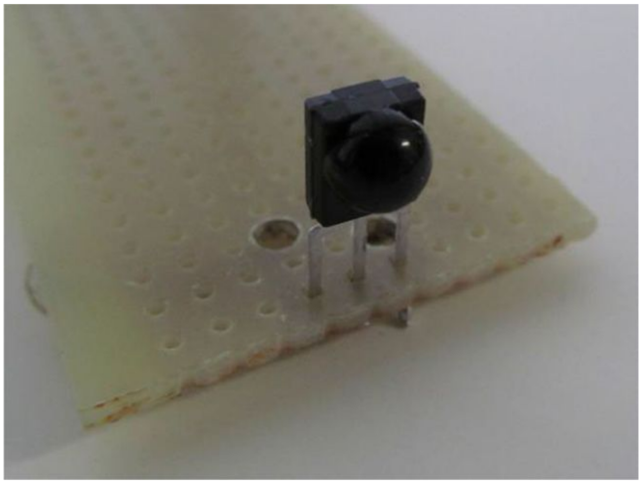


Fig. 24 - Minimold Without Holder

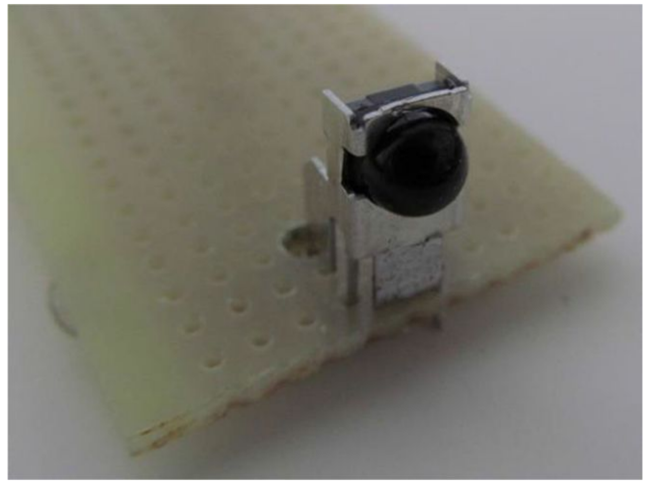


Fig. 25 - Minimold With Holder CA1

SUMMARY OF TEST RESULTS							
PACKAGE	**FREQUENCY (GHz)**	**DUT**	**5 cm**	**3 cm**	**1 cm**	**0 cm**	**THRESHOLD (cm)**
No Holder 	2.4	13338	0	0	0	0	0
		93338	0	0	2	15	1
	5	13338	0	0	0	0	0
		93338	0	0	1	1000	1
Holder CA1 	2.4	13338	0	0	0	0	0
		93338	0	0	3	10	1
	5	13338	0	0	0	0	0
		93338	0	0	4500	12k	3