

Filtering for Modular Data/Power Ports (RJ11 through RJ45 sizes)



Overview

Steward's new line of "Slimline" Common Mode Chokes provide an effective EMI solution for filtering Data/Power modular connectors.

Steward's CM2722 for use with standard 4 line single module application, CM3822 for use with 6 line single module applications (including 4 line data & 2 line power), and CM5022 for use with a full RJ45 8 & 10 line single module application will provide the lowest cost, smallest footprint EMI solution available on the market today.

Discussion

Modular jack ports (all of which have tight transmission specifications) support several very different protocols which generate a wide range of EMI issues. Modular jacks range from the RJ11 2 & 4 line application to the RJ45 8 & 10 line types. The most common data port is the RJ45. The RJ45 is used to support a broad range of serial data transmission (10 Mbs thru 250 Mbs) and, in some cases, current loads. These ports have created several layers of EMI issues that need to be addressed.

Signal lines - The various data protocols have a broad range of carrier frequencies to support 10 / 100 base T Ethernet up to the 1Gbs data (4 X 250 Mbs) transmission rates.

Power Lines - Though currently a limited application, power can be handled by two or more conductors in the connector. These power lines are a source of some unwanted EMI. The main issue, as in all power applications, is conducted common mode noise; so the use of a Common Mode Choke to provide filtration has proven to be the best solution.

1. **PROBLEM:**

The geometry of the typical filtered connector utilizes a group of wound toroids configured as common mode chokes which tends to create too much Normal Mode Impedance. This causes failure in transmission signal integrity due to excessive differential impedance on the line. The reason this occurs is due to the need to use small toroids wound with a large number of turns. This configuration usually provides from 1400 to 1800 ohms peak to obtain a broad band filter of greater than 100 ohms from 10 MHz to 1 GHz. The resulting high peak performance curve has high Q, and therefore, high inter-winding capacitance leading to poor normal mode performance.

STEWARD SOLUTION:

Steward's "Slimline" Common Mode Chokes have the lowest Normal mode impedance in the industry today (See Data Performance curves on last page). Steward's unique part geometry provides superior performance and minimum net impedance at 10MHz, 100MHz and 250MHz. These chokes also provide a considerable amount of broadband Common Mode Filtration. For example the 200 ohm parts yield more than 100 ohms of pure Common Mode rejection from 10 MHz to 1 GHz. The net circuit impedance (Normal Mode) has less than 60 ohms impedance from 10 to 250 Mhz, less than 25 ohms @ 100 MHz, and less than 5 ohms @ 10 MHz. Steward ferrite materials currently used in all Steward multi-line products have a volume resistivity (ohms per cm) that effectively removes electrical crosstalk. Also, the geometry used by Steward minimizes inter-winding capacitance, the primary source of crosstalk in most common mode chokes.

2. **PROBLEM:**

The large footprint required for a separate Common Mode Choke and shielded modular connector requires far too much board space compared to the typical shielded / filtered modular connector.

STEWARD SOLUTION:

Steward's new "Slimline" Common Mode Chokes when, combined with the use of a standard Shielded RJ45 modular connector, has a smaller footprint than the standard RJ45 filtered/shielded modular assembly. This provides a net DECREASE in footprint over the currently accepted solution by as much as 25% for a typical 4 line filtered solution versus a shielded/filtered modular assembly.

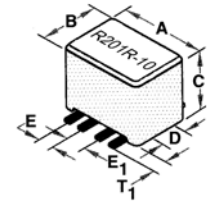
3. **PROBLEM:**

The shielded/filtered modular connector is very costly, due to its construction.

STEWARD SOLUTION:

The combined cost of a "Slimline" Common Mode Choke with a standard shielded modular connector will provide approximately a 40% decrease in the cost per filtered line, over a filtered/shielded assembly.

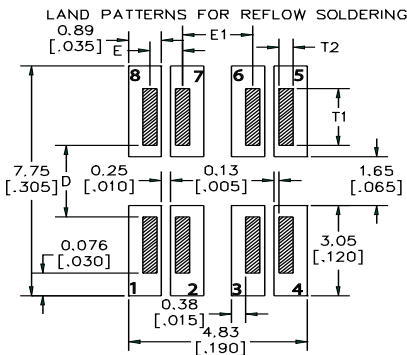
Steward PART NUMBERING SYSTEM EXAMPLE



CM	2722	R	800	R	-10
Product Series Code	Part Size Code	Rated Continuous Current Code	Impedance Value Code	Packaging Code	Additional Description

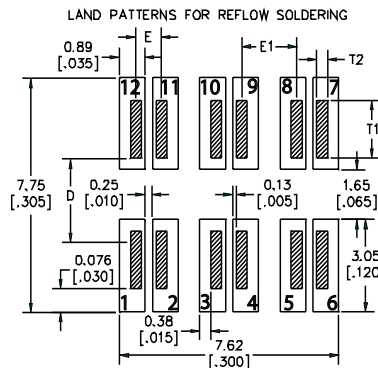
PART NUMBER	Fig #	# of Lines	A mm (inches)	B mm (inches)	C mm (inches)	D mm (inches)	E mm (inches)	E1 mm (inches)	T1 mm (inches)	DCR MAX (Ohms)	Typical Impedance @ 100 MHz
CM2722R800R-10	1	4	6.99 ± 0.10 (0.275 ± 0.004)	5.72 ± 0.10 (0.220 ± 0.004)	4.37 ± 0.08 (0.170 ± 0.003)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	80
CM2722R151R-10	1	4	6.99 ± 0.10 (0.275 ± 0.004)	5.72 ± 0.10 (0.220 ± 0.004)	7.62 ± 0.13 (0.300 ± 0.005)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	150
CM2722R201R-10	1	4	6.99 ± 0.10 (0.275 ± 0.004)	5.72 ± 0.10 (0.220 ± 0.004)	9.53 ± 0.15 (0.375 ± 0.006)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	200
CM3822R800R-10	2	6	9.78 ± 0.15 (0.385 ± 0.006)	5.72 ± 0.10 (0.220 ± 0.004)	4.37 ± 0.08 (0.170 ± 0.003)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	80
CM3822R151R-10	2	6	9.78 ± 0.15 (0.385 ± 0.006)	5.72 ± 0.10 (0.220 ± 0.004)	7.62 ± 0.13 (0.300 ± 0.005)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	150
CM3818R201R-10	2	6	9.78 ± 0.15 (0.385 ± 0.006)	5.72 ± 0.10 (0.220 ± 0.004)	9.53 ± 0.15 (0.375 ± 0.006)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	200
CM5022R800R-10	3	8	12.57 ± 0.20 (0.495 ± 0.008)	5.72 ± 0.10 (0.220 ± 0.004)	4.37 ± 0.08 (0.170 ± 0.003)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	80
CM5022R151R-10	3	8	12.57 ± 0.20 (0.495 ± 0.008)	5.72 ± 0.10 (0.220 ± 0.004)	7.62 ± 0.13 (0.300 ± 0.005)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	150
CM5022R201R-10	3	8	12.57 ± 0.20 (0.495 ± 0.008)	5.72 ± 0.10 (0.220 ± 0.004)	9.53 ± 0.15 (0.375 ± 0.006)	2.41 ± 0.08 (0.095 ± 0.003)	0.89 ± 0.13 (0.035 ± 0.005)	1.91 ± 0.13 (0.075 ± 0.005)	1.91 ± 0.25 (0.075 ± 0.010)	0.020	200

CM2722



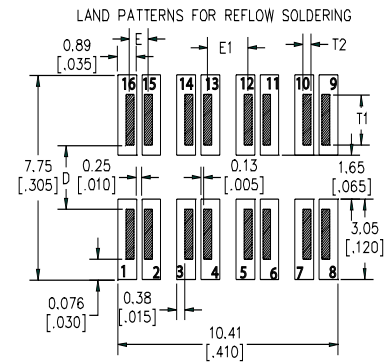
* WIRE LENGTH [T1 = 1.91 (.075)]

CM3822



* WIRE WIDTH [T2 = 0.38 (.015)]

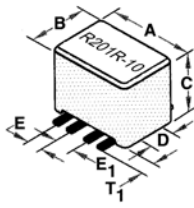
CM5022



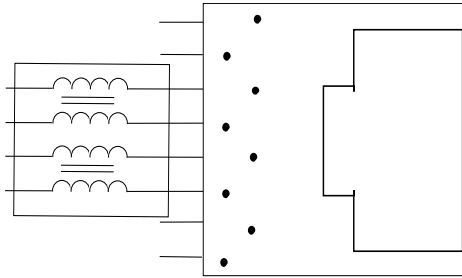
* WIRE THICKNESS [T3 = 0.38 (.015)]

(SEE FIGURE 1,2 or 3)

Figure 1

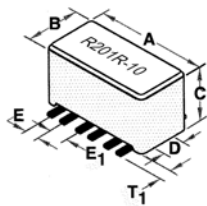


Typical 4 Line Application (Ethernet Port)
CM2722

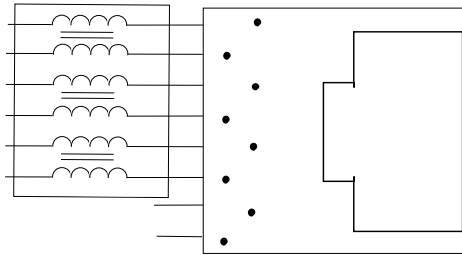


Shielded RJ45 Connector

Figure 2

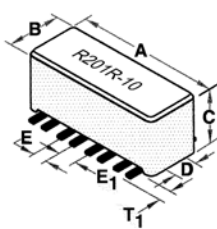


Typical 6 Line Application (Ethernet Port)
CM3822

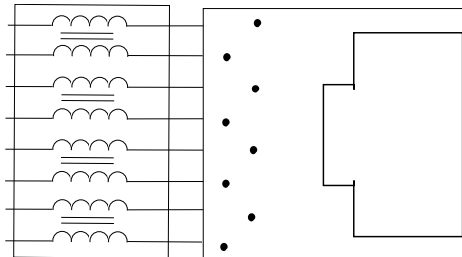


Shielded RJ45 Connector

Figure 3

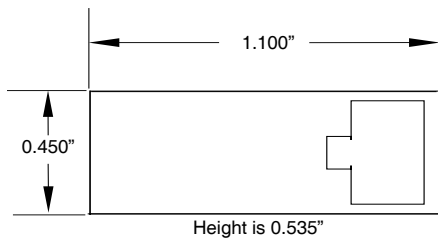


Typical 8 Line Application (Ethernet Port)
CM5022

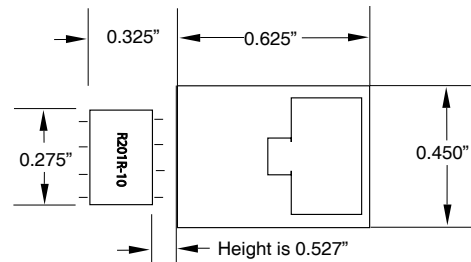


Shielded RJ45 Connector

Board Space Comparison for a 4 Line Application



Typical Filtered and Shielded RJ45 Connector
(approx. 0.495 in² of board space)



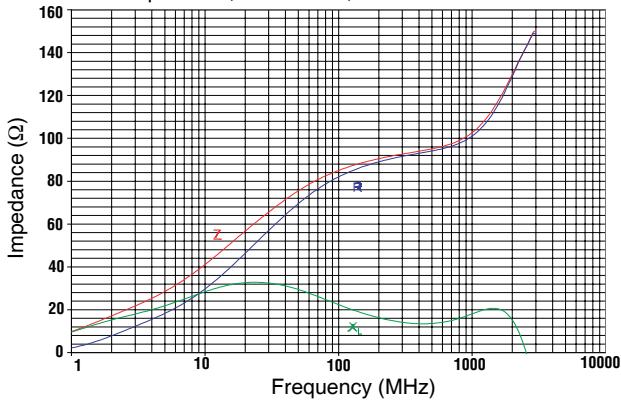
Typical Shielded 4 line RJ45 Connector with
Steward **CM2722R201R-10**
(Steward solution: approx. connector area = .281 in²,
approx. common mode choke area = .089in²
approx. combined area = 0.370 in² of board space)

25% Less Printed Circuit Board area required

CM2722R800R-10, CM3822R800R-10, CM5022R800R-10

Z, R, X_L vs. Frequency

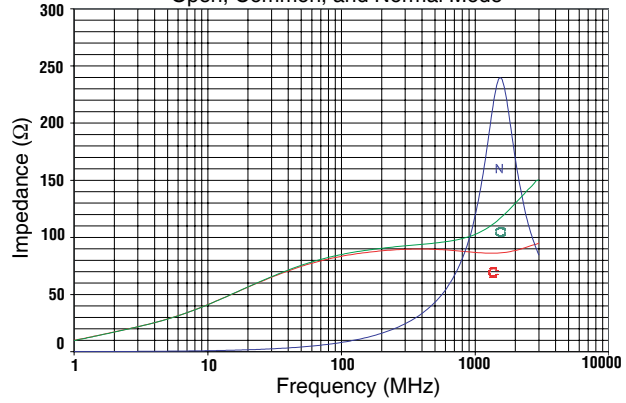
Impedance, Resistance, Inductive Reactance



CM2722R800R-10, CM3822R800R-10, CM5022R800R-10

Z, vs. Frequency

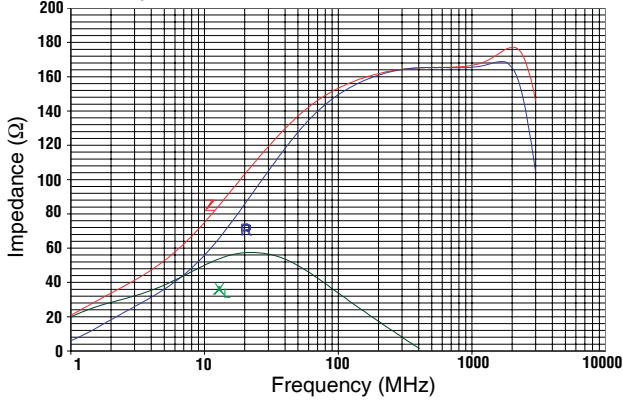
Open, Common, and Normal Mode



CM2722R151R-10, CM3822R151R-10, CM5022R151R-10

Z, R, X_L vs. Frequency

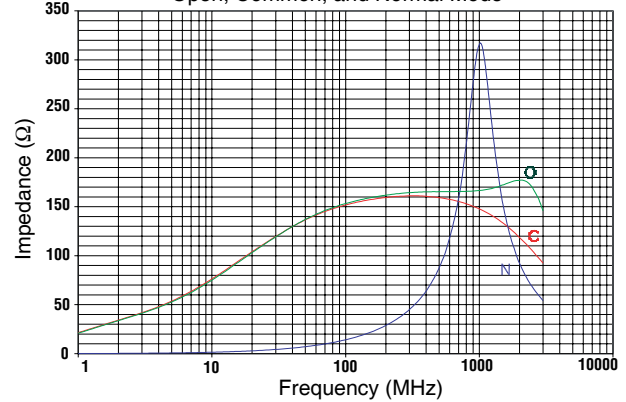
Impedance, Resistance, Inductive Reactance



CM2722R151R-10, CM3822R151R-10, CM5022R151R-10

Z, vs. Frequency

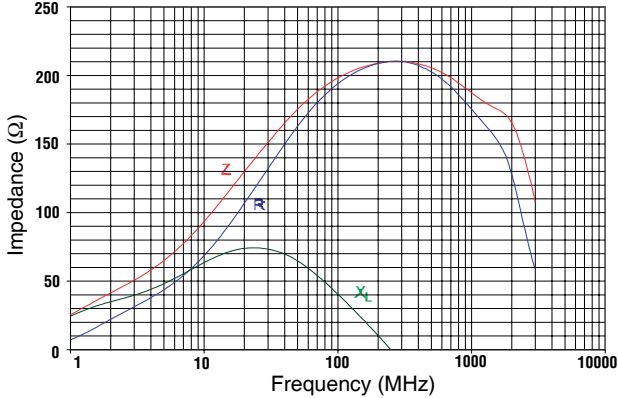
Open, Common, and Normal Mode



CM2722R201R-10, CM3822R201R-10, CM5022R201R-10

Z, R, X_L vs. Frequency

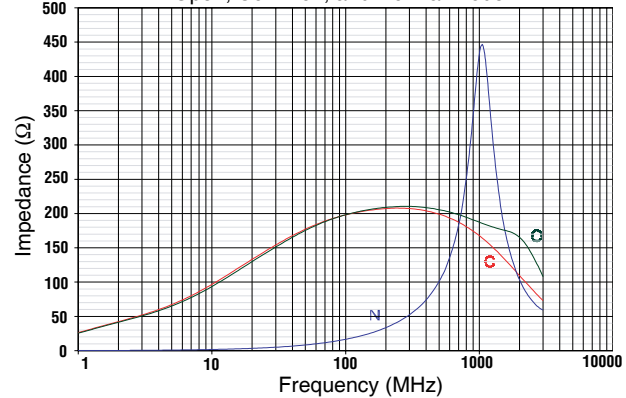
Impedance, Resistance, Inductive Reactance



CM2722R201R-10, CM3822R201R-10, CM5022R201R-10

Z, vs. Frequency

Open, Common, and Normal Mode



Steward produces an extensive line of ferrite products for Inductive and EMI Filtering Applications. Products include ferrite EMI cable cores, connector plates, unique common mode chokes, can-bus chokes, high current thru hole and surface mount components, impedance chip beads, surface mount inductors, toroid inductor cores and ferrite powders. Please consult our web site, Steward's EMI and Inductive Components full catalog, or contact your nearest Steward office or representative for additional information.

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