Application Note No. 047

Matching Methods for Variable Capacitance Diodes

RF & Protection Devices

Never stop thinking

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Revision History: 2008-02-14, V2.1

Previous Version: V2.0, 2006-02-15

Page	Subjects (major changes since last revision)
7-9	**Table 2** and **Table 3** update to current Infineon product range

1 Matching Methods for Variable Capacitance Diodes

This application note covers the field of the selection methods that are applied on variable capacitance diodes to reduce the effort on adjusting electronic circuits in production.

Varicap or variable capacitance diodes are key semiconductors components for VCO‘s and tuner circuits. It is a semiconductor diode in which the voltage dependency of the PN junction capacitance in reverse bias node is utilized and the Q factor is optimized. These diodes are ideal tuning elements for Satellite-, TV-, VCR- and Radio - tuners and for VCO applications in mobile communication. Variable capacitance diodes for tuner applications are classified in different categories (FM, VHF, UHF, SAT) according to the application frequency and their capacitance values.

Attention: Matching of diodes is usually not required for varicap diodes in VCO applications

But for tuner applications there must be sufficient tracking of the input -, intermediate - and oscillator - circuits in order to get a good band pass response. The capacitances of the diodes, that are used in these stages have to be matched.

For this propose capacitance diodes are sorted into matched sets of similar capacitance over the entire reverse voltage range.

There are four different selections methods which can be used to provide matched diodes:

- A: In line matching (SCD80, SC79)
- B: In line matching in groups
- C: Group matching (only SOD323)
- D: Floating matching (only SOD323)
- E: Unmatched (SOD323, SCD80, SC79)

A: In-line matching (SCD80, SC79)

Inline matching, pick and place matching, direct matching assembly are all expressions for a new tracking method.

Neighboring diode chips are picked up intelligently in an orderly structure and one after another from the wafer and are placed consecutively on the leadframe. Remaining in this order the diodes are molded, punched and tested electrically. In the end the capacitance values are gliding matched within a defined $\Delta C/C\%$ tolerance of n consecutive diodes on the tape.

For this matching method a good wafer quality, a very small capacitance tolerance and a very good uniformity of the total capacitance curves are necessary in order to get reels with small matched capacitance tolerances.

Advantage

A very close matching quality of C_t and a very good C_t vs. V_R characteristics of consecutive diodes. (See **Figure 1**)

Disadvantage

No capacitance selection is possible.

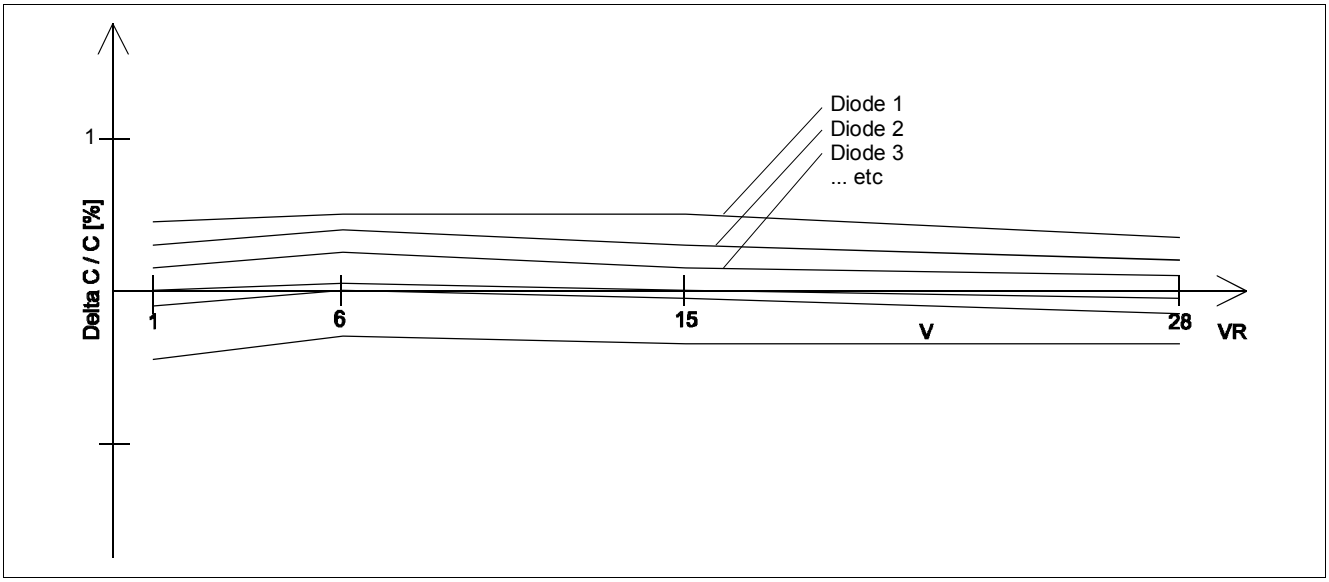

Figure 1 Capacitance Variation in Inline Matched Selections

B: Inline matching in groups

This matching method is a combination of method A: and C:. On one reel we have more than one group with group separations and the devices of the different groups are inline matched.

C: Group matching (only SOD323)

For this method the capacitance target range at discrete reverse voltages is split into capacitance subgroups which are allocated into capacitance tolerance categories.

Figure 1 for example shows the capacitance spread range and the capacitance C_t at fixed reverse voltages V_R. Every capacitance range at the discrete reverse voltage will be assigned to fixed capacitance categories C_c (C_c=1,2,3...n) with a capacitance tolerance ΔC/C%= (Cmax.n - Cmin.n)/Cmin.n). Diodes with the same group address from a matched group.

For example:

Table 1 Group matching (only SOD323)

Reverse Voltage	1 V	6 V	15 V	25 V	28 V
Group no. 1 address	4	3	3	2	2
Group no. 2 address	4	4	5	3	3
Group no. 2 address	2	2	3	2	2

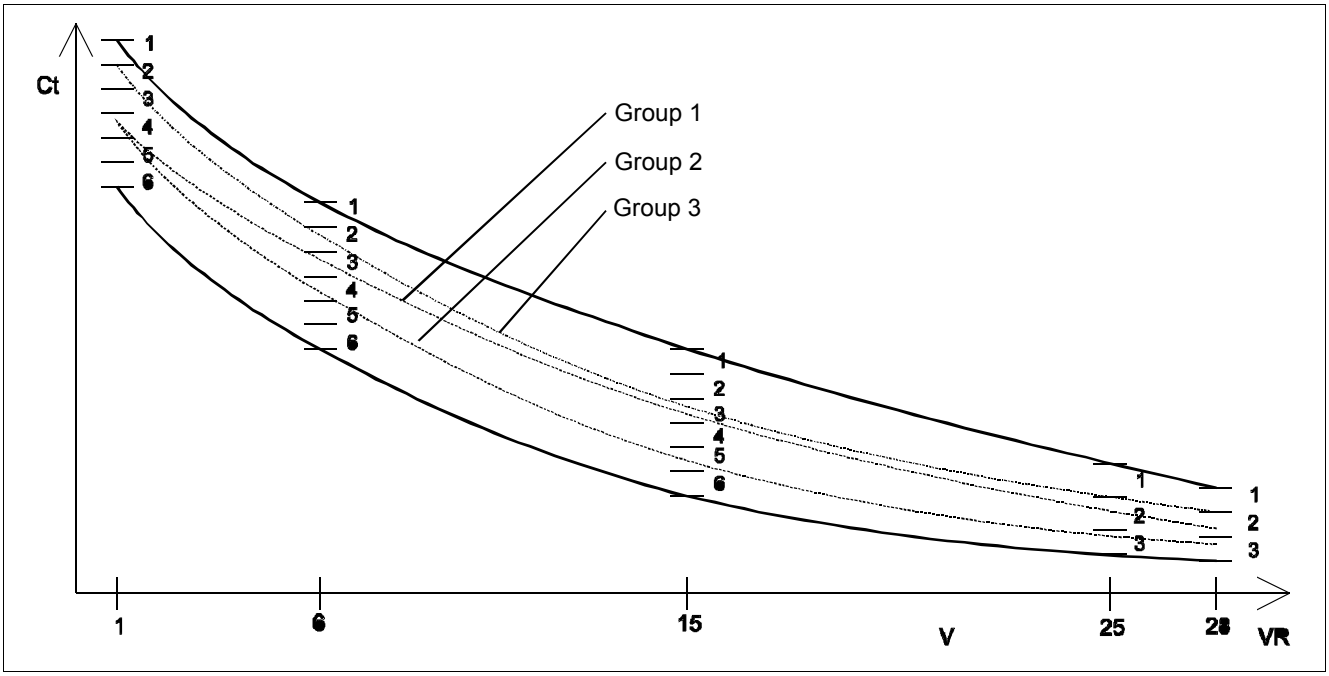

Figure 2 Capacitance Spread and Group Addresses

Diodes from these matched groups (or preselected capacitance groups) are randomly distributed in quality. To get a reel with 3 000 or 10 000 devices, possible two or more matched groups must be on one reel. Matched groups on the reel ate separated by empty pockets.

Advantage

In this matching method any number of devices in a group are matched and any selection of capacitance ratio is directly possible.

Disadvantage

In this matching method more than one matched group is on the reel and the diode capacitance curves might cross each other (see **Figure 3**)

D: Floating matching (only SOD323)

The continuos processing of a complete tape is made possible by what we call floating matching. Continuos matching on the tape is accomplished by successive placing of “related” preselected matched groups (according method A) on the tape.

In this case a random section of the tape of a specified number of consecutive taped diodes (typically 7) are always matched with a capacitance tolerance ΔC/C%.

Advantage

No group separation on the tape by empty pockets, which means easier handling by the customers and tight matching quality

Disadvantage

No total capacitance ratio- selection possible.

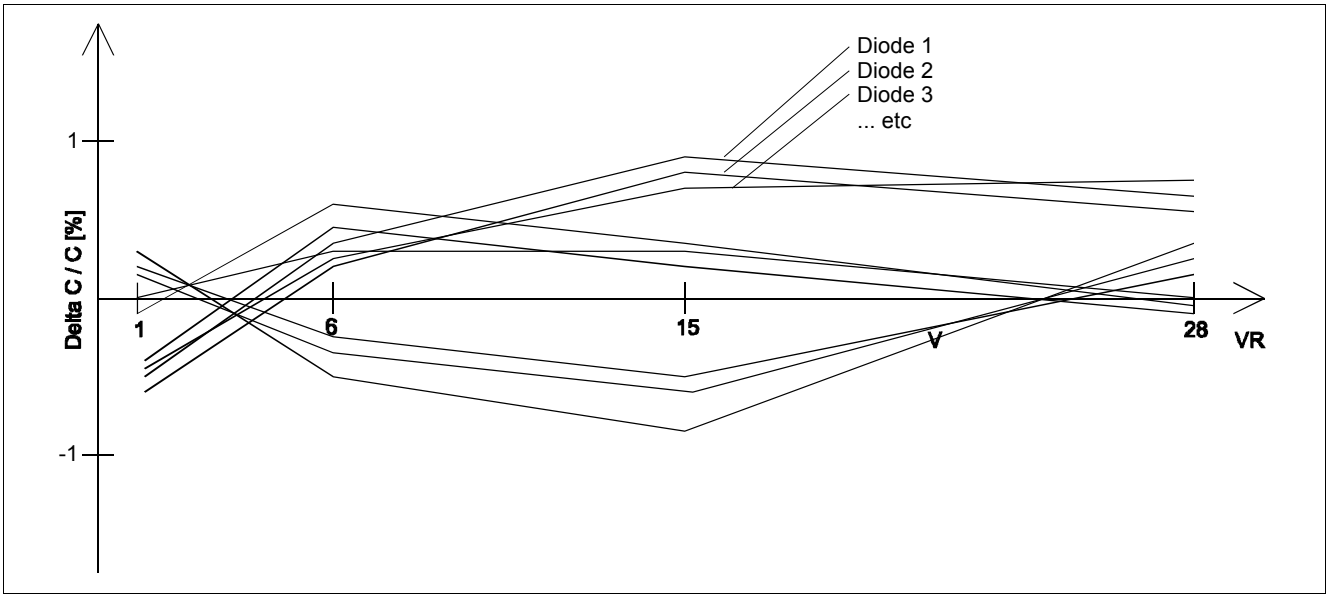

Figure 3 Capacitance Variations in group or floating matched selection

E: Unmatched (SOD323, SCD80, SC79)

Unmatched diodes are sufficient for all applications where it is not necessary to track several resonant circuit to the same resonant frequency (e.g. VCO‘s in mobile communication).

2 Available matching methods per package and the corresponding E-numbers

One tables for every package: SOD323, SCD80 and SC79.

Table 2 SOD323 overview of matching methods

Matching	Type	3k
Group matched	BB439	E6327
Floating matched	BB439	
Unmatched	BB439	~~E7263~~
Group matched	BB545	E7904
Floating matched	BB545	~~E7906~~
Unmatched	BB545	~~E7908~~
Group matched	BB535	E7904
Floating matched	BB535	~~E7906~~
Unmatched	BB535	E7908
Group matched	BB639	E7904
Floating matched	BB639	~~E7906~~
Unmatched	BB639	~~E7908~~
Group matched	BB639C	E7904
Floating matched	BB639C	~~E7906~~
Unmatched	BB639C	E7908
Group matched	BB640	E6327

Table 2 SOD323 overview of matching methods (cont'd)

Matching	Type	3k
Floating matched	BB640	~~E7786~~
Unmatched	BB640	E7263
Group matched	BB644	E7904
Floating matched	BB644	
Unmatched	BB644	~~E7908~~
Group matched	BB669	E7904
Floating matched	BB669	~~E7906~~
Unmatched	BB669	~~E7908~~
Group matched	BB831	E7904
Floating matched	BB831	~~E7906~~
Unmatched	BB831	E7908
Group matched	BB833	E6327
Floating matched	BB833	
Unmatched	BB833	~~E7263~~
Group matched	BB837	
Floating matched	BB837	E6327
Unmatched	BB837	~~E7263~~

Note: All ~~E7xxx~~ E-numbers are discontinued

Table 3 SCD80 overview of matching methods

Matching	Type	3k	8k[1)]
In-line matched	BB555	E7902	E7912
Unmatched	BB555	E7908	
In-line matched	BB565	E7902	E7912
Unmatched	BB565	E7908	
In-line matched	BB659	E7902	
Unmatched	BB659	E7908	
In-line matched	BB659C	E7902	E7912
Unmatched	BB659C	E7908	
In-line matched	BB664	E7902	E7912
Unmatched	BB664	E7908	
In-line matched	BB689	E7902	E7912
Unmatched	BB689	E7908	
In-line matched	BB857	E7902	
Unmatched	BB857	E7908	
Unmatched	BBY51-02W	E6327	
Unmatched	BBY52-02W	E6327	E6127
Unmatched	BBY53-02W	E6327	
Unmatched	BBY55-02W	E6327	
In-line matched	BBY56-02W	E7902	
Unmatched	BBY56-02W	E6327	E6127

Table 3 SCD80 overview of matching methods (cont'd)

Matching	Type	3k	8k[1)]
Unmatched	BBY57-02W	E6327	E6127
Unmatched	BBY58-02W	E6327	E6127

1) With 2 mm reel pitch, detailed information available on data sheet

Table 4 SC79 overview of matching methods

Matching	Type	3k	8k[1)]
In-line matched	BB555-02V	E7902	E7912
In-line matched	BB565-02V	E7902	E7912
In-line matched	BB659C-02V	E7902	E7912
In-line matched	BB664-02V	E7902	E7912
In-line matched	BB689-02V	E7902	E7912
Unmatched	BBY53-02V	E6327	
Unmatched	BBY55-02V	E6327	
Unmatched	BBY56-02V	E6327	
Unmatched	BBY57-02V	E6327	
Unmatched	BBY58-02V	E6327	
Unmatched	BBY59-02V	E6327	
Unmatched	BBY65-02V	E6327	
Unmatched	BBY66-02V	E6327	

1) With 2 mm reel pitch, detailed information available on data sheets