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## Notes about Over Current Recovery mode in L99DZ100G/P

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### Introduction

All the embedded outputs of the L99DZ100G(P), from OUT1 to OUT15 and OUT\_HS, come with the Over Current protection (latch); this feature is enabled by default. For the 9 outputs from OUT1 to OUT8 and OUT\_HS, besides the Over Current protection feature, a mode called Over Current Recovery (OCR) or Auto Recovery is implemented.

Scope of this Technical Note is to give an overview of the Over Current Recovery mode, detailing the timing parameters involved in this mechanism in order to provide detailed information about that Protection mechanism (see [Section Appendix A: References](#)).

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# 1 The Over Current Recovery mode

The Over Current Recovery allows to automatically switch ON the Outputs that have been switched OFF after an Over Current detection; this method is needed when loads with start-up currents higher than the Over Current limits need to be driven.

If the outputs are not configured in Over Current Recovery mode, once the load current reaches the Over Current threshold, after the time interval  $T_{FOC}^{(a)}$ , the status bit  $OUTx\_OC$  (SR 3) is latched and the driver is switched OFF too; in this case the microcontroller has to Read & Clear the according status bits in order to reactivate the corresponding output driver.

If the outputs (from OUT1 to OUT8 and OUT\_HS) are configured in Over Current Recovery mode, once the Over Current condition is detected (i.e. the load current reaches the Over Current threshold), the corresponding driver is switched OFF and hence automatically switched ON after a certain time interval.

The Over Current Recovery mode can be individually enabled for a given output, i.e. for each of the Half Bridges (OUT\_1, .. , OUT6) and for each of the High Side drivers (OUT7, OUT8 and OUT\_HS) by setting the corresponding  $OUTx\_OCR$  (CR7) bit.

The Activation sequence of a specific Output driver (switch OFF / switch ON) can be seen as composed by the following 3 timings (see [Figure 1](#) and [Figure 2](#)):

- $T_{blinking}$
- $T_{ocr}$
- $T_{off}$

The  $T_{blinking}$  time, has been designed to be 40  $\mu$ s (typ).

The  $T_{ocr}$  time is the filter time, i.e. current needs to be above the OC threshold for  $t > T_{ocr}$  to detect an OC condition.

The  $T_{off}$  is the time interval in which the output driver is switched OFF.

The following two situations may occur:

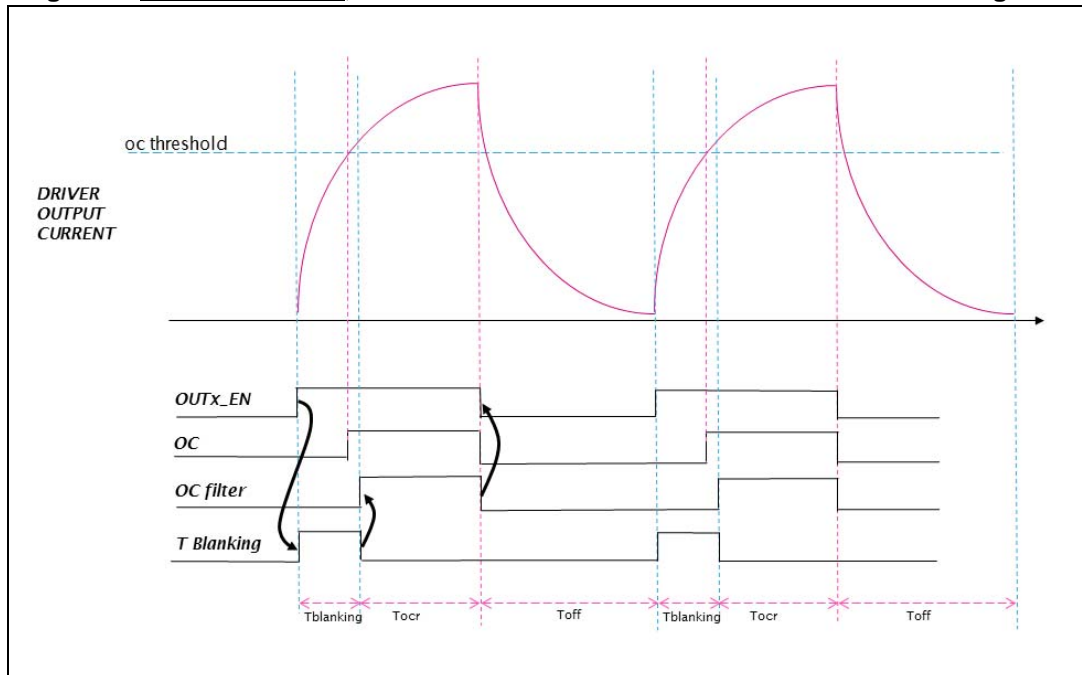
- Hard Short case: the OC threshold is reached before the end of the blanking time ([Figure 1](#))
- Overload case: the OC threshold is reached after the end of the blanking time ([Figure 2](#)).

## 1.1 The Hard Short case

The Hard Short case refers to the situation in which the driver output current reaches the OC threshold before of the fixed by design  $T_{blinking}$  time, as reported in [Figure 1](#).

a.  $T_{FOC}$  parameter reported in Section 3.4.12 of the L99DZ100G(P) datasheet is represented in [Table 1](#) by the  $T_{ocr\_hb}$  parameter and in [Table 2](#) by the  $T_{ocr\_hs}$  parameter.

Figure 1. **Hard Short case**, the OC threshold is reached before end of blanking time



In this case:

$$T_{on} = T_{blanking} + T_{ocr} \quad (1)$$

Being  $T_{blanking}$  and  $T_{ocr}$  values guaranteed by design, both  $T_{on}$  and  $T_{off}$  are hence guaranteed by design.

The accuracy of the values reported in [Table 1](#) and [Table 2](#) depends on the accuracy of the frequency generated by the internal oscillator OSC1.

## 1.2 The Overload case

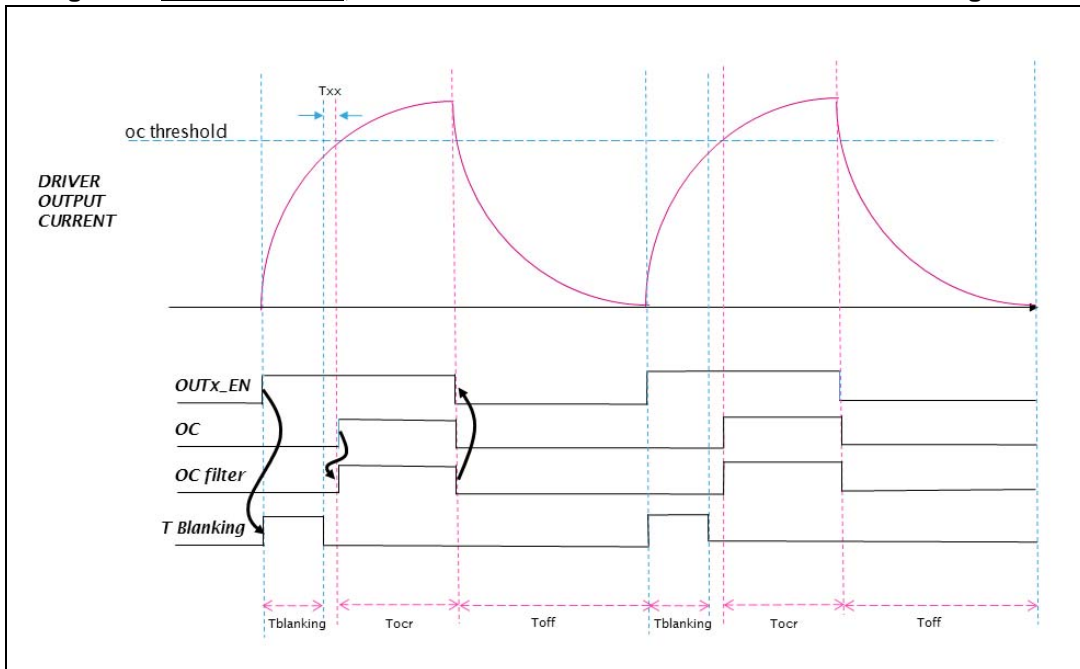
In the Overload case the time interval in which the OUTx driver is ON,  $T_{on}$  is not only composed by the  $T_{blanking}$  and the  $T_{ocr}$  time intervals, but also from the time interval comprised between the end of the  $T_{blanking}$  interval and the time in which the OC threshold is reached by the driver output current.

So, in the Overload case

$$T_{on} = T_{blanking} + T_{ocr} + T_{xx} \quad (2)$$

where  $T_{xx}$  is in the range [ 0, xx] sec (strictly depending on the overload characteristics)

Figure 2. Overload case, the OC threshold is reached after end of blanking time



That means a minimum value of the  $T_{on}$  can be guaranteed by design (the case  $T_{xx} = 0$  and the Hard Short and Overload case are equivalent) meanwhile the maximum value of  $T_{on}$  depends on the load connected to the OUTx and cannot be guaranteed by design.

## 2 The Over Current Recovery settings

In the following tables the minimum, typical and maximum values for the  $T_{blanking}$ ,  $T_{ocr}$  and  $T_{off}$  timing parameters are reported; [Table 1](#) reports the parameters for the Half Bridges and [Table 2](#) for the High Sides depending on the values assigned to the (HB\_TON\_1, HB\_TON\_0) and (HS\_TON\_1, HS\_TON\_0) pairs and to the OCR\_FREQ bit.

**Table 1. Half Bridges (OUT1, ... , OUT6) Over Current Recovery settings**

Symbol	Parameter		Test Condition	Min.	Typ.	Max.	Unit
$T_{blanking}$			Guaranteed by Design	33	40	47	$\mu s$
$T_{ocr\_hb}$	Over Current Filter Time for Half Bridges	HB_TON = 00	Guaranteed by Design	53	64	75	$\mu s$
		HB_TON = 01		40	48	56	$\mu s$
		HB_TON = 10		33	40	47	$\mu s$
		HB_TON = 11		26	32	38	$\mu s$
$T_{off\_hb}$	OFF Time for Half Bridges	HB_TON = 00 & OCR_FREQ = 0	Guaranteed by Design	398	480	562	$\mu s$
		HB_TON = 00 & OCR_FREQ = 1		192	232	272	$\mu s$
		HB_TON = 01 & OCR_FREQ = 0		305	368	431	$\mu s$
		HB_TON = 01 & OCR_FREQ = 1		146	176	206	$\mu s$
		HB_TON = 10 & OCR_FREQ = 0		252	304	356	$\mu s$
		HB_TON = 10 & OCR_FREQ = 1		120	144	168	$\mu s$
		HB_TON = 11 & OCR_FREQ = 0		218	264	310	$\mu s$
		HB_TON = 11 & OCR_FREQ = 1		106	128	150	$\mu s$



**Table 2. High Sides (OUT7, OUT8 and OUT\_HS) Over Current Recovery settings**

Symbol	Parameter		Test Condition	Min.	Typ.	Max.	Unit
$T_{blanking}$			Guaranteed by Design	33	40	47	$\mu s$
$T_{ocr\_hs}$	Over Current Filter Time for High Sides	HS_TON = 00	Guaranteed by Design	53	64	75	$\mu s$
		HS_TON = 01		40	48	56	$\mu s$
		HS_TON = 10		33	40	47	$\mu s$
		HS_TON = 11		26	32	38	$\mu s$
$T_{off\_hs}$	OFF Time for High Sides	HS_TON = 00 & OCR_FREQ = 0	Guaranteed by Design	398	480	562	$\mu s$
		HS_TON = 00 & OCR_FREQ = 1		192	232	272	$\mu s$
		HS_TON = 01 & OCR_FREQ = 0		305	368	431	$\mu s$
		HS_TON = 01 & OCR_FREQ = 1		146	176	206	$\mu s$
		HS_TON = 10 & OCR_FREQ = 0		252	304	356	$\mu s$
		HS_TON = 10 & OCR_FREQ = 1		120	144	168	$\mu s$
		HS_TON = 11 & OCR_FREQ = 0		218	264	310	$\mu s$
		HS_TON = 11 & OCR_FREQ = 1		106	128	150	$\mu s$

Basing on the values reported in [Table 1](#) and [Table 2](#) the Activation sequence, involved in the switch OFF / switch ON of a certain OUT, can be computed.

### 3 Conclusion

The Technical Note describes the Over Current Recovery mode by which the L99DZ100G(P) device can drive loads with start-up current higher than the overcurrent limits, highlighting the time intervals involved in this mechanism; how the activation / deactivation of the Output driver works has been here detailed.

## Appendix A    References

L99DZ100G/P datasheet rev4 (DocID029077 Rev 4)

## Revision history

**Table 3. Document revision history**

Date	Revision	Changes
13-Jan-2017	1	Initial release.

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