Hyper-frequency pulsed measurements have been performed at 3GHz. The stimulus duration was 300ms and the profile duration, which corresponds to the time for which the scattering parameters measurements are performed during the stimulus duration, was 250ms. The maximum stable gain MSG was determined under different pulsed conditions at $V_d = 10V$ (Fig. 4). At room temperature in class B for the quiescent bias point, the MSG was -4dB. If the device was polarised in class A, the MSG obtained was 10dB better because the device is hotter under these conditions and the surface trap states were lower [6]. The MSG obtained at a chuck temperature of 130°C in class B was 2.5dB better than the first MSG for the same reason. So, by heating the device, the MSG can be improved.

Conclusion: Pulsed measurements have demonstrated the presence of electronic traps. The electrons can be untrapped by light and/or temperature and/or the quiescent bias point. Hyper-frequency pulsed measurements at 3GHz seem to prove that when the device is heated, the MSG improves. That is the reason why the GaN material is a good candidate for high power and high temperature applications.

Acknowledgment: This work has been carried out with the financial help of the DGA (French Army), Contract No. 97-065, the Conseil Régional du Nord and the CNRS.

References


Introduction: In many practical variable structure systems (VSS), the boundedness of the control input should be considered because of physical constraints; the bounded control input cannot assure the global stability of the system. Hence some approaches are proposed to estimate the stability region of mismatched uncertain VSS subject to bounded controllers. In [1, 2] techniques for estimating the ASR and PSR of mismatched uncertain VSS with a bounded controller were proposed.

In this Letter, consider the following mismatched uncertain system:

$$\dot{x} = Ax + Bu + F(t,x)$$

where $x \in \mathbb{R}^p$ is the state vector, $u \in \mathbb{R}^p$ is the control input, and the continuous function $F(t,x)$ is the uncertainty which contains both the matched part and mismatched part. It is assumed that $F$ can be decomposed as $F(t,x) = f(t,x) + B(t,x)$, where $f: \mathbb{R}^p \to \mathbb{R}^p$ is the mismatched part and $B: \mathbb{R}^p \to \mathbb{R}^p$ is the matched part. We denote the switching surface by $\sigma = 0$, where the switching function $\sigma = x^T S = x^T S = 0$ is an $m$-state vector. The following assumptions are needed:

A1: There exist known non-negative constants $K_1$ and $K_2$ such that $|f(t,x)| \leq K_1 |x| + K_2$.

A2: There exist known non-negative constants $K_3$ and $K_4$ such that $|B(t,x)| \leq K_3 |x| + K_4$.

A3: The control input has an upper bound $|u| \leq K$ such that $u = K - K_3$ is positive.

A4: The pair $(A,B)$ is completely controllable; $S = 0$ is invertible. The notation $\tilde{\cdot}$ in assumptions A1-A3 denotes the Euclidean norm of $\cdot$.

In this Letter we address the problems of estimating the PSR, ASR, and ESR for the mismatched uncertain VSS (eqn. 1). An example is given to illustrate that the new result gives a more improved estimation of stability regions than do existing methods.

Estimation of stability regions: First, the results [3] are used to determine the switching surface. Consider the nominal system $\dot{x} = Ax + Bu$, and let $J = \text{diag}(\lambda_1, \lambda_2, ..., \lambda_m)$ where the negative and real eigenvalues $\lambda_i, i = 1, 2, ..., m$ are the desired eigenvalues in the sliding mode. Let $\lambda_{\text{max}}$ and $\lambda_{\text{min}}$ denote the maximum and minimum eigenvalues of $J$, respectively. By assumption A4, there exist matrices $W \in \mathbb{R}^{p \times (m-n)}$ and $N \in \mathbb{R}^{n \times (m-n)}$ such that $[A + B1W]W = WJ$. If $SW = 0$, it can be seen that $\text{Ran}(W) \cap \text{Ran}(B) = \{0\}$ because $SB$ is invertible. Hence $[W,B]$ is nonsingular. $W$ and $B$ denote the generalised inverses of $W$ and $B$, respectively. Then select $S = B^T$ and a transformation matrix $M$ such that $y = Mx$ where

$$y = Mx = \begin{bmatrix} z \\ \sigma \\ M \begin{bmatrix} W \\ S \end{bmatrix} \end{bmatrix} (2)$$

with $M^{-1} = [W,B]$, $z = W^T x$ and $\sigma = Sx$. Using the fact $W^T A W = J$, the system of eqn. 1 in the new co-ordinates is

$$\dot{y} = MAM^{-1}y + MB(u + h) + MF$$

$$= A_0 y + A_1 y + B(u + h) + MF$$

where the matrices $A_0$ and $A_1$ are defined by

$$A_0 = \begin{bmatrix} 0 \\ \lambda_{\text{min}}(J) \end{bmatrix}$$

and

$$A_1 = \begin{bmatrix} 0 \\ SAW \end{bmatrix} \begin{bmatrix} W \\ A \end{bmatrix} \begin{bmatrix} N \\ AW \end{bmatrix} \lambda_{\text{max}}(J) \end{bmatrix}$$

Before estimating the stability regions, the following result is given:

Lemma: Select $0 < \alpha < 1$, $0 \leq \beta < 1$ and $0 < \epsilon < \delta$ such that the function $g(\alpha, \beta) = 4\alpha^2 - 4\alpha + \beta^2 + \epsilon < 0$. Define $Q = (2(\alpha - 1)A_0$. Then the following matrix is positive definite:

$$Q = \begin{bmatrix} \lambda_{\text{min}}(Q) & -q_1 \\ -q_1 & -2\alpha \lambda_{\text{max}}(J) \end{bmatrix}$$

where $q_1 = \beta \lambda_{\text{max}}(J)$ and $q_2 = \lambda_{\text{max}}(Q)$. Then $Q = 0$ and $g(\alpha, \beta) < 0$, we have

Stability regions estimation for mismatched uncertain variable structure systems with bounded controllers

Kuo-Kai Shyu, Yao-Wen Tsai and Chiu-Keng Lai

The problem of estimating the stability regions of mismatched uncertain variable structure systems (VSS) with bounded controllers is considered. Based on Lyapunov stability theory, the estimations of stability regions such as the practical stability region (PSR), asymptotical stability region (ASR), and exponential stability region (ESR) are discussed.
Then along any trajectory not escape $\Omega_d$ through region $R$, it is obvious that the matrix $Q$ is positive definite. Therefore, any trajectory starting in $\Omega_d$, will converge to $\Gamma$ and stay in $\Gamma$ thereafter. That is, the region $\Omega_{d\Gamma}$ will asymptotically approach $\Gamma$.

**Remark:** For the system with only matched uncertainty, i.e. $k_f = k_g = 0$, the region $\Omega_{d\Gamma}$ is an estimation of ASR.

**Corollary:** If $k_f = 0$ and $0 \leq k_g \leq q_1(||M|| ||W||)$, then $\Omega_{d\Gamma}$ is an estimation of ESR.

**Proof of corollary:** Suppose that the system trajectory is in the region $\Omega_{d\Gamma}$. Using eqn. 11, we have $V \leq -\lambda_{\min}(Q)||y||^2$. Hence the corollary is proved.

**Example:** Consider a system described by eqn. 1 with

$$A = \begin{bmatrix} -1 & 0 & -1 \\ 0 & -1 & 1 \\ 3 & 2 & -1 \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

Suppose that $|z| < k = 20$, $||x|| < 0.2|z|$ and $||x|| < 0.3|z|$. If matrix $J$ is chosen to be $J = \text{diag}(-1,-2)$, the sliding function can be designed using $\sigma = 5x = [0 \ 1 \ 1]$. We choose $\alpha = 0.5$ and $\beta = 0.715$ such that $q_1 = 0.715$ and $q_2 = 0.988$. Then we see that the conditions of the corollary hold. Hence from the theorem and corollary, we have an estimated ASR $\Omega_{ASR} \approx (\Gamma)$.

Now, using the method of Hui and Zak [1], the estimation of ASR is given by $\Sigma = \{(z,x) : ||x|| \leq 1.3, 4.239 ||x|| \leq 1.383 ||x|| \leq 20\}$. Also, using theorem 2 and remark 6 from Glazos and Zak [2], the ASR is given by $\Sigma' = \{(z,x) : 3.761 ||x|| \leq 3.159 ||x|| \leq 20\}$.

The stability regions $\Sigma$, $\Sigma'$ and $\Omega_{ASR}$ are shown in Fig. 1. The new result can lead to an improvement in the estimation of $\Omega_{ASR}$. It should be noted that for region $\Sigma$, by using the Hui and Zak [1] method and region $\Sigma'$ using the Glazos and Zak [2] method, only estimations of the ASR are obtained. Region $\Omega_{ASR}$ using our method is larger than $\Sigma$ and $\Sigma'$. Furthermore, $\Omega_{ASR}$ is an estimation of ESR.
References


Errata


Editor's correction

The expression $G(D) = g_0 + g_1 D + \ldots + g_m D^m$ which occurs in the sentence after eqn. 1, should read:

$G(D) = g_0 + g_1 D + \ldots + g_m D^m$


Editor's correction

The expression for the modulation pulse after eqn. 6 should read:

$r(t) = j r(t) \exp[i(\pi t/2T)]$


Author's correction

The authors are grateful to A. Hill (BT Laboratories, Ipswich) for pointing out the inaccuracy in Figs. 1 and 2 of our Letter. The second (output) demultiplexer in those figures should be rotated about the horizontal axis, as shown below. This inaccuracy does not affect the reported results.

Fig. 1 Schematic diagram of device with two identical demultiplexers and microlens array.

Fig. 2 Schematic diagram of device with multiorder diffractive element, demultiplexer, and iris.

Inset: Intensity profiles in iris plane for three wavelength channels within signal window.