

# Relazione di Laboratorio 2

## Esperienza A4

### A.A. 2023/2024

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## 1 Cenni teorici

Lo scopo dell'esperienza è quello di verificare le relazioni funzionali di carica e scarica di un condensatore in un circuito RC in corrente continua. Per la carica si consideri il seguente circuito:

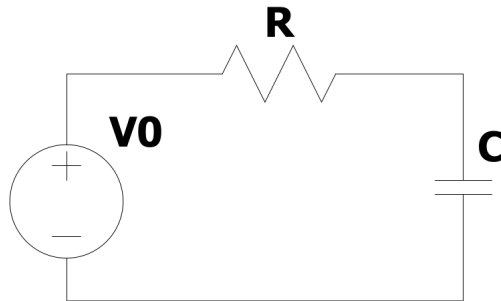


Figure 1: Circuito carica condensatore

Per la seconda legge di Kirchhoff si ha:

$$V_0 = V_R + V_C = Ri(t) + \frac{q(t)}{C}; i(t) = \frac{dq(t)}{dt} \quad (1.1)$$

$$R \frac{dq}{dt} = V_0 - \frac{q}{C} \quad (1.2)$$

$$\frac{dq}{q - CV_0} = -\frac{dt}{RC} \quad (1.3)$$

Risolvendo l'equazione differenziale a variabili separabili [1.3](#) si ottiene

$$q(t) = CV_0(1 - e^{-\frac{t}{RC}}) \quad (1.4)$$



Figure 2: Circuito scarica condensatore

Dalla quale si calcola:

$$V_C(t) = \frac{q(t)}{C} = V_0(1 - e^{-\frac{t}{RC}}) \quad (1.5)$$

Per la scarica si consideri il seguente circuito: Si ha:

$$V_C = \frac{q}{C} = V_R = Ri; i = -\frac{dq}{dt} \quad (1.6)$$

$$\frac{dq}{dt} = -\frac{q}{RC} \quad (1.7)$$

Risolvendo l'equazione differenziale a variabili separabili [1.7](#) risulta:

$$q(t) = q_0 e^{-\frac{t}{RC}} \quad (1.8)$$

Ergo:

$$V_C(t) = \frac{q}{C} = \frac{q_0}{C} e^{-\frac{t}{RC}} = V_0 e^{-\frac{t}{RC}} \quad (1.9)$$

Dunque le relazioni [1.5](#) e [1.9](#) descrivono la dipendenza funzionale della differenza di potenziale tra le armature del condensatore dal tempo, rispettivamente per la carica e la scarica. La quantità  $\tau = RC$  è chiamato tempo caratteristico.

## 2 Strumenti e metodo di misura

Per eseguire l'esperimento sono stati utilizzati i seguenti strumenti di misura:

- Resistenze dal valore nominale di  $560\Omega$  e  $1200\Omega$
- Condensatore da capacità nominale di  $0.2\mu F$
- Oscilloscopio Rigol DS1102e
- Multimetro Proster BM4070
- Generatore di segnali Rigol DG1022
- Diodo
- Sonda

- Cavo BNC-Coccodrillo
- Cavo BNC-BNC
- T-BNC

Si è costruito il seguente circuito:

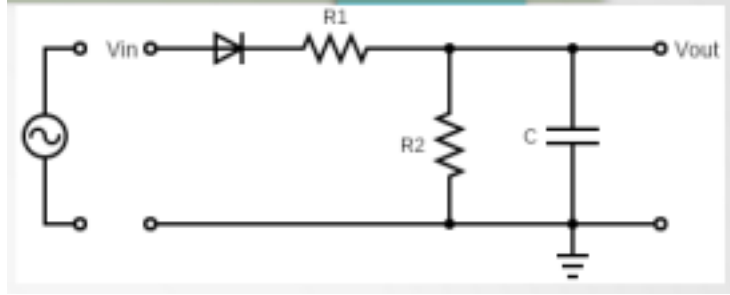


Figure 3: Circuito realizzato

Si è applicato un segnale ad onda quadra, con frequenza nominale di  $50Hz$ , all'ingresso del circuito e si è utilizzato un diodo al fine di non far passare la semi-onda negativa del segnale. Il circuito cosiffatto permette la carica del condensatore durante la semi-onda positiva del segnale e la scarica durante la negativa. Analizzando tale circuito si osserva che:

$$V_o = V_i \frac{Z_{R_2} || Z_C}{R_1 + Z_{R_2} || Z_C} \quad (2.1)$$

$$Z_{R_2} || Z_C = \frac{\frac{R_2}{sC}}{R_2 + \frac{1}{sC}} = \frac{R_2}{sCR_2 + 1}; jw \rightarrow s \quad (2.2)$$

$$\frac{V_o}{V_i} = \frac{\frac{R_2}{sCR_2 + 1}}{R_1 + \frac{R_2}{sCR_2 + 1}} = \frac{R_2}{sCR_1R_2 + R_1 + R_2} = \frac{\frac{R_2}{R_1 + R_2}}{sC(R_1 || R_2) + 1} \quad (2.3)$$

$$V_o = \frac{V'_i}{1 + sC(R_1 || R_2)}; \text{con } V'_i = V_i \frac{R_2}{R_1 + R_2} \quad (2.4)$$

Dunque per la fase di carica è come se si applicasse il segnale "partizionato"  $V'_i$  al circuito serie:

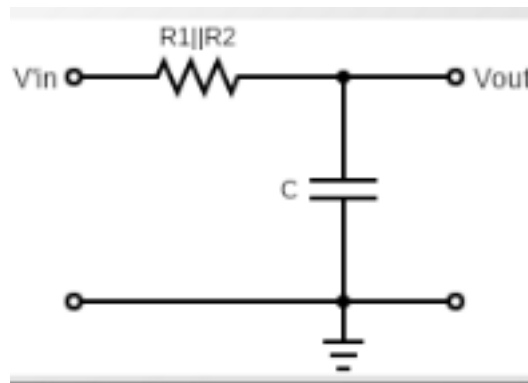


Figure 4: Circuito equivalente in fase di carica

Ergo la costante di tempo di carica risulta:

$$\tau_c = \frac{R_1 R_2}{R_1 + R_2} C \quad (2.5)$$

Per la fase di scarica, poiché il diodo polarizzato inversamente si comporta come un circuito aperto, si ha:

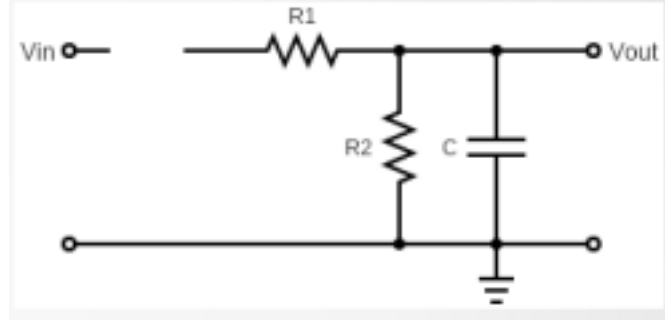


Figure 5: Circuito equivalente scarica

Per cui la costante di tempo di scarica è:

$$\tau_{sc} = R_2 C \quad (2.6)$$

Poiché si è voluto costruire un circuito con  $\tau_{sc} \simeq 3\tau_c$ , per 2.5 e 2.6, deve aversi  $R_2 = 2R_1$ . Per effettuare la misura senza alterare le condizioni del circuito si è collegata una sonda ai capi del condensatore. Tramite la sonda si trasferisce il segnale all'oscilloscopio collegando la sonda al canale 2 dell'oscilloscopio, così da poter visualizzare l'andamento di carica e scarica del circuito. Per verificare il corretto funzionamento del circuito è stata sdoppiata l'uscita del generatore di funzioni tramite una T-BNC: Un segnale è stato trasmesso al circuito ed l'altro è stato collegato con un cavo BNC-BNC direttamente al canale 1 dell'oscilloscopio. Al fine di visualizzare correttamente i tempi di carica e scarica è stato impostato un duty cycle dell'onda quadra al 20%. Infine si sono esportati i dati visualizzati dall'oscilloscopio in formato csv. Tale procedimento è stato ripetuto anche per un'onda quadra con frequenza nominale di  $90Hz$

### 3 Analisi Dati

Le resistenze utilizzate hanno valori:  $R_1 = (551 \pm 4.8)\Omega$  ed  $R_2 = (1182.0 \pm 9.7)\Omega$ .

Il condensatore utilizzato ha una capacità:  $C = (2.110 \pm 0.073)10^{-7}F$ . Le incertezze sulle resistenze e sulla capacità sono state determinate utilizzando le indicazioni fornite dal costruttore del multimetro digitale Proster BM4070.

Dunque da 2.5 e 2.6 si ha:  $\tau_c = (7.93 \pm 0.29)10^{-5}s$ ;  $\tau_{sc} = (2.494 \pm 0.088)10^{-4}s$ . Le incertezze sono state calcolate tramite:

$$\Delta\tau_c = \sqrt{\left(\frac{\partial\tau_c}{\partial R_1}\Delta R_1\right)^2 + \left(\frac{\partial\tau_c}{\partial R_2}\Delta R_2\right)^2 + \left(\frac{\partial\tau_c}{\partial C}\Delta C\right)^2} \quad (3.1)$$

$$\Delta\tau_{sc} = \sqrt{\left(\frac{\partial\tau_{sc}}{\partial R_2}\Delta R_2\right)^2 + \left(\frac{\partial\tau_{sc}}{\partial C}\Delta C\right)^2} = \sqrt{(C\Delta R_2)^2 + (R_2\Delta C)^2} \quad (3.2)$$

I valori misurati dall'oscilloscopio Rigol ds1102e sono riportati in appendice [A](#). I seguenti grafici sono i rispettivi plot dei dati in [A](#)

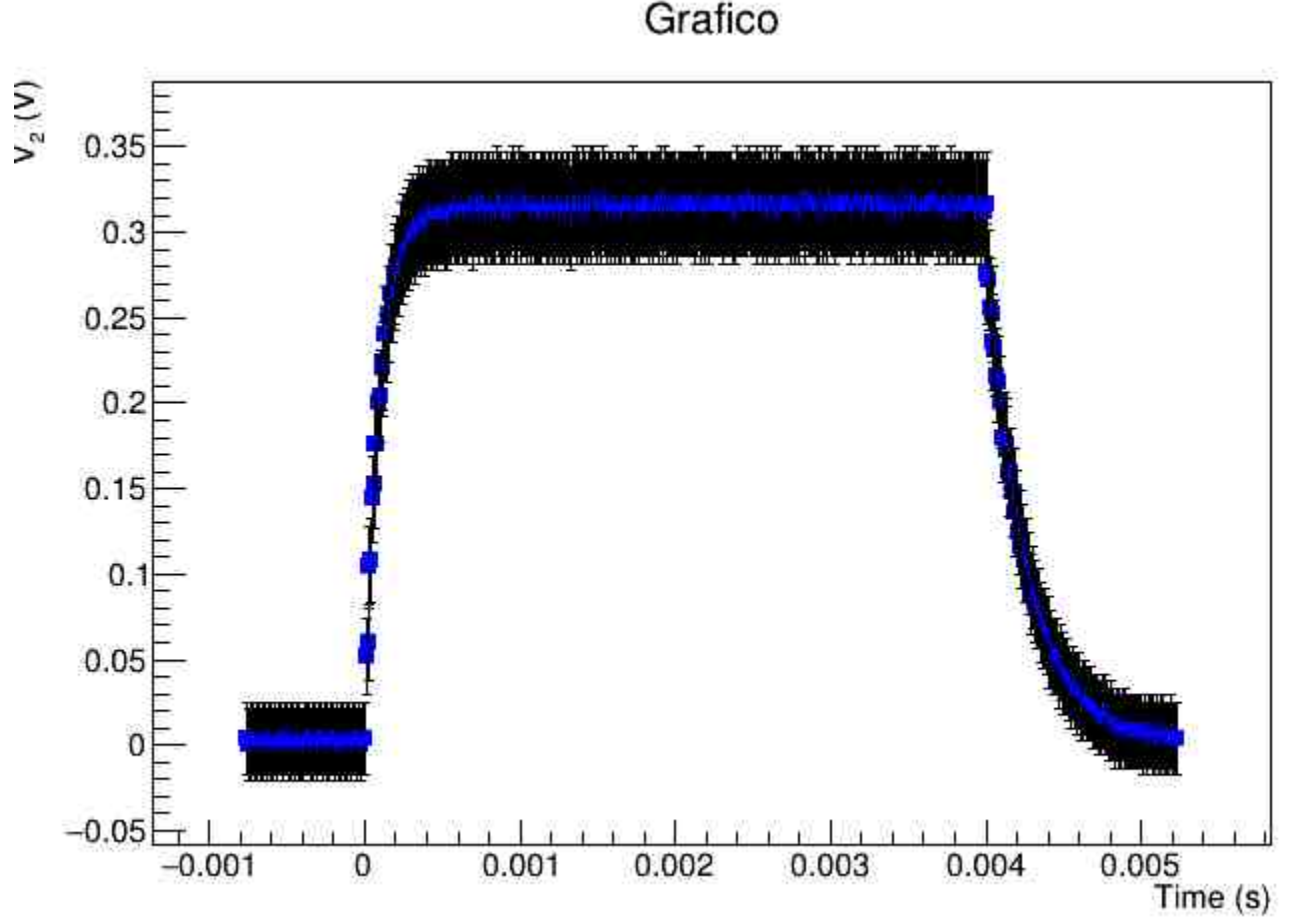


Figure 6: Plot dati con segnale a  $50Hz$

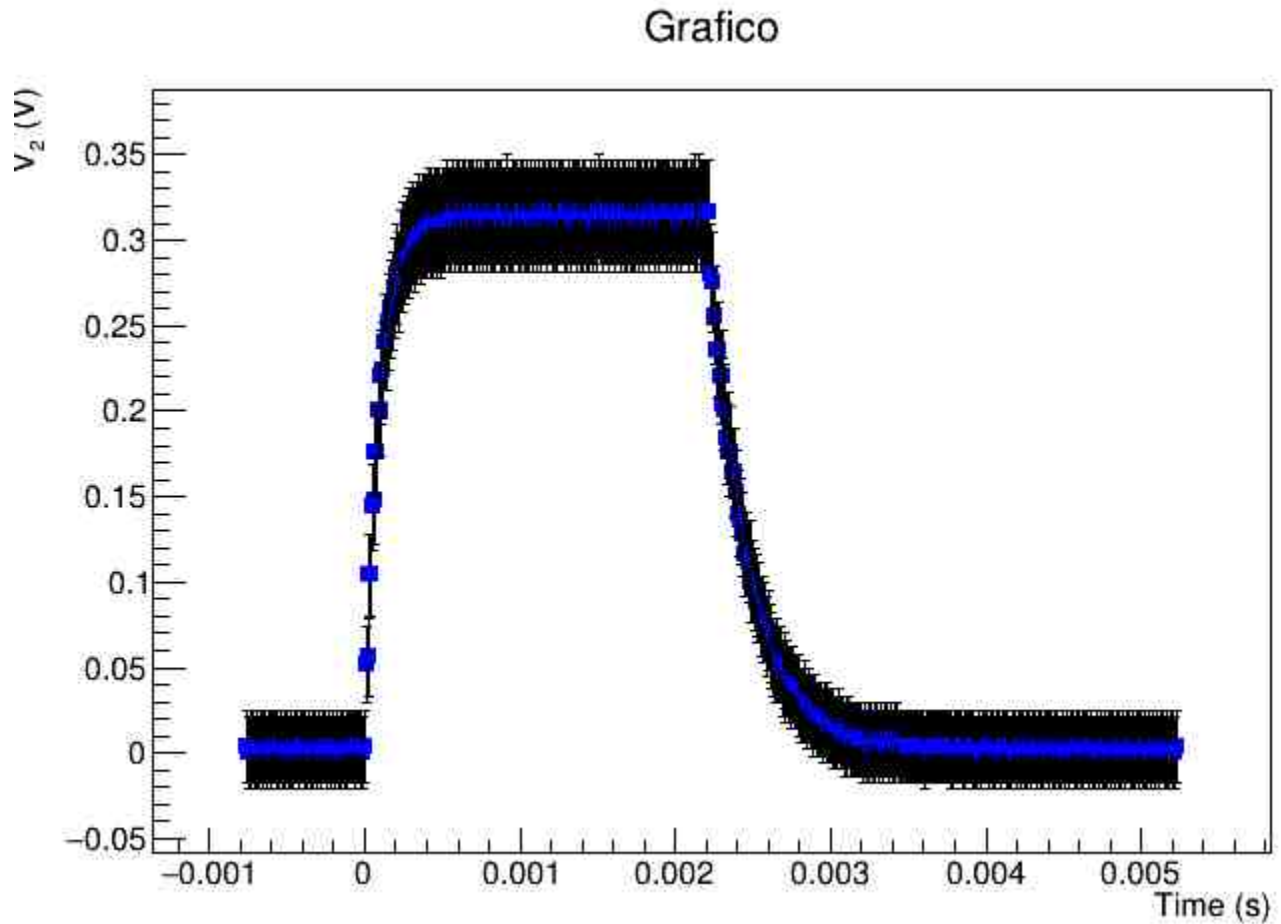


Figure 7: Plot dati con segnale a  $90Hz$

Le incertezze sulle misure effettuate dall'oscilloscopio sono state determinate utilizzando le indicazioni fornite dal costruttore nel manuale dello strumento.

Come si può vedere dai grafici 6 e 7, all'inizio  $V_c$  aumenta molto rapidamente (fase di carica), successivamente rimane costante (condensatore carico), per poi diminuire (fase di scarica) fino ad arrivare a 0 (condensatore scarico). Poiché la 1.5 vale soltanto durante la carica, si sono considerati solo i valori appartenenti al "ramo" ascendente dei grafici. Tali valori sono:

| <b>Carica 50Hz</b> |                 |           |               |
|--------------------|-----------------|-----------|---------------|
| $V_c(V)$           | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 0.004              | 0.021           | 0.0000000 | 0.0000016     |
| 0.052              | 0.023           | 0.0000100 | 0.0000016     |
| 0.060              | 0.023           | 0.0000200 | 0.0000016     |
| 0.104              | 0.024           | 0.0000300 | 0.0000016     |
| 0.108              | 0.024           | 0.0000400 | 0.0000016     |
| 0.144              | 0.025           | 0.0000500 | 0.0000016     |
| 0.152              | 0.026           | 0.0000600 | 0.0000016     |
| 0.176              | 0.026           | 0.0000700 | 0.0000016     |
| 0.176              | 0.026           | 0.0000800 | 0.0000016     |
| 0.200              | 0.027           | 0.0000900 | 0.0000016     |
| 0.204              | 0.027           | 0.0001000 | 0.0000016     |
| 0.220              | 0.028           | 0.0001100 | 0.0000016     |
| 0.224              | 0.028           | 0.0001200 | 0.0000016     |
| 0.240              | 0.028           | 0.0001300 | 0.0000016     |
| 0.240              | 0.028           | 0.0001400 | 0.0000016     |
| 0.252              | 0.029           | 0.0001500 | 0.0000016     |
| 0.252              | 0.029           | 0.0001600 | 0.0000016     |
| 0.264              | 0.029           | 0.0001700 | 0.0000016     |
| 0.264              | 0.029           | 0.0001800 | 0.0000016     |
| 0.272              | 0.029           | 0.0001900 | 0.0000016     |
| 0.276              | 0.029           | 0.0002000 | 0.0000016     |
| 0.280              | 0.029           | 0.0002100 | 0.0000016     |
| 0.280              | 0.029           | 0.0002200 | 0.0000016     |
| 0.288              | 0.030           | 0.0002300 | 0.0000016     |
| 0.288              | 0.030           | 0.0002400 | 0.0000016     |
| 0.292              | 0.030           | 0.0002500 | 0.0000016     |
| 0.292              | 0.030           | 0.0002600 | 0.0000016     |
| 0.296              | 0.030           | 0.0002700 | 0.0000016     |
| 0.296              | 0.030           | 0.0002800 | 0.0000016     |
| 0.300              | 0.030           | 0.0002900 | 0.0000016     |
| 0.300              | 0.030           | 0.0003000 | 0.0000016     |
| 0.304              | 0.030           | 0.0003100 | 0.0000016     |
| 0.300              | 0.030           | 0.0003200 | 0.0000016     |
| 0.304              | 0.030           | 0.0003300 | 0.0000016     |
| 0.304              | 0.030           | 0.0003400 | 0.0000016     |
| 0.308              | 0.030           | 0.0003500 | 0.0000016     |
| 0.304              | 0.030           | 0.0003600 | 0.0000016     |
| 0.308              | 0.030           | 0.0003700 | 0.0000016     |
| 0.308              | 0.030           | 0.0003800 | 0.0000016     |
| 0.304              | 0.030           | 0.0003900 | 0.0000016     |

| <b>Carica 50Hz</b> |                 |           |               |
|--------------------|-----------------|-----------|---------------|
| $V_c(V)$           | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 0.308              | 0.030           | 0.0004000 | 0.0000016     |
| 0.312              | 0.030           | 0.0004100 | 0.0000016     |
| 0.308              | 0.030           | 0.0004200 | 0.0000016     |
| 0.312              | 0.030           | 0.0004300 | 0.0000016     |
| 0.308              | 0.030           | 0.0004400 | 0.0000016     |
| 0.312              | 0.030           | 0.0004500 | 0.0000016     |
| 0.312              | 0.030           | 0.0004600 | 0.0000016     |
| 0.308              | 0.030           | 0.0004700 | 0.0000016     |
| 0.312              | 0.030           | 0.0004800 | 0.0000016     |
| 0.312              | 0.030           | 0.0004900 | 0.0000016     |
| 0.312              | 0.030           | 0.0005000 | 0.0000016     |
| 0.308              | 0.030           | 0.0005100 | 0.0000016     |
| 0.312              | 0.030           | 0.0005200 | 0.0000016     |
| 0.308              | 0.030           | 0.0005300 | 0.0000016     |
| 0.312              | 0.030           | 0.0005400 | 0.0000016     |
| 0.316              | 0.030           | 0.0005500 | 0.0000016     |
| 0.312              | 0.030           | 0.0005600 | 0.0000016     |
| 0.316              | 0.030           | 0.0005700 | 0.0000016     |
| 0.312              | 0.030           | 0.0005800 | 0.0000016     |
| 0.312              | 0.030           | 0.0005900 | 0.0000016     |
| 0.312              | 0.030           | 0.0006000 | 0.0000016     |
| 0.316              | 0.030           | 0.0006100 | 0.0000016     |
| 0.316              | 0.030           | 0.0006200 | 0.0000016     |
| 0.312              | 0.030           | 0.0006300 | 0.0000016     |
| 0.312              | 0.030           | 0.0006400 | 0.0000016     |
| 0.316              | 0.030           | 0.0006500 | 0.0000016     |

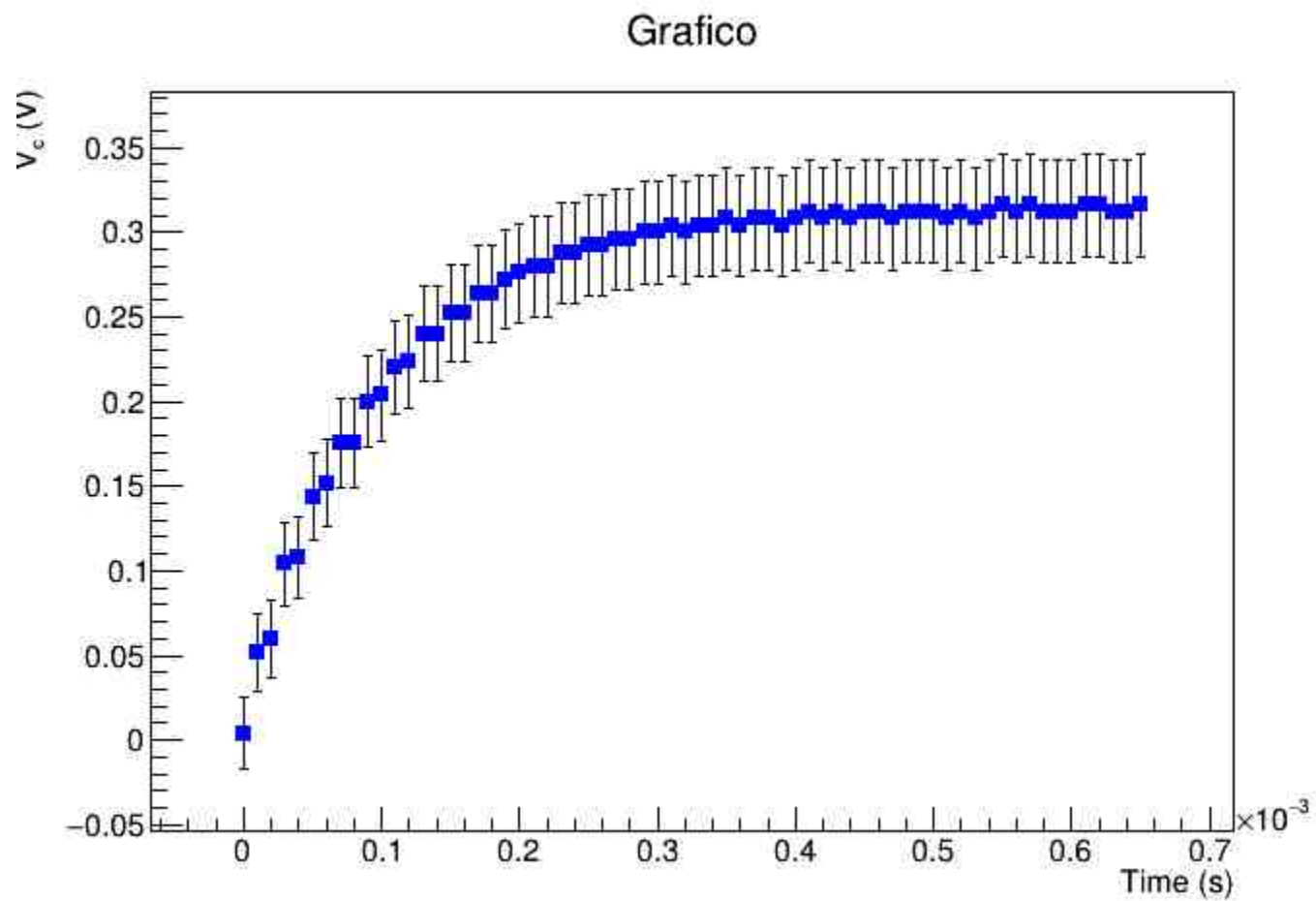


Figure 8: Plot dati carica con segnale a  $50Hz$



| <b>Carica 90Hz</b> |                 |           |               |
|--------------------|-----------------|-----------|---------------|
| $V_c(V)$           | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 0.004              | 0.021           | 0.0000000 | 0.0000016     |
| 0.052              | 0.023           | 0.0000100 | 0.0000016     |
| 0.056              | 0.023           | 0.0000200 | 0.0000016     |
| 0.104              | 0.024           | 0.0000300 | 0.0000016     |
| 0.104              | 0.024           | 0.0000400 | 0.0000016     |
| 0.144              | 0.025           | 0.0000500 | 0.0000016     |
| 0.148              | 0.025           | 0.0000600 | 0.0000016     |
| 0.176              | 0.026           | 0.0000700 | 0.0000016     |
| 0.176              | 0.026           | 0.0000800 | 0.0000016     |
| 0.200              | 0.027           | 0.0000900 | 0.0000016     |
| 0.200              | 0.027           | 0.0001000 | 0.0000016     |
| 0.220              | 0.028           | 0.0001100 | 0.0000016     |
| 0.224              | 0.028           | 0.0001200 | 0.0000016     |
| 0.240              | 0.028           | 0.0001300 | 0.0000016     |
| 0.240              | 0.028           | 0.0001400 | 0.0000016     |
| 0.252              | 0.029           | 0.0001500 | 0.0000016     |
| 0.252              | 0.029           | 0.0001600 | 0.0000016     |
| 0.260              | 0.029           | 0.0001700 | 0.0000016     |
| 0.264              | 0.029           | 0.0001800 | 0.0000016     |
| 0.272              | 0.029           | 0.0001900 | 0.0000016     |
| 0.272              | 0.029           | 0.0002000 | 0.0000016     |
| 0.280              | 0.029           | 0.0002100 | 0.0000016     |
| 0.276              | 0.029           | 0.0002200 | 0.0000016     |
| 0.288              | 0.030           | 0.0002300 | 0.0000016     |
| 0.288              | 0.030           | 0.0002400 | 0.0000016     |
| 0.292              | 0.030           | 0.0002500 | 0.0000016     |
| 0.292              | 0.030           | 0.0002600 | 0.0000016     |
| 0.296              | 0.030           | 0.0002700 | 0.0000016     |
| 0.296              | 0.030           | 0.0002800 | 0.0000016     |
| 0.300              | 0.030           | 0.0002900 | 0.0000016     |
| 0.300              | 0.030           | 0.0003000 | 0.0000016     |
| 0.304              | 0.030           | 0.0003100 | 0.0000016     |
| 0.300              | 0.030           | 0.0003200 | 0.0000016     |
| 0.304              | 0.030           | 0.0003300 | 0.0000016     |
| 0.304              | 0.030           | 0.0003400 | 0.0000016     |
| 0.308              | 0.030           | 0.0003500 | 0.0000016     |
| 0.304              | 0.030           | 0.0003600 | 0.0000016     |
| 0.308              | 0.030           | 0.0003700 | 0.0000016     |
| 0.308              | 0.030           | 0.0003800 | 0.0000016     |
| 0.308              | 0.030           | 0.0003900 | 0.0000016     |

| <b>Carica 90Hz</b> |                 |           |               |
|--------------------|-----------------|-----------|---------------|
| $V_c(V)$           | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 0.308              | 0.030           | 0.0004000 | 0.0000016     |
| 0.312              | 0.030           | 0.0004100 | 0.0000016     |

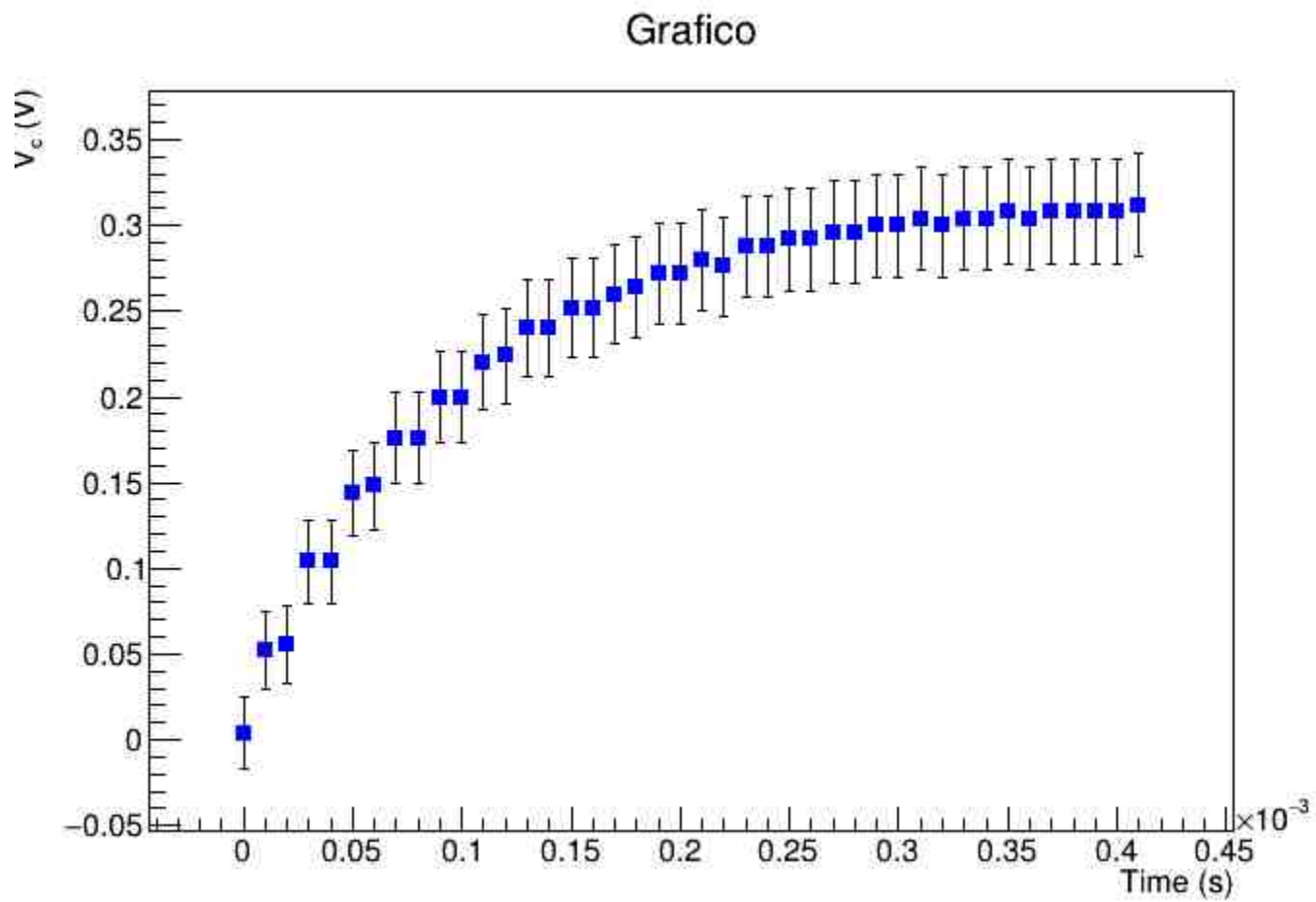


Figure 9: Plot dati carica con segnale a  $90Hz$

Per la scarica sono stati considerati, quindi, solo i valori appartenenti al "ramo" discendente dei grafici, i quali sono:

| Scarica 50Hz |                 |           |               | Scarica 50Hz |                 |           |               |
|--------------|-----------------|-----------|---------------|--------------|-----------------|-----------|---------------|
| $V_c(V)$     | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | $V_c(V)$     | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 0.3160       | 0.0305          | 0.0039600 | 0.0000017     | 0.0720       | 0.0232          | 0.0043600 | 0.0000018     |
| 0.3120       | 0.0304          | 0.0039700 | 0.0000017     | 0.0680       | 0.0230          | 0.0043700 | 0.0000018     |
| 0.3160       | 0.0305          | 0.0039800 | 0.0000017     | 0.0680       | 0.0230          | 0.0043800 | 0.0000018     |
| 0.3120       | 0.0304          | 0.0039900 | 0.0000017     | 0.0640       | 0.0229          | 0.0043900 | 0.0000018     |
| 0.3160       | 0.0305          | 0.0040000 | 0.0000018     | 0.0640       | 0.0229          | 0.0044000 | 0.0000018     |
| 0.2760       | 0.0293          | 0.0040100 | 0.0000018     | 0.0560       | 0.0227          | 0.0044100 | 0.0000018     |
| 0.2720       | 0.0292          | 0.0040200 | 0.0000018     | 0.0560       | 0.0227          | 0.0044200 | 0.0000018     |
| 0.2560       | 0.0287          | 0.0040300 | 0.0000018     | 0.0520       | 0.0226          | 0.0044300 | 0.0000018     |
| 0.2520       | 0.0286          | 0.0040400 | 0.0000018     | 0.0520       | 0.0226          | 0.0044400 | 0.0000018     |
| 0.2360       | 0.0281          | 0.0040500 | 0.0000018     | 0.0520       | 0.0226          | 0.0044500 | 0.0000018     |
| 0.2320       | 0.0280          | 0.0040600 | 0.0000018     | 0.0520       | 0.0226          | 0.0044600 | 0.0000018     |
| 0.2160       | 0.0275          | 0.0040700 | 0.0000018     | 0.0440       | 0.0223          | 0.0044700 | 0.0000018     |
| 0.2120       | 0.0274          | 0.0040800 | 0.0000018     | 0.0480       | 0.0224          | 0.0044800 | 0.0000018     |
| 0.2000       | 0.0270          | 0.0040900 | 0.0000018     | 0.0400       | 0.0222          | 0.0044900 | 0.0000018     |
| 0.2000       | 0.0270          | 0.0041000 | 0.0000018     | 0.0440       | 0.0223          | 0.0045000 | 0.0000018     |
| 0.1800       | 0.0264          | 0.0041100 | 0.0000018     | 0.0400       | 0.0222          | 0.0045100 | 0.0000018     |
| 0.1800       | 0.0264          | 0.0041200 | 0.0000018     | 0.0400       | 0.0222          | 0.0045200 | 0.0000018     |
| 0.1760       | 0.0263          | 0.0041300 | 0.0000018     | 0.0360       | 0.0221          | 0.0045300 | 0.0000018     |
| 0.1720       | 0.0262          | 0.0041400 | 0.0000018     | 0.0360       | 0.0221          | 0.0045400 | 0.0000018     |
| 0.1600       | 0.0258          | 0.0041500 | 0.0000018     | 0.0320       | 0.0220          | 0.0045500 | 0.0000018     |
| 0.1600       | 0.0258          | 0.0041600 | 0.0000018     | 0.0360       | 0.0221          | 0.0045600 | 0.0000018     |
| 0.1480       | 0.0254          | 0.0041700 | 0.0000018     | 0.0320       | 0.0220          | 0.0045700 | 0.0000018     |
| 0.1480       | 0.0254          | 0.0041800 | 0.0000018     | 0.0320       | 0.0220          | 0.0045800 | 0.0000018     |
| 0.1360       | 0.0251          | 0.0041900 | 0.0000018     | 0.0280       | 0.0218          | 0.0045900 | 0.0000018     |
| 0.1360       | 0.0251          | 0.0042000 | 0.0000018     | 0.0320       | 0.0220          | 0.0046000 | 0.0000018     |
| 0.1240       | 0.0247          | 0.0042100 | 0.0000018     | 0.0240       | 0.0217          | 0.0046100 | 0.0000018     |
| 0.1240       | 0.0247          | 0.0042200 | 0.0000018     | 0.0280       | 0.0218          | 0.0046200 | 0.0000018     |
| 0.1160       | 0.0245          | 0.0042300 | 0.0000018     | 0.0240       | 0.0217          | 0.0046300 | 0.0000018     |
| 0.1160       | 0.0245          | 0.0042400 | 0.0000018     | 0.0280       | 0.0218          | 0.0046400 | 0.0000018     |
| 0.1080       | 0.0242          | 0.0042500 | 0.0000018     | 0.0240       | 0.0217          | 0.0046500 | 0.0000018     |
| 0.1080       | 0.0242          | 0.0042600 | 0.0000018     | 0.0240       | 0.0217          | 0.0046600 | 0.0000018     |
| 0.1000       | 0.0240          | 0.0042700 | 0.0000018     | 0.0240       | 0.0217          | 0.0046700 | 0.0000018     |
| 0.1000       | 0.0240          | 0.0042800 | 0.0000018     | 0.0240       | 0.0217          | 0.0046800 | 0.0000018     |
| 0.0880       | 0.0236          | 0.0042900 | 0.0000018     | 0.0200       | 0.0216          | 0.0046900 | 0.0000018     |
| 0.0920       | 0.0238          | 0.0043000 | 0.0000018     | 0.0200       | 0.0216          | 0.0047000 | 0.0000018     |
| 0.0840       | 0.0235          | 0.0043100 | 0.0000018     | 0.0200       | 0.0216          | 0.0047100 | 0.0000018     |
| 0.0840       | 0.0235          | 0.0043200 | 0.0000018     | 0.0200       | 0.0216          | 0.0047200 | 0.0000018     |
| 0.0800       | 0.0234          | 0.0043300 | 0.0000018     | 0.0160       | 0.0215          | 0.0047300 | 0.0000018     |
| 0.0800       | 0.0234          | 0.0043400 | 0.0000018     | 0.0160       | 0.0215          | 0.0047400 | 0.0000018     |
| 0.0720       | 0.0232          | 0.0043500 | 0.0000018     | 0.0200       | 0.0216          | 0.0047500 | 0.0000018     |

| <b>Scarica 50Hz</b> |                 |           |               |
|---------------------|-----------------|-----------|---------------|
| $V_c(V)$            | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 0.0200              | 0.0216          | 0.0047600 | 0.0000018     |
| 0.0160              | 0.0215          | 0.0047700 | 0.0000018     |
| 0.0160              | 0.0215          | 0.0047800 | 0.0000018     |
| 0.0120              | 0.0214          | 0.0047900 | 0.0000018     |
| 0.0120              | 0.0214          | 0.0048000 | 0.0000018     |
| 0.0160              | 0.0215          | 0.0048100 | 0.0000018     |
| 0.0120              | 0.0214          | 0.0048200 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0048300 | 0.0000018     |
| 0.0120              | 0.0214          | 0.0048400 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0048500 | 0.0000018     |
| 0.0120              | 0.0214          | 0.0048600 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0048700 | 0.0000018     |
| 0.0120              | 0.0214          | 0.0048800 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0048900 | 0.0000018     |
| 0.0120              | 0.0214          | 0.0049000 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0049100 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0049200 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0049300 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0049400 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0049500 | 0.0000018     |
| 0.0080              | 0.0212          | 0.0049600 | 0.0000018     |

## Grafico

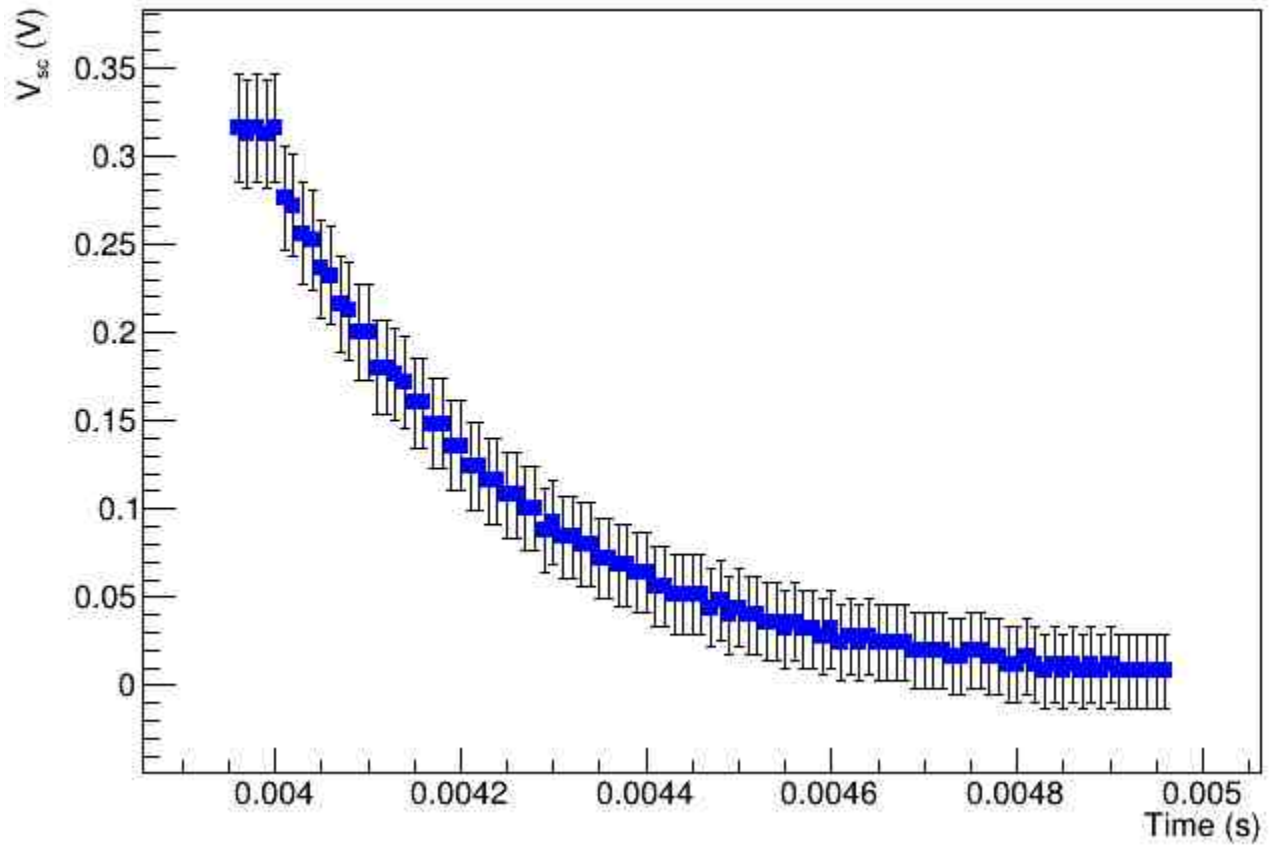


Figure 10: Plot dati scarica con segnale a  $50Hz$

| Scarica 90Hz |                 |           |               | Scarica 90Hz |                 |           |               |
|--------------|-----------------|-----------|---------------|--------------|-----------------|-----------|---------------|
| $V_c(V)$     | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | $V_c(V)$     | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 0.316        | 0.030           | 0.0022100 | 0.0000017     | 0.060        | 0.023           | 0.0026100 | 0.0000017     |
| 0.316        | 0.030           | 0.0022200 | 0.0000017     | 0.064        | 0.023           | 0.0026200 | 0.0000017     |
| 0.280        | 0.029           | 0.0022300 | 0.0000017     | 0.056        | 0.023           | 0.0026300 | 0.0000017     |
| 0.276        | 0.029           | 0.0022400 | 0.0000017     | 0.052        | 0.023           | 0.0026400 | 0.0000017     |
| 0.256        | 0.029           | 0.0022500 | 0.0000017     | 0.056        | 0.023           | 0.0026500 | 0.0000017     |
| 0.256        | 0.029           | 0.0022600 | 0.0000017     | 0.052        | 0.023           | 0.0026600 | 0.0000017     |
| 0.236        | 0.028           | 0.0022700 | 0.0000017     | 0.052        | 0.023           | 0.0026700 | 0.0000017     |
| 0.236        | 0.028           | 0.0022800 | 0.0000017     | 0.052        | 0.023           | 0.0026800 | 0.0000017     |
| 0.220        | 0.028           | 0.0022900 | 0.0000017     | 0.044        | 0.022           | 0.0026900 | 0.0000017     |
| 0.220        | 0.028           | 0.0023000 | 0.0000017     | 0.048        | 0.022           | 0.0027000 | 0.0000017     |
| 0.204        | 0.027           | 0.0023100 | 0.0000017     | 0.040        | 0.022           | 0.0027100 | 0.0000017     |
| 0.200        | 0.027           | 0.0023200 | 0.0000017     | 0.044        | 0.022           | 0.0027200 | 0.0000017     |
| 0.184        | 0.027           | 0.0023300 | 0.0000017     | 0.040        | 0.022           | 0.0027300 | 0.0000017     |
| 0.184        | 0.027           | 0.0023400 | 0.0000017     | 0.040        | 0.022           | 0.0027400 | 0.0000017     |
| 0.176        | 0.026           | 0.0023500 | 0.0000017     | 0.036        | 0.022           | 0.0027500 | 0.0000017     |
| 0.176        | 0.026           | 0.0023600 | 0.0000017     | 0.040        | 0.022           | 0.0027600 | 0.0000017     |
| 0.164        | 0.026           | 0.0023700 | 0.0000017     | 0.036        | 0.022           | 0.0027700 | 0.0000017     |
| 0.164        | 0.026           | 0.0023800 | 0.0000017     | 0.036        | 0.022           | 0.0027800 | 0.0000017     |
| 0.152        | 0.026           | 0.0023900 | 0.0000017     | 0.036        | 0.022           | 0.0027900 | 0.0000017     |
| 0.152        | 0.026           | 0.0024000 | 0.0000017     | 0.032        | 0.022           | 0.0028000 | 0.0000017     |
| 0.140        | 0.025           | 0.0024100 | 0.0000017     | 0.028        | 0.022           | 0.0028100 | 0.0000017     |
| 0.136        | 0.025           | 0.0024200 | 0.0000017     | 0.028        | 0.022           | 0.0028200 | 0.0000017     |
| 0.128        | 0.025           | 0.0024300 | 0.0000017     | 0.032        | 0.022           | 0.0028300 | 0.0000017     |
| 0.128        | 0.025           | 0.0024400 | 0.0000017     | 0.028        | 0.022           | 0.0028400 | 0.0000017     |
| 0.116        | 0.024           | 0.0024500 | 0.0000017     | 0.024        | 0.022           | 0.0028500 | 0.0000017     |
| 0.116        | 0.024           | 0.0024600 | 0.0000017     | 0.028        | 0.022           | 0.0028600 | 0.0000017     |
| 0.112        | 0.024           | 0.0024700 | 0.0000017     | 0.024        | 0.022           | 0.0028700 | 0.0000017     |
| 0.112        | 0.024           | 0.0024800 | 0.0000017     | 0.024        | 0.022           | 0.0028800 | 0.0000017     |
| 0.100        | 0.024           | 0.0024900 | 0.0000017     | 0.020        | 0.022           | 0.0028900 | 0.0000017     |
| 0.100        | 0.024           | 0.0025000 | 0.0000017     | 0.024        | 0.022           | 0.0029000 | 0.0000017     |
| 0.096        | 0.024           | 0.0025100 | 0.0000017     | 0.020        | 0.022           | 0.0029100 | 0.0000017     |
| 0.092        | 0.024           | 0.0025200 | 0.0000017     | 0.020        | 0.022           | 0.0029200 | 0.0000017     |
| 0.088        | 0.024           | 0.0025300 | 0.0000017     | 0.020        | 0.022           | 0.0029300 | 0.0000017     |
| 0.088        | 0.024           | 0.0025400 | 0.0000017     | 0.020        | 0.022           | 0.0029400 | 0.0000017     |
| 0.080        | 0.023           | 0.0025500 | 0.0000017     | 0.016        | 0.021           | 0.0029500 | 0.0000017     |
| 0.080        | 0.023           | 0.0025600 | 0.0000017     | 0.020        | 0.022           | 0.0029600 | 0.0000017     |
| 0.076        | 0.023           | 0.0025700 | 0.0000017     | 0.016        | 0.021           | 0.0029700 | 0.0000017     |
| 0.076        | 0.023           | 0.0025800 | 0.0000017     | 0.020        | 0.022           | 0.0029800 | 0.0000017     |
| 0.068        | 0.023           | 0.0025900 | 0.0000017     | 0.016        | 0.021           | 0.0029900 | 0.0000017     |
| 0.072        | 0.023           | 0.0026000 | 0.0000017     | 0.016        | 0.021           | 0.0030000 | 0.0000017     |

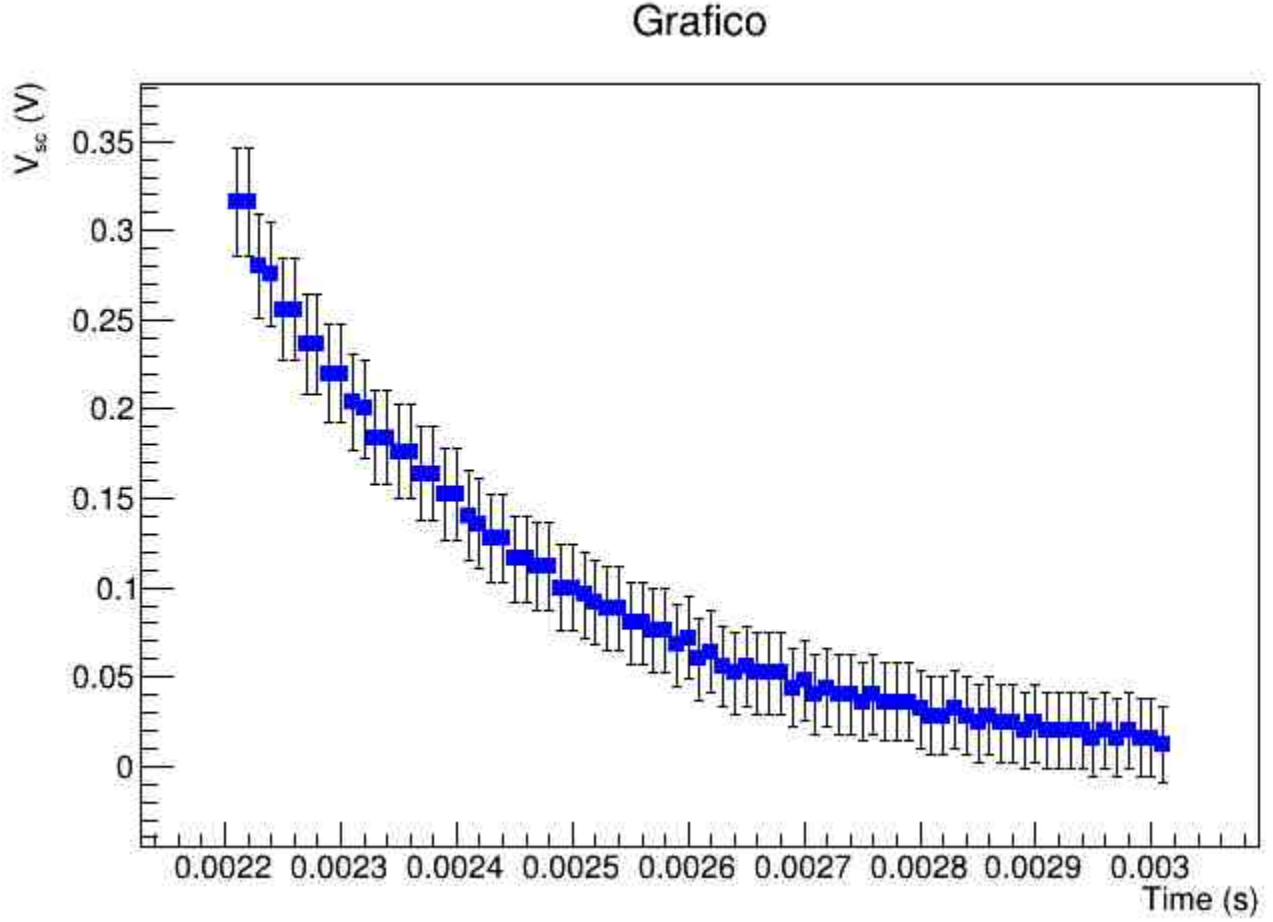


Figure 11: Plot dati scarica con segnale a  $90Hz$

### 3.1 Best fit

La procedura di best fit che è stata utilizzata per l'analisi dei dati è basata sulla minimizzazione del  $\chi^2$  così definito:

$$\chi^2 = \sum_{i=1}^N \frac{(y_i - F(x_i))^2}{\sigma_{y_i}^2 + \left(\frac{\partial F(x_i)}{\partial x} \sigma_{x_i}\right)^2} \quad (3.3)$$

dove gli  $y_i$  sono i valori della variabile dipendente misurata, gli  $F(x_i)$  sono i valori previsti dal modello nella sua forma funzionale (cioè dipendenti dai parametri che si desidera trovare), gli  $x_i$  sono i valori misurati della variabile indipendente, i  $\sigma_{y_i}$  sono gli errori associati alla variabile dipendente, i  $\sigma_{x_i}$  sono gli errori associati alla variabile indipendente ed  $N$  il numero di valori su cui si sta effettuando la procedura di best fit.

Per la verifica della relazione 1.5 è stata effettuata una procedura di best fit sul seguente

modello:

$$Y = e^{MX} \quad (3.4)$$

con  $Y = \frac{V_0 - V_C}{V_0}$  ;  $X = t$  ed  $M = -\frac{1}{RC}$ . Le incertezze su  $Y$  sono state determinate tramite:

$$\Delta Y = \sqrt{\left(\frac{\partial Y}{\partial V_C} \Delta V_C\right)^2 + \left(\frac{\partial Y}{\partial V_0} \Delta V_0\right)^2} = \sqrt{\left(\frac{\Delta V_C}{V_0}\right)^2 + \left(\frac{V_C \Delta V_0}{V_0^2}\right)^2} \quad (3.5)$$



| Dati Fit Carica 50Hz |            |           |               |
|----------------------|------------|-----------|---------------|
| $Y$                  | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ |
| 0.987                | 0.067      | 0.0000000 | 0.0000016     |
| 0.835                | 0.073      | 0.0000100 | 0.0000016     |
| 0.810                | 0.074      | 0.0000200 | 0.0000016     |
| 0.671                | 0.083      | 0.0000300 | 0.0000016     |
| 0.658                | 0.083      | 0.0000400 | 0.0000016     |
| 0.544                | 0.091      | 0.0000500 | 0.0000016     |
| 0.519                | 0.093      | 0.0000600 | 0.0000016     |
| 0.443                | 0.099      | 0.0000700 | 0.0000016     |
| 0.443                | 0.099      | 0.0000800 | 0.0000016     |
| 0.367                | 0.105      | 0.0000900 | 0.0000016     |
| 0.354                | 0.106      | 0.0001000 | 0.0000016     |
| 0.304                | 0.110      | 0.0001100 | 0.0000016     |
| 0.291                | 0.111      | 0.0001200 | 0.0000016     |
| 0.241                | 0.115      | 0.0001300 | 0.0000016     |
| 0.241                | 0.115      | 0.0001400 | 0.0000016     |
| 0.203                | 0.119      | 0.0001500 | 0.0000016     |
| 0.203                | 0.119      | 0.0001600 | 0.0000016     |
| 0.165                | 0.122      | 0.0001700 | 0.0000016     |
| 0.165                | 0.122      | 0.0001800 | 0.0000016     |
| 0.139                | 0.124      | 0.0001900 | 0.0000016     |
| 0.127                | 0.125      | 0.0002000 | 0.0000016     |
| 0.114                | 0.126      | 0.0002100 | 0.0000016     |
| 0.114                | 0.126      | 0.0002200 | 0.0000016     |
| 0.089                | 0.129      | 0.0002300 | 0.0000016     |
| 0.089                | 0.129      | 0.0002400 | 0.0000016     |
| 0.076                | 0.130      | 0.0002500 | 0.0000016     |
| 0.076                | 0.130      | 0.0002600 | 0.0000016     |
| 0.063                | 0.131      | 0.0002700 | 0.0000016     |
| 0.063                | 0.131      | 0.0002800 | 0.0000016     |
| 0.051                | 0.132      | 0.0002900 | 0.0000016     |
| 0.051                | 0.132      | 0.0003000 | 0.0000016     |
| 0.038                | 0.133      | 0.0003100 | 0.0000016     |
| 0.051                | 0.132      | 0.0003200 | 0.0000016     |
| 0.038                | 0.133      | 0.0003300 | 0.0000016     |
| 0.038                | 0.133      | 0.0003400 | 0.0000016     |
| 0.025                | 0.134      | 0.0003500 | 0.0000016     |
| 0.038                | 0.133      | 0.0003600 | 0.0000016     |
| 0.025                | 0.134      | 0.0003700 | 0.0000016     |
| 0.025                | 0.134      | 0.0003800 | 0.0000016     |
| 0.038                | 0.133      | 0.0003900 | 0.0000016     |

| Dati Fit Carica 50Hz |            |           |               |
|----------------------|------------|-----------|---------------|
| $Y$                  | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ |
| 0.025                | 0.134      | 0.0004000 | 0.0000016     |
| 0.013                | 0.135      | 0.0004100 | 0.0000016     |
| 0.025                | 0.134      | 0.0004200 | 0.0000016     |
| 0.013                | 0.135      | 0.0004300 | 0.0000016     |
| 0.025                | 0.134      | 0.0004400 | 0.0000016     |
| 0.013                | 0.135      | 0.0004500 | 0.0000016     |
| 0.013                | 0.135      | 0.0004600 | 0.0000016     |
| 0.025                | 0.134      | 0.0004700 | 0.0000016     |
| 0.013                | 0.135      | 0.0004800 | 0.0000016     |
| 0.013                | 0.135      | 0.0004900 | 0.0000016     |
| 0.013                | 0.135      | 0.0005000 | 0.0000016     |
| 0.025                | 0.134      | 0.0005100 | 0.0000016     |
| 0.013                | 0.135      | 0.0005200 | 0.0000016     |
| 0.025                | 0.134      | 0.0005300 | 0.0000016     |
| 0.013                | 0.135      | 0.0005400 | 0.0000016     |
| 0.000                | 0.136      | 0.0005500 | 0.0000016     |
| 0.013                | 0.135      | 0.0005600 | 0.0000016     |
| 0.000                | 0.136      | 0.0005700 | 0.0000016     |
| 0.013                | 0.135      | 0.0005800 | 0.0000016     |
| 0.013                | 0.135      | 0.0005900 | 0.0000016     |
| 0.013                | 0.135      | 0.0006000 | 0.0000016     |
| 0.000                | 0.136      | 0.0006100 | 0.0000016     |
| 0.000                | 0.136      | 0.0006200 | 0.0000016     |
| 0.013                | 0.135      | 0.0006300 | 0.0000016     |
| 0.013                | 0.135      | 0.0006400 | 0.0000016     |
| 0.000                | 0.136      | 0.0006500 | 0.0000016     |

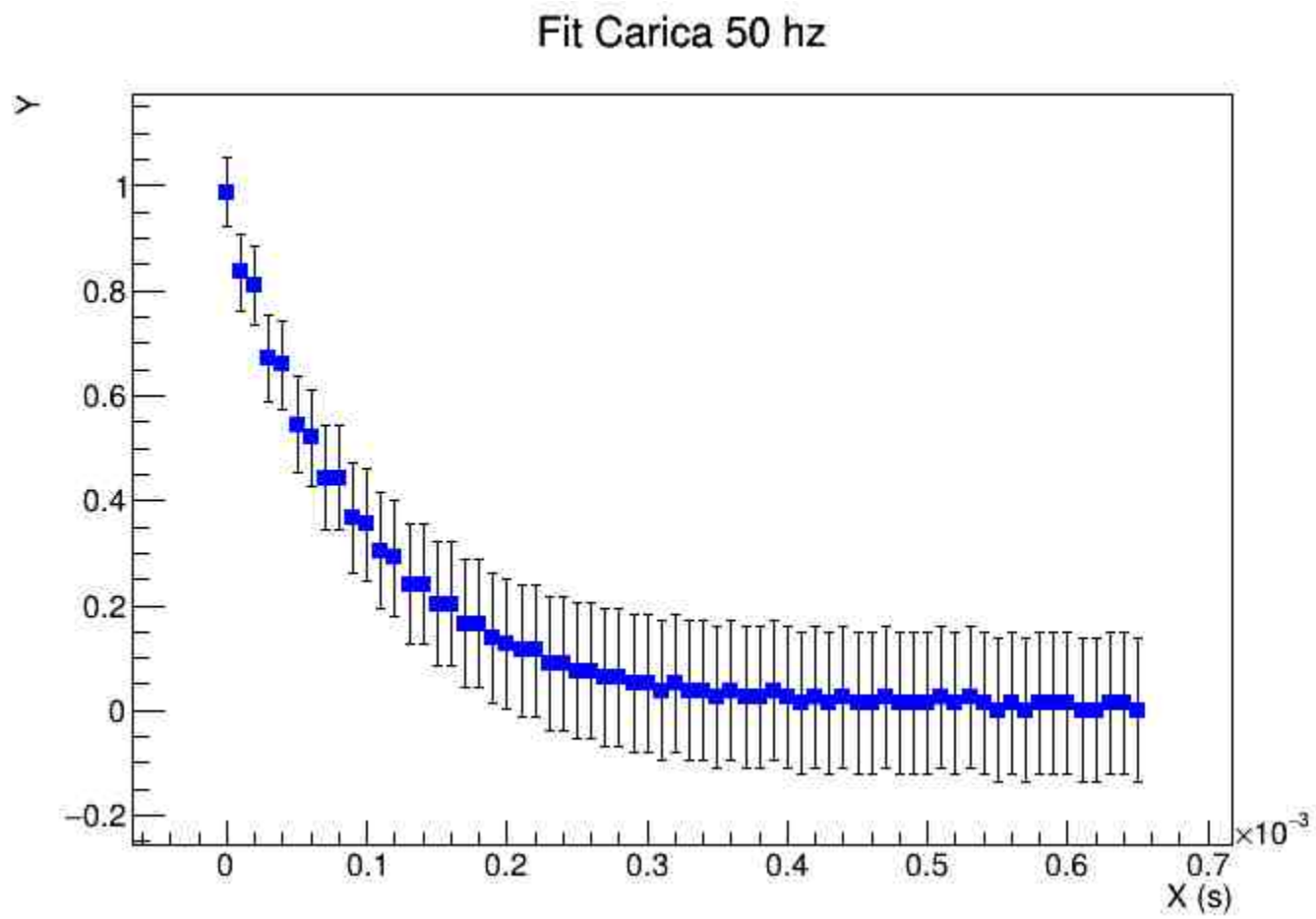


Figure 12: Plot dati fit carica 50Hz

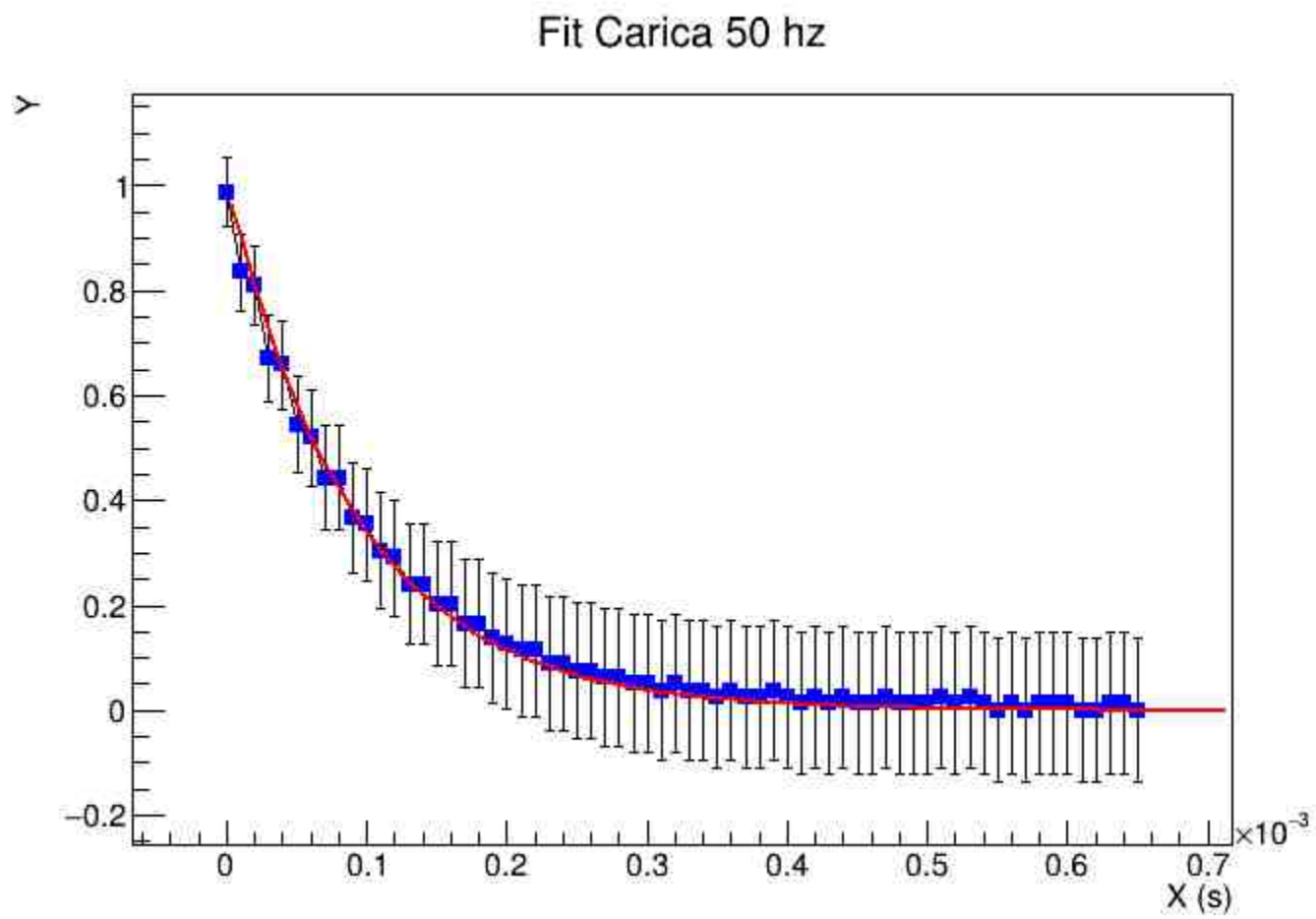


Figure 13: Best fit carica 50Hz

| <b>Dati Fit Carica 90Hz</b> |            |           |               |
|-----------------------------|------------|-----------|---------------|
| $Y$                         | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ |
| 0.9872                      | 0.0677     | 0.0000000 | 0.0000016     |
| 0.8333                      | 0.0723     | 0.0000100 | 0.0000016     |
| 0.8205                      | 0.0727     | 0.0000200 | 0.0000016     |
| 0.6667                      | 0.0773     | 0.0000300 | 0.0000016     |
| 0.6667                      | 0.0773     | 0.0000400 | 0.0000016     |
| 0.5385                      | 0.0812     | 0.0000500 | 0.0000016     |
| 0.5256                      | 0.0815     | 0.0000600 | 0.0000016     |
| 0.4359                      | 0.0842     | 0.0000700 | 0.0000016     |
| 0.4359                      | 0.0842     | 0.0000800 | 0.0000016     |
| 0.3590                      | 0.0865     | 0.0000900 | 0.0000016     |
| 0.3590                      | 0.0865     | 0.0001000 | 0.0000016     |
| 0.2949                      | 0.0885     | 0.0001100 | 0.0000016     |
| 0.2821                      | 0.0888     | 0.0001200 | 0.0000016     |
| 0.2308                      | 0.0904     | 0.0001300 | 0.0000016     |
| 0.2308                      | 0.0904     | 0.0001400 | 0.0000016     |
| 0.1923                      | 0.0915     | 0.0001500 | 0.0000016     |
| 0.1923                      | 0.0915     | 0.0001600 | 0.0000016     |
| 0.1667                      | 0.0923     | 0.0001700 | 0.0000016     |
| 0.1538                      | 0.0927     | 0.0001800 | 0.0000016     |
| 0.1282                      | 0.0935     | 0.0001900 | 0.0000016     |
| 0.1282                      | 0.0935     | 0.0002000 | 0.0000016     |
| 0.1026                      | 0.0942     | 0.0002100 | 0.0000016     |
| 0.1154                      | 0.0938     | 0.0002200 | 0.0000016     |
| 0.0769                      | 0.0950     | 0.0002300 | 0.0000016     |
| 0.0769                      | 0.0950     | 0.0002400 | 0.0000016     |
| 0.0641                      | 0.0954     | 0.0002500 | 0.0000016     |
| 0.0641                      | 0.0954     | 0.0002600 | 0.0000016     |
| 0.0513                      | 0.0958     | 0.0002700 | 0.0000016     |
| 0.0513                      | 0.0958     | 0.0002800 | 0.0000016     |
| 0.0385                      | 0.0962     | 0.0002900 | 0.0000016     |
| 0.0385                      | 0.0962     | 0.0003000 | 0.0000016     |
| 0.0256                      | 0.0965     | 0.0003100 | 0.0000016     |
| 0.0385                      | 0.0962     | 0.0003200 | 0.0000016     |
| 0.0256                      | 0.0965     | 0.0003300 | 0.0000016     |
| 0.0256                      | 0.0965     | 0.0003400 | 0.0000016     |
| 0.0128                      | 0.0969     | 0.0003500 | 0.0000016     |
| 0.0256                      | 0.0965     | 0.0003600 | 0.0000016     |
| 0.0128                      | 0.0969     | 0.0003700 | 0.0000016     |
| 0.0128                      | 0.0969     | 0.0003800 | 0.0000016     |
| 0.0128                      | 0.0969     | 0.0003900 | 0.0000016     |

| <b>Dati Fit Carica 90Hz</b> |            |           |               |
|-----------------------------|------------|-----------|---------------|
| $Y$                         | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ |
| 0.0128                      | 0.0969     | 0.0004000 | 0.0000016     |
| 0.0000                      | 0.0973     | 0.0004100 | 0.0000016     |

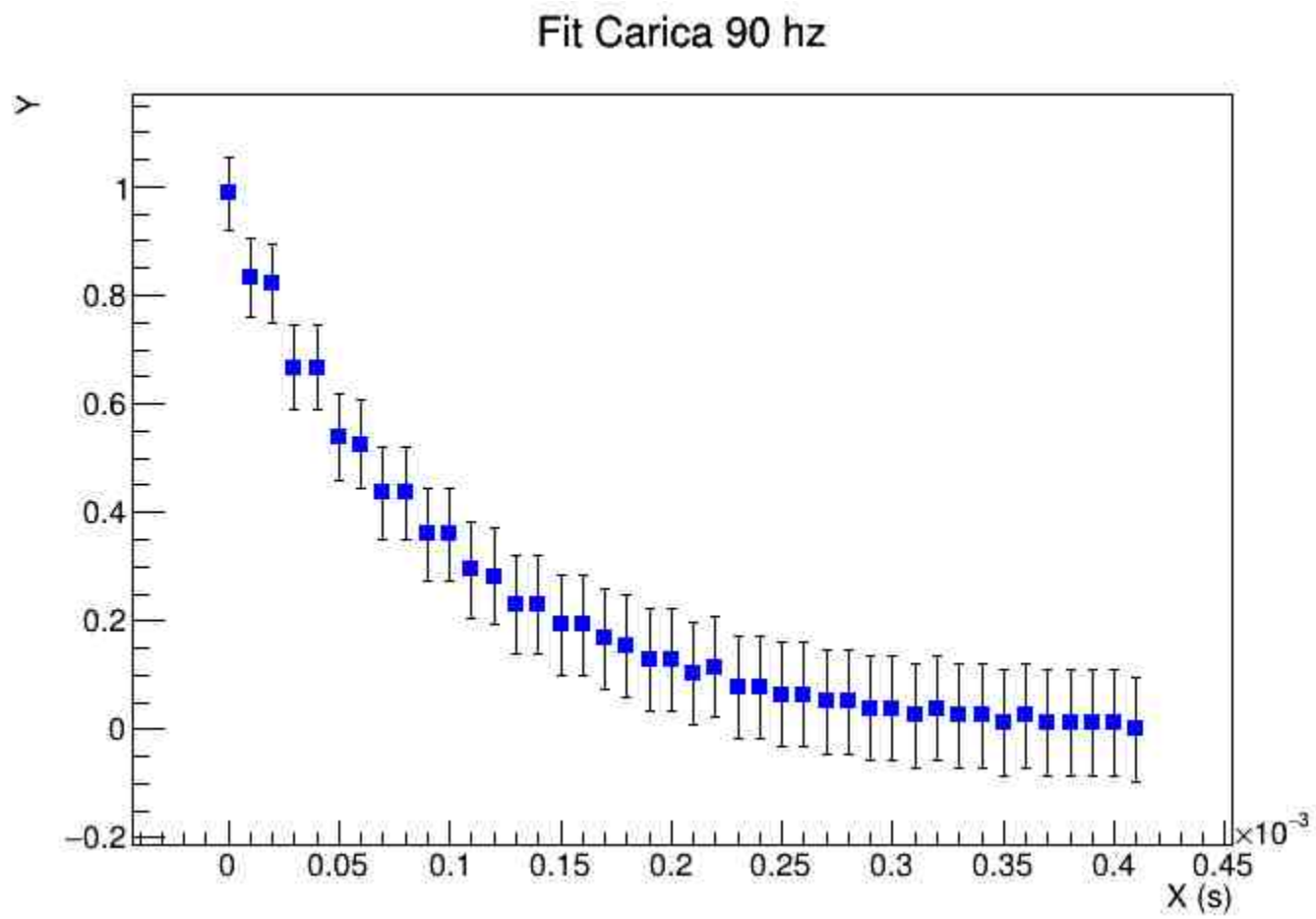


Figure 14: Plot dati fit carica 90Hz

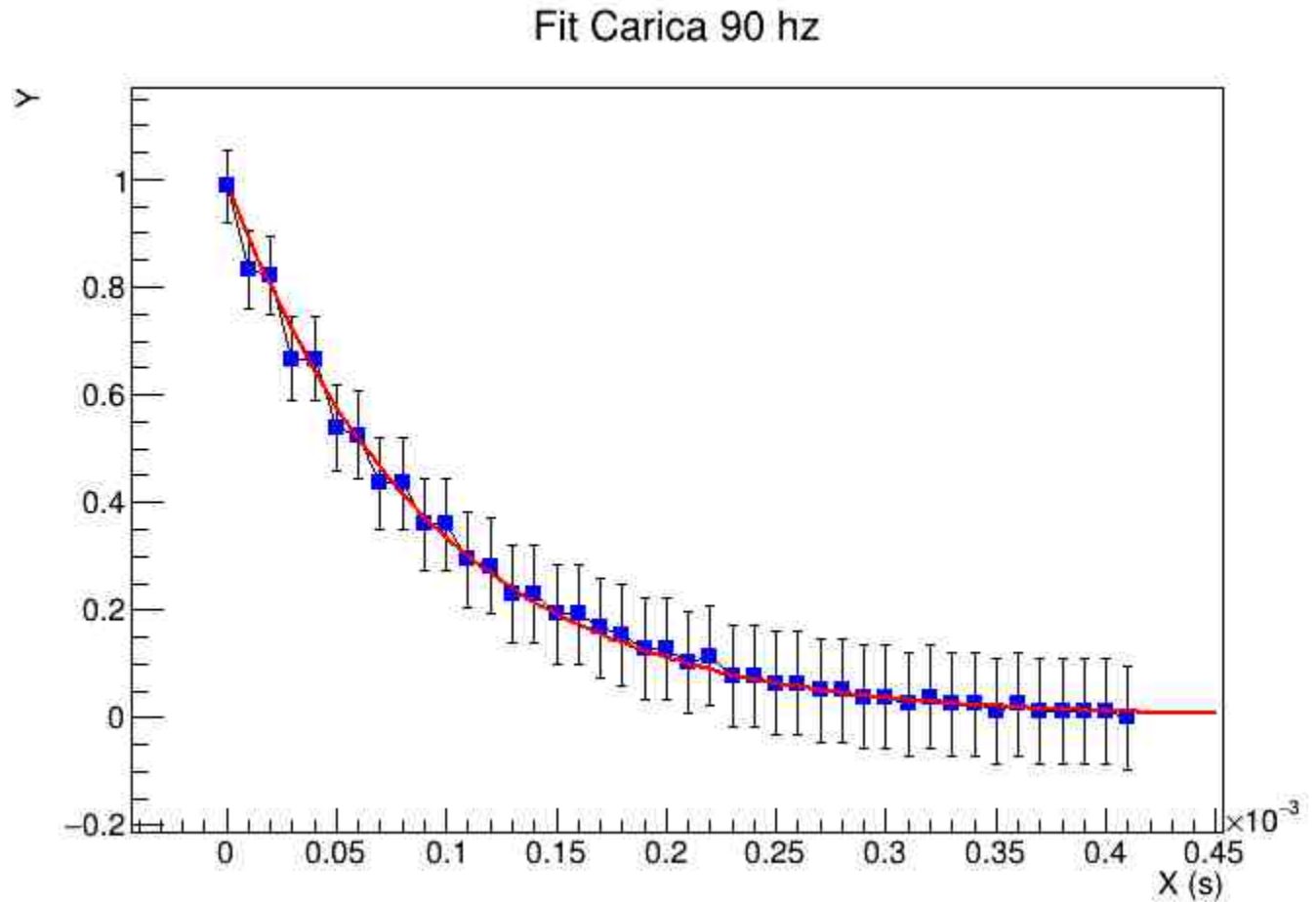


Figure 15: Best fit carica 90Hz

La procedura di best fit ha prodotto:

- $M = (-1.080 \pm 0.078)10^4 s^{-1}$ ; per la carica a 50Hz
- $M = (-1.090 \pm 0.065)10^4 s^{-1}$ ; per la carica 90Hz

Per la verifica di 1.9 è stato utilizzato il modello:

$$Y = e^{MX} \quad (3.6)$$

con  $Y = \frac{V_C}{V_0}$ ;  $X = t$  ed  $M = -\frac{1}{RC}$ . Gli errori associati a  $Y$  sono stati calcolati tramite 3.5. Inoltre è stata eseguita una traslazione sui valori delle  $X$  al fine di "far iniziare" la scarica al tempo  $t = 0$ . Tale operazione, essendo una semplice elaborazione numerica, non collegata al processo di misura, non è stata considerata per la propagazione dell'errore.

| Dati Fit Scarica 50Hz |            |           |               | Dati Fit Scarica 50Hz |            |           |               |
|-----------------------|------------|-----------|---------------|-----------------------|------------|-----------|---------------|
| $Y$                   | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ | $Y$                   | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ |
| 1.000                 | 0.136      | 0.0000000 | 0.0000017     | 0.228                 | 0.077      | 0.0004000 | 0.0000018     |
| 0.987                 | 0.135      | 0.0000100 | 0.0000017     | 0.215                 | 0.076      | 0.0004100 | 0.0000018     |
| 1.000                 | 0.136      | 0.0000200 | 0.0000017     | 0.215                 | 0.076      | 0.0004200 | 0.0000018     |
| 0.987                 | 0.135      | 0.0000300 | 0.0000017     | 0.203                 | 0.075      | 0.0004300 | 0.0000018     |
| 1.000                 | 0.136      | 0.0000400 | 0.0000018     | 0.203                 | 0.075      | 0.0004400 | 0.0000018     |
| 0.873                 | 0.125      | 0.0000500 | 0.0000018     | 0.177                 | 0.074      | 0.0004500 | 0.0000018     |
| 0.861                 | 0.124      | 0.0000600 | 0.0000018     | 0.177                 | 0.074      | 0.0004600 | 0.0000018     |
| 0.810                 | 0.120      | 0.0000700 | 0.0000018     | 0.165                 | 0.073      | 0.0004700 | 0.0000018     |
| 0.797                 | 0.119      | 0.0000800 | 0.0000018     | 0.165                 | 0.073      | 0.0004800 | 0.0000018     |
| 0.747                 | 0.114      | 0.0000900 | 0.0000018     | 0.165                 | 0.073      | 0.0004900 | 0.0000018     |
| 0.734                 | 0.113      | 0.0001000 | 0.0000018     | 0.165                 | 0.073      | 0.0005000 | 0.0000018     |
| 0.684                 | 0.109      | 0.0001100 | 0.0000018     | 0.139                 | 0.072      | 0.0005100 | 0.0000018     |
| 0.671                 | 0.108      | 0.0001200 | 0.0000018     | 0.152                 | 0.073      | 0.0005200 | 0.0000018     |
| 0.633                 | 0.105      | 0.0001300 | 0.0000018     | 0.127                 | 0.071      | 0.0005300 | 0.0000018     |
| 0.633                 | 0.105      | 0.0001400 | 0.0000018     | 0.139                 | 0.072      | 0.0005400 | 0.0000018     |
| 0.570                 | 0.100      | 0.0001500 | 0.0000018     | 0.127                 | 0.071      | 0.0005500 | 0.0000018     |
| 0.570                 | 0.100      | 0.0001600 | 0.0000018     | 0.127                 | 0.071      | 0.0005600 | 0.0000018     |
| 0.557                 | 0.099      | 0.0001700 | 0.0000018     | 0.114                 | 0.071      | 0.0005700 | 0.0000018     |
| 0.544                 | 0.098      | 0.0001800 | 0.0000018     | 0.114                 | 0.071      | 0.0005800 | 0.0000018     |
| 0.506                 | 0.095      | 0.0001900 | 0.0000018     | 0.101                 | 0.070      | 0.0005900 | 0.0000018     |
| 0.506                 | 0.095      | 0.0002000 | 0.0000018     | 0.114                 | 0.071      | 0.0006000 | 0.0000018     |
| 0.468                 | 0.092      | 0.0002100 | 0.0000018     | 0.101                 | 0.070      | 0.0006100 | 0.0000018     |
| 0.468                 | 0.092      | 0.0002200 | 0.0000018     | 0.101                 | 0.070      | 0.0006200 | 0.0000018     |
| 0.430                 | 0.090      | 0.0002300 | 0.0000018     | 0.089                 | 0.070      | 0.0006300 | 0.0000018     |
| 0.430                 | 0.090      | 0.0002400 | 0.0000018     | 0.101                 | 0.070      | 0.0006400 | 0.0000018     |
| 0.392                 | 0.087      | 0.0002500 | 0.0000018     | 0.076                 | 0.069      | 0.0006500 | 0.0000018     |
| 0.392                 | 0.087      | 0.0002600 | 0.0000018     | 0.089                 | 0.070      | 0.0006600 | 0.0000018     |
| 0.367                 | 0.085      | 0.0002700 | 0.0000018     | 0.076                 | 0.069      | 0.0006700 | 0.0000018     |
| 0.367                 | 0.085      | 0.0002800 | 0.0000018     | 0.089                 | 0.070      | 0.0006800 | 0.0000018     |
| 0.342                 | 0.083      | 0.0002900 | 0.0000018     | 0.076                 | 0.069      | 0.0006900 | 0.0000018     |
| 0.342                 | 0.083      | 0.0003000 | 0.0000018     | 0.076                 | 0.069      | 0.0007000 | 0.0000018     |
| 0.316                 | 0.082      | 0.0003100 | 0.0000018     | 0.076                 | 0.069      | 0.0007100 | 0.0000018     |
| 0.316                 | 0.082      | 0.0003200 | 0.0000018     | 0.076                 | 0.069      | 0.0007200 | 0.0000018     |
| 0.278                 | 0.079      | 0.0003300 | 0.0000018     | 0.063                 | 0.069      | 0.0007300 | 0.0000018     |
| 0.291                 | 0.080      | 0.0003400 | 0.0000018     | 0.063                 | 0.069      | 0.0007400 | 0.0000018     |
| 0.266                 | 0.079      | 0.0003500 | 0.0000018     | 0.063                 | 0.069      | 0.0007500 | 0.0000018     |
| 0.266                 | 0.079      | 0.0003600 | 0.0000018     | 0.063                 | 0.069      | 0.0007600 | 0.0000018     |
| 0.253                 | 0.078      | 0.0003700 | 0.0000018     | 0.051                 | 0.068      | 0.0007700 | 0.0000018     |
| 0.253                 | 0.078      | 0.0003800 | 0.0000018     | 0.051                 | 0.068      | 0.0007800 | 0.0000018     |
| 0.228                 | 0.077      | 0.0003900 | 0.0000018     | 0.063                 | 0.069      | 0.0007900 | 0.0000018     |

| <b>Dati Fit Scarica 50Hz</b> |            |           |               |
|------------------------------|------------|-----------|---------------|
| $Y$                          | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ |
| 0.063                        | 0.069      | 0.0008000 | 0.0000018     |
| 0.051                        | 0.068      | 0.0008100 | 0.0000018     |
| 0.051                        | 0.068      | 0.0008200 | 0.0000018     |
| 0.038                        | 0.068      | 0.0008300 | 0.0000018     |
| 0.038                        | 0.068      | 0.0008400 | 0.0000018     |
| 0.051                        | 0.068      | 0.0008500 | 0.0000018     |
| 0.038                        | 0.068      | 0.0008600 | 0.0000018     |
| 0.025                        | 0.067      | 0.0008700 | 0.0000018     |
| 0.038                        | 0.068      | 0.0008800 | 0.0000018     |
| 0.025                        | 0.067      | 0.0008900 | 0.0000018     |
| 0.038                        | 0.068      | 0.0009000 | 0.0000018     |
| 0.025                        | 0.067      | 0.0009100 | 0.0000018     |
| 0.038                        | 0.068      | 0.0009200 | 0.0000018     |
| 0.025                        | 0.067      | 0.0009300 | 0.0000018     |
| 0.038                        | 0.068      | 0.0009400 | 0.0000018     |
| 0.025                        | 0.067      | 0.0009500 | 0.0000018     |
| 0.025                        | 0.067      | 0.0009600 | 0.0000018     |
| 0.025                        | 0.067      | 0.0009700 | 0.0000018     |
| 0.025                        | 0.067      | 0.0009800 | 0.0000018     |
| 0.025                        | 0.067      | 0.0009900 | 0.0000018     |
| 0.025                        | 0.067      | 0.0010000 | 0.0000018     |



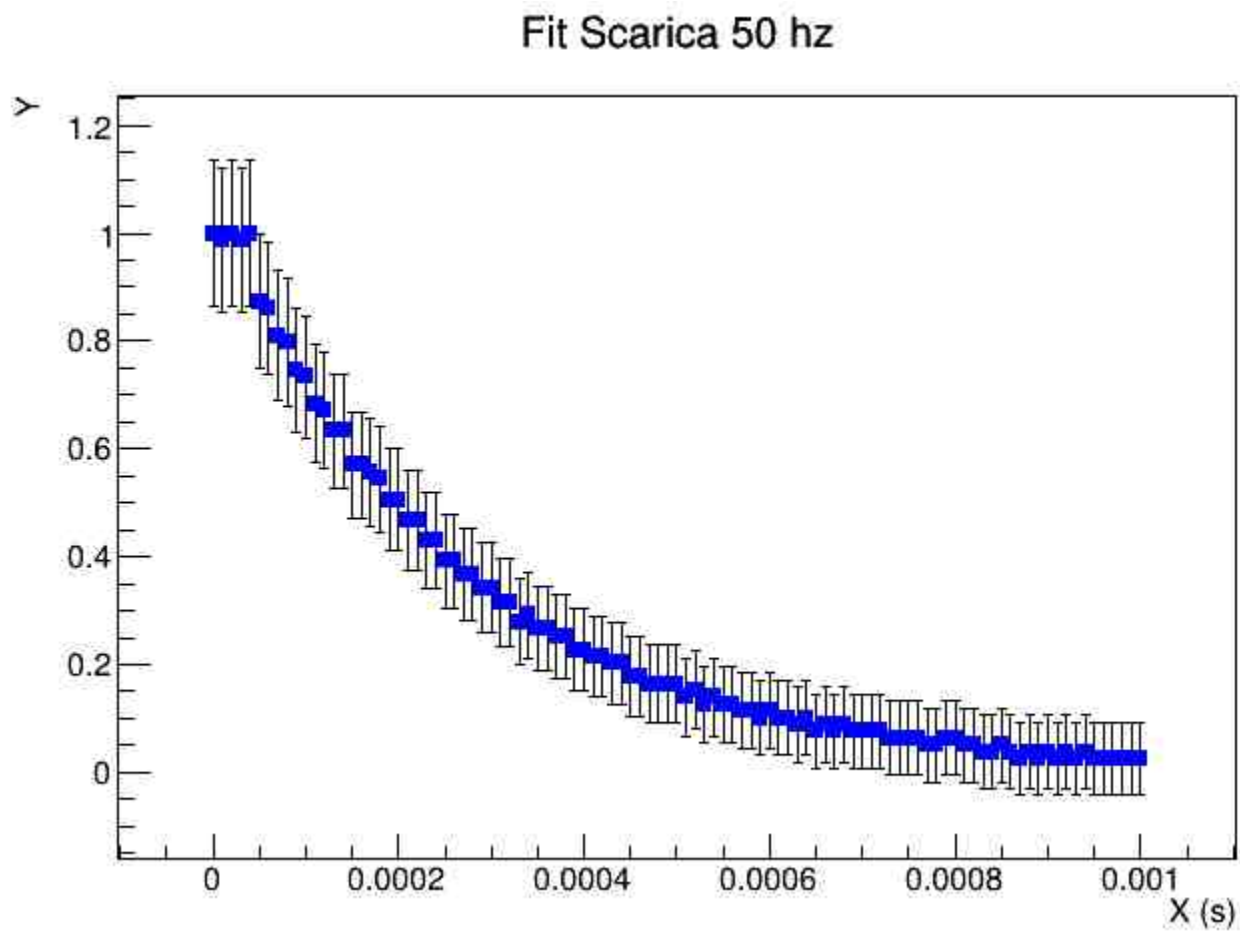


Figure 16: Plot dati fit scarica  $50Hz$

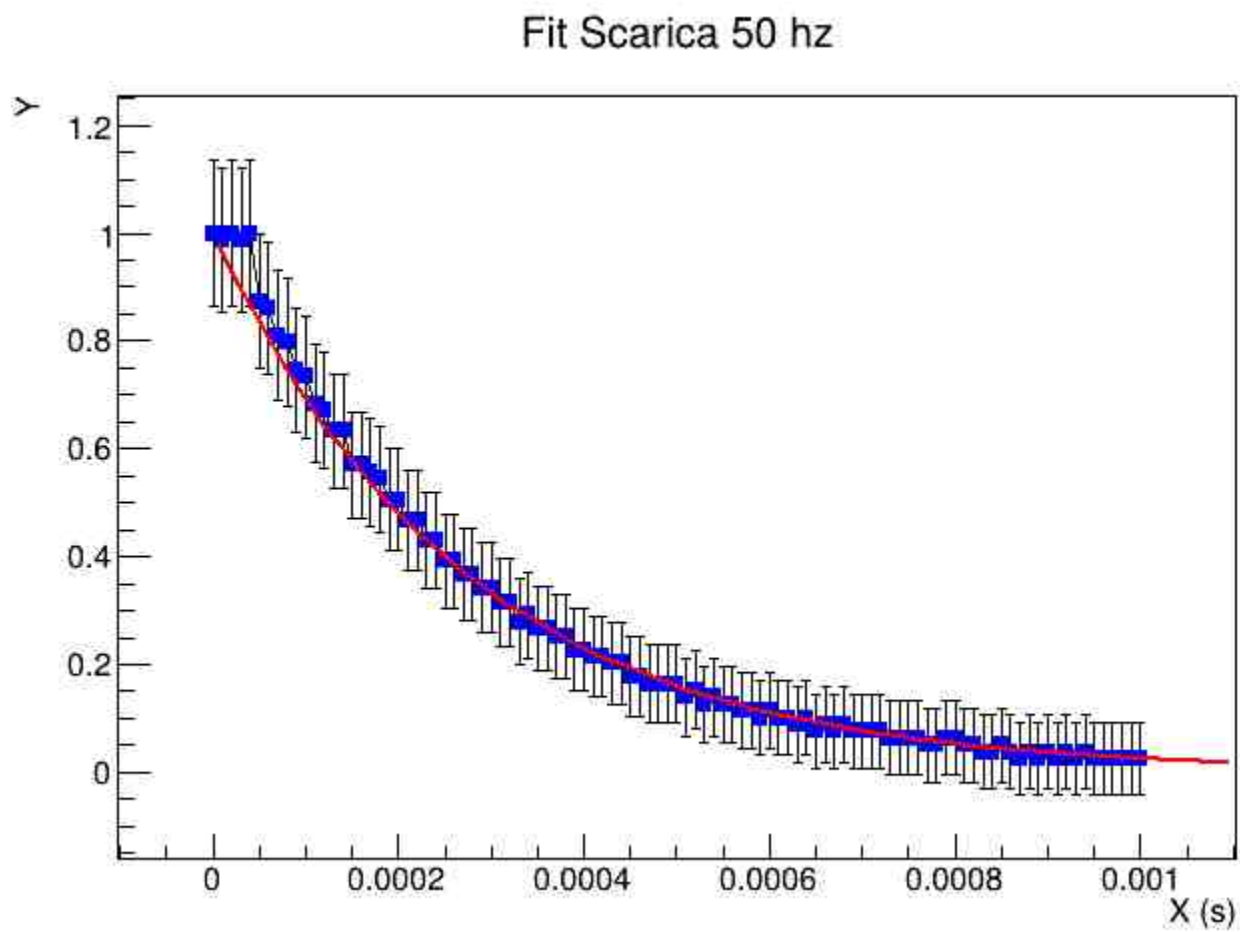


Figure 17: Best fit scarica  $50Hz$

| Dati Fit Scarica 90Hz |            |           |               | Dati Fit Scarica 90Hz |            |           |               |
|-----------------------|------------|-----------|---------------|-----------------------|------------|-----------|---------------|
| $Y$                   | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ | $Y$                   | $\Delta Y$ | $X(s)$    | $\Delta X(s)$ |
| 1.0000                | 0.1364     | 0.0000000 | 0.0000017     | 0.1899                | 0.0744     | 0.0004000 | 0.0000017     |
| 1.0000                | 0.1364     | 0.0000100 | 0.0000017     | 0.2025                | 0.0751     | 0.0004100 | 0.0000017     |
| 0.8861                | 0.1263     | 0.0000200 | 0.0000017     | 0.1772                | 0.0738     | 0.0004200 | 0.0000017     |
| 0.8734                | 0.1252     | 0.0000300 | 0.0000017     | 0.1646                | 0.0731     | 0.0004300 | 0.0000017     |
| 0.8101                | 0.1198     | 0.0000400 | 0.0000017     | 0.1772                | 0.0738     | 0.0004400 | 0.0000017     |
| 0.8101                | 0.1198     | 0.0000500 | 0.0000017     | 0.1646                | 0.0731     | 0.0004500 | 0.0000017     |
| 0.7468                | 0.1144     | 0.0000600 | 0.0000017     | 0.1646                | 0.0731     | 0.0004600 | 0.0000017     |
| 0.7468                | 0.1144     | 0.0000700 | 0.0000017     | 0.1646                | 0.0731     | 0.0004700 | 0.0000017     |
| 0.6962                | 0.1102     | 0.0000800 | 0.0000017     | 0.1392                | 0.0719     | 0.0004800 | 0.0000017     |
| 0.6962                | 0.1102     | 0.0000900 | 0.0000017     | 0.1519                | 0.0725     | 0.0004900 | 0.0000017     |
| 0.6456                | 0.1060     | 0.0001000 | 0.0000017     | 0.1266                | 0.0713     | 0.0005000 | 0.0000017     |
| 0.6329                | 0.1050     | 0.0001100 | 0.0000017     | 0.1392                | 0.0719     | 0.0005100 | 0.0000017     |
| 0.5823                | 0.1010     | 0.0001200 | 0.0000017     | 0.1266                | 0.0713     | 0.0005200 | 0.0000017     |
| 0.5823                | 0.1010     | 0.0001300 | 0.0000017     | 0.1266                | 0.0713     | 0.0005300 | 0.0000017     |
| 0.5570                | 0.0990     | 0.0001400 | 0.0000017     | 0.1139                | 0.0707     | 0.0005400 | 0.0000017     |
| 0.5570                | 0.0990     | 0.0001500 | 0.0000017     | 0.1266                | 0.0713     | 0.0005500 | 0.0000017     |
| 0.5190                | 0.0961     | 0.0001600 | 0.0000017     | 0.1139                | 0.0707     | 0.0005600 | 0.0000017     |
| 0.5190                | 0.0961     | 0.0001700 | 0.0000017     | 0.1139                | 0.0707     | 0.0005700 | 0.0000017     |
| 0.4810                | 0.0932     | 0.0001800 | 0.0000017     | 0.1139                | 0.0707     | 0.0005800 | 0.0000017     |
| 0.4810                | 0.0932     | 0.0001900 | 0.0000017     | 0.1013                | 0.0702     | 0.0005900 | 0.0000017     |
| 0.4430                | 0.0905     | 0.0002000 | 0.0000017     | 0.0886                | 0.0696     | 0.0006000 | 0.0000017     |
| 0.4304                | 0.0896     | 0.0002100 | 0.0000017     | 0.0886                | 0.0696     | 0.0006100 | 0.0000017     |
| 0.4051                | 0.0878     | 0.0002200 | 0.0000017     | 0.1013                | 0.0702     | 0.0006200 | 0.0000017     |
| 0.4051                | 0.0878     | 0.0002300 | 0.0000017     | 0.0886                | 0.0696     | 0.0006300 | 0.0000017     |
| 0.3671                | 0.0852     | 0.0002400 | 0.0000017     | 0.0759                | 0.0691     | 0.0006400 | 0.0000017     |
| 0.3671                | 0.0852     | 0.0002500 | 0.0000017     | 0.0886                | 0.0696     | 0.0006500 | 0.0000017     |
| 0.3544                | 0.0843     | 0.0002600 | 0.0000017     | 0.0759                | 0.0691     | 0.0006600 | 0.0000017     |
| 0.3544                | 0.0843     | 0.0002700 | 0.0000017     | 0.0759                | 0.0691     | 0.0006700 | 0.0000017     |
| 0.3165                | 0.0819     | 0.0002800 | 0.0000017     | 0.0633                | 0.0686     | 0.0006800 | 0.0000017     |
| 0.3165                | 0.0819     | 0.0002900 | 0.0000017     | 0.0759                | 0.0691     | 0.0006900 | 0.0000017     |
| 0.3038                | 0.0811     | 0.0003000 | 0.0000017     | 0.0633                | 0.0686     | 0.0007000 | 0.0000017     |
| 0.2911                | 0.0803     | 0.0003100 | 0.0000017     | 0.0633                | 0.0686     | 0.0007100 | 0.0000017     |
| 0.2785                | 0.0795     | 0.0003200 | 0.0000017     | 0.0633                | 0.0686     | 0.0007200 | 0.0000017     |
| 0.2785                | 0.0795     | 0.0003300 | 0.0000017     | 0.0633                | 0.0686     | 0.0007300 | 0.0000017     |
| 0.2532                | 0.0780     | 0.0003400 | 0.0000017     | 0.0506                | 0.0681     | 0.0007400 | 0.0000017     |
| 0.2532                | 0.0780     | 0.0003500 | 0.0000017     | 0.0633                | 0.0686     | 0.0007500 | 0.0000017     |
| 0.2405                | 0.0772     | 0.0003600 | 0.0000017     | 0.0506                | 0.0681     | 0.0007600 | 0.0000017     |
| 0.2405                | 0.0772     | 0.0003700 | 0.0000017     | 0.0633                | 0.0686     | 0.0007700 | 0.0000017     |
| 0.2152                | 0.0758     | 0.0003800 | 0.0000017     | 0.0506                | 0.0681     | 0.0007800 | 0.0000017     |
| 0.2278                | 0.0765     | 0.0003900 | 0.0000017     | 0.0506                | 0.0681     | 0.0007900 | 0.0000017     |

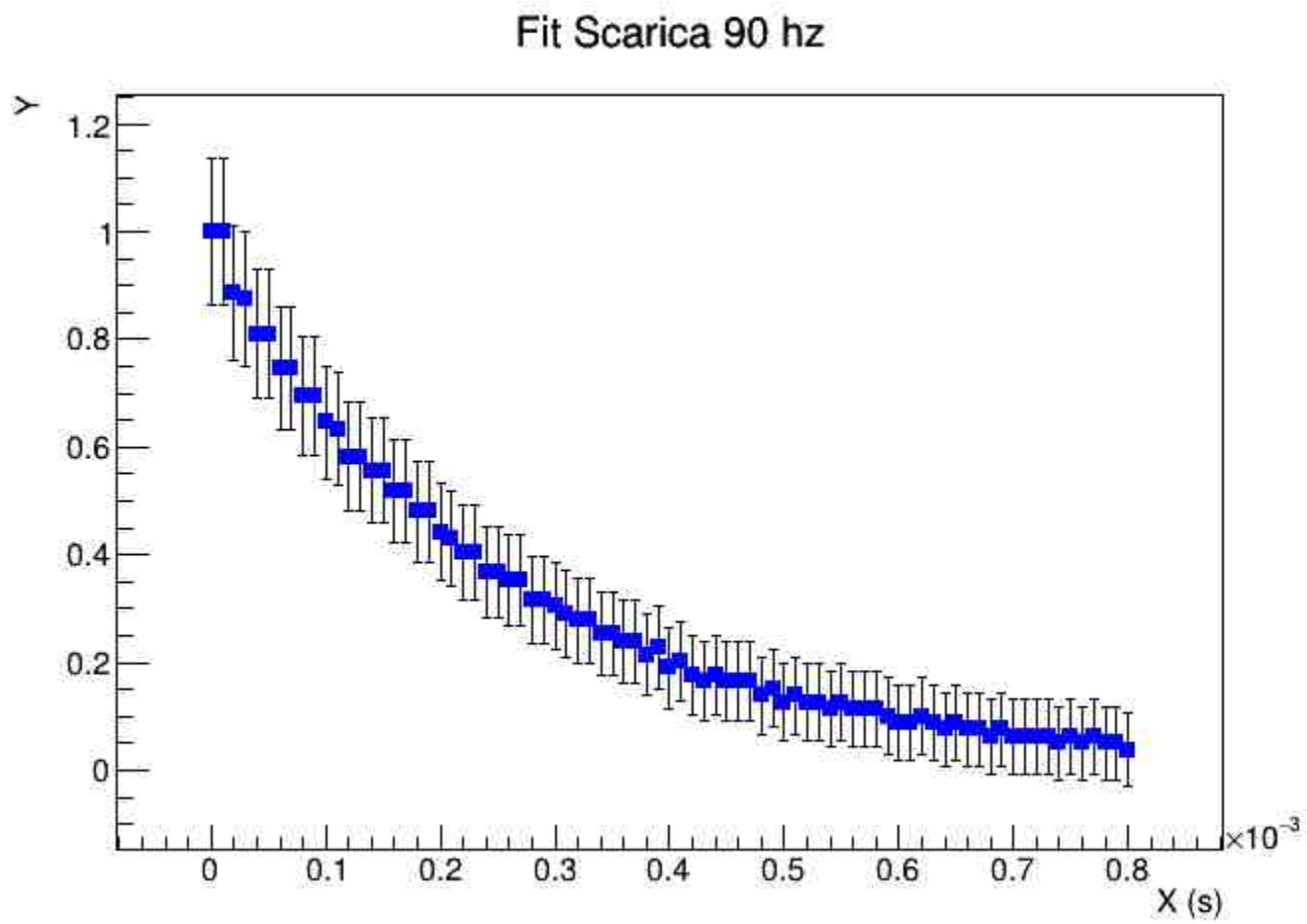


Figure 18: Plot dati fit scarica 90Hz

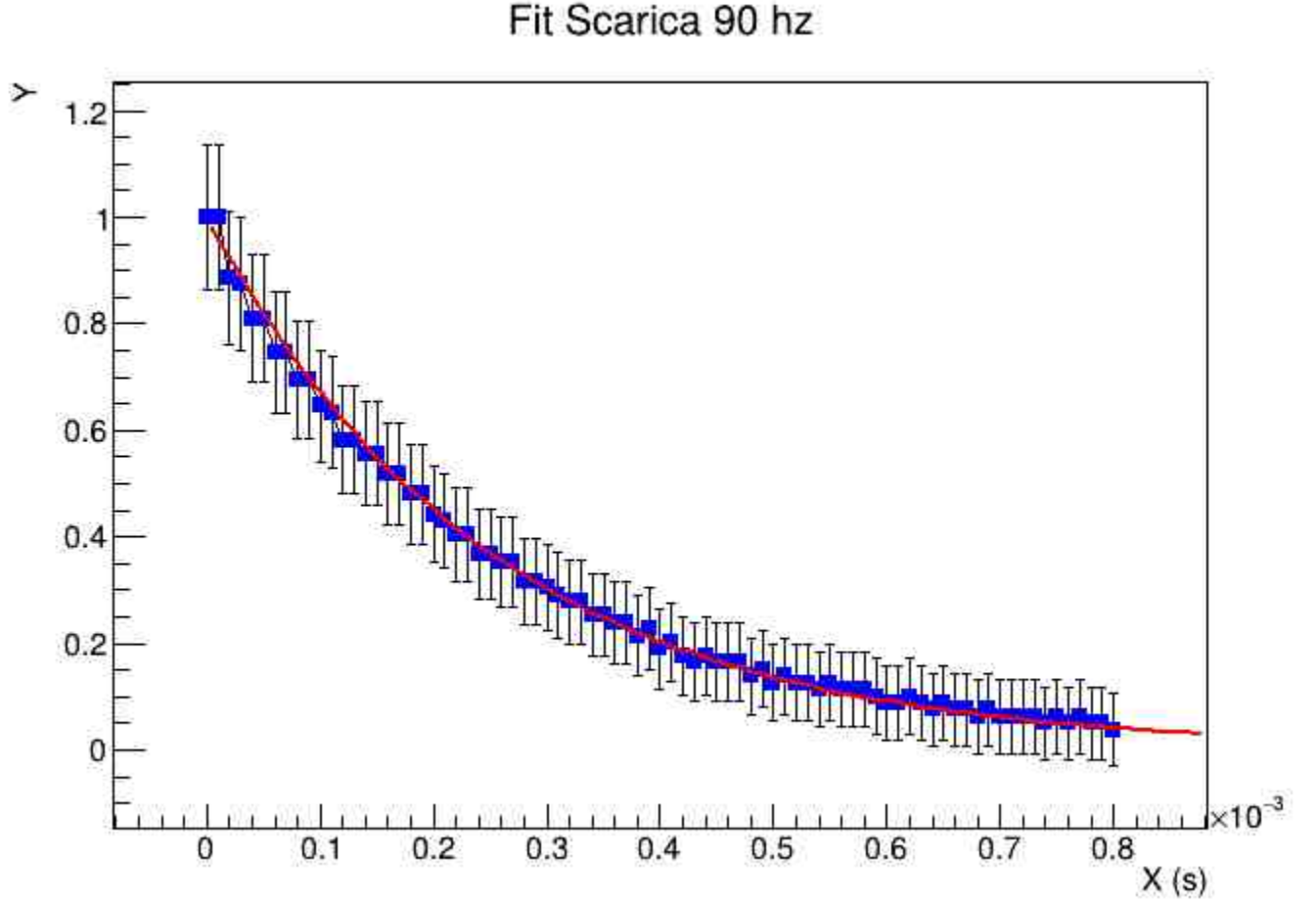


Figure 19: Best fit scarica 90Hz

La procedura di best fit ha prodotto:

- $M = (-3.66 \pm 0.11)10^3 s^{-1}$ ; scarica a 50Hz
- $M = (-3.98 \pm 0.13)10^2 s^{-1}$ ; scarica a 90Hz

## 4 Conclusioni

Dai valori dei coefficienti  $M$  ottenuti dal best fit è possibile ricavare  $\tau$  tramite:

$$\tau_{fit} = -\frac{1}{M} \quad (4.1)$$

La cui incertezza è:

$$\Delta\tau_{fit} = \sqrt{\left(\frac{\partial\tau_{fit}}{\partial M}\Delta M\right)^2} = \frac{\Delta M}{M^2} \quad (4.2)$$

Dunque si ha:

- Per la carica a  $50Hz$ ;  $\tau_{fit} = (9.28 \pm 0.67)10^{-5}s$
- Per la scarica a  $50Hz$ ;  $\tau_{fit} = (2.731 \pm 0.084)10^{-4}s$
- Per la carica a  $90Hz$ ;  $\tau_{fit} = (9.14 \pm 0.54)10^{-5}s$
- Per la scarica a  $90Hz$ ;  $\tau_{fit} = (2.514 \pm 0.083)10^{-4}s$

Considerando i  $\tau$  attesi  $(7.93 \pm 0.29)10^{-5}s$  e  $\tau_{sc} = (2.494 \pm 0.088)10^{-4}s$ , si evince che i valori di  $\tau$  di scarica, ottenuti tramite best fit, risultano conformi al valore teorico atteso. I valori di  $\tau$  di carica, calcolati con il best fit, risultano conformi tra di loro ma differenti dal valore previsto. Vi è uno scarto minimo (calcolato considerando il massimo errore possibile per il  $\tau$  teorico e il minimo errore possibile per i  $\tau$  ottenuti dal best fit) di circa  $9.62 * 10^{-6}s$ . Tale discrepanza, non essendo presente per la fase di scarica, è plausibile che possa essere stata causata da una resistenza spuria dovuta ai contatti non ottimali tra il generatore di segnale e il circuito usato per eseguire l'esperimento.

## Appendix A    Dati Oscilloscopio

Le incertezze sulle misure effettuate dall'oscilloscopio sono state determinate utilizzando le indicazioni fornite dal costruttore nel manuale dello strumento.

| Dati segnale 50Hz |          |                 |            |               | Dati segnale 50Hz |          |                 |            |               |
|-------------------|----------|-----------------|------------|---------------|-------------------|----------|-----------------|------------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$     | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$     | $\Delta t(s)$ |
| 1                 | 0.0040   | 0.0211          | -0.0007600 | 0.0000015     | 41                | 0.0040   | 0.0211          | -0.0003600 | 0.0000016     |
| 2                 | 0.0000   | 0.0210          | -0.0007500 | 0.0000015     | 42                | 0.0000   | 0.0210          | -0.0003500 | 0.0000016     |
| 3                 | 0.0040   | 0.0211          | -0.0007400 | 0.0000015     | 43                | 0.0040   | 0.0211          | -0.0003400 | 0.0000016     |
| 4                 | 0.0000   | 0.0210          | -0.0007300 | 0.0000015     | 44                | 0.0000   | 0.0210          | -0.0003300 | 0.0000016     |
| 5                 | 0.0040   | 0.0211          | -0.0007200 | 0.0000015     | 45                | 0.0040   | 0.0211          | -0.0003200 | 0.0000016     |
| 6                 | 0.0000   | 0.0210          | -0.0007100 | 0.0000015     | 46                | 0.0000   | 0.0210          | -0.0003100 | 0.0000016     |
| 7                 | 0.0000   | 0.0210          | -0.0007000 | 0.0000015     | 47                | 0.0040   | 0.0211          | -0.0003000 | 0.0000016     |
| 8                 | 0.0040   | 0.0211          | -0.0006900 | 0.0000015     | 48                | 0.0040   | 0.0211          | -0.0002900 | 0.0000016     |
| 9                 | 0.0040   | 0.0211          | -0.0006800 | 0.0000015     | 49                | 0.0040   | 0.0211          | -0.0002800 | 0.0000016     |
| 10                | 0.0000   | 0.0210          | -0.0006700 | 0.0000015     | 50                | 0.0000   | 0.0210          | -0.0002700 | 0.0000016     |
| 11                | 0.0000   | 0.0210          | -0.0006600 | 0.0000015     | 51                | 0.0040   | 0.0211          | -0.0002600 | 0.0000016     |
| 12                | 0.0040   | 0.0211          | -0.0006500 | 0.0000015     | 52                | 0.0000   | 0.0210          | -0.0002500 | 0.0000016     |
| 13                | 0.0040   | 0.0211          | -0.0006400 | 0.0000015     | 53                | 0.0040   | 0.0211          | -0.0002400 | 0.0000016     |
| 14                | 0.0000   | 0.0210          | -0.0006300 | 0.0000015     | 54                | 0.0000   | 0.0210          | -0.0002300 | 0.0000016     |
| 15                | 0.0040   | 0.0211          | -0.0006200 | 0.0000015     | 55                | 0.0040   | 0.0211          | -0.0002200 | 0.0000016     |
| 16                | 0.0000   | 0.0210          | -0.0006100 | 0.0000015     | 56                | 0.0040   | 0.0211          | -0.0002100 | 0.0000016     |
| 17                | 0.0040   | 0.0211          | -0.0006000 | 0.0000015     | 57                | 0.0040   | 0.0211          | -0.0002000 | 0.0000016     |
| 18                | 0.0000   | 0.0210          | -0.0005900 | 0.0000015     | 58                | 0.0000   | 0.0210          | -0.0001900 | 0.0000016     |
| 19                | 0.0040   | 0.0211          | -0.0005800 | 0.0000015     | 59                | 0.0040   | 0.0211          | -0.0001800 | 0.0000016     |
| 20                | 0.0000   | 0.0210          | -0.0005700 | 0.0000015     | 60                | 0.0000   | 0.0210          | -0.0001700 | 0.0000016     |
| 21                | 0.0000   | 0.0210          | -0.0005600 | 0.0000015     | 61                | 0.0000   | 0.0210          | -0.0001600 | 0.0000016     |
| 22                | 0.0040   | 0.0211          | -0.0005500 | 0.0000015     | 62                | 0.0040   | 0.0211          | -0.0001500 | 0.0000016     |
| 23                | 0.0040   | 0.0211          | -0.0005400 | 0.0000015     | 63                | 0.0040   | 0.0211          | -0.0001400 | 0.0000016     |
| 24                | 0.0000   | 0.0210          | -0.0005300 | 0.0000015     | 64                | 0.0000   | 0.0210          | -0.0001300 | 0.0000016     |
| 25                | 0.0040   | 0.0211          | -0.0005200 | 0.0000015     | 65                | 0.0040   | 0.0211          | -0.0001200 | 0.0000016     |
| 26                | 0.0040   | 0.0211          | -0.0005100 | 0.0000015     | 66                | 0.0000   | 0.0210          | -0.0001100 | 0.0000016     |
| 27                | 0.0040   | 0.0211          | -0.0005000 | 0.0000015     | 67                | 0.0040   | 0.0211          | -0.0001000 | 0.0000016     |
| 28                | 0.0000   | 0.0210          | -0.0004900 | 0.0000015     | 68                | 0.0000   | 0.0210          | -0.0000900 | 0.0000016     |
| 29                | 0.0040   | 0.0211          | -0.0004800 | 0.0000015     | 69                | 0.0040   | 0.0211          | -0.0000800 | 0.0000016     |
| 30                | 0.0000   | 0.0210          | -0.0004700 | 0.0000015     | 70                | 0.0040   | 0.0211          | -0.0000700 | 0.0000016     |
| 31                | 0.0040   | 0.0211          | -0.0004600 | 0.0000015     | 71                | 0.0040   | 0.0211          | -0.0000600 | 0.0000016     |
| 32                | 0.0000   | 0.0210          | -0.0004500 | 0.0000015     | 72                | 0.0000   | 0.0210          | -0.0000500 | 0.0000016     |
| 33                | 0.0040   | 0.0211          | -0.0004400 | 0.0000015     | 73                | 0.0040   | 0.0211          | -0.0000400 | 0.0000016     |
| 34                | 0.0000   | 0.0210          | -0.0004300 | 0.0000015     | 74                | 0.0000   | 0.0210          | -0.0000300 | 0.0000016     |
| 35                | 0.0040   | 0.0211          | -0.0004200 | 0.0000015     | 75                | 0.0000   | 0.0210          | -0.0000200 | 0.0000016     |
| 36                | 0.0000   | 0.0210          | -0.0004100 | 0.0000015     | 76                | 0.0040   | 0.0211          | -0.0000100 | 0.0000016     |
| 37                | 0.0000   | 0.0210          | -0.0004000 | 0.0000016     | 77                | 0.0040   | 0.0211          | 0.0000000  | 0.0000016     |
| 38                | 0.0040   | 0.0211          | -0.0003900 | 0.0000016     | 78                | 0.0520   | 0.0226          | 0.0000100  | 0.0000016     |
| 39                | 0.0040   | 0.0211          | -0.0003800 | 0.0000016     | 79                | 0.0600   | 0.0228          | 0.0000200  | 0.0000016     |
| 40                | 0.0040   | 0.0211          | -0.0003700 | 0.0000016     | 80                | 0.1040   | 0.0241          | 0.0000300  | 0.0000016     |

| Dati segnale 50Hz |          |                 |           |               | Dati segnale 50Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 81                | 0.1080   | 0.0242          | 0.0000400 | 0.0000016     | 121               | 0.3080   | 0.0302          | 0.0004400 | 0.0000016     |
| 82                | 0.1440   | 0.0253          | 0.0000500 | 0.0000016     | 122               | 0.3120   | 0.0304          | 0.0004500 | 0.0000016     |
| 83                | 0.1520   | 0.0256          | 0.0000600 | 0.0000016     | 123               | 0.3120   | 0.0304          | 0.0004600 | 0.0000016     |
| 84                | 0.1760   | 0.0263          | 0.0000700 | 0.0000016     | 124               | 0.3080   | 0.0302          | 0.0004700 | 0.0000016     |
| 85                | 0.1760   | 0.0263          | 0.0000800 | 0.0000016     | 125               | 0.3120   | 0.0304          | 0.0004800 | 0.0000016     |
| 86                | 0.2000   | 0.0270          | 0.0000900 | 0.0000016     | 126               | 0.3120   | 0.0304          | 0.0004900 | 0.0000016     |
| 87                | 0.2040   | 0.0271          | 0.0001000 | 0.0000016     | 127               | 0.3120   | 0.0304          | 0.0005000 | 0.0000016     |
| 88                | 0.2200   | 0.0276          | 0.0001100 | 0.0000016     | 128               | 0.3080   | 0.0302          | 0.0005100 | 0.0000016     |
| 89                | 0.2240   | 0.0277          | 0.0001200 | 0.0000016     | 129               | 0.3120   | 0.0304          | 0.0005200 | 0.0000016     |
| 90                | 0.2400   | 0.0282          | 0.0001300 | 0.0000016     | 130               | 0.3080   | 0.0302          | 0.0005300 | 0.0000016     |
| 91                | 0.2400   | 0.0282          | 0.0001400 | 0.0000016     | 131               | 0.3120   | 0.0304          | 0.0005400 | 0.0000016     |
| 92                | 0.2520   | 0.0286          | 0.0001500 | 0.0000016     | 132               | 0.3160   | 0.0305          | 0.0005500 | 0.0000016     |
| 93                | 0.2520   | 0.0286          | 0.0001600 | 0.0000016     | 133               | 0.3120   | 0.0304          | 0.0005600 | 0.0000016     |
| 94                | 0.2640   | 0.0289          | 0.0001700 | 0.0000016     | 134               | 0.3160   | 0.0305          | 0.0005700 | 0.0000016     |
| 95                | 0.2640   | 0.0289          | 0.0001800 | 0.0000016     | 135               | 0.3120   | 0.0304          | 0.0005800 | 0.0000016     |
| 96                | 0.2720   | 0.0292          | 0.0001900 | 0.0000016     | 136               | 0.3120   | 0.0304          | 0.0005900 | 0.0000016     |
| 97                | 0.2760   | 0.0293          | 0.0002000 | 0.0000016     | 137               | 0.3120   | 0.0304          | 0.0006000 | 0.0000016     |
| 98                | 0.2800   | 0.0294          | 0.0002100 | 0.0000016     | 138               | 0.3160   | 0.0305          | 0.0006100 | 0.0000016     |
| 99                | 0.2800   | 0.0294          | 0.0002200 | 0.0000016     | 139               | 0.3160   | 0.0305          | 0.0006200 | 0.0000016     |
| 100               | 0.2880   | 0.0296          | 0.0002300 | 0.0000016     | 140               | 0.3120   | 0.0304          | 0.0006300 | 0.0000016     |
| 101               | 0.2880   | 0.0296          | 0.0002400 | 0.0000016     | 141               | 0.3120   | 0.0304          | 0.0006400 | 0.0000016     |
| 102               | 0.2920   | 0.0298          | 0.0002500 | 0.0000016     | 142               | 0.3160   | 0.0305          | 0.0006500 | 0.0000016     |
| 103               | 0.2920   | 0.0298          | 0.0002600 | 0.0000016     | 143               | 0.3120   | 0.0304          | 0.0006600 | 0.0000016     |
| 104               | 0.2960   | 0.0299          | 0.0002700 | 0.0000016     | 144               | 0.3160   | 0.0305          | 0.0006700 | 0.0000016     |
| 105               | 0.2960   | 0.0299          | 0.0002800 | 0.0000016     | 145               | 0.3160   | 0.0305          | 0.0006800 | 0.0000016     |
| 106               | 0.3000   | 0.0300          | 0.0002900 | 0.0000016     | 146               | 0.3120   | 0.0304          | 0.0006900 | 0.0000016     |
| 107               | 0.3000   | 0.0300          | 0.0003000 | 0.0000016     | 147               | 0.3080   | 0.0302          | 0.0007000 | 0.0000016     |
| 108               | 0.3040   | 0.0301          | 0.0003100 | 0.0000016     | 148               | 0.3160   | 0.0305          | 0.0007100 | 0.0000016     |
| 109               | 0.3000   | 0.0300          | 0.0003200 | 0.0000016     | 149               | 0.3160   | 0.0305          | 0.0007200 | 0.0000016     |
| 110               | 0.3040   | 0.0301          | 0.0003300 | 0.0000016     | 150               | 0.3120   | 0.0304          | 0.0007300 | 0.0000016     |
| 111               | 0.3040   | 0.0301          | 0.0003400 | 0.0000016     | 151               | 0.3120   | 0.0304          | 0.0007400 | 0.0000016     |
| 112               | 0.3080   | 0.0302          | 0.0003500 | 0.0000016     | 152               | 0.3160   | 0.0305          | 0.0007500 | 0.0000016     |
| 113               | 0.3040   | 0.0301          | 0.0003600 | 0.0000016     | 153               | 0.3160   | 0.0305          | 0.0007600 | 0.0000016     |
| 114               | 0.3080   | 0.0302          | 0.0003700 | 0.0000016     | 154               | 0.3120   | 0.0304          | 0.0007700 | 0.0000016     |
| 115               | 0.3080   | 0.0302          | 0.0003800 | 0.0000016     | 155               | 0.3120   | 0.0304          | 0.0007800 | 0.0000016     |
| 116               | 0.3040   | 0.0301          | 0.0003900 | 0.0000016     | 156               | 0.3160   | 0.0305          | 0.0007900 | 0.0000016     |
| 117               | 0.3080   | 0.0302          | 0.0004000 | 0.0000016     | 157               | 0.3160   | 0.0305          | 0.0008000 | 0.0000016     |
| 118               | 0.3120   | 0.0304          | 0.0004100 | 0.0000016     | 158               | 0.3120   | 0.0304          | 0.0008100 | 0.0000016     |
| 119               | 0.3080   | 0.0302          | 0.0004200 | 0.0000016     | 159               | 0.3120   | 0.0304          | 0.0008200 | 0.0000016     |
| 120               | 0.3120   | 0.0304          | 0.0004300 | 0.0000016     | 160               | 0.3160   | 0.0305          | 0.0008300 | 0.0000016     |



| Dati segnale 50Hz |          |                 |           |               | Dati segnale 50Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 161               | 0.3120   | 0.0304          | 0.0008400 | 0.0000016     | 201               | 0.3160   | 0.0305          | 0.0012400 | 0.0000016     |
| 162               | 0.3200   | 0.0306          | 0.0008500 | 0.0000016     | 202               | 0.3120   | 0.0304          | 0.0012500 | 0.0000016     |
| 163               | 0.3160   | 0.0305          | 0.0008600 | 0.0000016     | 203               | 0.3160   | 0.0305          | 0.0012600 | 0.0000016     |
| 164               | 0.3120   | 0.0304          | 0.0008700 | 0.0000016     | 204               | 0.3120   | 0.0304          | 0.0012700 | 0.0000016     |
| 165               | 0.3160   | 0.0305          | 0.0008800 | 0.0000016     | 205               | 0.3160   | 0.0305          | 0.0012800 | 0.0000016     |
| 166               | 0.3120   | 0.0304          | 0.0008900 | 0.0000016     | 206               | 0.3120   | 0.0304          | 0.0012900 | 0.0000016     |
| 167               | 0.3120   | 0.0304          | 0.0009000 | 0.0000016     | 207               | 0.3160   | 0.0305          | 0.0013000 | 0.0000016     |
| 168               | 0.3160   | 0.0305          | 0.0009100 | 0.0000016     | 208               | 0.3120   | 0.0304          | 0.0013100 | 0.0000016     |
| 169               | 0.3160   | 0.0305          | 0.0009200 | 0.0000016     | 209               | 0.3160   | 0.0305          | 0.0013200 | 0.0000016     |
| 170               | 0.3120   | 0.0304          | 0.0009300 | 0.0000016     | 210               | 0.3080   | 0.0302          | 0.0013300 | 0.0000016     |
| 171               | 0.3160   | 0.0305          | 0.0009400 | 0.0000016     | 211               | 0.3160   | 0.0305          | 0.0013400 | 0.0000016     |
| 172               | 0.3200   | 0.0306          | 0.0009500 | 0.0000016     | 212               | 0.3160   | 0.0305          | 0.0013500 | 0.0000016     |
| 173               | 0.3160   | 0.0305          | 0.0009600 | 0.0000016     | 213               | 0.3120   | 0.0304          | 0.0013600 | 0.0000016     |
| 174               | 0.3120   | 0.0304          | 0.0009700 | 0.0000016     | 214               | 0.3200   | 0.0306          | 0.0013700 | 0.0000016     |
| 175               | 0.3120   | 0.0304          | 0.0009800 | 0.0000016     | 215               | 0.3160   | 0.0305          | 0.0013800 | 0.0000016     |
| 176               | 0.3200   | 0.0306          | 0.0009900 | 0.0000016     | 216               | 0.3120   | 0.0304          | 0.0013900 | 0.0000016     |
| 177               | 0.3160   | 0.0305          | 0.0010000 | 0.0000016     | 217               | 0.3200   | 0.0306          | 0.0014000 | 0.0000016     |
| 178               | 0.3120   | 0.0304          | 0.0010100 | 0.0000016     | 218               | 0.3120   | 0.0304          | 0.0014100 | 0.0000016     |
| 179               | 0.3160   | 0.0305          | 0.0010200 | 0.0000016     | 219               | 0.3160   | 0.0305          | 0.0014200 | 0.0000016     |
| 180               | 0.3160   | 0.0305          | 0.0010300 | 0.0000016     | 220               | 0.3120   | 0.0304          | 0.0014300 | 0.0000016     |
| 181               | 0.3120   | 0.0304          | 0.0010400 | 0.0000016     | 221               | 0.3160   | 0.0305          | 0.0014400 | 0.0000016     |
| 182               | 0.3160   | 0.0305          | 0.0010500 | 0.0000016     | 222               | 0.3200   | 0.0306          | 0.0014500 | 0.0000016     |
| 183               | 0.3160   | 0.0305          | 0.0010600 | 0.0000016     | 223               | 0.3120   | 0.0304          | 0.0014600 | 0.0000016     |
| 184               | 0.3120   | 0.0304          | 0.0010700 | 0.0000016     | 224               | 0.3200   | 0.0306          | 0.0014700 | 0.0000016     |
| 185               | 0.3160   | 0.0305          | 0.0010800 | 0.0000016     | 225               | 0.3160   | 0.0305          | 0.0014800 | 0.0000016     |
| 186               | 0.3120   | 0.0304          | 0.0010900 | 0.0000016     | 226               | 0.3120   | 0.0304          | 0.0014900 | 0.0000016     |
| 187               | 0.3160   | 0.0305          | 0.0011000 | 0.0000016     | 227               | 0.3160   | 0.0305          | 0.0015000 | 0.0000016     |
| 188               | 0.3120   | 0.0304          | 0.0011100 | 0.0000016     | 228               | 0.3160   | 0.0305          | 0.0015100 | 0.0000016     |
| 189               | 0.3120   | 0.0304          | 0.0011200 | 0.0000016     | 229               | 0.3120   | 0.0304          | 0.0015200 | 0.0000016     |
| 190               | 0.3160   | 0.0305          | 0.0011300 | 0.0000016     | 230               | 0.3200   | 0.0306          | 0.0015300 | 0.0000016     |
| 191               | 0.3120   | 0.0304          | 0.0011400 | 0.0000016     | 231               | 0.3160   | 0.0305          | 0.0015400 | 0.0000016     |
| 192               | 0.3160   | 0.0305          | 0.0011500 | 0.0000016     | 232               | 0.3160   | 0.0305          | 0.0015500 | 0.0000016     |
| 193               | 0.3160   | 0.0305          | 0.0011600 | 0.0000016     | 233               | 0.3120   | 0.0304          | 0.0015600 | 0.0000016     |
| 194               | 0.3120   | 0.0304          | 0.0011700 | 0.0000016     | 234               | 0.3160   | 0.0305          | 0.0015700 | 0.0000016     |
| 195               | 0.3160   | 0.0305          | 0.0011800 | 0.0000016     | 235               | 0.3160   | 0.0305          | 0.0015800 | 0.0000016     |
| 196               | 0.3120   | 0.0304          | 0.0011900 | 0.0000016     | 236               | 0.3120   | 0.0304          | 0.0015900 | 0.0000016     |
| 197               | 0.3160   | 0.0305          | 0.0012000 | 0.0000016     | 237               | 0.3160   | 0.0305          | 0.0016000 | 0.0000016     |
| 198               | 0.3120   | 0.0304          | 0.0012100 | 0.0000016     | 238               | 0.3120   | 0.0304          | 0.0016100 | 0.0000016     |
| 199               | 0.3120   | 0.0304          | 0.0012200 | 0.0000016     | 239               | 0.3160   | 0.0305          | 0.0016200 | 0.0000016     |
| 200               | 0.3160   | 0.0305          | 0.0012300 | 0.0000016     | 240               | 0.3120   | 0.0304          | 0.0016300 | 0.0000016     |

| Dati segnale 50Hz |          |                 |           |               | Dati segnale 50Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 241               | 0.3160   | 0.0305          | 0.0016400 | 0.0000016     | 281               | 0.3160   | 0.0305          | 0.0020400 | 0.0000016     |
| 242               | 0.3120   | 0.0304          | 0.0016500 | 0.0000016     | 282               | 0.3160   | 0.0305          | 0.0020500 | 0.0000016     |
| 243               | 0.3160   | 0.0305          | 0.0016600 | 0.0000016     | 283               | 0.3160   | 0.0305          | 0.0020600 | 0.0000016     |
| 244               | 0.3160   | 0.0305          | 0.0016700 | 0.0000016     | 284               | 0.3160   | 0.0305          | 0.0020700 | 0.0000016     |
| 245               | 0.3120   | 0.0304          | 0.0016800 | 0.0000016     | 285               | 0.3160   | 0.0305          | 0.0020800 | 0.0000016     |
| 246               | 0.3160   | 0.0305          | 0.0016900 | 0.0000016     | 286               | 0.3160   | 0.0305          | 0.0020900 | 0.0000016     |
| 247               | 0.3160   | 0.0305          | 0.0017000 | 0.0000016     | 287               | 0.3160   | 0.0305          | 0.0021000 | 0.0000016     |
| 248               | 0.3120   | 0.0304          | 0.0017100 | 0.0000016     | 288               | 0.3160   | 0.0305          | 0.0021100 | 0.0000016     |
| 249               | 0.3200   | 0.0306          | 0.0017200 | 0.0000016     | 289               | 0.3160   | 0.0305          | 0.0021200 | 0.0000016     |
| 250               | 0.3120   | 0.0304          | 0.0017300 | 0.0000016     | 290               | 0.3120   | 0.0304          | 0.0021300 | 0.0000016     |
| 251               | 0.3120   | 0.0304          | 0.0017400 | 0.0000016     | 291               | 0.3160   | 0.0305          | 0.0021400 | 0.0000016     |
| 252               | 0.3160   | 0.0305          | 0.0017500 | 0.0000016     | 292               | 0.3200   | 0.0306          | 0.0021500 | 0.0000016     |
| 253               | 0.3160   | 0.0305          | 0.0017600 | 0.0000016     | 293               | 0.3160   | 0.0305          | 0.0021600 | 0.0000016     |
| 254               | 0.3120   | 0.0304          | 0.0017700 | 0.0000016     | 294               | 0.3120   | 0.0304          | 0.0021700 | 0.0000016     |
| 255               | 0.3160   | 0.0305          | 0.0017800 | 0.0000016     | 295               | 0.3160   | 0.0305          | 0.0021800 | 0.0000016     |
| 256               | 0.3160   | 0.0305          | 0.0017900 | 0.0000016     | 296               | 0.3120   | 0.0304          | 0.0021900 | 0.0000016     |
| 257               | 0.3160   | 0.0305          | 0.0018000 | 0.0000016     | 297               | 0.3160   | 0.0305          | 0.0022000 | 0.0000016     |
| 258               | 0.3160   | 0.0305          | 0.0018100 | 0.0000016     | 298               | 0.3160   | 0.0305          | 0.0022100 | 0.0000016     |
| 259               | 0.3160   | 0.0305          | 0.0018200 | 0.0000016     | 299               | 0.3120   | 0.0304          | 0.0022200 | 0.0000016     |
| 260               | 0.3120   | 0.0304          | 0.0018300 | 0.0000016     | 300               | 0.3160   | 0.0305          | 0.0022300 | 0.0000016     |
| 261               | 0.3160   | 0.0305          | 0.0018400 | 0.0000016     | 301               | 0.3160   | 0.0305          | 0.0022400 | 0.0000016     |
| 262               | 0.3120   | 0.0304          | 0.0018500 | 0.0000016     | 302               | 0.3160   | 0.0305          | 0.0022500 | 0.0000016     |
| 263               | 0.3160   | 0.0305          | 0.0018600 | 0.0000016     | 303               | 0.3160   | 0.0305          | 0.0022600 | 0.0000016     |
| 264               | 0.3160   | 0.0305          | 0.0018700 | 0.0000016     | 304               | 0.3160   | 0.0305          | 0.0022700 | 0.0000016     |
| 265               | 0.3160   | 0.0305          | 0.0018800 | 0.0000016     | 305               | 0.3160   | 0.0305          | 0.0022800 | 0.0000016     |
| 266               | 0.3160   | 0.0305          | 0.0018900 | 0.0000016     | 306               | 0.3160   | 0.0305          | 0.0022900 | 0.0000016     |
| 267               | 0.3120   | 0.0304          | 0.0019000 | 0.0000016     | 307               | 0.3160   | 0.0305          | 0.0023000 | 0.0000016     |
| 268               | 0.3200   | 0.0306          | 0.0019100 | 0.0000016     | 308               | 0.3120   | 0.0304          | 0.0023100 | 0.0000016     |
| 269               | 0.3120   | 0.0304          | 0.0019200 | 0.0000016     | 309               | 0.3160   | 0.0305          | 0.0023200 | 0.0000016     |
| 270               | 0.3200   | 0.0306          | 0.0019300 | 0.0000016     | 310               | 0.3160   | 0.0305          | 0.0023300 | 0.0000016     |
| 271               | 0.3160   | 0.0305          | 0.0019400 | 0.0000016     | 311               | 0.3160   | 0.0305          | 0.0023400 | 0.0000016     |
| 272               | 0.3120   | 0.0304          | 0.0019500 | 0.0000016     | 312               | 0.3160   | 0.0305          | 0.0023500 | 0.0000016     |
| 273               | 0.3160   | 0.0305          | 0.0019600 | 0.0000016     | 313               | 0.3160   | 0.0305          | 0.0023600 | 0.0000016     |
| 274               | 0.3160   | 0.0305          | 0.0019700 | 0.0000016     | 314               | 0.3120   | 0.0304          | 0.0023700 | 0.0000016     |
| 275               | 0.3160   | 0.0305          | 0.0019800 | 0.0000016     | 315               | 0.3120   | 0.0304          | 0.0023800 | 0.0000016     |
| 276               | 0.3120   | 0.0304          | 0.0019900 | 0.0000016     | 316               | 0.3200   | 0.0306          | 0.0023900 | 0.0000016     |
| 277               | 0.3160   | 0.0305          | 0.0020000 | 0.0000016     | 317               | 0.3160   | 0.0305          | 0.0024000 | 0.0000016     |
| 278               | 0.3120   | 0.0304          | 0.0020100 | 0.0000016     | 318               | 0.3160   | 0.0305          | 0.0024100 | 0.0000016     |
| 279               | 0.3160   | 0.0305          | 0.0020200 | 0.0000016     | 319               | 0.3160   | 0.0305          | 0.0024200 | 0.0000016     |
| 280               | 0.3160   | 0.0305          | 0.0020300 | 0.0000016     | 320               | 0.3160   | 0.0305          | 0.0024300 | 0.0000016     |

| Dati segnale 50Hz |          |                 |           |               | Dati segnale 50Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 321               | 0.3160   | 0.0305          | 0.0024400 | 0.0000016     | 361               | 0.3160   | 0.0305          | 0.0028400 | 0.0000016     |
| 322               | 0.3160   | 0.0305          | 0.0024500 | 0.0000016     | 362               | 0.3200   | 0.0306          | 0.0028500 | 0.0000016     |
| 323               | 0.3160   | 0.0305          | 0.0024600 | 0.0000016     | 363               | 0.3160   | 0.0305          | 0.0028600 | 0.0000016     |
| 324               | 0.3200   | 0.0306          | 0.0024700 | 0.0000016     | 364               | 0.3160   | 0.0305          | 0.0028700 | 0.0000016     |
| 325               | 0.3160   | 0.0305          | 0.0024800 | 0.0000016     | 365               | 0.3160   | 0.0305          | 0.0028800 | 0.0000016     |
| 326               | 0.3160   | 0.0305          | 0.0024900 | 0.0000016     | 366               | 0.3160   | 0.0305          | 0.0028900 | 0.0000016     |
| 327               | 0.3160   | 0.0305          | 0.0025000 | 0.0000016     | 367               | 0.3160   | 0.0305          | 0.0029000 | 0.0000016     |
| 328               | 0.3160   | 0.0305          | 0.0025100 | 0.0000016     | 368               | 0.3120   | 0.0304          | 0.0029100 | 0.0000016     |
| 329               | 0.3120   | 0.0304          | 0.0025200 | 0.0000016     | 369               | 0.3200   | 0.0306          | 0.0029200 | 0.0000016     |
| 330               | 0.3200   | 0.0306          | 0.0025300 | 0.0000016     | 370               | 0.3120   | 0.0304          | 0.0029300 | 0.0000016     |
| 331               | 0.3160   | 0.0305          | 0.0025400 | 0.0000016     | 371               | 0.3200   | 0.0306          | 0.0029400 | 0.0000016     |
| 332               | 0.3160   | 0.0305          | 0.0025500 | 0.0000016     | 372               | 0.3120   | 0.0304          | 0.0029500 | 0.0000016     |
| 333               | 0.3120   | 0.0304          | 0.0025600 | 0.0000016     | 373               | 0.3160   | 0.0305          | 0.0029600 | 0.0000016     |
| 334               | 0.3200   | 0.0306          | 0.0025700 | 0.0000016     | 374               | 0.3160   | 0.0305          | 0.0029700 | 0.0000016     |
| 335               | 0.3160   | 0.0305          | 0.0025800 | 0.0000016     | 375               | 0.3120   | 0.0304          | 0.0029800 | 0.0000016     |
| 336               | 0.3120   | 0.0304          | 0.0025900 | 0.0000016     | 376               | 0.3200   | 0.0306          | 0.0029900 | 0.0000016     |
| 337               | 0.3160   | 0.0305          | 0.0026000 | 0.0000016     | 377               | 0.3160   | 0.0305          | 0.0030000 | 0.0000016     |
| 338               | 0.3200   | 0.0306          | 0.0026100 | 0.0000016     | 378               | 0.3160   | 0.0305          | 0.0030100 | 0.0000016     |
| 339               | 0.3160   | 0.0305          | 0.0026200 | 0.0000016     | 379               | 0.3160   | 0.0305          | 0.0030200 | 0.0000016     |
| 340               | 0.3160   | 0.0305          | 0.0026300 | 0.0000016     | 380               | 0.3120   | 0.0304          | 0.0030300 | 0.0000016     |
| 341               | 0.3120   | 0.0304          | 0.0026400 | 0.0000016     | 381               | 0.3160   | 0.0305          | 0.0030400 | 0.0000016     |
| 342               | 0.3200   | 0.0306          | 0.0026500 | 0.0000016     | 382               | 0.3160   | 0.0305          | 0.0030500 | 0.0000016     |
| 343               | 0.3160   | 0.0305          | 0.0026600 | 0.0000016     | 383               | 0.3160   | 0.0305          | 0.0030600 | 0.0000016     |
| 344               | 0.3120   | 0.0304          | 0.0026700 | 0.0000016     | 384               | 0.3160   | 0.0305          | 0.0030700 | 0.0000016     |
| 345               | 0.3160   | 0.0305          | 0.0026800 | 0.0000016     | 385               | 0.3160   | 0.0305          | 0.0030800 | 0.0000016     |
| 346               | 0.3160   | 0.0305          | 0.0026900 | 0.0000016     | 386               | 0.3160   | 0.0305          | 0.0030900 | 0.0000016     |
| 347               | 0.3160   | 0.0305          | 0.0027000 | 0.0000016     | 387               | 0.3200   | 0.0306          | 0.0031000 | 0.0000016     |
| 348               | 0.3160   | 0.0305          | 0.0027100 | 0.0000016     | 388               | 0.3160   | 0.0305          | 0.0031100 | 0.0000016     |
| 349               | 0.3160   | 0.0305          | 0.0027200 | 0.0000016     | 389               | 0.3160   | 0.0305          | 0.0031200 | 0.0000016     |
| 350               | 0.3160   | 0.0305          | 0.0027300 | 0.0000016     | 390               | 0.3120   | 0.0304          | 0.0031300 | 0.0000016     |
| 351               | 0.3160   | 0.0305          | 0.0027400 | 0.0000016     | 391               | 0.3160   | 0.0305          | 0.0031400 | 0.0000016     |
| 352               | 0.3120   | 0.0304          | 0.0027500 | 0.0000016     | 392               | 0.3200   | 0.0306          | 0.0031500 | 0.0000016     |
| 353               | 0.3160   | 0.0305          | 0.0027600 | 0.0000016     | 393               | 0.3160   | 0.0305          | 0.0031600 | 0.0000016     |
| 354               | 0.3120   | 0.0304          | 0.0027700 | 0.0000016     | 394               | 0.3200   | 0.0306          | 0.0031700 | 0.0000016     |
| 355               | 0.3160   | 0.0305          | 0.0027800 | 0.0000016     | 395               | 0.3160   | 0.0305          | 0.0031800 | 0.0000016     |
| 356               | 0.3120   | 0.0304          | 0.0027900 | 0.0000016     | 396               | 0.3160   | 0.0305          | 0.0031900 | 0.0000016     |
| 357               | 0.3120   | 0.0304          | 0.0028000 | 0.0000016     | 397               | 0.3200   | 0.0306          | 0.0032000 | 0.0000016     |
| 358               | 0.3200   | 0.0306          | 0.0028100 | 0.0000016     | 398               | 0.3120   | 0.0304          | 0.0032100 | 0.0000016     |
| 359               | 0.3200   | 0.0306          | 0.0028200 | 0.0000016     | 399               | 0.3160   | 0.0305          | 0.0032200 | 0.0000016     |
| 360               | 0.3120   | 0.0304          | 0.0028300 | 0.0000016     | 400               | 0.3200   | 0.0306          | 0.0032300 | 0.0000016     |

| Dati segnale 50Hz |          |                 |           |               | Dati segnale 50Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 401               | 0.3160   | 0.0305          | 0.0032400 | 0.0000016     | 441               | 0.3160   | 0.0305          | 0.0036400 | 0.0000016     |
| 402               | 0.3160   | 0.0305          | 0.0032500 | 0.0000016     | 442               | 0.3200   | 0.0306          | 0.0036500 | 0.0000016     |
| 403               | 0.3160   | 0.0305          | 0.0032600 | 0.0000016     | 443               | 0.3160   | 0.0305          | 0.0036600 | 0.0000016     |
| 404               | 0.3160   | 0.0305          | 0.0032700 | 0.0000016     | 444               | 0.3200   | 0.0306          | 0.0036700 | 0.0000016     |
| 405               | 0.3200   | 0.0306          | 0.0032800 | 0.0000016     | 445               | 0.3160   | 0.0305          | 0.0036800 | 0.0000016     |
| 406               | 0.3120   | 0.0304          | 0.0032900 | 0.0000016     | 446               | 0.3160   | 0.0305          | 0.0036900 | 0.0000016     |
| 407               | 0.3160   | 0.0305          | 0.0033000 | 0.0000016     | 447               | 0.3120   | 0.0304          | 0.0037000 | 0.0000016     |
| 408               | 0.3160   | 0.0305          | 0.0033100 | 0.0000016     | 448               | 0.3160   | 0.0305          | 0.0037100 | 0.0000016     |
| 409               | 0.3160   | 0.0305          | 0.0033200 | 0.0000016     | 449               | 0.3160   | 0.0305          | 0.0037200 | 0.0000016     |
| 410               | 0.3160   | 0.0305          | 0.0033300 | 0.0000016     | 450               | 0.3160   | 0.0305          | 0.0037300 | 0.0000016     |
| 411               | 0.3160   | 0.0305          | 0.0033400 | 0.0000016     | 451               | 0.3160   | 0.0305          | 0.0037400 | 0.0000016     |
| 412               | 0.3120   | 0.0304          | 0.0033500 | 0.0000016     | 452               | 0.3120   | 0.0304          | 0.0037500 | 0.0000016     |
| 413               | 0.3160   | 0.0305          | 0.0033600 | 0.0000016     | 453               | 0.3120   | 0.0304          | 0.0037600 | 0.0000016     |
| 414               | 0.3160   | 0.0305          | 0.0033700 | 0.0000016     | 454               | 0.3200   | 0.0306          | 0.0037700 | 0.0000016     |
| 415               | 0.3160   | 0.0305          | 0.0033800 | 0.0000016     | 455               | 0.3200   | 0.0306          | 0.0037800 | 0.0000016     |
| 416               | 0.3120   | 0.0304          | 0.0033900 | 0.0000016     | 456               | 0.3120   | 0.0304          | 0.0037900 | 0.0000016     |
| 417               | 0.3160   | 0.0305          | 0.0034000 | 0.0000016     | 457               | 0.3160   | 0.0305          | 0.0038000 | 0.0000016     |
| 418               | 0.3120   | 0.0304          | 0.0034100 | 0.0000016     | 458               | 0.3120   | 0.0304          | 0.0038100 | 0.0000016     |
| 419               | 0.3160   | 0.0305          | 0.0034200 | 0.0000016     | 459               | 0.3160   | 0.0305          | 0.0038200 | 0.0000016     |
| 420               | 0.3120   | 0.0304          | 0.0034300 | 0.0000016     | 460               | 0.3160   | 0.0305          | 0.0038300 | 0.0000016     |
| 421               | 0.3200   | 0.0306          | 0.0034400 | 0.0000016     | 461               | 0.3160   | 0.0305          | 0.0038400 | 0.0000016     |
| 422               | 0.3120   | 0.0304          | 0.0034500 | 0.0000016     | 462               | 0.3120   | 0.0304          | 0.0038500 | 0.0000016     |
| 423               | 0.3120   | 0.0304          | 0.0034600 | 0.0000016     | 463               | 0.3160   | 0.0305          | 0.0038600 | 0.0000016     |
| 424               | 0.3160   | 0.0305          | 0.0034700 | 0.0000016     | 464               | 0.3120   | 0.0304          | 0.0038700 | 0.0000016     |
| 425               | 0.3200   | 0.0306          | 0.0034800 | 0.0000016     | 465               | 0.3160   | 0.0305          | 0.0038800 | 0.0000016     |
| 426               | 0.3160   | 0.0305          | 0.0034900 | 0.0000016     | 466               | 0.3160   | 0.0305          | 0.0038900 | 0.0000016     |
| 427               | 0.3160   | 0.0305          | 0.0035000 | 0.0000016     | 467               | 0.3160   | 0.0305          | 0.0039000 | 0.0000016     |
| 428               | 0.3120   | 0.0304          | 0.0035100 | 0.0000016     | 468               | 0.3160   | 0.0305          | 0.0039100 | 0.0000016     |
| 429               | 0.3160   | 0.0305          | 0.0035200 | 0.0000016     | 469               | 0.3160   | 0.0305          | 0.0039200 | 0.0000016     |
| 430               | 0.3200   | 0.0306          | 0.0035300 | 0.0000016     | 470               | 0.3120   | 0.0304          | 0.0039300 | 0.0000016     |
| 431               | 0.3160   | 0.0305          | 0.0035400 | 0.0000016     | 471               | 0.3160   | 0.0305          | 0.0039400 | 0.0000016     |
| 432               | 0.3120   | 0.0304          | 0.0035500 | 0.0000016     | 472               | 0.3160   | 0.0305          | 0.0039500 | 0.0000016     |
| 433               | 0.3200   | 0.0306          | 0.0035600 | 0.0000016     | 473               | 0.3160   | 0.0305          | 0.0039600 | 0.0000016     |
| 434               | 0.3120   | 0.0304          | 0.0035700 | 0.0000016     | 474               | 0.3120   | 0.0304          | 0.0039700 | 0.0000016     |
| 435               | 0.3160   | 0.0305          | 0.0035800 | 0.0000016     | 475               | 0.3160   | 0.0305          | 0.0039800 | 0.0000016     |
| 436               | 0.3120   | 0.0304          | 0.0035900 | 0.0000016     | 476               | 0.3120   | 0.0304          | 0.0039900 | 0.0000016     |
| 437               | 0.3160   | 0.0305          | 0.0036000 | 0.0000016     | 477               | 0.3160   | 0.0305          | 0.0040000 | 0.0000016     |
| 438               | 0.3160   | 0.0305          | 0.0036100 | 0.0000016     | 478               | 0.2760   | 0.0293          | 0.0040100 | 0.0000016     |
| 439               | 0.3160   | 0.0305          | 0.0036200 | 0.0000016     | 479               | 0.2720   | 0.0292          | 0.0040200 | 0.0000016     |
| 440               | 0.3160   | 0.0305          | 0.0036300 | 0.0000016     | 480               | 0.2560   | 0.0287          | 0.0040300 | 0.0000016     |

| Dati segnale 50Hz |          |                 |           |               | Dati segnale 50Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 481               | 0.2520   | 0.0286          | 0.0040400 | 0.0000016     | 521               | 0.0520   | 0.0226          | 0.0044400 | 0.0000016     |
| 482               | 0.2360   | 0.0281          | 0.0040500 | 0.0000016     | 522               | 0.0520   | 0.0226          | 0.0044500 | 0.0000016     |
| 483               | 0.2320   | 0.0280          | 0.0040600 | 0.0000016     | 523               | 0.0520   | 0.0226          | 0.0044600 | 0.0000016     |
| 484               | 0.2160   | 0.0275          | 0.0040700 | 0.0000016     | 524               | 0.0440   | 0.0223          | 0.0044700 | 0.0000016     |
| 485               | 0.2120   | 0.0274          | 0.0040800 | 0.0000016     | 525               | 0.0480   | 0.0224          | 0.0044800 | 0.0000016     |
| 486               | 0.2000   | 0.0270          | 0.0040900 | 0.0000016     | 526               | 0.0400   | 0.0222          | 0.0044900 | 0.0000016     |
| 487               | 0.2000   | 0.0270          | 0.0041000 | 0.0000016     | 527               | 0.0440   | 0.0223          | 0.0045000 | 0.0000016     |
| 488               | 0.1800   | 0.0264          | 0.0041100 | 0.0000016     | 528               | 0.0400   | 0.0222          | 0.0045100 | 0.0000016     |
| 489               | 0.1800   | 0.0264          | 0.0041200 | 0.0000016     | 529               | 0.0400   | 0.0222          | 0.0045200 | 0.0000016     |
| 490               | 0.1760   | 0.0263          | 0.0041300 | 0.0000016     | 530               | 0.0360   | 0.0221          | 0.0045300 | 0.0000016     |
| 491               | 0.1720   | 0.0262          | 0.0041400 | 0.0000016     | 531               | 0.0360   | 0.0221          | 0.0045400 | 0.0000016     |
| 492               | 0.1600   | 0.0258          | 0.0041500 | 0.0000016     | 532               | 0.0320   | 0.0220          | 0.0045500 | 0.0000016     |
| 493               | 0.1600   | 0.0258          | 0.0041600 | 0.0000016     | 533               | 0.0360   | 0.0221          | 0.0045600 | 0.0000016     |
| 494               | 0.1480   | 0.0254          | 0.0041700 | 0.0000016     | 534               | 0.0320   | 0.0220          | 0.0045700 | 0.0000016     |
| 495               | 0.1480   | 0.0254          | 0.0041800 | 0.0000016     | 535               | 0.0320   | 0.0220          | 0.0045800 | 0.0000016     |
| 496               | 0.1360   | 0.0251          | 0.0041900 | 0.0000016     | 536               | 0.0280   | 0.0218          | 0.0045900 | 0.0000016     |
| 497               | 0.1360   | 0.0251          | 0.0042000 | 0.0000016     | 537               | 0.0320   | 0.0220          | 0.0046000 | 0.0000016     |
| 498               | 0.1240   | 0.0247          | 0.0042100 | 0.0000016     | 538               | 0.0240   | 0.0217          | 0.0046100 | 0.0000016     |
| 499               | 0.1240   | 0.0247          | 0.0042200 | 0.0000016     | 539               | 0.0280   | 0.0218          | 0.0046200 | 0.0000016     |
| 500               | 0.1160   | 0.0245          | 0.0042300 | 0.0000016     | 540               | 0.0240   | 0.0217          | 0.0046300 | 0.0000016     |
| 501               | 0.1160   | 0.0245          | 0.0042400 | 0.0000016     | 541               | 0.0280   | 0.0218          | 0.0046400 | 0.0000016     |
| 502               | 0.1080   | 0.0242          | 0.0042500 | 0.0000016     | 542               | 0.0240   | 0.0217          | 0.0046500 | 0.0000016     |
| 503               | 0.1080   | 0.0242          | 0.0042600 | 0.0000016     | 543               | 0.0240   | 0.0217          | 0.0046600 | 0.0000016     |
| 504               | 0.1000   | 0.0240          | 0.0042700 | 0.0000016     | 544               | 0.0240   | 0.0217          | 0.0046700 | 0.0000016     |
| 505               | 0.1000   | 0.0240          | 0.0042800 | 0.0000016     | 545               | 0.0240   | 0.0217          | 0.0046800 | 0.0000016     |
| 506               | 0.0880   | 0.0236          | 0.0042900 | 0.0000016     | 546               | 0.0200   | 0.0216          | 0.0046900 | 0.0000016     |
| 507               | 0.0920   | 0.0238          | 0.0043000 | 0.0000016     | 547               | 0.0200   | 0.0216          | 0.0047000 | 0.0000016     |
| 508               | 0.0840   | 0.0235          | 0.0043100 | 0.0000016     | 548               | 0.0200   | 0.0216          | 0.0047100 | 0.0000016     |
| 509               | 0.0840   | 0.0235          | 0.0043200 | 0.0000016     | 549               | 0.0200   | 0.0216          | 0.0047200 | 0.0000016     |
| 510               | 0.0800   | 0.0234          | 0.0043300 | 0.0000016     | 550               | 0.0160   | 0.0215          | 0.0047300 | 0.0000016     |
| 511               | 0.0800   | 0.0234          | 0.0043400 | 0.0000016     | 551               | 0.0160   | 0.0215          | 0.0047400 | 0.0000016     |
| 512               | 0.0720   | 0.0232          | 0.0043500 | 0.0000016     | 552               | 0.0200   | 0.0216          | 0.0047500 | 0.0000016     |
| 513               | 0.0720   | 0.0232          | 0.0043600 | 0.0000016     | 553               | 0.0200   | 0.0216          | 0.0047600 | 0.0000016     |
| 514               | 0.0680   | 0.0230          | 0.0043700 | 0.0000016     | 554               | 0.0160   | 0.0215          | 0.0047700 | 0.0000016     |
| 515               | 0.0680   | 0.0230          | 0.0043800 | 0.0000016     | 555               | 0.0160   | 0.0215          | 0.0047800 | 0.0000016     |
| 516               | 0.0640   | 0.0229          | 0.0043900 | 0.0000016     | 556               | 0.0120   | 0.0214          | 0.0047900 | 0.0000016     |
| 517               | 0.0640   | 0.0229          | 0.0044000 | 0.0000016     | 557               | 0.0120   | 0.0214          | 0.0048000 | 0.0000016     |
| 518               | 0.0560   | 0.0227          | 0.0044100 | 0.0000016     | 558               | 0.0160   | 0.0215          | 0.0048100 | 0.0000016     |
| 519               | 0.0560   | 0.0227          | 0.0044200 | 0.0000016     | 559               | 0.0120   | 0.0214          | 0.0048200 | 0.0000016     |
| 520               | 0.0520   | 0.0226          | 0.0044300 | 0.0000016     | 560               | 0.0080   | 0.0212          | 0.0048300 | 0.0000016     |

| Dati segnale 50Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 561               | 0.0120   | 0.0214          | 0.0048400 | 0.0000016     |
| 562               | 0.0080   | 0.0212          | 0.0048500 | 0.0000016     |
| 563               | 0.0120   | 0.0214          | 0.0048600 | 0.0000016     |
| 564               | 0.0080   | 0.0212          | 0.0048700 | 0.0000016     |
| 565               | 0.0120   | 0.0214          | 0.0048800 | 0.0000016     |
| 566               | 0.0080   | 0.0212          | 0.0048900 | 0.0000016     |
| 567               | 0.0120   | 0.0214          | 0.0049000 | 0.0000016     |
| 568               | 0.0080   | 0.0212          | 0.0049100 | 0.0000016     |
| 569               | 0.0080   | 0.0212          | 0.0049200 | 0.0000016     |
| 570               | 0.0080   | 0.0212          | 0.0049300 | 0.0000016     |
| 571               | 0.0080   | 0.0212          | 0.0049400 | 0.0000016     |
| 572               | 0.0080   | 0.0212          | 0.0049500 | 0.0000016     |
| 573               | 0.0080   | 0.0212          | 0.0049600 | 0.0000016     |
| 574               | 0.0080   | 0.0212          | 0.0049700 | 0.0000016     |
| 575               | 0.0080   | 0.0212          | 0.0049800 | 0.0000016     |
| 576               | 0.0080   | 0.0212          | 0.0049900 | 0.0000016     |
| 577               | 0.0080   | 0.0212          | 0.0050000 | 0.0000016     |
| 578               | 0.0040   | 0.0211          | 0.0050100 | 0.0000016     |
| 579               | 0.0080   | 0.0212          | 0.0050200 | 0.0000016     |
| 580               | 0.0040   | 0.0211          | 0.0050300 | 0.0000016     |
| 581               | 0.0040   | 0.0211          | 0.0050400 | 0.0000016     |
| 582               | 0.0080   | 0.0212          | 0.0050500 | 0.0000016     |
| 583               | 0.0080   | 0.0212          | 0.0050600 | 0.0000016     |
| 584               | 0.0040   | 0.0211          | 0.0050700 | 0.0000016     |
| 585               | 0.0080   | 0.0212          | 0.0050800 | 0.0000016     |
| 586               | 0.0040   | 0.0211          | 0.0050900 | 0.0000016     |
| 587               | 0.0080   | 0.0212          | 0.0051000 | 0.0000016     |
| 588               | 0.0040   | 0.0211          | 0.0051100 | 0.0000016     |
| 589               | 0.0040   | 0.0211          | 0.0051200 | 0.0000016     |
| 590               | 0.0080   | 0.0212          | 0.0051300 | 0.0000016     |
| 591               | 0.0080   | 0.0212          | 0.0051400 | 0.0000016     |
| 592               | 0.0040   | 0.0211          | 0.0051500 | 0.0000016     |
| 593               | 0.0040   | 0.0211          | 0.0051600 | 0.0000016     |
| 594               | 0.0040   | 0.0211          | 0.0051700 | 0.0000016     |
| 595               | 0.0040   | 0.0211          | 0.0051800 | 0.0000016     |
| 596               | 0.0080   | 0.0212          | 0.0051900 | 0.0000016     |
| 597               | 0.0040   | 0.0211          | 0.0052000 | 0.0000016     |
| 598               | 0.0040   | 0.0211          | 0.0052100 | 0.0000016     |
| 599               | 0.0040   | 0.0211          | 0.0052200 | 0.0000016     |
| 600               | 0.0040   | 0.0211          | 0.0052300 | 0.0000016     |

| Dati segnale 90Hz |          |                 |            |               | Dati segnale 90Hz |          |                 |            |               |
|-------------------|----------|-----------------|------------|---------------|-------------------|----------|-----------------|------------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$     | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$     | $\Delta t(s)$ |
| 1                 | 0.0040   | 0.0211          | -0.0007600 | 0.0000015     | 41                | 0.0040   | 0.0211          | -0.0003600 | 0.0000015     |
| 2                 | 0.0000   | 0.0210          | -0.0007500 | 0.0000015     | 42                | 0.0000   | 0.0210          | -0.0003500 | 0.0000015     |
| 3                 | 0.0000   | 0.0210          | -0.0007400 | 0.0000015     | 43                | 0.0040   | 0.0211          | -0.0003400 | 0.0000015     |
| 4                 | 0.0040   | 0.0211          | -0.0007300 | 0.0000015     | 44                | 0.0000   | 0.0210          | -0.0003300 | 0.0000015     |
| 5                 | 0.0040   | 0.0211          | -0.0007200 | 0.0000015     | 45                | 0.0040   | 0.0211          | -0.0003200 | 0.0000015     |
| 6                 | 0.0000   | 0.0210          | -0.0007100 | 0.0000015     | 46                | 0.0000   | 0.0210          | -0.0003100 | 0.0000015     |
| 7                 | 0.0040   | 0.0211          | -0.0007000 | 0.0000015     | 47                | 0.0040   | 0.0211          | -0.0003000 | 0.0000015     |
| 8                 | 0.0000   | 0.0210          | -0.0006900 | 0.0000015     | 48                | 0.0040   | 0.0211          | -0.0002900 | 0.0000015     |
| 9                 | 0.0000   | 0.0210          | -0.0006800 | 0.0000015     | 49                | 0.0000   | 0.0210          | -0.0002800 | 0.0000015     |
| 10                | 0.0040   | 0.0211          | -0.0006700 | 0.0000015     | 50                | 0.0040   | 0.0211          | -0.0002700 | 0.0000015     |
| 11                | 0.0040   | 0.0211          | -0.0006600 | 0.0000015     | 51                | 0.0040   | 0.0211          | -0.0002600 | 0.0000015     |
| 12                | 0.0000   | 0.0210          | -0.0006500 | 0.0000015     | 52                | 0.0000   | 0.0210          | -0.0002500 | 0.0000015     |
| 13                | 0.0040   | 0.0211          | -0.0006400 | 0.0000015     | 53                | 0.0000   | 0.0210          | -0.0002400 | 0.0000015     |
| 14                | 0.0000   | 0.0210          | -0.0006300 | 0.0000015     | 54                | 0.0040   | 0.0211          | -0.0002300 | 0.0000015     |
| 15                | 0.0040   | 0.0211          | -0.0006200 | 0.0000015     | 55                | 0.0000   | 0.0210          | -0.0002200 | 0.0000015     |
| 16                | 0.0000   | 0.0210          | -0.0006100 | 0.0000015     | 56                | 0.0040   | 0.0211          | -0.0002100 | 0.0000015     |
| 17                | 0.0040   | 0.0211          | -0.0006000 | 0.0000015     | 57                | 0.0040   | 0.0211          | -0.0002000 | 0.0000015     |
| 18                | 0.0040   | 0.0211          | -0.0005900 | 0.0000015     | 58                | 0.0000   | 0.0210          | -0.0001900 | 0.0000015     |
| 19                | 0.0040   | 0.0211          | -0.0005800 | 0.0000015     | 59                | 0.0040   | 0.0211          | -0.0001800 | 0.0000015     |
| 20                | 0.0000   | 0.0210          | -0.0005700 | 0.0000015     | 60                | 0.0000   | 0.0210          | -0.0001700 | 0.0000015     |
| 21                | 0.0040   | 0.0211          | -0.0005600 | 0.0000015     | 61                | 0.0040   | 0.0211          | -0.0001600 | 0.0000015     |
| 22                | 0.0000   | 0.0210          | -0.0005500 | 0.0000015     | 62                | 0.0000   | 0.0210          | -0.0001500 | 0.0000015     |
| 23                | 0.0040   | 0.0211          | -0.0005400 | 0.0000015     | 63                | 0.0040   | 0.0211          | -0.0001400 | 0.0000015     |
| 24                | 0.0000   | 0.0210          | -0.0005300 | 0.0000015     | 64                | 0.0000   | 0.0210          | -0.0001300 | 0.0000015     |
| 25                | 0.0040   | 0.0211          | -0.0005200 | 0.0000015     | 65                | 0.0040   | 0.0211          | -0.0001200 | 0.0000015     |
| 26                | 0.0000   | 0.0210          | -0.0005100 | 0.0000015     | 66                | 0.0000   | 0.0210          | -0.0001100 | 0.0000015     |
| 27                | 0.0040   | 0.0211          | -0.0005000 | 0.0000015     | 67                | 0.0040   | 0.0211          | -0.0001000 | 0.0000015     |
| 28                | 0.0000   | 0.0210          | -0.0004900 | 0.0000015     | 68                | 0.0040   | 0.0211          | -0.0000900 | 0.0000015     |
| 29                | 0.0040   | 0.0211          | -0.0004800 | 0.0000015     | 69                | 0.0040   | 0.0211          | -0.0000800 | 0.0000015     |
| 30                | 0.0000   | 0.0210          | -0.0004700 | 0.0000015     | 70                | 0.0000   | 0.0210          | -0.0000700 | 0.0000015     |
| 31                | 0.0000   | 0.0210          | -0.0004600 | 0.0000015     | 71                | 0.0040   | 0.0211          | -0.0000600 | 0.0000015     |
| 32                | 0.0040   | 0.0211          | -0.0004500 | 0.0000015     | 72                | 0.0040   | 0.0211          | -0.0000500 | 0.0000015     |
| 33                | 0.0040   | 0.0211          | -0.0004400 | 0.0000015     | 73                | 0.0040   | 0.0211          | -0.0000400 | 0.0000015     |
| 34                | 0.0000   | 0.0210          | -0.0004300 | 0.0000015     | 74                | 0.0000   | 0.0210          | -0.0000300 | 0.0000015     |
| 35                | 0.0000   | 0.0210          | -0.0004200 | 0.0000015     | 75                | 0.0040   | 0.0211          | -0.0000200 | 0.0000015     |
| 36                | 0.0040   | 0.0211          | -0.0004100 | 0.0000015     | 76                | 0.0000   | 0.0210          | -0.0000100 | 0.0000015     |
| 37                | 0.0040   | 0.0211          | -0.0004000 | 0.0000015     | 77                | 0.0040   | 0.0211          | 0.0000000  | 0.0000016     |
| 38                | 0.0000   | 0.0210          | -0.0003900 | 0.0000015     | 78                | 0.0520   | 0.0226          | 0.0000100  | 0.0000016     |
| 39                | 0.0040   | 0.0211          | -0.0003800 | 0.0000015     | 79                | 0.0560   | 0.0227          | 0.0000200  | 0.0000016     |
| 40                | 0.0000   | 0.0210          | -0.0003700 | 0.0000015     | 80                | 0.1040   | 0.0241          | 0.0000300  | 0.0000016     |

| Dati segnale 90Hz |          |                 |           |               | Dati segnale 90Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 81                | 0.1040   | 0.0241          | 0.0000400 | 0.0000016     | 121               | 0.3080   | 0.0302          | 0.0004400 | 0.0000016     |
| 82                | 0.1440   | 0.0253          | 0.0000500 | 0.0000016     | 122               | 0.3120   | 0.0304          | 0.0004500 | 0.0000016     |
| 83                | 0.1480   | 0.0254          | 0.0000600 | 0.0000016     | 123               | 0.3080   | 0.0302          | 0.0004600 | 0.0000016     |
| 84                | 0.1760   | 0.0263          | 0.0000700 | 0.0000016     | 124               | 0.3120   | 0.0304          | 0.0004700 | 0.0000016     |
| 85                | 0.1760   | 0.0263          | 0.0000800 | 0.0000016     | 125               | 0.3120   | 0.0304          | 0.0004800 | 0.0000016     |
| 86                | 0.2000   | 0.0270          | 0.0000900 | 0.0000016     | 126               | 0.3080   | 0.0302          | 0.0004900 | 0.0000016     |
| 87                | 0.2000   | 0.0270          | 0.0001000 | 0.0000016     | 127               | 0.3120   | 0.0304          | 0.0005000 | 0.0000016     |
| 88                | 0.2200   | 0.0276          | 0.0001100 | 0.0000016     | 128               | 0.3120   | 0.0304          | 0.0005100 | 0.0000016     |
| 89                | 0.2240   | 0.0277          | 0.0001200 | 0.0000016     | 129               | 0.3120   | 0.0304          | 0.0005200 | 0.0000016     |
| 90                | 0.2400   | 0.0282          | 0.0001300 | 0.0000016     | 130               | 0.3160   | 0.0305          | 0.0005300 | 0.0000016     |
| 91                | 0.2400   | 0.0282          | 0.0001400 | 0.0000016     | 131               | 0.3120   | 0.0304          | 0.0005400 | 0.0000016     |
| 92                | 0.2520   | 0.0286          | 0.0001500 | 0.0000016     | 132               | 0.3120   | 0.0304          | 0.0005500 | 0.0000016     |
| 93                | 0.2520   | 0.0286          | 0.0001600 | 0.0000016     | 133               | 0.3120   | 0.0304          | 0.0005600 | 0.0000016     |
| 94                | 0.2600   | 0.0288          | 0.0001700 | 0.0000016     | 134               | 0.3160   | 0.0305          | 0.0005700 | 0.0000016     |
| 95                | 0.2640   | 0.0289          | 0.0001800 | 0.0000016     | 135               | 0.3120   | 0.0304          | 0.0005800 | 0.0000016     |
| 96                | 0.2720   | 0.0292          | 0.0001900 | 0.0000016     | 136               | 0.3160   | 0.0305          | 0.0005900 | 0.0000016     |
| 97                | 0.2720   | 0.0292          | 0.0002000 | 0.0000016     | 137               | 0.3160   | 0.0305          | 0.0006000 | 0.0000016     |
| 98                | 0.2800   | 0.0294          | 0.0002100 | 0.0000016     | 138               | 0.3120   | 0.0304          | 0.0006100 | 0.0000016     |
| 99                | 0.2760   | 0.0293          | 0.0002200 | 0.0000016     | 139               | 0.3120   | 0.0304          | 0.0006200 | 0.0000016     |
| 100               | 0.2880   | 0.0296          | 0.0002300 | 0.0000016     | 140               | 0.3160   | 0.0305          | 0.0006300 | 0.0000016     |
| 101               | 0.2880   | 0.0296          | 0.0002400 | 0.0000016     | 141               | 0.3160   | 0.0305          | 0.0006400 | 0.0000016     |
| 102               | 0.2920   | 0.0298          | 0.0002500 | 0.0000016     | 142               | 0.3120   | 0.0304          | 0.0006500 | 0.0000016     |
| 103               | 0.2920   | 0.0298          | 0.0002600 | 0.0000016     | 143               | 0.3120   | 0.0304          | 0.0006600 | 0.0000016     |
| 104               | 0.2960   | 0.0299          | 0.0002700 | 0.0000016     | 144               | 0.3160   | 0.0305          | 0.0006700 | 0.0000016     |
| 105               | 0.2960   | 0.0299          | 0.0002800 | 0.0000016     | 145               | 0.3160   | 0.0305          | 0.0006800 | 0.0000016     |
| 106               | 0.3000   | 0.0300          | 0.0002900 | 0.0000016     | 146               | 0.3120   | 0.0304          | 0.0006900 | 0.0000016     |
| 107               | 0.3000   | 0.0300          | 0.0003000 | 0.0000016     | 147               | 0.3160   | 0.0305          | 0.0007000 | 0.0000016     |
| 108               | 0.3040   | 0.0301          | 0.0003100 | 0.0000016     | 148               | 0.3120   | 0.0304          | 0.0007100 | 0.0000016     |
| 109               | 0.3000   | 0.0300          | 0.0003200 | 0.0000016     | 149               | 0.3160   | 0.0305          | 0.0007200 | 0.0000016     |
| 110               | 0.3040   | 0.0301          | 0.0003300 | 0.0000016     | 150               | 0.3120   | 0.0304          | 0.0007300 | 0.0000016     |
| 111               | 0.3040   | 0.0301          | 0.0003400 | 0.0000016     | 151               | 0.3120   | 0.0304          | 0.0007400 | 0.0000016     |
| 112               | 0.3080   | 0.0302          | 0.0003500 | 0.0000016     | 152               | 0.3160   | 0.0305          | 0.0007500 | 0.0000016     |
| 113               | 0.3040   | 0.0301          | 0.0003600 | 0.0000016     | 153               | 0.3120   | 0.0304          | 0.0007600 | 0.0000016     |
| 114               | 0.3080   | 0.0302          | 0.0003700 | 0.0000016     | 154               | 0.3160   | 0.0305          | 0.0007700 | 0.0000016     |
| 115               | 0.3080   | 0.0302          | 0.0003800 | 0.0000016     | 155               | 0.3160   | 0.0305          | 0.0007800 | 0.0000016     |
| 116               | 0.3080   | 0.0302          | 0.0003900 | 0.0000016     | 156               | 0.3120   | 0.0304          | 0.0007900 | 0.0000016     |
| 117               | 0.3080   | 0.0302          | 0.0004000 | 0.0000016     | 157               | 0.3160   | 0.0305          | 0.0008000 | 0.0000016     |
| 118               | 0.3120   | 0.0304          | 0.0004100 | 0.0000016     | 158               | 0.3120   | 0.0304          | 0.0008100 | 0.0000016     |
| 119               | 0.3080   | 0.0302          | 0.0004200 | 0.0000016     | 159               | 0.3160   | 0.0305          | 0.0008200 | 0.0000016     |
| 120               | 0.3120   | 0.0304          | 0.0004300 | 0.0000016     | 160               | 0.3120   | 0.0304          | 0.0008300 | 0.0000016     |



| Dati segnale 90Hz |          |                 |           |               | Dati segnale 90Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 161               | 0.3120   | 0.0304          | 0.0008400 | 0.0000016     | 201               | 0.3120   | 0.0304          | 0.0012400 | 0.0000016     |
| 162               | 0.3160   | 0.0305          | 0.0008500 | 0.0000016     | 202               | 0.3160   | 0.0305          | 0.0012500 | 0.0000016     |
| 163               | 0.3160   | 0.0305          | 0.0008600 | 0.0000016     | 203               | 0.3160   | 0.0305          | 0.0012600 | 0.0000016     |
| 164               | 0.3120   | 0.0304          | 0.0008700 | 0.0000016     | 204               | 0.3160   | 0.0305          | 0.0012700 | 0.0000016     |
| 165               | 0.3160   | 0.0305          | 0.0008800 | 0.0000016     | 205               | 0.3160   | 0.0305          | 0.0012800 | 0.0000016     |
| 166               | 0.3120   | 0.0304          | 0.0008900 | 0.0000016     | 206               | 0.3120   | 0.0304          | 0.0012900 | 0.0000016     |
| 167               | 0.3120   | 0.0304          | 0.0009000 | 0.0000016     | 207               | 0.3120   | 0.0304          | 0.0013000 | 0.0000016     |
| 168               | 0.3160   | 0.0305          | 0.0009100 | 0.0000016     | 208               | 0.3160   | 0.0305          | 0.0013100 | 0.0000016     |
| 169               | 0.3200   | 0.0306          | 0.0009200 | 0.0000016     | 209               | 0.3160   | 0.0305          | 0.0013200 | 0.0000016     |
| 170               | 0.3120   | 0.0304          | 0.0009300 | 0.0000016     | 210               | 0.3120   | 0.0304          | 0.0013300 | 0.0000016     |
| 171               | 0.3120   | 0.0304          | 0.0009400 | 0.0000016     | 211               | 0.3160   | 0.0305          | 0.0013400 | 0.0000016     |
| 172               | 0.3160   | 0.0305          | 0.0009500 | 0.0000016     | 212               | 0.3160   | 0.0305          | 0.0013500 | 0.0000016     |
| 173               | 0.3120   | 0.0304          | 0.0009600 | 0.0000016     | 213               | 0.3160   | 0.0305          | 0.0013600 | 0.0000016     |
| 174               | 0.3160   | 0.0305          | 0.0009700 | 0.0000016     | 214               | 0.3120   | 0.0304          | 0.0013700 | 0.0000016     |
| 175               | 0.3160   | 0.0305          | 0.0009800 | 0.0000016     | 215               | 0.3160   | 0.0305          | 0.0013800 | 0.0000016     |
| 176               | 0.3120   | 0.0304          | 0.0009900 | 0.0000016     | 216               | 0.3120   | 0.0304          | 0.0013900 | 0.0000016     |
| 177               | 0.3120   | 0.0304          | 0.0010000 | 0.0000016     | 217               | 0.3160   | 0.0305          | 0.0014000 | 0.0000016     |
| 178               | 0.3160   | 0.0305          | 0.0010100 | 0.0000016     | 218               | 0.3120   | 0.0304          | 0.0014100 | 0.0000016     |
| 179               | 0.3160   | 0.0305          | 0.0010200 | 0.0000016     | 219               | 0.3160   | 0.0305          | 0.0014200 | 0.0000016     |
| 180               | 0.3120   | 0.0304          | 0.0010300 | 0.0000016     | 220               | 0.3120   | 0.0304          | 0.0014300 | 0.0000016     |
| 181               | 0.3160   | 0.0305          | 0.0010400 | 0.0000016     | 221               | 0.3120   | 0.0304          | 0.0014400 | 0.0000016     |
| 182               | 0.3120   | 0.0304          | 0.0010500 | 0.0000016     | 222               | 0.3160   | 0.0305          | 0.0014500 | 0.0000016     |
| 183               | 0.3120   | 0.0304          | 0.0010600 | 0.0000016     | 223               | 0.3160   | 0.0305          | 0.0014600 | 0.0000016     |
| 184               | 0.3160   | 0.0305          | 0.0010700 | 0.0000016     | 224               | 0.3120   | 0.0304          | 0.0014700 | 0.0000016     |
| 185               | 0.3120   | 0.0304          | 0.0010800 | 0.0000016     | 225               | 0.3160   | 0.0305          | 0.0014800 | 0.0000016     |
| 186               | 0.3160   | 0.0305          | 0.0010900 | 0.0000016     | 226               | 0.3120   | 0.0304          | 0.0014900 | 0.0000016     |
| 187               | 0.3160   | 0.0305          | 0.0011000 | 0.0000016     | 227               | 0.3120   | 0.0304          | 0.0015000 | 0.0000016     |
| 188               | 0.3120   | 0.0304          | 0.0011100 | 0.0000016     | 228               | 0.3200   | 0.0306          | 0.0015100 | 0.0000016     |
| 189               | 0.3160   | 0.0305          | 0.0011200 | 0.0000016     | 229               | 0.3160   | 0.0305          | 0.0015200 | 0.0000016     |
| 190               | 0.3120   | 0.0304          | 0.0011300 | 0.0000016     | 230               | 0.3120   | 0.0304          | 0.0015300 | 0.0000016     |
| 191               | 0.3120   | 0.0304          | 0.0011400 | 0.0000016     | 231               | 0.3160   | 0.0305          | 0.0015400 | 0.0000016     |
| 192               | 0.3160   | 0.0305          | 0.0011500 | 0.0000016     | 232               | 0.3160   | 0.0305          | 0.0015500 | 0.0000016     |
| 193               | 0.3160   | 0.0305          | 0.0011600 | 0.0000016     | 233               | 0.3160   | 0.0305          | 0.0015600 | 0.0000016     |
| 194               | 0.3120   | 0.0304          | 0.0011700 | 0.0000016     | 234               | 0.3120   | 0.0304          | 0.0015700 | 0.0000016     |
| 195               | 0.3160   | 0.0305          | 0.0011800 | 0.0000016     | 235               | 0.3160   | 0.0305          | 0.0015800 | 0.0000016     |
| 196               | 0.3160   | 0.0305          | 0.0011900 | 0.0000016     | 236               | 0.3160   | 0.0305          | 0.0015900 | 0.0000016     |
| 197               | 0.3160   | 0.0305          | 0.0012000 | 0.0000016     | 237               | 0.3160   | 0.0305          | 0.0016000 | 0.0000016     |
| 198               | 0.3120   | 0.0304          | 0.0012100 | 0.0000016     | 238               | 0.3120   | 0.0304          | 0.0016100 | 0.0000016     |
| 199               | 0.3160   | 0.0305          | 0.0012200 | 0.0000016     | 239               | 0.3160   | 0.0305          | 0.0016200 | 0.0000016     |
| 200               | 0.3120   | 0.0304          | 0.0012300 | 0.0000016     | 240               | 0.3160   | 0.0305          | 0.0016300 | 0.0000016     |

| Dati segnale 90Hz |          |                 |           |               | Dati segnale 90Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 241               | 0.3160   | 0.0305          | 0.0016400 | 0.0000016     | 281               | 0.3120   | 0.0304          | 0.0020400 | 0.0000017     |
| 242               | 0.3120   | 0.0304          | 0.0016500 | 0.0000016     | 282               | 0.3160   | 0.0305          | 0.0020500 | 0.0000017     |
| 243               | 0.3160   | 0.0305          | 0.0016600 | 0.0000016     | 283               | 0.3160   | 0.0305          | 0.0020600 | 0.0000017     |
| 244               | 0.3120   | 0.0304          | 0.0016700 | 0.0000016     | 284               | 0.3160   | 0.0305          | 0.0020700 | 0.0000017     |
| 245               | 0.3160   | 0.0305          | 0.0016800 | 0.0000016     | 285               | 0.3160   | 0.0305          | 0.0020800 | 0.0000017     |
| 246               | 0.3120   | 0.0304          | 0.0016900 | 0.0000016     | 286               | 0.3120   | 0.0304          | 0.0020900 | 0.0000017     |
| 247               | 0.3160   | 0.0305          | 0.0017000 | 0.0000016     | 287               | 0.3160   | 0.0305          | 0.0021000 | 0.0000017     |
| 248               | 0.3120   | 0.0304          | 0.0017100 | 0.0000016     | 288               | 0.3160   | 0.0305          | 0.0021100 | 0.0000017     |
| 249               | 0.3160   | 0.0305          | 0.0017200 | 0.0000016     | 289               | 0.3120   | 0.0304          | 0.0021200 | 0.0000017     |
| 250               | 0.3120   | 0.0304          | 0.0017300 | 0.0000016     | 290               | 0.3200   | 0.0306          | 0.0021300 | 0.0000017     |
| 251               | 0.3120   | 0.0304          | 0.0017400 | 0.0000016     | 291               | 0.3120   | 0.0304          | 0.0021400 | 0.0000017     |
| 252               | 0.3160   | 0.0305          | 0.0017500 | 0.0000016     | 292               | 0.3200   | 0.0306          | 0.0021500 | 0.0000017     |
| 253               | 0.3160   | 0.0305          | 0.0017600 | 0.0000016     | 293               | 0.3160   | 0.0305          | 0.0021600 | 0.0000017     |
| 254               | 0.3120   | 0.0304          | 0.0017700 | 0.0000016     | 294               | 0.3120   | 0.0304          | 0.0021700 | 0.0000017     |
| 255               | 0.3160   | 0.0305          | 0.0017800 | 0.0000016     | 295               | 0.3160   | 0.0305          | 0.0021800 | 0.0000017     |
| 256               | 0.3120   | 0.0304          | 0.0017900 | 0.0000016     | 296               | 0.3160   | 0.0305          | 0.0021900 | 0.0000017     |
| 257               | 0.3160   | 0.0305          | 0.0018000 | 0.0000016     | 297               | 0.3160   | 0.0305          | 0.0022000 | 0.0000017     |
| 258               | 0.3160   | 0.0305          | 0.0018100 | 0.0000016     | 298               | 0.3160   | 0.0305          | 0.0022100 | 0.0000017     |
| 259               | 0.3160   | 0.0305          | 0.0018200 | 0.0000016     | 299               | 0.3160   | 0.0305          | 0.0022200 | 0.0000017     |
| 260               | 0.3120   | 0.0304          | 0.0018300 | 0.0000016     | 300               | 0.2800   | 0.0294          | 0.0022300 | 0.0000017     |
| 261               | 0.3160   | 0.0305          | 0.0018400 | 0.0000016     | 301               | 0.2760   | 0.0293          | 0.0022400 | 0.0000017     |
| 262               | 0.3160   | 0.0305          | 0.0018500 | 0.0000016     | 302               | 0.2560   | 0.0287          | 0.0022500 | 0.0000017     |
| 263               | 0.3160   | 0.0305          | 0.0018600 | 0.0000016     | 303               | 0.2560   | 0.0287          | 0.0022600 | 0.0000017     |
| 264               | 0.3120   | 0.0304          | 0.0018700 | 0.0000016     | 304               | 0.2360   | 0.0281          | 0.0022700 | 0.0000017     |
| 265               | 0.3160   | 0.0305          | 0.0018800 | 0.0000016     | 305               | 0.2360   | 0.0281          | 0.0022800 | 0.0000017     |
| 266               | 0.3120   | 0.0304          | 0.0018900 | 0.0000016     | 306               | 0.2200   | 0.0276          | 0.0022900 | 0.0000017     |
| 267               | 0.3160   | 0.0305          | 0.0019000 | 0.0000016     | 307               | 0.2200   | 0.0276          | 0.0023000 | 0.0000017     |
| 268               | 0.3160   | 0.0305          | 0.0019100 | 0.0000016     | 308               | 0.2040   | 0.0271          | 0.0023100 | 0.0000017     |
| 269               | 0.3160   | 0.0305          | 0.0019200 | 0.0000016     | 309               | 0.2000   | 0.0270          | 0.0023200 | 0.0000017     |
| 270               | 0.3160   | 0.0305          | 0.0019300 | 0.0000016     | 310               | 0.1840   | 0.0265          | 0.0023300 | 0.0000017     |
| 271               | 0.3120   | 0.0304          | 0.0019400 | 0.0000016     | 311               | 0.1840   | 0.0265          | 0.0023400 | 0.0000017     |
| 272               | 0.3160   | 0.0305          | 0.0019500 | 0.0000016     | 312               | 0.1760   | 0.0263          | 0.0023500 | 0.0000017     |
| 273               | 0.3160   | 0.0305          | 0.0019600 | 0.0000016     | 313               | 0.1760   | 0.0263          | 0.0023600 | 0.0000017     |
| 274               | 0.3120   | 0.0304          | 0.0019700 | 0.0000016     | 314               | 0.1640   | 0.0259          | 0.0023700 | 0.0000017     |
| 275               | 0.3160   | 0.0305          | 0.0019800 | 0.0000016     | 315               | 0.1640   | 0.0259          | 0.0023800 | 0.0000017     |
| 276               | 0.3160   | 0.0305          | 0.0019900 | 0.0000016     | 316               | 0.1520   | 0.0256          | 0.0023900 | 0.0000017     |
| 277               | 0.3160   | 0.0305          | 0.0020000 | 0.0000017     | 317               | 0.1520   | 0.0256          | 0.0024000 | 0.0000017     |
| 278               | 0.3120   | 0.0304          | 0.0020100 | 0.0000017     | 318               | 0.1400   | 0.0252          | 0.0024100 | 0.0000017     |
| 279               | 0.3160   | 0.0305          | 0.0020200 | 0.0000017     | 319               | 0.1360   | 0.0251          | 0.0024200 | 0.0000017     |
| 280               | 0.3120   | 0.0304          | 0.0020300 | 0.0000017     | 320               | 0.1280   | 0.0248          | 0.0024300 | 0.0000017     |

| Dati segnale 90Hz |          |                 |           |               | Dati segnale 90Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 321               | 0.1280   | 0.0248          | 0.0024400 | 0.0000017     | 361               | 0.0280   | 0.0218          | 0.0028400 | 0.0000017     |
| 322               | 0.1160   | 0.0245          | 0.0024500 | 0.0000017     | 362               | 0.0240   | 0.0217          | 0.0028500 | 0.0000017     |
| 323               | 0.1160   | 0.0245          | 0.0024600 | 0.0000017     | 363               | 0.0280   | 0.0218          | 0.0028600 | 0.0000017     |
| 324               | 0.1120   | 0.0244          | 0.0024700 | 0.0000017     | 364               | 0.0240   | 0.0217          | 0.0028700 | 0.0000017     |
| 325               | 0.1120   | 0.0244          | 0.0024800 | 0.0000017     | 365               | 0.0240   | 0.0217          | 0.0028800 | 0.0000017     |
| 326               | 0.1000   | 0.0240          | 0.0024900 | 0.0000017     | 366               | 0.0200   | 0.0216          | 0.0028900 | 0.0000017     |
| 327               | 0.1000   | 0.0240          | 0.0025000 | 0.0000017     | 367               | 0.0240   | 0.0217          | 0.0029000 | 0.0000017     |
| 328               | 0.0960   | 0.0239          | 0.0025100 | 0.0000017     | 368               | 0.0200   | 0.0216          | 0.0029100 | 0.0000017     |
| 329               | 0.0920   | 0.0238          | 0.0025200 | 0.0000017     | 369               | 0.0200   | 0.0216          | 0.0029200 | 0.0000017     |
| 330               | 0.0880   | 0.0236          | 0.0025300 | 0.0000017     | 370               | 0.0200   | 0.0216          | 0.0029300 | 0.0000017     |
| 331               | 0.0880   | 0.0236          | 0.0025400 | 0.0000017     | 371               | 0.0200   | 0.0216          | 0.0029400 | 0.0000017     |
| 332               | 0.0800   | 0.0234          | 0.0025500 | 0.0000017     | 372               | 0.0160   | 0.0215          | 0.0029500 | 0.0000017     |
| 333               | 0.0800   | 0.0234          | 0.0025600 | 0.0000017     | 373               | 0.0200   | 0.0216          | 0.0029600 | 0.0000017     |
| 334               | 0.0760   | 0.0233          | 0.0025700 | 0.0000017     | 374               | 0.0160   | 0.0215          | 0.0029700 | 0.0000017     |
| 335               | 0.0760   | 0.0233          | 0.0025800 | 0.0000017     | 375               | 0.0200   | 0.0216          | 0.0029800 | 0.0000017     |
| 336               | 0.0680   | 0.0230          | 0.0025900 | 0.0000017     | 376               | 0.0160   | 0.0215          | 0.0029900 | 0.0000017     |
| 337               | 0.0720   | 0.0232          | 0.0026000 | 0.0000017     | 377               | 0.0160   | 0.0215          | 0.0030000 | 0.0000017     |
| 338               | 0.0600   | 0.0228          | 0.0026100 | 0.0000017     | 378               | 0.0120   | 0.0214          | 0.0030100 | 0.0000017     |
| 339               | 0.0640   | 0.0229          | 0.0026200 | 0.0000017     | 379               | 0.0160   | 0.0215          | 0.0030200 | 0.0000017     |
| 340               | 0.0560   | 0.0227          | 0.0026300 | 0.0000017     | 380               | 0.0120   | 0.0214          | 0.0030300 | 0.0000017     |
| 341               | 0.0520   | 0.0226          | 0.0026400 | 0.0000017     | 381               | 0.0120   | 0.0214          | 0.0030400 | 0.0000017     |
| 342               | 0.0560   | 0.0227          | 0.0026500 | 0.0000017     | 382               | 0.0160   | 0.0215          | 0.0030500 | 0.0000017     |
| 343               | 0.0520   | 0.0226          | 0.0026600 | 0.0000017     | 383               | 0.0120   | 0.0214          | 0.0030600 | 0.0000017     |
| 344               | 0.0520   | 0.0226          | 0.0026700 | 0.0000017     | 384               | 0.0120   | 0.0214          | 0.0030700 | 0.0000017     |
| 345               | 0.0520   | 0.0226          | 0.0026800 | 0.0000017     | 385               | 0.0120   | 0.0214          | 0.0030800 | 0.0000017     |
| 346               | 0.0440   | 0.0223          | 0.0026900 | 0.0000017     | 386               | 0.0080   | 0.0212          | 0.0030900 | 0.0000017     |
| 347               | 0.0480   | 0.0224          | 0.0027000 | 0.0000017     | 387               | 0.0120   | 0.0214          | 0.0031000 | 0.0000017     |
| 348               | 0.0400   | 0.0222          | 0.0027100 | 0.0000017     | 388               | 0.0080   | 0.0212          | 0.0031100 | 0.0000017     |
| 349               | 0.0440   | 0.0223          | 0.0027200 | 0.0000017     | 389               | 0.0120   | 0.0214          | 0.0031200 | 0.0000017     |
| 350               | 0.0400   | 0.0222          | 0.0027300 | 0.0000017     | 390               | 0.0080   | 0.0212          | 0.0031300 | 0.0000017     |
| 351               | 0.0400   | 0.0222          | 0.0027400 | 0.0000017     | 391               | 0.0080   | 0.0212          | 0.0031400 | 0.0000017     |
| 352               | 0.0360   | 0.0221          | 0.0027500 | 0.0000017     | 392               | 0.0080   | 0.0212          | 0.0031500 | 0.0000017     |
| 353               | 0.0400   | 0.0222          | 0.0027600 | 0.0000017     | 393               | 0.0080   | 0.0212          | 0.0031600 | 0.0000017     |
| 354               | 0.0360   | 0.0221          | 0.0027700 | 0.0000017     | 394               | 0.0080   | 0.0212          | 0.0031700 | 0.0000017     |
| 355               | 0.0360   | 0.0221          | 0.0027800 | 0.0000017     | 395               | 0.0080   | 0.0212          | 0.0031800 | 0.0000017     |
| 356               | 0.0360   | 0.0221          | 0.0027900 | 0.0000017     | 396               | 0.0080   | 0.0212          | 0.0031900 | 0.0000017     |
| 357               | 0.0320   | 0.0220          | 0.0028000 | 0.0000017     | 397               | 0.0080   | 0.0212          | 0.0032000 | 0.0000017     |
| 358               | 0.0280   | 0.0218          | 0.0028100 | 0.0000017     | 398               | 0.0040   | 0.0211          | 0.0032100 | 0.0000017     |
| 359               | 0.0280   | 0.0218          | 0.0028200 | 0.0000017     | 399               | 0.0080   | 0.0212          | 0.0032200 | 0.0000017     |
| 360               | 0.0320   | 0.0220          | 0.0028300 | 0.0000017     | 400               | 0.0040   | 0.0211          | 0.0032300 | 0.0000017     |

| Dati segnale 90Hz |          |                 |           |               | Dati segnale 90Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 401               | 0.0040   | 0.0211          | 0.0032400 | 0.0000017     | 441               | 0.0040   | 0.0211          | 0.0036400 | 0.0000017     |
| 402               | 0.0080   | 0.0212          | 0.0032500 | 0.0000017     | 442               | 0.0040   | 0.0211          | 0.0036500 | 0.0000017     |
| 403               | 0.0080   | 0.0212          | 0.0032600 | 0.0000017     | 443               | 0.0040   | 0.0211          | 0.0036600 | 0.0000017     |
| 404               | 0.0040   | 0.0211          | 0.0032700 | 0.0000017     | 444               | 0.0040   | 0.0211          | 0.0036700 | 0.0000017     |
| 405               | 0.0080   | 0.0212          | 0.0032800 | 0.0000017     | 445               | 0.0040   | 0.0211          | 0.0036800 | 0.0000017     |
| 406               | 0.0040   | 0.0211          | 0.0032900 | 0.0000017     | 446               | 0.0040   | 0.0211          | 0.0036900 | 0.0000017     |
| 407               | 0.0080   | 0.0212          | 0.0033000 | 0.0000017     | 447               | 0.0040   | 0.0211          | 0.0037000 | 0.0000017     |
| 408               | 0.0040   | 0.0211          | 0.0033100 | 0.0000017     | 448               | 0.0040   | 0.0211          | 0.0037100 | 0.0000017     |
| 409               | 0.0080   | 0.0212          | 0.0033200 | 0.0000017     | 449               | 0.0040   | 0.0211          | 0.0037200 | 0.0000017     |
| 410               | 0.0040   | 0.0211          | 0.0033300 | 0.0000017     | 450               | 0.0040   | 0.0211          | 0.0037300 | 0.0000017     |
| 411               | 0.0040   | 0.0211          | 0.0033400 | 0.0000017     | 451               | 0.0040   | 0.0211          | 0.0037400 | 0.0000017     |
| 412               | 0.0080   | 0.0212          | 0.0033500 | 0.0000017     | 452               | 0.0040   | 0.0211          | 0.0037500 | 0.0000017     |
| 413               | 0.0080   | 0.0212          | 0.0033600 | 0.0000017     | 453               | 0.0040   | 0.0211          | 0.0037600 | 0.0000017     |
| 414               | 0.0040   | 0.0211          | 0.0033700 | 0.0000017     | 454               | 0.0000   | 0.0210          | 0.0037700 | 0.0000017     |
| 415               | 0.0040   | 0.0211          | 0.0033800 | 0.0000017     | 455               | 0.0040   | 0.0211          | 0.0037800 | 0.0000017     |
| 416               | 0.0080   | 0.0212          | 0.0033900 | 0.0000017     | 456               | 0.0000   | 0.0210          | 0.0037900 | 0.0000017     |
| 417               | 0.0040   | 0.0211          | 0.0034000 | 0.0000017     | 457               | 0.0040   | 0.0211          | 0.0038000 | 0.0000017     |
| 418               | 0.0080   | 0.0212          | 0.0034100 | 0.0000017     | 458               | 0.0040   | 0.0211          | 0.0038100 | 0.0000017     |
| 419               | 0.0040   | 0.0211          | 0.0034200 | 0.0000017     | 459               | 0.0040   | 0.0211          | 0.0038200 | 0.0000017     |
| 420               | 0.0080   | 0.0212          | 0.0034300 | 0.0000017     | 460               | 0.0040   | 0.0211          | 0.0038300 | 0.0000017     |
| 421               | 0.0040   | 0.0211          | 0.0034400 | 0.0000017     | 461               | 0.0040   | 0.0211          | 0.0038400 | 0.0000017     |
| 422               | 0.0040   | 0.0211          | 0.0034500 | 0.0000017     | 462               | 0.0000   | 0.0210          | 0.0038500 | 0.0000017     |
| 423               | 0.0040   | 0.0211          | 0.0034600 | 0.0000017     | 463               | 0.0040   | 0.0211          | 0.0038600 | 0.0000017     |
| 424               | 0.0040   | 0.0211          | 0.0034700 | 0.0000017     | 464               | 0.0000   | 0.0210          | 0.0038700 | 0.0000017     |
| 425               | 0.0040   | 0.0211          | 0.0034800 | 0.0000017     | 465               | 0.0040   | 0.0211          | 0.0038800 | 0.0000017     |
| 426               | 0.0040   | 0.0211          | 0.0034900 | 0.0000017     | 466               | 0.0040   | 0.0211          | 0.0038900 | 0.0000017     |
| 427               | 0.0040   | 0.0211          | 0.0035000 | 0.0000017     | 467               | 0.0040   | 0.0211          | 0.0039000 | 0.0000017     |
| 428               | 0.0040   | 0.0211          | 0.0035100 | 0.0000017     | 468               | 0.0000   | 0.0210          | 0.0039100 | 0.0000017     |
| 429               | 0.0040   | 0.0211          | 0.0035200 | 0.0000017     | 469               | 0.0040   | 0.0211          | 0.0039200 | 0.0000017     |
| 430               | 0.0040   | 0.0211          | 0.0035300 | 0.0000017     | 470               | 0.0000   | 0.0210          | 0.0039300 | 0.0000017     |
| 431               | 0.0040   | 0.0211          | 0.0035400 | 0.0000017     | 471               | 0.0000   | 0.0210          | 0.0039400 | 0.0000017     |
| 432               | 0.0040   | 0.0211          | 0.0035500 | 0.0000017     | 472               | 0.0040   | 0.0211          | 0.0039500 | 0.0000017     |
| 433               | 0.0040   | 0.0211          | 0.0035600 | 0.0000017     | 473               | 0.0040   | 0.0211          | 0.0039600 | 0.0000017     |
| 434               | 0.0040   | 0.0211          | 0.0035700 | 0.0000017     | 474               | 0.0000   | 0.0210          | 0.0039700 | 0.0000017     |
| 435               | 0.0040   | 0.0211          | 0.0035800 | 0.0000017     | 475               | 0.0040   | 0.0211          | 0.0039800 | 0.0000017     |
| 436               | 0.0040   | 0.0211          | 0.0035900 | 0.0000017     | 476               | 0.0040   | 0.0211          | 0.0039900 | 0.0000017     |
| 437               | 0.0040   | 0.0211          | 0.0036000 | 0.0000017     | 477               | 0.0040   | 0.0211          | 0.0040000 | 0.0000018     |
| 438               | 0.0000   | 0.0210          | 0.0036100 | 0.0000017     | 478               | 0.0040   | 0.0211          | 0.0040100 | 0.0000018     |
| 439               | 0.0040   | 0.0211          | 0.0036200 | 0.0000017     | 479               | 0.0000   | 0.0210          | 0.0040200 | 0.0000018     |
| 440               | 0.0040   | 0.0211          | 0.0036300 | 0.0000017     | 480               | 0.0040   | 0.0211          | 0.0040300 | 0.0000018     |

| Dati segnale 90Hz |          |                 |           |               | Dati segnale 90Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ | N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 481               | 0.0040   | 0.0211          | 0.0040400 | 0.0000018     | 521               | 0.0040   | 0.0211          | 0.0044400 | 0.0000018     |
| 482               | 0.0000   | 0.0210          | 0.0040500 | 0.0000018     | 522               | 0.0000   | 0.0210          | 0.0044500 | 0.0000018     |
| 483               | 0.0000   | 0.0210          | 0.0040600 | 0.0000018     | 523               | 0.0040   | 0.0211          | 0.0044600 | 0.0000018     |
| 484               | 0.0040   | 0.0211          | 0.0040700 | 0.0000018     | 524               | 0.0000   | 0.0210          | 0.0044700 | 0.0000018     |
| 485               | 0.0040   | 0.0211          | 0.0040800 | 0.0000018     | 525               | 0.0000   | 0.0210          | 0.0044800 | 0.0000018     |
| 486               | 0.0000   | 0.0210          | 0.0040900 | 0.0000018     | 526               | 0.0040   | 0.0211          | 0.0044900 | 0.0000018     |
| 487               | 0.0000   | 0.0210          | 0.0041000 | 0.0000018     | 527               | 0.0040   | 0.0211          | 0.0045000 | 0.0000018     |
| 488               | 0.0040   | 0.0211          | 0.0041100 | 0.0000018     | 528               | 0.0000   | 0.0210          | 0.0045100 | 0.0000018     |
| 489               | 0.0040   | 0.0211          | 0.0041200 | 0.0000018     | 529               | 0.0040   | 0.0211          | 0.0045200 | 0.0000018     |
| 490               | 0.0000   | 0.0210          | 0.0041300 | 0.0000018     | 530               | 0.0000   | 0.0210          | 0.0045300 | 0.0000018     |
| 491               | 0.0040   | 0.0211          | 0.0041400 | 0.0000018     | 531               | 0.0000   | 0.0210          | 0.0045400 | 0.0000018     |
| 492               | 0.0000   | 0.0210          | 0.0041500 | 0.0000018     | 532               | 0.0040   | 0.0211          | 0.0045500 | 0.0000018     |
| 493               | 0.0000   | 0.0210          | 0.0041600 | 0.0000018     | 533               | 0.0040   | 0.0211          | 0.0045600 | 0.0000018     |
| 494               | 0.0040   | 0.0211          | 0.0041700 | 0.0000018     | 534               | 0.0000   | 0.0210          | 0.0045700 | 0.0000018     |
| 495               | 0.0040   | 0.0211          | 0.0041800 | 0.0000018     | 535               | 0.0040   | 0.0211          | 0.0045800 | 0.0000018     |
| 496               | 0.0040   | 0.0211          | 0.0041900 | 0.0000018     | 536               | 0.0000   | 0.0210          | 0.0045900 | 0.0000018     |
| 497               | 0.0000   | 0.0210          | 0.0042000 | 0.0000018     | 537               | 0.0040   | 0.0211          | 0.0046000 | 0.0000018     |
| 498               | 0.0040   | 0.0211          | 0.0042100 | 0.0000018     | 538               | 0.0000   | 0.0210          | 0.0046100 | 0.0000018     |
| 499               | 0.0040   | 0.0211          | 0.0042200 | 0.0000018     | 539               | 0.0040   | 0.0211          | 0.0046200 | 0.0000018     |
| 500               | 0.0000   | 0.0210          | 0.0042300 | 0.0000018     | 540               | 0.0000   | 0.0210          | 0.0046300 | 0.0000018     |
| 501               | 0.0040   | 0.0211          | 0.0042400 | 0.0000018     | 541               | 0.0040   | 0.0211          | 0.0046400 | 0.0000018     |
| 502               | 0.0000   | 0.0210          | 0.0042500 | 0.0000018     | 542               | 0.0040   | 0.0211          | 0.0046500 | 0.0000018     |
| 503               | 0.0040   | 0.0211          | 0.0042600 | 0.0000018     | 543               | 0.0000   | 0.0210          | 0.0046600 | 0.0000018     |
| 504               | 0.0000   | 0.0210          | 0.0042700 | 0.0000018     | 544               | 0.0040   | 0.0211          | 0.0046700 | 0.0000018     |
| 505               | 0.0040   | 0.0211          | 0.0042800 | 0.0000018     | 545               | 0.0040   | 0.0211          | 0.0046800 | 0.0000018     |
| 506               | 0.0000   | 0.0210          | 0.0042900 | 0.0000018     | 546               | 0.0000   | 0.0210          | 0.0046900 | 0.0000018     |
| 507               | 0.0040   | 0.0211          | 0.0043000 | 0.0000018     | 547               | 0.0000   | 0.0210          | 0.0047000 | 0.0000018     |
| 508               | 0.0040   | 0.0211          | 0.0043100 | 0.0000018     | 548               | 0.0040   | 0.0211          | 0.0047100 | 0.0000018     |
| 509               | 0.0040   | 0.0211          | 0.0043200 | 0.0000018     | 549               | 0.0040   | 0.0211          | 0.0047200 | 0.0000018     |
| 510               | 0.0000   | 0.0210          | 0.0043300 | 0.0000018     | 550               | 0.0000   | 0.0210          | 0.0047300 | 0.0000018     |
| 511               | 0.0040   | 0.0211          | 0.0043400 | 0.0000018     | 551               | 0.0040   | 0.0211          | 0.0047400 | 0.0000018     |
| 512               | 0.0000   | 0.0210          | 0.0043500 | 0.0000018     | 552               | 0.0000   | 0.0210          | 0.0047500 | 0.0000018     |
| 513               | 0.0040   | 0.0211          | 0.0043600 | 0.0000018     | 553               | 0.0040   | 0.0211          | 0.0047600 | 0.0000018     |
| 514               | 0.0000   | 0.0210          | 0.0043700 | 0.0000018     | 554               | 0.0000   | 0.0210          | 0.0047700 | 0.0000018     |
| 515               | 0.0040   | 0.0211          | 0.0043800 | 0.0000018     | 555               | 0.0000   | 0.0210          | 0.0047800 | 0.0000018     |
| 516               | 0.0040   | 0.0211          | 0.0043900 | 0.0000018     | 556               | 0.0040   | 0.0211          | 0.0047900 | 0.0000018     |
| 517               | 0.0040   | 0.0211          | 0.0044000 | 0.0000018     | 557               | 0.0040   | 0.0211          | 0.0048000 | 0.0000018     |
| 518               | 0.0000   | 0.0210          | 0.0044100 | 0.0000018     | 558               | 0.0000   | 0.0210          | 0.0048100 | 0.0000018     |
| 519               | 0.0040   | 0.0211          | 0.0044200 | 0.0000018     | 559               | 0.0040   | 0.0211          | 0.0048200 | 0.0000018     |
| 520               | 0.0000   | 0.0210          | 0.0044300 | 0.0000018     | 560               | 0.0000   | 0.0210          | 0.0048300 | 0.0000018     |

| Dati segnale 90Hz |          |                 |           |               |
|-------------------|----------|-----------------|-----------|---------------|
| N.                | $V_c(V)$ | $\Delta V_c(v)$ | $t(s)$    | $\Delta t(s)$ |
| 561               | 0.0040   | 0.0211          | 0.0048400 | 0.0000018     |
| 562               | 0.0000   | 0.0210          | 0.0048500 | 0.0000018     |
| 563               | 0.0040   | 0.0211          | 0.0048600 | 0.0000018     |
| 564               | 0.0000   | 0.0210          | 0.0048700 | 0.0000018     |
| 565               | 0.0040   | 0.0211          | 0.0048800 | 0.0000018     |
| 566               | 0.0000   | 0.0210          | 0.0048900 | 0.0000018     |
| 567               | 0.0000   | 0.0210          | 0.0049000 | 0.0000018     |
| 568               | 0.0040   | 0.0211          | 0.0049100 | 0.0000018     |
| 569               | 0.0040   | 0.0211          | 0.0049200 | 0.0000018     |
| 570               | 0.0000   | 0.0210          | 0.0049300 | 0.0000018     |
| 571               | 0.0040   | 0.0211          | 0.0049400 | 0.0000018     |
| 572               | 0.0000   | 0.0210          | 0.0049500 | 0.0000018     |
| 573               | 0.0000   | 0.0210          | 0.0049600 | 0.0000018     |
| 574               | 0.0040   | 0.0211          | 0.0049700 | 0.0000018     |
| 575               | 0.0000   | 0.0210          | 0.0049800 | 0.0000018     |
| 576               | 0.0040   | 0.0211          | 0.0049900 | 0.0000018     |
| 577               | 0.0040   | 0.0211          | 0.0050000 | 0.0000018     |
| 578               | 0.0000   | 0.0210          | 0.0050100 | 0.0000018     |
| 579               | 0.0040   | 0.0211          | 0.0050200 | 0.0000018     |
| 580               | 0.0000   | 0.0210          | 0.0050300 | 0.0000018     |
| 581               | 0.0000   | 0.0210          | 0.0050400 | 0.0000018     |
| 582               | 0.0040   | 0.0211          | 0.0050500 | 0.0000018     |
| 583               | 0.0000   | 0.0210          | 0.0050600 | 0.0000018     |
| 584               | 0.0040   | 0.0211          | 0.0050700 | 0.0000018     |
| 585               | 0.0040   | 0.0211          | 0.0050800 | 0.0000018     |
| 586               | 0.0000   | 0.0210          | 0.0050900 | 0.0000018     |
| 587               | 0.0040   | 0.0211          | 0.0051000 | 0.0000018     |
| 588               | 0.0000   | 0.0210          | 0.0051100 | 0.0000018     |
| 589               | 0.0000   | 0.0210          | 0.0051200 | 0.0000018     |
| 590               | 0.0040   | 0.0211          | 0.0051300 | 0.0000018     |
| 591               | 0.0040   | 0.0211          | 0.0051400 | 0.0000018     |
| 592               | 0.0000   | 0.0210          | 0.0051500 | 0.0000018     |
| 593               | 0.0000   | 0.0210          | 0.0051600 | 0.0000018     |
| 594               | 0.0040   | 0.0211          | 0.0051700 | 0.0000018     |
| 595               | 0.0000   | 0.0210          | 0.0051800 | 0.0000018     |
| 596               | 0.0040   | 0.0211          | 0.0051900 | 0.0000018     |
| 597               | 0.0000   | 0.0210          | 0.0052000 | 0.0000018     |
| 598               | 0.0040   | 0.0211          | 0.0052100 | 0.0000018     |
| 599               | 0.0000   | 0.0210          | 0.0052200 | 0.0000018     |
| 600               | 0.0040   | 0.0211          | 0.0052300 | 0.0000018     |

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