



**Promega**

## Technical Manual

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# ChipShot™ Direct Labeling and Clean-Up System

INSTRUCTIONS FOR USE OF PRODUCT Z4100.



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# ChipShot™ Direct Labeling and Clean-Up System

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## 1. Description

The ChipShot™ Direct Labeling<sup>(a)</sup> and Clean-Up System generates fluorescent cDNAs by direct labeling using Cy<sup>®</sup>3 and Cy<sup>®</sup>5 dCTP. Either total RNA or poly(A)+ mRNA can be used with these systems. Resulting cDNAs are labeled to provide efficient microarray hybridization results. The ChipShot™ Direct Labeling System includes a human Total RNA Positive Control to evaluate the performance of the labeling and labeling clean-up procedures. The ChipShot™ Membrane Clean-Up System produces highly purified, labeled cDNAs that are essentially free of unincorporated nucleotides. Amplification of RNA is not required. All reagents are specifically optimized for microarray applications.

## 2. Product Components and Storage Conditions

Product	Size	Cat.#
ChipShot™ Direct Labeling and Clean-Up System	25 reactions	Z4100

This system contains sufficient reagents to label and purify 25 cDNAs (24 experimental and 1 control). Includes:

- 1 ChipShot™ Direct Labeling System (25 reactions; Z3602)
- 1 ChipShot™ Membrane Clean-Up System (25 columns; Z3612)

**Storage Conditions:** Store the ChipShot™ Direct Labeling System (Z3602) at  $-20^{\circ}\text{C}$ , except for the RNase A, which should be stored at room temperature, and the Total RNA Positive Control, which should be stored at  $-70^{\circ}\text{C}$ . Store the ChipShot™ Membrane Clean-Up System (Z3612) at room temperature.

## 3. ChipShot™ Direct Labeling and Clean-Up Protocols

The quality and cleanliness of the starting RNA and the resulting cDNA are critical factors for successful use of arrays. We recommend that RNA quality be thoroughly checked before attempting to synthesize cDNA and that the labeled cDNA be purified and quantified using a spectrophotometer. Minimize the exposure of solutions containing fluorescent nucleotides to light to prevent photobleaching. CyDye™-labeled cDNA is stable at  $4^{\circ}\text{C}$  for several weeks.

We recommend that you wear gloves throughout the cDNA synthesis procedure.

For information on total RNA isolation, please see the *SV Total RNA Isolation System* (Cat.# Z3100) *Technical Manual #TM048* or the *PureYield™ RNA Midiprep System* (Cat.# Z3470 and 3741) *Technical Manual #TM279*.

For information on mRNA isolation, please see the *PolyATract® mRNA Isolation System* (Cat.#Z5200, Z5420) *Technical Manual #TM021*.

**Note:** RNA prepared using these systems has been used with microarrays; see references 1–6.

### Materials to Be Supplied by the User

- water bath or heating block, preheated to  $70^{\circ}\text{C}$
- water bath or heating block, preheated to  $42^{\circ}\text{C}$
- water bath or heating block, preheated to  $37^{\circ}\text{C}$
- 80% ethanol, molecular biology grade
- microcentrifuge

**Materials to Be Supplied by the User (continued)**

- spectrophotometer
- microcuvette
- Cy<sup>®</sup>3 dCTP (GE Healthcare Bio-sciences #PA53021)
- Cy<sup>®</sup>5 dCTP (GE Healthcare Bio-sciences #PA55021)

**Materials Supplied in the Systems****ChipShot™ Direct Labeling System  
(Z3602)**

- |  |                              |
|--|------------------------------|
| • MgCl <sub>2</sub> (25mM)                           | • Total RNA Positive Control |
| • Oligo(dT) Primer                                   | • RNase H                    |
| • dNTP Mix, Total RNA                                | • RNase Solution (RNase A)   |
| • dNTP Mix, mRNA                                     |                              |
| • Random Primers                                     |                              |
| • ChipShot™ Reverse Transcriptase 5X Reaction Buffer |                              |
| • ChipShot™ Reverse Transcriptase                    |                              |
| • Nuclease-Free Water                                |                              |

**ChipShot™ Membrane  
Clean-Up System (Z3612)**

- Binding Solution
- ChipShot™ Membrane Column
- Elution Buffer
- Collection Tubes
- Sodium Acetate, 3M (pH 5.2)

**Notes:**

1. Protect labeled dNTPs from light at all times to prevent photobleaching.
2. Do not use CyDye™-labeled UTP.
3. Never store the ChipShot™ Reverse Transcriptase at room temperature.
4. The Total RNA Positive Control is provided as a control for the labeling and clean-up procedures. It is not intended as a control for subsequent array hybridization.

**3.A. Direct cDNA Labeling Protocol for Total RNA**

We recommend using both random primers and oligo(dT) for labeled cDNA synthesis. Using both random primers and oligo(dT) to synthesize cDNA from total RNA maximizes the coverage of transcribed sequences and their detection by hybridization to array probes representing upstream sequences. Using random primers also results in the synthesis of large amounts of ribosomal cDNA, which may cross-hybridize to related array probes and contribute non-specific signal intensities. Cross-hybridization events can be detected and measured by including negative control probes (e.g. sequences that have no known homology with the target) in the arrays. Alternatively, the synthesis of cDNA from total RNA may be initiated using oligo(dT) alone, in which case the expected cDNA yield and the frequency of incorporation (FOI) will correspond to those of reactions using mRNA.

See *Promega Notes* 91, 10-12, for additional information on primers and template RNA ([www.promega.com/pnotes](http://www.promega.com/pnotes)).

### 3.A. Direct cDNA Labeling Protocol for Total RNA (continued)

- For each CyDye™ labeling reaction, assemble the following reagents in a microcentrifuge tube. Keep the reagents on ice, and mix the total RNA and primers as follows:

Total RNA or Total RNA Positive Control	5µg
Random Primers (3µg/µl)	1µl
Oligo(dT) Primer (2µg/µl)	1µl
Nuclease-Free Water to a total volume of	<b>20µl</b>

- Incubate RNA/primer solution at 70°C for 10 minutes, then place on ice.
- While the RNA/primer solution is incubating at 70°C, prepare labeling mix as follows. Perform Cy®3 and Cy®5 reactions in separate tubes.

Component	Cy®3	Cy®5
ChipShot™ Reverse Transcriptase		
5X Reaction Buffer	8µl	8µl
MgCl <sub>2</sub> (25mM)	4.8µl	4.8µl
dNTP mix, Total RNA	2µl	3µl
Cy®3 dCTP (1mM)	1µl	—
Cy®5 dCTP (1mM)	—	1µl
ChipShot™ Reverse Transcriptase	3.2µl	3.2µl
Nuclease-Free Water	1µl	—
<b>final volume</b>	<b>20µl</b>	<b>20µl</b>

#### Notes:

The dNTP mixes for mRNA and total RNA are NOT interchangeable and are optimized for use with CyDye™-labeled dCTP. Do not use labeled dUTP.

CyDye™ stocks are typically supplied as 25nmol in 25µl. This is a 1mM stock.

- Add the entire 20µl labeling mix to each tube of RNA/primer solution, vortex (40µl total volume), spin briefly and incubate at room temperature (22–25°C) for 10 minutes protected from light.
- Incubate at 42°C for 2 hours protected from light.
- Add 1.0µl RNase H and 0.35µl RNase Solution to each cDNA-synthesis reaction. Mix gently and incubate at 37°C for 15 minutes.

**Note:** To obtain maximum day-to-day reproducibility, incubate tubes in a thermal cycler.

### 3.B. cDNA Labeling Protocol for mRNA

- For each CyDye™ labeling reaction, assemble the following reagents in a microcentrifuge tube. Keep the reagents on ice, and mix the mRNA and primers as follows:

mRNA	1.5µg
Random Primers (3µg/µl)	1µl
Nuclease-Free Water to a total volume of	<b>20µl</b>

- Incubate RNA/primer solution at 70°C for 10 minutes, then place on ice.
- While the RNA/primer solution is incubating at 70°C, prepare labeling mix as follows. Perform Cy®3 and Cy®5 reactions in separate tubes.

Component	Cy®3	Cy®5
ChipShot™ Reverse Transcriptase		
5X Reaction Buffer	8µl	8µl
MgCl <sub>2</sub> (25mM)	4.8µl	4.8µl
dNTP mix, mRNA	2µl	3µl
Cy®3 dCTP (1mM)	1µl	–
Cy®5 dCTP (1mM)	–	1µl
ChipShot™ Reverse Transcriptase	3.2µl	3.2µl
Nuclease-Free Water	1µl	–
<b>final volume</b>	<b>20µl</b>	<b>20µl</b>



#### Notes:

The dNTP mixes for mRNA and total RNA are NOT interchangeable and are optimized for use with CyDye™-labeled dCTP. Do not use labeled dUTP.

CyDye™ stocks are typically supplied as 25nmol in 25µl. This is a 1mM stock.

- Add the entire 20µl labeling mix to each tube of RNA/primer solution (40µl total volume), vortex, spin briefly and incubate at room temperature (22–25°C) for 10 minutes protected from light.
- Incubate at 42°C for 2 hours protected from light.
- Add 1.0µl RNase H and 0.35µl RNase Solution to each cDNA-synthesis reaction. Mix gently and incubate at 37°C for 15 minutes.

**Note:** To obtain maximum day-to-day reproducibility, incubate tubes in a thermal cycler.

### 3.C. Purifying CyDye™-Labeled cDNA



#### Notes:

Protect the labeled sample from light as much as possible.

Keep the tube capped during all centrifugation steps.

1. To 40µl of the synthesized, labeled cDNA, add the following components in the order listed:

Sodium Acetate, 3M (pH 5.2)	4µl
Binding Solution	225µl

2. Vortex gently for 5–10 seconds to mix.
3. Place a ChipShot™ Membrane Column into a Collection Tube. Apply solution the column and cap the tube.
4. Let the column stand at room temperature for 5 minutes, then spin at  $10,000 \times g$  for 1 minute.
5. Discard the column flowthrough.
6. Wash column with 500µl of 80% ethanol, cap the tube, and centrifuge at  $10,000 \times g$  for 1 minute.
7. Discard the column flowthrough.
8. Repeat Steps 6 and 7 twice for a total of 3 washes.
9. Centrifuge column at  $10,000 \times g$  for 1 minute to remove traces of ethanol.
10. Place column in a clean Collection Tube (provided).
11. To elute labeled cDNA, add 60µl of Elution Buffer, and let the column stand at room temperature for 1 minute. Centrifuge at  $10,000 \times g$  for 1 minute, and discard column. The eluted cDNA can be stored in a light-proof container at 4°C for several weeks.
12. Quantitate absorbance at 260, 550 and 650nm, and calculate frequency of incorporation.

**Note:** Absorbance readings should be taken using undiluted cDNA directly in a microcuvette. Diluting the cDNA prior to reading the absorbance may give inaccurate readings due to low concentration. The cDNA used for spectrophotometry should be recovered for use in the hybridization reaction. Clean the cuvette thoroughly between samples to prevent cross-contamination.

Frequency of incorporation (FOI) is defined as the number of CyDye™-labeled nucleotides incorporated per 1,000 nucleotides of cDNA. Best results are obtained with cDNAs having an FOI as recommended in Table 1. The FOI can be calculated as follows:

$$\text{FOI} = \frac{\text{pmol of dye incorporated} \times 324.5}{\text{ng of cDNA}}$$

$$\text{Amount of labeled cDNA (ng)} = A_{260} \times 37 \times \text{total volume } (\mu\text{l})$$

$$\text{For Cy}^{\textcircled{3}}: \text{ pmol of dye incorporated} = \frac{A_{550} \times \text{total volume } (\mu\text{l})}{0.15}$$

$$\text{For Cy}^{\textcircled{5}}: \text{ pmol of dye incorporated} = \frac{A_{650} \times \text{total volume } (\mu\text{l})}{0.25}$$

**Note:** These equations were generated using the following constants: Average Molar Mass of dNTP = 324.5; one  $A_{260}$  unit of single-stranded DNA = 37  $\mu\text{g/ml}$ ; extinction coefficient of  $\text{Cy}^{\textcircled{3}}$  = 150,000  $\text{M}^{-1}\text{cm}^{-1}$  at 550nm; extinction coefficient of  $\text{Cy}^{\textcircled{5}}$  = 250,000  $\text{M}^{-1}\text{cm}^{-1}$  at 650nm.

Best results are obtained with cDNAs that fall into the following ranges:

**Table 1. Expected cDNA Yields and FOI.**

<b>5<math>\mu\text{g}</math> total RNA</b>	<b>ng yield</b>	<b>pmol</b>	<b>FOI</b>
$\text{Cy}^{\textcircled{3}}$	1,200–2,400	100–225	20–40
$\text{Cy}^{\textcircled{5}}$	1,000–2,400	50–160	12–25
<b>1.5<math>\mu\text{g}</math> mRNA</b>	<b>ng yield</b>	<b>pmol</b>	<b>FOI</b>
$\text{Cy}^{\textcircled{3}}$	350–650	40–90	25–50
$\text{Cy}^{\textcircled{5}}$	325–650	30–75	20–40

#### 4. Preparing cDNA for Hybridization

The labeled cDNA is suitable for use with many different hybridization solutions and protocols. Here are some suggestions for preparing the cDNA for hybridization.

1. Dry the appropriate amount of each dye-labeled cDNA using a speed-vacuum concentrator.

##### Calculating the Volume of Hybridization Solution to Use

The volume of hybridization solution needed depends on the size of the printed area and cover glass. We recommend using a glass coverslip, such as the Corning 2870 and 2940 cover glass product lines. Use 2.5–3.5  $\mu\text{l}$  of hybridization solution per  $\text{cm}^2$  of surface area. This range of volume will accommodate differences in humidity conditions and hybridization times. The fluorescence strength required to achieve high levels of sensitivity and broad dynamic range depends on the template used to synthesize the  $\text{CyDye}^{\text{TM}}$ -cDNA.

#### 4. Preparing cDNA for Hybridization (continued)

Table 2. Examples of Recommended Hybridization Solution Volumes and Amount of cDNA Based on Varying Coverslip Sizes.

Coverslip Size	Surface Area (cm <sup>2</sup> )	Volume of Hybridization Solution	Amount of Labeled cDNA from Total RNA (per slide)	Amount of Labeled cDNA from mRNA (per slide)
22 × 22mm	4.84	12–17µl	12–17pmol	3–4pmol
24 × 40mm	9.60	24–33µl	24–33pmol	6–8pmol
24 × 60mm	14.4	36–50µl	36–50pmol	9–12pmol

\*If doing a two-color hybridization, combine the recommended amount of both dye-labeled cDNAs. For example, for a 22 × 22mm coverslip with a two-color hybridization using total RNA-derived cDNA, combine 12–17pmol of Cy<sup>®</sup>3-labeled and 12–17pmol of Cy<sup>®</sup>5-labeled cDNAs.

#### Calculating the Amount of cDNA to Use

**Total RNA.** For CyDye<sup>™</sup>-labeled cDNA made from total RNA, dry down an amount of cDNA containing 1.0pmol of labeled nucleotides per microliter of hybridization solution that will be used per dye.

**mRNA.** For CyDye<sup>™</sup>-labeled cDNA made from mRNA, dry down an amount of cDNA containing 0.25pmol of labeled nucleotides per microliter of hybridization solution that will be used per dye.

2. Resuspend the dye-labeled cDNA in the required volume of hybridization solution.
3. Incubate the labeled cDNA solution at 95°C for 5 minutes, protecting samples from light.
4. Centrifuge the cDNA at 13,500 × g for two minutes to collect condensation. Do not place the solution on ice because this will cause precipitation of some of the components.
5. Apply the labeled cDNA to the surface of the printed slide and place the coverglass on the array.

## 5. Troubleshooting

For questions not addressed here, please contact your local Promega Branch Office or Distributor. Contact information available at: [www.promega.com](http://www.promega.com). E-mail: [techserv@promega.com](mailto:techserv@promega.com)

### 5.A. Troubleshooting, cDNA Labeling and Clean-Up

Symptoms	Possible Causes and Comments
Low cDNA yield	<p>RNA degradation/RNase introduced during handling:</p> <ul style="list-style-type: none"> <li>• Use nuclease-free, commercially autoclaved reaction tubes, sterile aerosol-barrier tips and gloves.</li> <li>• Ensure that reagents, tips and tubes are kept RNase-free by using sterile technique.</li> <li>• RNA storage conditions are important. Store at <math>-70^{\circ}\text{C}</math>. Keep RNA target in single-use aliquots to minimize freeze-thaw cycles. Once thawed, keep RNA on ice.</li> <li>• Use RNasin® Ribonuclease Inhibitor (Cat.# N2511, N2515) to inhibit degradation of target during cDNA synthesis (40 units/40<math>\mu\text{l}</math> reaction).</li> <li>• Use DEPC-treated glassware and solutions when manipulating and storing RNA. Wear gloves at all times. RNases introduced after elution will degrade the RNA.</li> <li>• Work quickly during sample preparation.</li> </ul> <p>cDNA degradation. DNase contamination from the RNA preparation method may be digesting the cDNA.</p> <hr/> <p>Inhibitors may be present in RNA preparation. Inhibitors such as SDS, EDTA, polysaccharides, heparin, guanidine isothiocyanate or other salts may carry over from some RNA preparations and interfere with cDNA labeling. To determine if the experimental RNA preparation contains an inhibitor, set up a spiking experiment by adding control RNA to experimental RNA and assess inhibition of cDNA synthesis.</p> <hr/> <p>Incorrect primer:RNA ratio. Confirm RNA concentration and use the recommended amount of template RNA. Mix well before use.</p> <hr/> <p>Incorrect dNTP concentration. The dNTP mixes for mRNA and total RNA are NOT interchangeable. Confirm that the appropriate dNTP mix is used for the type of RNA template in the reaction.</p>

### 5.A. Troubleshooting cDNA Labeling and Clean-Up (continued)

Symptoms	Possible Causes and Comments
Low yield of cDNA (continued)	CyDye™-labeled dUTP was used. The dNTP mixes are optimized for use with CyDye™-labeled dCTP. Using CyDye™-labeled dUTP will result in extremely poor yield and low FOI.
cDNA yield is acceptable, but Frequency of Incorporation (FOI) is low	Insufficient RNase activity. Residual RNA present in cDNA sample can result in an A <sub>260</sub> absorbance reading that does not accurately represent the amount of labeled cDNA present. Perform recommended RNase H treatment step before ChipShot™ Membrane Clean-Up. Refer to Table 1 for expected yield ratios.  Poor CyDye™-labeled nucleotide incorporation. Insufficient concentration of CyDye™-labeled dCTP. Use recommended amount of CyDye™-labeled nucleotide. Protect CyDye™ dyes from heat and light to ensure that they do not degrade, especially Cy®5 dye.
cDNA yield is acceptable, but Frequency of Incorporation (FOI) is high.	Contaminating CyDye™-labeled nucleotides. Follow the cDNA purification protocol (Section 3.C).

### 5.B. General Suggestions for Troubleshooting Hybridization

Based on our experience, here are some suggestions for troubleshooting hybridization.

Symptoms	Possible Causes and Comments
Spots appear smeared as comets	The DNA concentration is too high. Print using a lower DNA concentration. Make note of the UV energy required for cDNA and long oligonucleotides from the slide manufacturer.  Coverslip slid into place over labeled cDNA solution. Drop the coverslip squarely on the array. Do not slide coverslip across the array. Practice coverslip placement with water and plain slide before performing on an array.
Low fluorescent signal	Too little or too much incorporation of the fluorescent dye in the sample probe. Check the FOI of cDNA before using. If the appropriate dye incorporation is obtained, less labeled cDNA is used, and the highest signals and lowest background are obtained (Table 1).

## 5.B. General Suggestions for Troubleshooting Hybridization (continued)

Symptoms	Possible Causes and Comments
Low fluorescent signal (continued)	Degradation of fluorescent dye in the cDNA. Keep labeled dyes and labeled cDNAs protected from light.
Fluorescent spots in the background	<p>Powder from gloves may have contaminated slides during printing or hybridization. Use powder-free gloves during all portions of the microarray process.</p> <p>Dust may have settled on the slide. Work in a dust-free hood or environment.</p>
Uneven or high background	<p>Air bubbles were trapped under the coverslip during hybridization and prevent the labeled cDNA from contacting the arrayed nucleic acid. Small bubbles will dissipate during hybridization; no action is necessary. For larger bubbles, hold the slide and coverslip so that the larger bubbles rise to the top of the slide and escape from under the coverslip. Practice placing the coverslip on the slide with water and a plain slide before performing on an array.</p> <p>Incomplete washing. Use clean washing vessels for each run. Washing steps are critical to low backgrounds. Slides should not be allowed to dry until the final wash step.</p> <p>Incomplete or improper drying. Immediately blow-dry or spin-dry the slides after the last wash step.</p> <p>Excess amounts of labeled cDNA with poorly incorporated dye. Check FOI of labeled cDNA before using it for hybridization. See Table 1.</p>
Black holes	Low expressors surrounded by background fluorescence. Depending upon the appearance of the background around the black hole, refer to the appropriate background solutions (above). Black holes appear as dark spots within the background field. These spots have the expected size, shape and placement of printed spots.

## 5.B. Troubleshooting, Hybridization (continued)

Symptoms	Possible Causes and Comments
Unexpected hybridization patterns	Arrays hybridized with different cDNAs and washed in same bath and wash solutions. Always wash arrays hybridized with different cDNAs separately and with freshly prepared wash solutions.
Intense uniform fluorescence around outer edge of coverslip	<p>The hybridization solution has dried out. Ensure that there is proper humidity during hybridization and that the slides have not been hybridized too long.</p> <p>Be sure to drop the coverslip into place. Sliding the coverslip into place can leave some cDNAs uncovered on the arrayed slide. Be sure to match the cDNA volume with coverslip size so that it does not wick to the underside of the slide.</p>

## 6. References

1. Ishida, S. *et al.* (2001) Role for e2F in control of both DNA replication and mitotic functions as revealed from DNA microarray analysis. *Mol. Cell Biol.* **21**, 4684-99.
2. Maleck, K. *et al.* (2000) The transcriptome of *Arabidopsis thaliana* during systemic acquired resistance. *Nat. Genet.* **26**, 403-10.
3. Morgan, R.W. *et al.* (2001) Induction of host gene expression following infection of chicken embryo fibroblasts with oncogenic Marek's disease virus. *J. Virol.* **75**, 533-9.
4. Travers, K.J. *et al.* (2000) Functional and genomic analyses reveal essential coordination between unfolded protein response and ER associated degradation. *Cell* **101**, 249-58.
5. Ferbeyre, G. *et al.* (2000) PML is induced by oncogenic ras and promotes premature senescence. *Gen. Dev.* **14**, 2015-17.
6. Brisco, P. *et al.* (2006) PureYield™ RNA Midiprep System: Isolating Pure Total RNA without DNase. *Promega Notes* **93**, 14-19.

## 7. Related Products

Product	Size	Cat.#
PureYield™ RNA Midiprep System*	10 preps	Z3740
	50 preps	Z3741
SV Total RNA Isolation System		Z3100
PolyAtract® mRNA Isolation System II with Magnetic Stand*	3 isolations	Z5200
PolyAtract® System 1000*	scalable	Z5420
RNAagents® Total RNA Isolation System*	scalable	Z5100
ChipShot™ Indirect Labeling and Clean-Up System	25 reactions	Z4000

\*For Laboratory Use.

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